Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior

TITLE

Curricula developed and implemented have relevance to the local, regional, national, and global developmental needs for the following programs

- Program-1 B.Sc. (Hons) Agriculture
- Program-2 B.Sc. (Hons) Horticulture
- Program-(3-15) M.Sc. Agriculture & Horticulture
- Program-16 Ph.D. Program

- **Relevance to Local & Regional Needs highlighted in Yellow**
- **Relevance to National& Global Needs highlighted in Green**

PROGRAMME-1

B.Sc. (Hons.)

Agriculture

Department – Agronomy

1. AGR – 111 (Fundamentals of Agronomy)

Credit Hours: 4 (3+1)

Topics in Theory:

S. No.	Topics
1.	Agro-climatic zones of India and Madhya Pradesh and agro-ecological classification, Agriculture-definition and importance of agriculture
2.	Agronomy-meaning and scope of Agronomy, types of seeds, dormancy of seeds, viability of seeds,
3.	Seed treatment, sowing-methods, depth, plant density and geometry, nursery bed and transplanting, optimum plant population
4.	Tillage-definition and types of tillage including minimum and no tillage.
5.	Tilth-definition and characteristics of good tilth.
6.	Crop nutrition-essential nutrients-classification
7.	Nutrient mobility in plants, Factors affecting nutrient availability
8.	Functions and deficiency symptoms of primary nutrients
9.	Manures –types, nutrient content,
10.	Green manures, compost
11.	Fertilizers, INM
12.	Nutrient use efficiency
13.	Irrigation: definition and objectives
14.	Water resources and irrigation development in India and Rajasthan.
15.	Soil moisture constants and theories of soil water availability
16.	Crop water requirement and factors affecting it
17.	Scheduling of irrigation: meaning and different approaches for scheduling irrigation in field crops.
18.	Surface methods of irrigation; border, furrow, check basin and basin methods
19.	Sprinkler and drip methods; their layout, adaptability, advantages and limitations.
20.	Irrigation efficiency; different terms used and their importance.
21.	Water use efficiency -factors affecting and agronomic techniques to boost WUE
22.	Irrigation water quality-different criteria and limits used, effect of poor-quality water on plant growth.
23.	Management practices for efficient use of poor-quality waters including conjunctive use of water.
24.	Agricultural drainage-definition, benefits and different methods of drainage.
25.	Growth and development of crops, factors affecting growth and development,
26.	Plant ideotypes, crop rotation and its principles,
27.	Adaptation and distribution of crops,
28.	Crop management technologies in problematic areas,

29.	Harvesting and threshing of crops
30.	Weeds – definition, harmful and beneficial effects and classification
31.	Ecology of weeds
32.	Weed - reproduction and seed dissemination
33.	Crop-weed competition-concept and allelopathy
34.	Concepts of weed prevention, eradication and weed control
35.	Physical and cultural methods of weed control
36.	Chemical and biological methods of weed control
37.	Integrated weed management - An introduction
38.	Introduction to herbicides, advantages and limitations of herbicides usages
39.	Classification of herbicides

Topics in Practical:

S. No.	Topics
1.	Identification of crops, seeds, fertilizers,
2.	Common Pesticides in agriculture
3.	Study of agro-climatic zones of India and Madhya Pradesh
4.	Identification of weeds in crops
5.	Methods of herbicide and fertilizer application,
6.	Study of yield contributing characters and yield estimation,
7.	Seed germination and viability test
8.	Numerical exercises on fertilizer requirement of crops
9.	Plant geometry and plant population of various crops
10.	Herbicides requirement calculations and water requirement
11.	Use of tillage implements-reversible plough, one way plough, harrow, leveller, seed drill
12.	Study of soil moisture measuring devices
13.	Measurement of field capacity and irrigation water
14.	Determination of bulk density and infiltration rate

Suggested Readings:

- ICAR. 2010. Handbook of Agriculture (6th edition), Indian Council of Agricultural Research, New Delhi.
- Panda, S.C. 2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
- Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur
- Reddy, T. Yellamanda and Reddy, G.H. Sankara. 2016. Principles of Agronomy (2nd edition) , Kalyani Publishers, Ludhiana

- Reddy, S.R.2012. Principles of Crop Production (4th edition), Kalyani Publishers, Ludhiana.
- Gupta , O.P. 2005. Weed Management: Principles and Practices (2nd Ed) Agribios (India) Jodhpur.
- Mishra, R.D. and Ahmed, M. 1987. Manual on Irrigation Agronomy, Oxford & IBH Publishing Co. Pvt. Ltd., New-Delhi.
- राजपूत, आर.एल. एवं त्रिपाठी, एम.एल. (2009). खरपतवार प्रबंधन, कुाल पब्लिकेान, वाराणसी
- पोरवाल, बी. एल., सिंह, पुष्पेन्द्र एवम् शर्मा, डी. डी. 2000. सस्य विज्ञान के मूल तत्व, के. पी. प्रकाशन, उदयपुर

2. AGR – 112 (Agriculture Heritage)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Introduction of Indian agricultural heritage
2.	Ancient agricultural practices,
3.	Relevance of heritage to present day agriculture
4.	Past and present status of agriculture and farmers in society
5.	Journey of Indian agriculture and its development from past to modern era;
6.	Plant production and protection through indigenous traditional knowledge;
7.	Crop voyage in India and world;
8.	Agriculture -scope; Importance of agriculture and agricultural resources available in India;
9.	Crop significance and classifications;
10.	Classification of crops-botanical, agronomic, seasonal.
11.	Classification of crops based on life span, special purposes i.e. cover, green manure, catch, trap, cash, soiling.
12.	National agriculture setup in India;
13.	Current scenario of Indian agriculture;
14.	Indian agricultural concerns and future prospects.

Suggested Readings:

- ICAR. 2010. Handbook of Agriculture (6th edition), Indian Council of Agricultural Research, New Delhi.
- Nene, Y.L. 2007. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation, Secunderabad, Andhra Pradesh.
- Nene, Y.L., Saxena, R.C. and Choudhary, S.L. 2009. A Textbook on Ancient History of Indian Agriculture, Munshiram Manoharial Publishers Pvt. Ltd,
- Nene, Y.L., Choudhary, S.L. and Saxena, R.C. 2010. Textbook on Ancient History of Indian Agriculture, Asian Agri-History Foundation.
- D. Kumari, Manimuthu Veeral. 2014. Text Book on Agricultural Heritage of India. Agrotech

5. AGR – 222 (Farming Systems and Sustainable Agriculture)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Farming System-scope, importance, and concept
2.	Types and systems of farming system and factors affecting types of farming
3.	Farming system components and their maintenance,
4.	Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation
5.	Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system
6.	Sustainable agriculture-problems and its impact on agriculture
7.	indicators of sustainability, adaptation and mitigation,
8.	Conservation agriculture strategies in agriculture
9.	LEIA (Low external input agriculture), LEISA, HEIA (High external input agriculture)
10.	Integrated farming system-historical background, objectives & characteristics,
11.	components of IFS and its advantages,
12.	Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques,
13.	Resource cycling and flow of energy in different farming system,
14.	Farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmer's field.

Suggested Readings:

- Panda, S.C. (2004). Cropping Systems and Farming Systems, Agrobios (India), Jodhpur.
- Sharma, Arun K. 2002. A Handbook of Organic Farming, Agrobios (India) Ltd., Jodhpur
- Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (II Edition), Agrobios (India), Jodhpur.
- Shukla, Rajeev K. 2004. Sustainable Agriculture, Surbhee Publications, Jaipur
- Palaniappan, S.P.1985. Cropping Systems in the Tropics: Principles and Management, Wiley Easter Ltd. and TNAU, Coimbatore.
- Reddy S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
- गौतम, आर.सी. एवं सिंह, पंजाब. 1997. टिकाउ खेती, भारतीय कृषि अनुसन्धान परिषद, नई दिल्ली.

6. AGR – 223 (Introductory Agro-meteorology & Climate Change)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Meaning and scope of agricultural meteorology

2.	Earth's atmosphere- its composition, extent and structure, Atmospheric weather variables; Atmospheric pressure, its variation with height, Wind, types of wind, daily and seasonal variation of wind speed
3.	Cyclone, anticyclone, land breeze and sea breeze
4.	Nature and properties of solar radiation, solar constant, depletion of solar radiation, Short wave, long wave and thermal radiation, net radiation, albedo
5.	Atmospheric temperature, temperature inversion, lapse rate, Daily and seasonal variations of temperature, vertical profile of temperature,
6.	Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure,
7.	Process of condensation, formation of dew, fog, mist, frost, cloud
8.	Precipitation- process, types such as rain, snow, sleet, and hail
9.	Cloud formation and classification; Artificial rainmaking, Monsoon-mechanism and importance in Indian agriculture
10.	Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave
11.	Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock production
12.	Weather forecasting- types of weather forecast and their uses Climate change, climatic variability, global warming, causes of climate change
13.	Climate Change and its impact on regional and national Agriculture.

Topics in Practical:

S. No.	Topics
1.	Visit of Agro-meteorological Observatory, site selection of observatory, exposure of instruments and weather data recording.
2.	Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law.
3.	Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS.
4.	Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.
5.	Measurement of soil temperature and computation of soil heat flux.
6.	Determination of vapor pressure and relative humidity.
7.	Determination of dew point temperature.
8.	Measurement of atmospheric pressure and analysis of atmospheric conditions.
9.	Measurement of wind speed and wind direction, preparation of wind rose.
10.	Measurement, tabulation and analysis of rain.
11.	Measurement of open pan evaporation and evapo-transpiration.
12.	Computation of PET and AET.

➢ Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

8. AGR-312 Geo-informatics and Nano-technology for Precision Farming

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Precision agriculture: concepts and techniques; their issues and concernsfor Indian agriculture;
2.	Geo-informatics definition, concepts, tool and techniques; their use in Precision Agriculture
3.	Crop discrimination and Yield monitoring, soil mapping;
4.	Fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS;
5.	Remote sensing concepts and application in agriculture;
6.	Image processing and interpretation;
7.	Global positioning system (GPS), components and its functions;
8.	Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs
9.	STCR approach for precision agriculture;
10.	Nanotechnology, definition, concepts and techniques,
11.	Brief introduction about nanoscale effects,
12.	Nano-particles, nano-pesticides, nano-fertilizers, nano-sensors,
13.	Use of nanotechnology in seed and water for scaling-up farm productivity
14.	Use of nanotechnology in fertilizer and plant protection for scaling-up farm productivity

Topics in Practical:

S. No.	Topics
1.	Introduction to GIS software, spatial data creation and editing.
2.	Introduction to image processing software. Visual and digital interpretation of remote sensing images.
3.	Generation of spectral profiles of different objects.
4.	Supervised and unsupervised classification and acreage estimation.
5.	Multispectral remote sensing for soil mapping.
6.	Creation of thematic layers of soil fertility based on GIS.
7.	Creation of productivity and management zones
8.	Fertilizers recommendations based of VRT and STCR techniques.
9.	Crop stress (biotic/abiotic) monitoring using geospatial technology.

- Reddy, S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
- Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

10. AGR – 322 (Principles of Organic Farming)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Organic farming, principles and its scope in India;
2.	Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture;
3.	Organic ecosystem and their concepts;
4.	Organic nutrient resources and its fortification;
5.	Restrictions to nutrient use in organic farming;
6.	Choice of crops and varieties in organic farming;
7.	Fundamentals of insect, pest, disease mgt
8.	Weed management under organic mode of production;
9.	Operational structure of NPOP
10.	Certification process and standards of organic farming;
11.	Processing, levelling, economic considerations and viability,
12.	Marketing and export potential of organic products

Topics in Practical:

S. No.	Topics
1.	Visit of organic farms to study the various components and their utilization;
2.	Preparation of enrich compost,
3.	Vermicompost,
4.	Bio-fertilizers/bio-inoculants and their quality analysis;
5.	Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management;
6.	Cost of organic production system;
7.	Post-harvest management;
8.	Quality aspect, grading, packaging and handling.

Suggested Readings:

- Dhama, A.K. 2014. Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
- Sharma, Arun K. 2013. A Handbook of Organic Farming, Agrobios (India), Jodhpur
- Palaniappan, S.P. and Anandurai, K.1999. Organic Farming – Theory and Practice. Scientific

Pub. Jodhpur

- Thapa, U and Tripathy, P. 2006. Organic Farming in India, Problems and prospects, Agrtech, Publising Academy, Udaipur.
- शर्मा, अरूण के. 2015. जैविक खेती – नई दिशाए, एग्रोबायोस (इण्डिया), जोधपुर

11. AGR – 323 (Rainfed Agriculture and Watershed Management)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Rainfed agriculture- definition, history and its importance in India with particular to references Rajasthan
2.	Problems of dryland agriculture related to climate, soil, technological and socio-economic conditions
3.	Soil and water conservation techniques, Drought: types,
4.	Effect of water deficit on physio- morphological characteristics of the plants,
5.	Use of antitranspirants-their kind, mode of action and effect on crop yield.
6.	Crop adaptation and mitigation to drought;
7.	Water harvesting: importance, its techniques,
8.	Efficient utilization of water through soil and crop management practices,
9.	Water harvesting techniques in dry farming areas
10.	Watershed management- concept, definition, objectives and principles
11.	Integrated watershed management for drylands, a study of model watershed area
12.	Management of crops in rainfed areas,
13.	Contingent crop planning for aberrant weather conditions,
14.	Alternate cropping and land use strategies for dryland agriculture

Topics in Practical:

S. No.	Topics
1.	Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons.
2.	Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India.
3.	Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops.
4.	Critical analysis of rainfall and estimation of moisture index and aridity index and possible drought period in the country
5.	Field demonstration on construction of water harvesting structures, effective rainfall and its calculation.
6.	Studies on cultural practices for mitigating moisture stress.
7.	Spray of antitranspirants on dryland crops and their effect on crops

8.	Characterization and delineation of model watershed
9.	Field demonstration on soil & moisture conservation measures
10.	Crops and cropping systems for drylands
11.	Acquiring skill in tillage methods for *in-situ* moisture conservation
12.	Mulching and its effects on soil moistures conservation
13.	Seed soaking, seed treatment with chemicals for sowing in dryland areas
14.	Visit to rainfed research station/watershed**.**

Suggested Readings:

- Jayanthi, C. and Kalpana, R. 2016. Dryland Agriculture, Kalyani Publishers, Ludhiana.
- Reddy, S.R. and Reddy, G. Prabhakara. 2015. Dryland Agriculture, Kalyani Publishers, Ludhiana.
- Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
- Dhruva Narayan, V.V. Singh, P.P., Bhardwaj, S.P., U. Sharma, Sikha, A.K., Vital, K.P.R. and Das, S.K. 1987. Watershed Management for Drought Mitigation, ICAR, New Delhi.
- Singh, R.P., Sharma, S., Padmanabhan, N.V. , Das, S.K. and Mishra, P.K. 1990.A Field Manual on Watershed Management, ICAR (CRIDA), Hyderabad.
- Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.
- Singh, R.P. 1995, Sustainable Development of Dryland Agriculture in India. Scientific Publishers, Jodhpur.

12. AGR – 324 (Weed Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to weeds
2.	Characteristics of weeds
3.	Harmful and beneficial effects of weeds on ecosystem
4.	Classification of weeds
5.	Reproduction and dissemination of weeds
6.	Dormancy in weeds and its types
7.	Crop-weed competition
8.	Principles of weed management- an introduction
9.	Physical and cultural methods of weed control
10.	Chemical and biological methods of weed control
11.	Herbicide classification
12.	Herbicide active ingredient and formulations

Department – Agricultural Economics and Farm Management

13. AEC – 121 (Fundamentals of Agricultural Economics)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Economics: Meaning, scope and subject matter
2.	Definitions, activities, Approaches to economic analysis; Micro and macro economics, positive and normative analysis
3.	Nature of economic theory; rationality assumption
4.	Concept of equilibrium
5.	Economic laws as generalization of human behavior; Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare
6.	Agricultural economics: Meaning, definition, characteristics of agriculture; Importance and its role in economic development
7.	Agricultural planning and development in the country
8.	Demand: Meaning Law of demand, demand schedule and demand curve; Determinants
9.	Utility theory; law of diminishing marginal utility
10.	Equi-marginal utility principle
11.	Consumer's equilibrium and derivation of demand curve, concept of consumer surplus
12.	Elasticity of demand: concept and measurement of price elasticity
13.	Income elasticity and cross elasticity
14.	Production: Process, creation of utility
15.	Factors of production, input output relationship
16.	Laws of returns
17.	Law of variable proportions and law of returns to scale
18.	Cost: Cost concepts, short run and long run cost curves
19.	Supply: Stock v/s supply, law of supply, supply schedule, supply curve
20.	Determinants of supply, elasticity of supply
21.	Basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points.
22.	Distribution theory, Meaning, factor market and pricing of factors of production
23.	Concepts of rent, wage, interest and profit
24.	Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programmes on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation.
25.	Good and services tax (GST) - meaning, definition, advantage and disadvantages and its

	implication on Indian economy.
26.	Meaning, direct and indirect taxes, agricultural taxation
27.	Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure.
28.	Functions of Central Banks & commercial Banks in India
29.	VAT. Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

Suggested Readings:

- Dominick Salvatore, 2011, Outline of Microeconomics, Schaum's Outline Series.
- Bhavani Devi,P. Raghu Ram, S. Subba Reddy, T.V. Neelakanta Sastry, 2009, Agricultural economics, Oxford and IBH Co. Pvt. Ltd., , New Delhi.
- K. K. Dewett and J. D. Varma, 1986, Elementary Economic Theory, S. Chand & Company, New Delhi.
- Latika Sharma *et al* (2014) Principles of agricultural economics, Agrotech publishers, Udaipur.
- M.L. Jhingan, 2004, Micro Economic Theory, Vikas Publishing

14. AEC – 211 (Agricultural Finance and Co-operation)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Agricultural finance: Meaning, scope and significance,
2.	Credit needs and its role in Indian agriculture.
3.	Agricultural credit: Meaning, definition, need, classification.
4.	Credit analysis- 3 R's, 5 C's and 7 P's, of Credits
5.	Sources of agricultural finance: institutional and non-institutional sources
6.	Commercial banks, social control and nationalization of commercial banks, micro financing including KCC
7.	Lead Bank Scheme, RRBs
8.	Scale of finance and unit cost
9.	An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, World Bank
10.	Crop insurance and its scope
11.	Credit guarantee corporation of India
12.	Pradhan Mantri Fasal Bima Yogana- features, significant and limitation
13.	Cost of credit
14.	Recent development in agricultural credit
15.	Preparation and analysis of financial statements – balance sheet and income statement.
16.	Basic guidelines for preparation of project reports- bank norms – SWOT analysis

17.	Financial instruments and methods – e banking, Kisan Cards and core banking
18.	Agricultural cooperation: Meaning, brief history of cooperative development in India
19.	Objectives, principles of cooperation, significance of cooperatives in Indian agriculture
20.	Agricultural cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives,
21.	Cooperative warehousing; role of ICA, NCUI, NCDC, NAFED

Topics in Practical:

S. No.	Topics
1.	Optimum allocation of limited amount of capital among different enterprise
2.	Analysis of progress and performance of cooperatives using published data
3.	Analysis of progress and performance of commercial banks and RRBs using published data
4.	Visit to a commercial bank, cooperative bank and cooperative society to acquire first-hand knowledge of their management, schemes and procedures.
5.	Estimation of credit requirement of farm business – a case study
6.	Preparation and analysis of balance sheet – a case study
7.	Preparation and analysis of income statement – a case study.
8.	Appraisal of a loan proposal – a case study
9.	Techno-economic parameters for preparation of projects
10.	Preparation of bankable projects for various agricultural products and its value added products.
11.	Different type of repayment plans

Suggested Readings:

- S. Subba Reddy, P. Raghu Ram, 1996, Agricultural finance and management, Oxford & IBH Pub. Co, New Delhi
- Kamat, G.S., 1978, New Dimensions of Cooperative Management, Himalayan Publishing House, Mumbai.
- Nelson and Murray, 1988. Agricultural Finance. Kalyani Publishers, New Delhi.
- Pandey, U.K. 1990. An Introduction to Agricultural Finance, Kalyani Publishers, New Delhi.
- Singh, J.P., 1988, Agricultural Finance Theory and Practices, Ashish Publishing House, New Delhi.
- Muniraj, R. 1987, Farm finance for development, Oxford & IBH Pub. Co., New Delhi.

15. AEC – 221 (Agricultural Marketing, Trade and Prices)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Agricultural marketing: Concepts and definitions of market, marketing, agricultural marketing,
2.	Market structure
3.	Basic features of Perfectly competitive and imperfect market
4.	Price determination under perfect competition
5.	Short run and long run equilibrium of firm & industry; Shut down and break-even point
6.	Marketing mix and market segmentation: Classification and characteristics of agricultural markets
7.	Demand, supply and producer's surplus of agri-commodities: Nature and determinants of demand and supply of farm products
8.	Producer's surplus – meaning and its types, marketable and marketed surplus
9.	Factors affecting marketable surplus of agri-commodities
10.	Product life cycle :PLC and competitive strategies: Meaning and stages in PLC; Characteristics of PLC; strategies in different stages of PLC
11.	Pricing and promotion strategies: pricing considerations and approaches - cost based and competition-based pricing
12.	Market promotion :Advertising, personal selling, Sales promotion and publicity – their meaning and merits & demerits
13.	Marketing process and functions: Marketing process-concentration, dispersion and equalization;
14.	Exchange functions – buying and selling;
15.	Physical functions – storage, transport and processing; Facilitating functions – packaging, branding, grading, quality control and labelling (AGMARK)
16.	Market functionaries and marketing channels
17.	Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products;
18.	Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; Marketing efficiency; marketing costs, margins and price spread;
19.	Factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs;
20.	Role of Govt. In agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions
21.	Cooperative marketing in India
22.	Risk in marketing: Types of risk in marketing Speculation & hedging; an overview of futures trading
23.	Agricultural prices and policy: Meaning and functions of price

24.	Administered prices; need for agricultural price policy
25.	Trade: Concept of International Trade and its need,
26.	Theories of absolute and comparative advantage
27.	Present status and prospects of international trade in agri-commodities; GATT and WTO
28.	Agreement on Agriculture (AoA and its implications on Indian agriculture; IPR)

Topics in Practical:

S. No.	Topics
1.	Plotting and study of demand and supply curves and calculation of elasticities**;**
2.	Study of relationship between market arrivals and prices of some selected commodities
3.	Computation of marketable and marketed surplus of important commodities
4.	Study of price behaviour over time for some selected commodities, Construction of index numbers
5.	Price forecasting; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity
6.	Collection of data regarding marketing costs, margins and price spread and presentation of report in the class;
7.	Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. To study their organization and functioning;
8.	Application of principles of comparative advantage of international trade

Suggested Readings:

- S. Subba Reddy, P. Raghu Ram, 1996, Agricultural finance and management, Oxford & IBH Pub. Co, New Delhi
- Kamat, G.S., 1978, New Dimensions of Cooperative Management, Himalayan Publishing House, Mumbai.
- Nelson and Murray, 1988. Agricultural Finance. Kalyani Publishers, New Delhi.
- Pandey, U.K. 1990. An Introduction to Agricultural Finance, Kalyani Publishers, New Delhi.
- Singh, J.P., 1988, Agricultural Finance Theory and Practices, Ashish Publishing House, New Delhi.
- Muniraj, R. 1987, Farm finance for development, Oxford & IBH Pub. Co., New Delhi.

16. AEC – 321 (Farm Management, Production & Resource Economics)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Farm management: Meaning and concept, objectives and relationship with other sciences
2.	Meaning and definition of farms, its types and characteristics, factor determining types and size of farms.
3.	Principles of farm management: concept of production function and its type

Department – Agricultural Engineering

17. AEG – 121 (Soil and Water Conservation Engineering)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to Soil and Water Conservation causes of soil erosion.
2.	Definition and agents of soil erosion.
3.	Water erosion and its forms -raindrop, sheet, rill and gully erosion.
4.	Gully classification and control measures.
5.	Soil loss estimation by universal Soil Loss Equation.
6.	Principles of water erosion control: Introduction to contouring, strip cropping. Contour bund.
7.	Graded bund and bench terracing.
8.	Grassed waterways and their design.
9.	Water harvesting and its techniques.
10.	Wind erosion- mechanics of wind erosion, types of soil movement.
11.	Principles of wind erosion control and its control measures.

Topics in Practical:

S. No.	Topics
1.	General status of soil conservation in India and Madhya Pradesh.
2.	Calculation of soil erosion index.
3.	Estimation of soil loss.
4.	Measurement of soil loss.
5.	Preparation of contour maps.
6.	Design of grassed waterways.
7.	Design of contour bunds.
8.	Design of graded bunds.
9.	Design of bench terracing system.
10.	Problem on wind erosion.

Suggested Readings:

- Water harvesting and recycling: Indian experience. Sharma and Sikka. Central Soil Water Conservation Research Institute, Dehradun.
- Land and Water Management Engineering. 1982. Murthy V.V.N. Kalyani Publishers, New Delhi.
- Irrigation: Theory and Practices.2012. Michael A.M. Vikas Publishing House Pvt. Ltd., New Delhi.
- Principles of Agricultural. Engineering. Vol. II. 2012. Michael A.M. and T.P. Ojha. Jain Brothers, New Delhi.

➢ Soil and Water Conservation Water Management. 2010. Mahnot, S.C., Singh P.K. and Chaplot, P.C., Apex Publication House, Udaipur.

18. AEG – 211 (Farm Machinery and Power)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Status of Farm Power in India and MP, Sources of Farm Power.
2.	I.C. engines and its components, Working principles of IC engines.
3.	Comparison of two stroke and four stroke cycle engines. I.C. engine terminology and Problem based on it.
4.	Air cleaning system- Pre cleaners, oil-soaked type and oil bath type air cleaners; hydraulic control system of a tractor.
5.	Cooling system-thermo siphon system and forced circulation system; fuel supply system of I.C. engines.
6.	Lubricating system- splash system and forced feed system of I.C. engines.
7.	Power transmission system- clutch, gearbox, differential, final drive, and P.T.O. shaft of a tractor.
8.	Tractor types, Cost analysis of tractor power and attached implement.
9.	Familiarization with primary tillage implements- mould board plough, disc plough
10.	Familiarization with secondary tillage implements- cultivators harrows and hoes.
11.	Familiarization with implement for intercultural operations and for hill agriculture.
12.	Familiarization with sowing and planting equipment-seed drill and planters.
13.	Calibration of a seed drill and solved problems based on it.
14.	Familiarization with Plant Protection equipment- sprayer and duster.
15.	Familiarization with harvesting equipment- reaper, mover, combine harvester.
16.	Familiarization with threshing equipment- multi-crop power thresher

Topics in Practical:

S. No.	Topics
1.	To Study of different components of I.C. engine.
2.	To study of air cleaning and fuel supply system of I.C. engine.
3.	Familiarization with transmission system-clutch, gear box, differential, final drive.
4.	Study of cooling and lubrication system of engine.
5.	Familiarization with brake, steering, hydraulic control system of tractor.
6.	Learning of tractor driving.
7.	Familiarization with operation of power tiller and implements for hill agriculture.
8.	Study of primary tillage implements: mould board plough, disc plough.
9.	Study of secondary tillage implements- cultivators, harrows and hoes.

10.	Familiarization with seed-cum-fertilizer drills their seed metering mechanism.
11.	Calibration of seed drill and numerical based on it.
12.	Study of planters and transplanters.
13.	Familiarization with different types of sprayers and dusters.
14.	Familiarization with different inter-cultivation equipment.
15.	Familiarization with harvesting and threshing machinery.

Suggested Readings:

- Principles of Agricultural Engineering. Vol. I. 2012. Michael, A.M. and T.P. Ojha. Jain Brothers, Jodhpur.
- Farm Tractors, Maintenance and Repair.1989. Rai and Jain. Tata Mc Graw Hill Publ. New Delhi.
- Elements of Farm Machinery.1989. Srivastava, A.C. Oxford IBH Publ. Company, New Delhi.
- Elements of Agricultural Engineering, Vol. I & III. 1989. Singhal, O.P. Suraj Prakashan, Allahabad.
- Element of Agricultural Engineering. 1990. Sahay, Jagdishwar. Agro. Book Agency, New Chitragupta Nagar, Patna.

19. AEG – 221 (Renewable Energy and Green Technology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of energy sources, contribution of these sources in agricultural sector.
2.	Familiarization with biomass utilization for bio fuel production and their application.
3.	Familiarization with different types of biogas plants- fixed dome and floating drum type biogas plants.
4.	Biogas production techniques and various uses of biogas.
5.	Biomass gasification and familiarization with different types of gasifiers-.cross draft, updraft and down draft gasifiers.
6.	Bio alcohol, biodiesel and bio-oil production and their utilization as bio energy resource
7.	Introduction of solar energy, their collection and application
8.	Familiarization with solar energy gadgets: solar cooker, solar water heater
9.	Application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application
10.	Introduction of wind energy and their application.

Topics in Practical:

S. No.	Topics
1.	To Study of fixed dome and floating drum type biogas plants.
2.	To Study of cross draft, updraft and down draft gasifiers.

3.	To study the production process of biodiesel.
4.	To study briquetting machine.
5.	To study the production process of bio-fuels.
6.	To study solar photovoltaic system: solar light, solar pumping, and solar fencing.
7.	To study solar cooker,
8.	To study solar drying system.
9.	To study solar distillation and solar pond.

Suggested Readings:

- Navinikrat Urja Srot (Hindi) Rathore NS. Himanshu Publications.
- G.D. Rai. Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
- N. S. Rathore. A.K. Kurchania, N.L. Panwar. (2007). Non-Conventional Energy Sources, Himanshu Publications.
- N.S. Rathore. A. K. Kurchania, N.L. Panwar. (2007). Renewable Energy, Theory and Practice, Himanshu Publications.
- K.C. Khandelwal. & S.S. Mandi. (1990). Biogas Technology.

20. AEG – 321 (Protected Cultivation and Secondary Agriculture)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to greenhouse technology, types of green houses and Plant response to Greenhouse environment.
2.	Planning and design of greenhouses.
3.	Design criteria of green house for cooling and heating purposes.
4.	Greenhouse equipments, materials of construction for traditional and low-cost green houses.
5.	Irrigation systems used in green houses.
6.	Passive solar green house and hot air greenhouse heating systems, greenhouse drying.
7.	Cost estimation and economic analysis of green house.
8.	Important engineering properties such as physical, thermal, aero & hydrodynamic of cereals, pulses and oilseed. Application of these in PHT equipment design and operation.
9.	Drying and dehydration: Moisture measurement, EMC, drying theory, various drying methods.
10.	Commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer).
11.	Material handling equipment: conveyers and elevators, their working principle and selection.
12.	Introduction to greenhouse technology, types of green houses and Plant response to Greenhouse environment.

Ludhiana.

- Ambrose, D.P. [2007]. The Insects: Beneficial and Harmful aspects. Kalyani Publishers, Ludhiana.
- Gillott, Cedric [2005]. Entomology [Third Edition] Springer, Dordrecht, Netherlands.
- Kachhwaha, N. [2011]. Principles of entomology basic and applied. AGROBIOS, Jodhpur.
- Mathur, Y.K. and Upadhyay, K.D. [2012]. A textbook of entomology [7th Edition]. Aman Publishing House, Meerut.
- Richards, O.W. and Davies, R.G. [1977]. Imm's general textbook of entomology Tenth Edition Vol. I & II. Chapman & Hall, London.
- Romoser, W.S. and Stoffolann, J.G. [1998]. The science of entomology [Fourth Edition]. McGraw Hill Company, New York.
- Sharma, Sandeep [2013]. Instructional manual on classification of insects. RVSKVV Publication No. 30/2013.
- Shrivastava, K.P. and Dhaliwal, G.S. [2011]. A textbook of applied entomology Vol. II [Third Edition], Kalyani Publishers, Ludhiana.
- Shrivastava, P.D. and Singh, R.P. [1997]. An introduction to entomology. Concept Publishing Company, New Delhi.

22. ENT – 311 (Pests of Crops & Stored Grains and their Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Paddy – Grasshopper, *gundhi* bug, hispa
2.	Paddy – Brown plant hopper, Green leaf hopper, White backed plant hopper
3.	Cotton – Aphid, whitefly, red cotton bug, mite
4.	Cotton – Pink boll worm, spotted boll worm, American boll worm.
5.	*Kharif* pulses [Pigeon pea, green gram, black gram] – Pod fly, pod bug, aphid, pod borer [*Meruca*].
6.	Soybean – Girdle beetle, green semilooper, stink bug, Bihar caterpillar.
7.	Sorghum & maize – Shoot fly, stem borer, cob borer [midge, ear head bug]
8.	Sesame and Groundnut – Leaf webber & capsule borer, hawk moth, white grub, red hairy caterpillar.
9.	Wheat and sugarcane – Termite, early shoot borer, top shoot borer, pyrilla.
10.	Chickpea and pea – Gram cut worm, gram pod borer, pea leaf miner, pea pod borer.
11.	Mustard, safflower and sunflower – Mustard aphid, safflower aphid, mustard sawfly, painted bug, and safflower capsule fly.
12.	Linseed, sunhemp and Mesta – Linseed bug fly, sunhemp hairy caterpillar
13.	Causes of deterioration of grains in store and role of physical, mechanical, chemical and biological factors.
14.	Scientific name, systematic position, host range, distribution, identification, nature of

	damage and biology of rice weevil, *khapra* beetle and pulse beetle.
15.	Scientific name, systematic position, host range, distribution, identification, nature of damage and biology of red flour beetle, rice moth, mite and mould.
16.	Scientific name, systematic position, host range, distribution, identification, nature of damage and biology of house mouse, Norway rat, larger bandicoot rat and house sparrow.
17.	Storage structures [traditional, PUSA bin, warehouse] and principles of stored grain management.
18.	Preventive and curative measures of stored grain pests.
19.	Scientific name, systematic position, distribution, host range, identification, nature of damage, biology and management of –
20.	Solanaceous vegetables – Shoot & fruit borer of brinjal, potato tuber moth.
21.	Cruciferous and malvaceous vegetables – Diamond back moth, shoot & fruit borer of okra, okra jassid.
22.	Cucurbits – Red pumpkin beetle, fruit fly
23.	Tomato, chilies, and sweet potato – Tomato fruit borer, chilly thrip, chilly bud fly, sweet potato weevil.
24.	Mango and Guava – Mango leaf hopper, mango mealy bug, mango stone weevil and guava bark eating caterpillar.
25.	Anar and citrus – Anar butterfly, lemon butterfly, citrus psylla, fruit sucking moth.
26.	Grapevine and banana – Vine borer, vine girdler, banana aphid and banana rhizome borer.
27.	Apple and ber – Apple wooly aphid, San Jose scale, ber fruit fly and ber mealy bug.
28.	Coffee and tea – Coffee mealy bug, coffee green plant bug, tea aphid and tea jassid.
29.	Coconut and cashew nut - Rhinoceros beetle, nut borer, cashew nut shoot borer and cashew nut inflorescence caterpillar.
30.	Rose, chrysanthemum and marigold – Rose scale, aphid, and marigold leaf miner.
31.	Tobacco – Tobacco caterpillar, cut worm and gram pod borer.
32.	Turmeric, pepper and coriander – Banana lacewing, Pollu beetle, coriander aphid.
33.	Onion, garlic, ginger and beetle vine – Thrips, ginger fly maggot, and beetle vine scale.

Topics in Practical:

S. No.	Topics
1.	Identification of rice weevil and pulse beetle.
2.	Structure of different storage structures of your locality.
3.	Visit to warehouse.
4.	Identification of immature and mature stages of crop pests and their damaging symptoms – Rice, sorghum, sugarcane, cotton, pulses, potato, tomato, cucurbits, chilli, ginger, bhindi anar, citrus, mango, guava, rose and crops of your locality.

Suggested Readings:

- Ambrose, D.P. [2007]. The Insects: Beneficial and Harmful Aspects. Kalyani Publishers, Ludhiana.
- Atwal, A.S. and Dhaliwal, G.S. [2002]. Agricultural Pests of South Asia and Their Management. Kalyani Publishers, Ludhiana.
- Awasthi, V.B. [2007]. Agricultural Insect Pests and Their Control. Scientific Publishers (India), Jodhpur.
- Dhaliwal, G.S. [2008]. An Outline of Entomology. Kalyani Publishers, Ludhiana.
- Hill, D.S. [1993]. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, Cambridge.
- Kachhwaha, N. [2011]. Principles of entomology basic and applied. AGROBIOS, Jodhpur.
- Mathur, Y.K. and Upadhyay, K.D. [2012]. A textbook of entomology [7th Edition]. Aman Publishing House, Meerut.
- Sharma, Sandeep and Choudhary, Arun [2007]. Storage Pests Management. Mahamaya Publishers, New Delhi.
- Sharma, Sandeep [2013]. Instructional manual on Pests of Field Crops. RVSKVV Publication No. 29/2013.
- Shrivastava, K.P. and Dhaliwal, G.S. [2011]. A Textbook of Applied Entomology Vol. II (Third Edition). Kalyani Publishers, Ludhiana.

23. ENT – 321 (Management of Beneficial Insects)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of beneficial insects. Beekeeping, various species of honey bees, bee biology and different castes of bees in bee colony.
2.	Bee keeping equipments, bee hives, commercial method of bee rearing.
3.	Seasonal management of bee colony, management for pollination, honey production, swarm control, absconding, summer and rainy season, before and after migration of bee colony and queen management.
4.	Bee pasturage, bee pollinating plants, bee foraging and communication skill in honey bees.
5.	Natural enemies of bees and their management.
6.	Importance of sericulture, types of silk worms, host plants and type of silk produced by them.
7.	Voltinism in silk worm, factors induce voltinism, biology of silk worm.
8.	Varieties of mulberry, mulberry cultivation, methods of harvesting and preservation of mulberry leaves.
9.	Rearing equipments and rearing techniques of silk worm, mounting, harvesting of cocoon and reeling.
10.	Natural enemies of silk worm and their management.
11.	Importance of lac culture, uses of lac, species of lac insects and their morphology. Biology and host plants of lac insects.

Department – Agricultural Extension and Communication

24. EXT – 111 (Rural Sociology and Educational Psychology)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Sociology: Meaning, definition, scope, importance in agriculture.
2.	Rural sociology: Meaning, definition, scope and importance of rural sociology in extension education.
3.	Society: Meaning & definition of society. Difference between rural and urban society, important characteristics of Indian rural society.
4.	Social group: Definition, meaning & types of social group, role of social group in agricultural extension and characteristic of groups.
5.	Social stratification: Meaning, definition, function, types: class and caste.
6.	Culture: Definition, meaning, classification of culture: material and non-material culture, characteristics, function & role of culture in extension, types of customs: folkways, mores, taboos and rituals, cultural lag, culture trait, culture complex, culture pattern, ethnocentrism, xenocentrism, tempocentrism.
7.	Social institution: Definition, meanings, and types of institution: political, education, economic, family and religion function of institution.
8.	Social change and development: Meaning, definition, factors affecting of social change, nature, dimension of social change.
9.	Educational psychology: Definition, meaning, scope, importance in agricultural extension.
10.	Behavior: Definition and types of behavior: Cognitive, affective, psychomotor domain.
11.	Personality: Definition, meaning, types and factors affecting of personality.
12.	Learning: Definition of learning and learning experience, elements of learning situation, principles of learning.
13.	Motivation: Definition, meaning, types, Maslow's need hierarchy theory of motivation.
14.	Intelligence: Definition, meaning, factors affecting of intelligence, measuring general intelligence.

Suggested Readings:

- Chitambar, J.B. (1997) Introductory Rural Sociology Willey Eastern Limited, New Delhi.
- Mondal, Sagar and G.L. Ray (2012) Text book on rural development entrepreneurship and communication Skills. Kalyani Publishers, New Delhi.
- Chauhan, M.S., Dangi K.L., Maheshwari Alpana and Mundra, S.N. (2012) Hand book of Rural Sociology Agrotech publishing Academy, Udaipur.
- Ray G.L. (2016) Extension Communication and Management. Kalyani Publishers, New Delhi.
- A.R. Desai (1994) Rural Sociology in India Popular Prakashan,
- Rajendra Kumar Sharma (1997) Rural Sociology Atlantic Publishers & Dist,
- Mangal S.K. (2007) Essentials of Education Psychology

25. EXT – 121 (Fundamentals of Agricultural Extension Education)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Education: Meaning, definition, Types: Formal, Normal, informal
2.	Extension Education: Meaning, definition, scope, process, objective and principle of Extension Education.
3.	Extension Programme Planning: Meaning, definition, objectives, principle and steps in programme development.
4.	Extension System in India: (A) Pre-independence- era: Sriniketan, Marthandam, Firka development scheme, Gurgaon experiment. (B) Post independent- era: Etawah pilot project, Nilokeheri project, Boodhan movement.
5.	Agricultural development programmes launched by ICAR: National demonstration, KVK, LLP, ORP, TOT, NARP, ATIC, NATP, ATMA, NAIP.
6.	New trends in Agriculture Extension: Privatization extension, cyber extension/ e-extension, meaning, definition, tools, advantage & disadvantage of cyber extension, market-led-extension, farmers-led-extension, expert system, Public Private Partnership (PPP).
7.	Rural Development: Concept, Meaning, definition and importance in agricultural extension.
8.	Rural Development Programmes launched by government of India: IADP, IAAP, ICDS, HYVP and IRDP.
9.	Community Development: Concept, meaning, definition, principal physiology of C.D.
10.	Rural Leadership: Concept, definition, types of leader in rural context and characteristics of leader.
11.	Extension Administration: Meaning, concept, principle and functions.
12.	Monitoring and Evaluation: Concept, definition and monitoring & evaluation of extension programmes.
13.	Transfer of technology: Concept, scope and importance.
14.	Extension teaching methods: Meaning, classification according to use and form, media mix strategies.
15.	Agriculture Journalism: Meaning, brief history, types and importance in agriculture.
16.	Diffusion and adoption of innovation: Meaning, definition, concept, elements of diffusion, process and stages of adoption, adopter categories, characteristics of innovation.
17.	Capacity building of extension personnel: Meaning, definition of training, types of training methods: lecture, panel discussion, group discussion, colloquium, syndicate, symposium, seminar, workshop, conference, brain storming, buzz-session and role-playing.

Topics in Practical:

S. No.	Topics

27. EXT – 311(Entrepreneurship Development and Business Communication)

Credit Hours: 2(1+1)

Topics in Theory:

S. No.	Topics
1.	Entrepreneurship: Concept, meaning, definition, factors responsible for entrepreneurship, assessment of entrepreneurship skill, opportunities for entrepreneurship, rural entrepreneurship.
2.	Entrepreneur: Concept meaning, definition, types of entrepreneur, characteristics of entrepreneur and difference between entrepreneur and manager.
3.	Enterprise: Meaning, definition, management of enterprise.
4.	SWOT analysis: Concept, meaning and use.
5.	Entrepreneurship Development: Phases of entrepreneurship development process: stimulatory phases, Support phases and Sustaining phases.
6.	Entrepreneurial behavior: Definition, concept and dimension: achievement motivation as a dimension entrepreneurial behavior, Gender dimension of entrepreneurial behavior, Leadership as a dimension entrepreneurial behavior.
7.	Achievement motivation: Meaning, concept and factors affecting of achievement motivation.
8.	Government Policy: IPR-1948, IPR-1956, IPR-1977, IPR-1980, IPR-1990, New small enterprise policy 1991, MSMED Act-2006.
9.	Programs and Institutions for Entrepreneurship development: National level training institution (NISIET, NIESBUD, IIE, EDDI), Apex national level govt. organization (SIDO), central level infrastructure development organization (NSIC& KVIC), state level entrepreneurship training institutions: institute of entrepreneurship development, center of entrepreneurship and management development.
10.	Business Leadership Skill: Communication skills for entrepreneurship development, developing organizing skill, managerial skill and problem solving skill.
11.	Supply chain management: Meaning, concept, definition, problems and functions of supply chain management.
12.	Entrepreneurship development programme: Meaning, objectives and phases of EDP.
13.	Total quality management, project planning, formulation and report preparation.

Topics in Practical:

S. No.	Topics
1.	Assessment of entrepreneurial potential.
2.	Study of the problem solving ability of entrepreneur.
3.	Study of the managerial skill of entrepreneur.
4.	An exercise in creativity and time audit
5.	Project Preparation
6.	Visit to entrepreneurship development institute and entrepreneurs

7.	Visit to enterprises related to agriculture

Suggested Readings:

- Khanka, S.S. (2013) Entrepreneurial development. S. Chand & Company Pvt. LTD., New Delhi.
- Desai Vasant (2007) Dynamic of Entrepreneurial development & Management. Himalaya Publishing House, Mumbai.
- Grover, Indu (2008) Hand book on empowerment and Entrepreneurship Vinayak book House, Udaipur.
- Mondal, Sagar and Ray, G.L. (2012) Text book on rural development entrepreneurship and communication Skills. Kalyani Publishers, New Delhi.

➢ Arya, P.S. 2001. Vegetable Breeding and Seed Production. Kalyani Pub., Ludhiana

31. GPB – 222 (Commercial Plant Breeding)

Credit Hours: 3 (1+2)

Topics in Theory:

S. No.	Topics
1.	Types of crops and modes of plant reproduction
2.	Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed Production
3.	Genetic purity test of commercial hybrids
4.	Advances in hybrid seed production of maize, rice, sorghum, pearl
5.	Millet
6.	Advances in hybrid seed production of castor, sunflower
7.	Advances in hybrid seed production of cotton, pigeon pea, brassica
8.	Quality seed production of vegetable crops under open and protected Environment
9.	Alternative strategies for the development of the line and cultivars: haploid inducer
10.	Tissue culture techniques
11.	Biotechnological tools
12.	IPR issues in commercial plant breeding
13.	DUS testing and registration of varieties under PPV & FR Act
14.	Variety testing, release and notification systems in India
15.	Types of seeds, Principles and techniques of seed production
16.	Quality testing in self- and cross-pollinated crops

Topics in Practical:

S. No.	Topics
1.	Floral biology in self-pollinated species
2.	Floral biology in cross pollinated species
3.	Selfing and crossing techniques
4.	Techniques of seed production in self- and cross-pollinated crops using A/B/R and two line system
5.	Learning techniques in hybrid seed production using male-sterility in field crops
6.	Understanding the difficulties in hybrid seed production
7.	Tools and techniques for optimizing hybrid seed production
8.	Concept of line its multiplication and purification in hybrid seed Production
9.	Role of pollinators in hybrid seed production
10.	Hybrid seed production techniques in sorghum & Pearl millet
11.	Hybrid seed production techniques in maize

12.	Hybrid seed production techniques in rice
13.	Hybrid seed production techniques in rapeseed-mustard
14.	Hybrid seed production techniques in sunflower
15.	Hybrid seed production techniques in pigeon pea
16.	Hybrid seed production techniques in cotton
17.	Hybrid seed production techniques in vegetable crops
18.	Sampling and analytical procedures for purity testing and detection of spurious seed
19.	Seed drying
20.	Seed storage structure in quality seed management
21.	Screening techniques during seed processing viz., grading and Packaging
22.	Visit to public private seed production units
23.	Visit to public private seed processing plants

Suggested Readings:

- Chopra, V.L. 2000. *Breeding of Field Crops* (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Mandal, AK., P.K. Ganguli and S.P. Banerjee. 1991. *Advances in Plant Breeding*. Vol. I and II. CBS Publishers and Distributors, New Delhi.
- Manjit S. Kang 2004. *Crop Improvement: Challenges in the Twenty-First Century* (Edt). International Book Distributing Co. Lucknow.
- Poehlman, J.M. 1987. *Breeding of Field Crops*. AVI Publishing Co. INC, East Port, Conneacticut, USA.

32. GPB – 311 [Crop Improvement – I (Kharif crops)]

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Centers of origin, distribution of species, wild relatives in different Kharif cereals & pulses
2.	Centers of origin, distribution of species, wild relatives in different Kharif oilseeds, fibres, fodders and cash crops, vegetable and horticultural crops
3.	Plant genetic resources, its utilization and conservation of Kharif crops
4.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Kharif self-pollinated,
5.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Kharif cross pollinated
6.	Important concepts of breeding Kharif vegetatively propagated crops
7.	Major breeding objectives and procedures including conventional and modern innovative approaches for development of Kharif hybrids and varieties for yield, adaptability & stability,

33. GPB – 312 (Intellectual Property Rights)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO
2.	Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc
3.	Types of Intellectual Property and legislations covering IPR in India:- Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets
4.	Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement
5.	Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database
6.	Origin and history including a brief introduction to UPOV for protection of plant varieties
7.	Protection of plant varieties under UPOV and PPV & FR Act of India, Plant breeders' rights, Registration of plant varieties under PPV&FR Act 2001
8.	Breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders
9.	Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA)
10.	Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing

Suggested Readings:

- B D Singh: Principles of plant breeding, Kalyani publication, New Delhi
- Phundan Singh: IPR and plant breeders right , Kalyani publication, New Delhi
- Phundan Singh and Rajeev Singh : IPR and plant breeders right at a glance , Kalyani publication, New Delhi

34. GPB – 321 [Crop Improvement – II (Rabi Crops)]

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Centers of origin, distribution of species, wild relatives in different Rabi cereals & pulses;
2.	Centers of origin, distribution of species, wild relatives in different Rabi oilseeds, fibres, fodders and cash crops, vegetable and horticultural crops
3.	Plant genetic resources, its utilization and conservation, Rabi crops
4.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Rabi self-pollinated crops

- Chadha, K.L., Handbook of Horticulture, (ICAR),2002, ICAR, New Delhi
- K.V. Peter, Basics Horticulture, 2009, New India Publishing Agency
- Kausal Kumar Misra and Rajesh Kumar, Fundamentals of Horticulture, 2014.Biotech Books
- D.K. Salunkhe and S.S. Kadam, A handbook of Fruit Science and Technology, 2013. CRC Press
- S. Prasad and U. Kumar, A handbook of Fruit Production, 2010. Agrobios (India).
- Jitendra Singh. Basic Horticulture, 2011. Kalyani Publications, New Delhi

36. HORT – 211 (Production Technology for Vegetables & Spices)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of vegetables & spices in human nutrition and national economy
2.	Classification of Vegetables
3.	Types of vegetable gardening with special reference to kitchen gardening
4.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, Tomato, Brinjal, Chilli, Capsicum
5.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Cucumber, Melons, Gourds, Pumpkin
6.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of French bean, Peas
7.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Cabbage, Cauliflower, Knol-khol;
8.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Bulb crops such as Onion, Garlic
9.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Root crops such as Carrot, Radish, Beetroot
10.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Potato and Sweet potato
11.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and

	methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Leafy vegetables such as Amaranth and Palak;
12.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Perennial vegetables such as drumstick and pointed gourd
13.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of Coriander, cumin, fenugreek
14.	Origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of & fennel; Turmeric & Ginger.

Topics in Practical:

S. No.	Topics
1.	Identification of vegetables & spice crops and their seeds
2.	Nursery raising. Direct seed sowing and transplanting
3.	Study of morphological characters of different vegetables & spices
4.	Fertilizer application, Harvesting & preparation for market of Tomato, Brinjal, Chilli, Capsicum,
5.	Fertilizer application, Harvesting & preparation for market of Cucumber, Melons, Gourds, Pumpkin, French bean, Peas and Okra;
6.	Fertilizer application, Harvesting & preparation for market of Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic
7.	Fertilizer application, Harvesting & preparation for market of ; Root crops such as Carrot, Radish, Beetroot; Tuber crops such as Potato and Sweet potato; Leafy vegetables such as Amaranth and Palak
8.	Fertilizer application, Harvesting & preparation for market of Coriander, cumin, fenugreek
9.	Fertilizer application, Harvesting & preparation for market of fennel; Turmeric & Ginger
10.	Economics of vegetables and spices cultivation.

Suggested Readings:

- S. Thamburaj, 2014. Text Book of Vegetable, Tuber crops and Spices. ICAR, New Delhi
- B.R. Choudhary, 2009. A text Book on Production Technology of Vegetables. Kalyani Publishers. Ludhiana.
- T.K. Bose, 2002.Vegetable Crops. Nayaprakash. Kolkata
- T. R. Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.

- Kumar,N.J.B.M.Md.AbdulKhaddar,RangaSwamy,P.andIrulappan,I.1997.Introduction toSpices,PlantationCropsMedicinalandAromaticPlants.Oxford&IBH,NewDelhi.
- Jain,S.K.1968.MedicinalPlants.NationalBookTrustNewDelhi.Oxford&IBH,NewDelhi.

38. HORT – 222 (Production Technology for Fruit and Plantation Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance and scope of fruit and plantation crop industry in India, Importance of rootstocks
2.	Production technologies for the cultivation of major fruits-Mango, Banana.
3.	Production technologies for the cultivation of major fruits-Citrus,
4.	Production technologies for the cultivation of major fruits-Grape
5.	Production technologies for the cultivation of major fruit guava, papaya,
6.	Production technologies for the cultivation of major fruit litchi, sapota,
7.	Production technologies for the cultivation of apple, pear, peach,
8.	Production technologies for the cultivation of walnut, almond
9.	Production technologies for the cultivation of minor fruits- Date palm, Ber,
10.	Production technologies for the cultivation of Pineapple, Aonla,
11.	Production technologies for the cultivation of Pomegranate, jackfruit,
12.	Production technologies for the cultivation of Strawberry, Custard apple
13.	Production technologies for the cultivation of, Bael , coconut
14.	Production technologies for the cultivation of, arecanut, cashew,
15.	Production technologies for the cultivation of, tea, coffee & rubber.

Topics in Practical:

S. No.	Topics
1.	Description and identification of fruit and plantation crops
2.	Seed propagation. Scarification and stratification of seeds
3.	Propagation methods for fruit and plantation crops including micro propagation
4.	Preparation of plant bio regulators and their uses,
5.	Important pests, diseases and physiological disorders of major fruits
6.	Important pests, diseases and physiological disorders of minor fruits
7.	Important pests, diseases and physiological disorders of plantation crops
8.	Visit to commercial orchards

Suggested Readings:

	management etc; Geospatial technology for generating valuable agricultural information. Decision support systems, concepts, components and applications in Agriculture Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions, Preparation of contingent crop-planning using IT tools

Topics in Practical:

S. No.	Topics
1.	Introduction to Computers and Operating System: Display of Computer Components, accessories, Creating Files & Folders, File Management using DOS and Windows OS
2.	Application of MS-Office: Use of MS-Word and MS Power-point for creating, editing and presenting a scientific Document. MS-Excel: Creating a spread sheet, creating graph (Bar, line ,Pie diagrams and histogram), analysis of scientific data.
3.	Statistical Analysis: Use of Statistical tools and writing mathematical expressions using MS- Excel, Calculation of Mean, Standard Deviation , Correlation and Regression using Mathematical Expression in Excel.
4.	Database in Agriculture: MS-Access: Creating database, preparing queries and reports, demonstration of Agri-information system.
5.	World Wide Web(WWW): Display of Introductory Concepts in Internet Explorer (IE), Search Engine (Google), Creation of Email.
6.	Introduction to computer programming languages: Practical on standard Input / Output Operation in BASIC, BASIC language (Programming codes for only calculating Mean and Standard Deviation).
7.	Preparation of contingent crop planning using ICT
8.	e-Agriculture : Practical Hands on Crop Simulation Models (CSM) such as DSSAT/ Crop-Info/ Crop Syst/ Wofost: Computation of water and nutrient requirements of crop using CSM and IT tools. Display if Introductory Geospatial Technology using a GIS software system for generating valuable information for agriculture. Practical Hands on Decision Support system in Agriculture.
9.	Introduction of Geospatial Technology, for generating information important for Agriculture. Introduction of Geospatial Technology for generating valuable information for Agriculture
10.	Hands on practice on preparation of Decision Support System. Preparation of contingent crop planning. Hands on Decision Support System. Preparation of contingent crop planning

Suggested Readings:

- Gurvinder Singh, Rachhpal Singh & Sluja KK. 2003 Fundamentals of Computer Programming and Information Technology. Kalyani Publishers.
- Harshwardhan P. Bal. 2003. Perl Programming for Bioinformatics. Tata Mc Graw-Hill Education.

Department – Plant Pathology

43. PPT – 121 (Fundamentals of Plant Pathology)

Credit Hours: 4 (3+1)

Topics in Theory:

S. No.	Topics
1.	Introduction: Importance of plant diseases, scope and objectives of Plant Pathology
2.	History of Plant Pathology with special reference to Indian work
3.	Terms and concepts in Plant Pathology
4.	Pathogenesis. causes / factors affecting disease development: disease triangle and tetrahedron
5.	Classification of plant diseases
6.	Important plant pathogenic organisms
7.	Different groups of fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas
8.	Different groups of viruses, viroids, algae and protozoa
9.	Phanerogamic parasites and nematodes with examples of diseases caused by them
10.	Diseases and symptoms due to abiotic causes
11.	Fungi :general characters, definition, somatic structures types of fungal thalli, fungal tissues, modifications of thallus
12.	Reproduction in fungi (asexual and sexual).
13.	Nomenclature, binomial system of nomenclature, rules of nomenclature, classification of fungi
14.	Key to divisions , sub-divisions, orders and classes of fungi
15.	Bacteria and mollicutes: general morphological characters, basic methods of classification and reproduction
16.	Viruses: nature, structure, replication and transmission
17.	Study of phanerogamic plant parasites
18.	Nematodes: general morphology and reproduction, Nematode classification
19.	Symptoms and nature of damage caused by plant parasitic nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.)
20.	Growth and reproduction of plant pathogens
21.	Liberation / dispersal and survival of plant pathogens
22.	Types of parasitism and variability in plant pathogens, Pathogenesis
23.	Role of enzymes, toxins and growth regulators in disease development
24.	Defense mechanism in plants
25.	Epidemiology: Factors affecting disease development.
26.	Principles and methods of plant disease management
27.	Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Topics in Practical:

S. No.	Topics
1.	Acquaintance with various laboratory equipments and microscopy
2.	Collection and preservation of disease preparation
3.	Preparation of media, isolation and Koch's postulates
4.	General study of different structures of fungi
5.	Study of symptoms of various plant diseases
6.	Study of representative fungal genera.
7.	Transmission of plant viruses.
8.	Study of morphological features and identification of plant parasitic nematodes.
9.	Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting.
10.	Staining and identification of plant pathogenic bacteria.
11.	Study of phanerogamic plant parasites.

Suggested Readings:

- Agrios, G.N. (2005). Plant Pathology. 5th Edn. Academic Press, New York, USA.
- Bhale, U, Mishra M. ,Kumar, S. and Gupta, OM (2015). Laboratory Manual on Plant
- Pathology, A S AP Publisher.
- Bilgrami, K.S. and Dube, H.C. (1990). A Text book of Modern Plant Pathology, Vikas Publishing House Pvt. Ltd, India; New Ed edition.
- Kamat, M.N. (1967). Introductory Plant Pathology, 3rdEds revised, Prakash Publisher,
- Jaipur.
- Malhrotra, R.S. (2003). Plant Pathology, Tata McGraw-Hill Education,
- Nene, Y.L. and Thapliyal, P. L. (1987). Fungicides in Plant Disease Control, 2ndeds.
- Oxford & IBH Publishing, New Delhi.
- Pathak, V.N. (1972). Essentials of Plant Pathology, Prakash publisher, Jaipur.
- Sathe, T.V. (2011). Agrochemicals and Pest Management, Daya Publishing House.
- Sharma, C.S. (2013). Plant Pathology, Published by Agrotech Press.
- Sharma, P.D. (2013). Plant Pathology, Rastogi Publications, Meerut.
- Sharma, R. (2012). PlantVirus, ABD publisher.
- Singh, R.S. (1990). Plant Diseases. 9th Eds. Oxford & IBH Publishing Company.

Department - Biochemistry/Physiology/Microbiology/ Environmental Science

47. EVS-111 (Fundamentals of Plant Biochemistry and Biotechnology)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Importance of Biochemistry.
2.	Properties of Water, pH and Buffer.
3.	Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Polysaccharides.
4.	Lipid: Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids.
5.	Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins.
6.	Metabolism of carbohydrates and lipids
7.	Concepts and application of plant biotechnology : Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications;
8.	Micro-propagation methods; organogenesis and embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance; somatic hybridization and cybrids;
9.	Somaclonal variation and its use in crop improvement; cryo-preservation;
10.	Introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods;
11.	Transgenics and its importance in crop improvement;
12.	PCR techniques and its applications;
13.	RFLP, RAPD, SSR;
14.	Marker Assisted Breeding in crop improvement;
15.	Biotechnology regulations

Topics in Practical:

S. No.	Topics
1.	Preparation of solution, pH & buffers
2.	Qualitative tests of carbohydrates and amino acids.
3.	Quantitative estimation of glucose/ proteins
4.	Titration methods for estimation of amino acids/lipids, ,
5.	Effect of pH, temperature and substrate concentration on enzyme action
6.	Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides.

7.	Sterilization techniques.
8.	Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium
9.	Callus induction from various explants.
10.	Micro-propagation, hardening and acclimatization
11.	Demonstration on isolation of DNA.
12.	Demonstration of gel electrophoresis techniques and DNA finger printing

Suggested Readings:

- Plant Biochemistry- V. Arun Kumar, N. Senthil Kumar and K. Siva Kumar, 2010, APH Publishing Corporation, New Delhi.
- Biotechnology-Expanding Horizons, B.D. Singh, 2014, Kalyani Publishers, Ludhiana
- Principles and Techniques of Biochemistry and Molecular Biology, Eds. Keith Wilson and John Walker, 7th Edition, 2010, Cambridge University Press
- A Textbook of Biotechnology, Revised Edition, 2014, R.C. Dubey, S. Chand Publishing Company, New Delhi
- Lehninger Principles of Biochemistry by Albert Lehninger, David Nelson and Michael Cox, Seventh Edition, 2017 Macmilla.

48. EVS – 112 (Introduction to Forestry)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction – definitions of basic terms related to forestry
2.	Objectives of silviculture, forest classification, salient features of Indian Forest Policies
3.	Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers
4.	Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations
5.	Crown classification. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning
6.	Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement
7.	Non instrumental methods of height measurement - shadow and single pole method
8.	Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement; tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees
9.	Agroforestry – definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens
10.	Cultivation practices of two important fast growing tree species of the region

Topics in Practical:

S. No.	Topics
1.	Identification of tree-species
2.	Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees
3.	Height measurement of standing trees by shadow method, single pole method and hypsometer
4.	Volume measurement of logs using various formulae
5.	Nursery lay out, seed sowing, vegetative propagation techniques
6.	Forest plantations and their management
7.	Visits of nearby forest based industries

Suggested Readings:

- Indian Forestry- by K. Manikandan and S. Prabhu.
- Principles and Practices of Silviculture- by A. P. Dwivedi.
- Silviculture- by L. S Khanna
- Forest Mensuration – by Lal

49. EVS – 113 (Introductory Biology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to the living world and diversity, difference between living and non-living, properties of living organisms,
2.	Origin of life : Fossil, history of studies into the origin of life, early condition on earth, origin of organic molecules, RNA metabolism, protein and lipid theories,
3.	Eugenics: meaning, type and development of eugenics, Evolution: heredity, variation, mechanism and outcome of evolution, difference between eugenic and evolution.
4.	Binomial nomenclature and classification: Definition, system and rules, Cell : plant and animal cell differences and their function, cell division: Mitosis and meiosis
5.	Morphology of flowering plants: types and modification of leaf, stem, root, Parts of flower and inflorescence
6.	Seed structure: Monocot and dicot seed, Seed germination, factors affecting seed germination.
7.	Plant systematic- viz; Brassicaceae, Fabaceae, Solanceae and Poaceae
8.	Role of animals in agriculture

Topics in Practical:

S. No.	Topics
1.	Morphology of flowering plants – root, stem and leaf and their modifications

6.	Separation of photosynthetic pigments through paper chromatography
7.	Measurement of respiration by using Ganong's respirometer
8.	Tissue tests for mineral nutrients
9.	Estimation of relative water content (RWC)
10.	Measurement of photosynthetic CO2 assimilation by Infra-Red Gas Analyser (IRGA)

Suggested Readings:

- N. K. Gupta & Sunita Gupta, (2004). Plant Physiology. Oxford and IBH publication, New Delhi.
- S. N. Pandey and B. K. Sinha (1995). Vikas Publishing House Pvt. Ltd., new Delhi
- J. B. Salisbury and C.W. Ross (1992). Plant Physiology, Wadswar Publishing Company, Belmont, California
- L. Taiz and E. Zieger (2006). Plant Physiology. 4th Ed. Sinauer Associates.
- C.P. Malik and A.K. Srivastava (2015), Text Book of Plant Physiology.
- R.K. Sinha (2015), Modern Plant Physiology.
- V.K. Jain (2015),Fundamentals of Plant Physiology
- Gontia, A. S. (2016). A Text Book of Plant Physiology(e-book) :Publisher, Satish Serial.

51. EVS - 122 (Agricultural Microbiology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction. Microbial world: Prokaryotic and eukaryotic microbes.
2.	Bacteria: Cell structure, chemoatotrophy, photoautotrophy, growth
3.	Bacterial genetics: genetics recombination- transformation, conjugation, and transduction, plasmids, transposon
4.	Soil organisms: macro and microorganisms, their beneficial and harmful effects
5.	Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles.
6.	Biological nitrogen fixation- symbiotic, associative and asymbiotic.
7.	Azolla, blue green algae and mycorrhiza
8.	Rhizosphere and phyllosphere
9.	Microbes in human welfare: silage production, bio-fertilizers, bio-pesticides, bio-fuel production and
10.	Bio-degradation of agro-waste.

Topics in Practical:

S. No.	Topics
1.	Introduction to microbiology laboratory and its equipments;
2.	Microscope- parts, principles of microscopy, resolving power and numerical aperture

3.	Methods of sterilization.
4.	Nutritional media and their preparations
5.	Enumeration of microbial population in soil- bacteria, fungi, actinomycetes
6.	Methods of isolation and purification of microbial cultures.
7.	Isolation of Rhizobium from legume root nodule
8.	Isolation of Azotobacter from soil
9.	Isolation of Azospirillum from roots
10.	Isolation of BGA
11.	Staining and microscopic examination of microbes

Suggested Readings:

- Rangaswami and Bhagyaraj :Agricultural Microbiology
- N.S. Subbarao : Soil Microbiology
- N. Mukherjee and T. Ghosh :Agricultural Microbiology
- L.L. Somani, S.C. Bhandari S.N. Saxena : Biofertilizers
- M. Alexender : Introduction to soil Microbiology
- P. Tauro, K.K. Kapoor and K.S. Yadav :An Introduction to Microbiology

52. EVS – 211 (Environmental Studies and Disaster Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Multidisciplinary nature of environmental studies, Definition, scope and importance
2.	Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
3.	Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
4.	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
5.	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
6.	Land resources: Land degradation; man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.
7.	Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs
8.	Ecological pyramids: Introduction, types, characteristic features, structure and function

	of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
9.	Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
10.	Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
11.	Environmental Pollution: definition, cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
12.	Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting and watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust and dies.
13.	Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.
14.	Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.
15.	Disaster Management: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
16.	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.
17.	Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community – based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Topics in Practical:

S. No.	Topics
1.	Study of natural ecosystem: Pond, river, and forest. and artificial ecosystem: etc.
2.	Study of artificial ecosystem: Crop land ecosystem
3.	Identification of common plants, insects and birds
4.	Visit to a local polluted site-Urban/Rural/Industrial/Agricultural

5.	Pollution Case Studies: case study and visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain.

Suggested Readings:

- Environmental Science - Bharucha Erach, 2017, University Grant Commission
- Environmental and Ecology - Hussain Majid,2013, Online book
- Environmental Biotechnology - Agrawal SK,2002, APH Publishing Corporation, New Delhi
- Introduction to Environment Science – Sharma JP,2003, Laxmi Publication, New Delhi
- Environment Geography – Singh Svindra,2015, Pryaga Pustak Bhawan, Allahabad
- Ecology and Environment – Ojha AK, 2017, Bodhik Publication, Allahabad

53. EVS – 321 (Principles of Food Science and Nutrition)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.);
2.	Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions)
3.	Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods)
4.	Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.)
5.	Food and nutrition, Malnutrition (over and under nutrition),
6.	Nutritional disorders; Energy metabolism (carbohydrate, fat, proteins)
7.	Balanced/ modified diets, Menu planning,
8.	New trends in food science and nutrition
9.	Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes
10.	Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure.
11.	Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain.
12.	Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Suggested Readings:

- Srilakshmi, B. (2010). Text Book of Food Science. New age international (P) limited, publisher, New Delhi
- Sehgal, S. and Raghuvanshi, R.S. (2007). Text Book of Community Nutrition, ICAR Publication
- Khaddar V., (1999). Text Book of Food. Storage and Preservation. Kalyani Publishers, New Delhi. 4 Srilakshmi, B. (2010). Text Book of Nutrition Science. New age international (P)

Department - Soil Science and Agricultural Chemistry

54. SAC – 111 (Fundamentals of Soil Science)

Credit Hours: 3 (2+ 1)

Topics in Theory:

S. No.	Topics
1.	Definitions of Soil, as a natural body, Soil Profile, components of soil;
2.	Pedological and edaphological concepts of soil;
3.	Soil genesis: soil forming rocks and minerals;
4.	Weathering, processes and factors of soil formation
5.	Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity
6.	Elementary knowledge of soil taxonomy classification and soils of India
7.	Soil water retention, movement and availability
8.	Soil air, composition, gaseous exchange, problem and plant growth
9.	Soil temperature; source, amount and flow of heat in soil; effect on plant growth
10.	Soil reaction-pH, soil acidity and alkalinity, buffering
11.	Effect of pH on nutrient availability
12.	Soil colloids - inorganic and organic components
13.	Silicate clays: constitution and properties
14.	Sources of charge; ion exchange,
15.	Cation exchange capacity & base saturation
16.	Soil organic matter: composition, properties and its influence on soil properties
17.	Humic substances - nature and properties
18.	Soil pollution - behaviour of pesticides and inorganic contaminants,
19.	Prevention and mitigation of soil pollution.
20.	Soil organisms: macro and microorganisms, their beneficial and harmful effects.

Topics in Practical:

S. No.	Topics
1.	Study of soil profile in field.
2.	Study of soil sampling tools, collection of representative soil sample, its processing and storage.
3.	Study of soil forming rocks and minerals.
4.	Determination of soil density, moisture content and porosity
5.	Determination of soil texture by feel and Bouyoucos Methods
6.	Studies of capillary rise phenomenon of water in soil column and water movement in soil.
7.	Determination of soil pH and electrical conductivity.

8.	Determination of cation exchange capacity of soil
9.	Study of soil map
10.	Determination of soil colour
11.	Demonstration of heat transfer in soil.
12.	Estimation of organic matter content of soil.

Suggested Readings:

- Baver, L.D. Gardener, W.H. and gardener W.R.(1976) Soil Physics Wiley Eastern Ltd, New Delhi
- Biswas, T.D. and Mukherjee, S.K. (2006) Text book of soil science. Tata McGraw Hill publishing Co. Ltd, New Delhi
- Brady, N.C. and Weil, R.R. (2002) The nature and properties of soils, prentice hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi
- Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi
- ISSS (2009) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi
- Chopra S.L. and Kanwar, J.S. (1991) Analytical Agricultural Chemistry, Kalyani publisher, Ludhiana 64
- Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
- Piper, C.S. (1950) Soil and plant analysis. Hans publications, Bombay
- Richards, L.A. (1960) Diagnosis and improvement of saline and alkali soils., USDA agriculture Hand book 60, Washington D.C., USA
- Agarwal, R.R., Yadav, J.S.P. & Gupta, R.N. (1982) Saline and alkali soils of India. ICAR, New Delhi.
- Sehgal, J. (2000) Pedology: Concepts and applications, Kalyani publisher, Ludhiana

55. SAC – 221 (Problematic Soils and Their Management)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Soil quality and health
2.	Distribution of Waste land and problem soils in India and their categorization based on properties
3.	Reclamation and management of Saline and sodic soils
4.	Acid soils, Acid Sulphate soils
5.	Eroded and Compacted soils
6.	Flooded soils
7.	Polluted soils
8.	Irrigation water – quality and standards,
9.	Utilization of saline water in agriculture
10.	Remote sensing and GIS in diagnosis and management of problem soils

11.	Multipurpose tree species, bio remediation of soils through MPTs
12.	Land capability and classification,
13.	Land suitability classification
14.	Problematic soils under different Agro-ecosystems

Suggested Readings:

- Bear FE. 1964. Chemistry of the Soil. Oxford & IBH.
- Jurinak JJ. 1978. Salt-affected Soils. Department of Soil Science & Biometeorology. Utah State Univ.
- USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford & IBH.
- Abrol, I.P. and Dhurva Narayana, V.V. (1998) Technologies for wasteland development, ICAR, New Delhi-110012
- Cirsan Paul, J.(1985) Principles of remote sensing. Longman, New York.
- Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. USDA Hand book No. 60, Washington, DC USA.
- Somani, L.L. and Totawat, K.L. (1993). Management of salt affected soils and waters. Agrotech publishing Academy, Udaipur.
- Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR, New Delhi.
- ISSS (2009) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi
- Ganesh, A. (2015). GPS principles and Applications (e-books); Publisher Satish Serials.

56. SAC – 311 (Manures, Fertilizers and Soil Fertility Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction and importance of organic manures,
2.	Properties and methods of preparation of bulky and concentrated manures.
3.	Green/leaf manuring.
4.	Fertilizer recommendation approaches.
5.	Integrated nutrient management.
6.	Chemical fertilizers: classification, ,
7.	Composition and properties of major nitrogenous, phosphatic, potassic fertilizers
8.	Secondary & micronutrient fertilizers,
9.	Complex fertilizers, nano fertilizers & Soil amendments,
10.	Fertilizer Storage, Fertilizer Control Order.
11.	History of soil fertility and plant nutrition
12.	Criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients

Department - Veterinary Science and Animal Husbandry

58. LPM – 211 (Livestock and Poultry Management)

Credit Hours: 4 (3+1)

Topics in Theory:

S. No.	Topics
1.	Role of livestock in the national economy
2.	Important Indian breeds of cattle
3.	Important exotic breeds of cattle
4.	Important breeds of buffalo
5.	Important Indian breeds of sheep and goat
6.	Important exotic breeds of sheep and goat
7.	Important Indian and exotic breeds of swine
8.	Important Indian and exotic breeds of poultry
9.	Reproduction in farm animals and poultry
10.	Housing principles, space requirements for different species of livestock
11.	Housing principles, space requirements for different species of poultry
12.	Management of calves and growing heifers
13.	Management of milch animals
14.	Management of sheep and goat
15.	Management of swine
16.	Incubation and hatching of eggs
17.	Brooding of chicks
18.	Management of growers and layers
19.	Improvement of farm animals and poultry
20.	Digestion in livestock
21.	Digestion in poultry
22.	Classification of feedstuffs
23.	Proximate principles of feed
24.	Nutrients and their functions
25.	Feed ingredients for ration for livestock and poultry
26.	Feeding of livestock and poultry. Feed supplements and feed additives
27.	Introduction of livestock diseases
28.	Introduction of poultry diseases
29.	Prevention (including vaccination schedule) and control of important diseases of livestock
30.	Prevention (including vaccination schedule) and control of important diseases of poultry

Topics in Practical:

S. No.	Topics
1.	Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records
2.	External body parts of cattle, buffalo, sheep, goat, swine and poultry
3.	Identification methods of farm animals and poultry
4.	Computation of rations for livestock. Formulation of concentrate mixtures
5.	Handling and restraining of livestock
6.	Judging of cattle, buffalo and poultry
7.	Culling of livestock and poultry
8.	Planning and layout of housing for different types of livestock
9.	Clean milk production, milking methods
10.	Hatchery operations, incubation and hatching equipments
11.	Management of chicks, growers and layers
12.	Debeaking, dusting and vaccination
13.	Economics of cattle, buffalo, sheep, goat, swine and poultry production

Suggested Readings:

- Livestock Production Management (N.S.R. Sastry and C.K. Thomas)
- A Text Book of Animal Husbandry (G.C. Banerjee)
- Poultry Production (R.A. Singh)
- Animal Husbandry (Harbansh Singh and Moore)
- Animal Husbandry and Dairying (Jagdish Prasad)
- Principles and practices of dairy farm management (Jagdish Prasad and Neeraj)
- Poultry (G. C. Benerjee)

NON-GRADIAL COURSES

I. NSS/NCC/Physical Education & Yoga Practices 2(0+2)

Semester I

61. Course Title: National Service Scheme I

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilization

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership

Social harmony and national integration

Indian history and culture, role of youth in nation building, conflict resolution and peace-building

Volunteerism and shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution and human rights

Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

Family and society

Concept of family, community (PRIs and other community-based organizations) and society

Semester II

62. Course Title: National Service Scheme II

Importance and role of youth leadership

Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies

Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes

Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations

Health, hygiene and sanitation

Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.

Youth health, lifestyle, HIV AIDS and first aid

Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid

Youth and yoga

History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Semester III

63. Course Title: National Service Scheme III

Vocational skill development

To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment

Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management

Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development

Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production-oriented project

Planning, implementation, management and impact assessment of project

Documentation and data reporting

Collection and analysis of data, documentation and dissemination of project reports

Semester IV

64. Course Title: National Service Scheme IV

Youth and crime

Sociological and psychological factors influencing youth crime, cybercrime, pear mentoring in preventing crime and awareness for juvenile justice

Civil/self defense

Civil defense services, aims and objectives of civil defense; needs and training of self defense

Resource mobilization

Writing a project proposal of self-fund units (SFUs) and its establishment

Additional life skills

Positive thinking, self-confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Semester I

65. Course Title: National Cadet Corps

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march and dressing.
4. Saluting at the halt, getting on parade, dismissing and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
6. Turning on the march and wheeling. Saluting on the march.
7. Marking time, forward march and halt.
8. Changing step, formation of squad and squad drill.
9. Command and control, organization, badges of rank, honors and awards
10. Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
11. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
12. Leadership traits, types of leadership. Character/personality development.
13. Civil defense organization, types of emergencies, firefighting, protection,
14. Maintenance of essential services, disaster management, aid during development projects. 15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
15. Structure and function of human body, diet and exercise, hygiene and sanitation.
16. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
17. Adventure activities
18. Basic principles of ecology, environmental conservation, pollution and its control.
19. Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self-defense.

References	
Cadet Hand Book (Army Wing)	Major R.C. Mishra
Cadet Hand Book (Army Wing)	Directorate General, NCC, Ministry of Defense, R.K. Puram, New Delhi

Semester II

66. Course Title: National Cadet Corps

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
2. Shoulder from the order and vice-versa, present from the order and vice-versa.
3. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa.
4. Guard mounting, guard of honor, Platoon/Coy Drill.

PROGRAMME-2

B.Sc. (Hons.)

Horticulture

18.	Breadfruit and Passion fruit: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
19.	Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures
20.	Seediness and kokkan disease in banana, citrus decline and casual factors and their management
21.	Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economics of production

Topics in Practical:

S. No.	Topics
1.	Description and identification of varieties based on flower and fruit morphology in Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit
2.	Training and pruning of grapes, mango, guava and citrus.
3.	Selection of site and planting system
4.	Pre-treatment of banana suckers, desuckering in banana, sex forms in papaya
5.	Use of plastics in fruit production
6.	Visit to commercial orchards and diagnosis of maladies
7.	Manure and fertilizer application including bio-fertilizer in fruit crops
8.	Preparation and application of growth regulators in banana, grapes and mango
9.	Seed production in papaya, latex extraction and preparation of crude papain
10.	Ripening of fruits, grading and packaging
11.	Production economics for tropical and sub-tropical fruits
12.	Mapping of arid and semi-arid zones of India
13.	Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona

Suggested Readings:

- H. P. Singh and M. M. Mustafa, 2009. Banana-new innovations. Westville Publishing House, New Delhi.
- M. S. Ladaniya, 2013. Citrus Fruits. Elsevier, India post ltd.
- Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. Tropical and Sub-Tropical-Vol-I. Nayaudyog-Kolkata
- Rajput, CBS and Srihari babu, R., 1985. Citriculture. Kalyani Publishers, New Delhi.
- Chundawat, B.S., 1990. Arid fruit culture. Oxford and IBH, New Delhi.

- Chadha, K. L. (ICAR) 2002, 2001. Hand book of Horticulture. ICAR, New Delhi.
- Symmonds, 1996. Banana. II Edn. Longman, London.
- Radha, T. and Mathew, L., 2007. Fruit crops. New India Publishing Agency.
- W. S. Dhillon, 2013. Fruit Production in India. Narendra Publishing House, New Delhi
- T. K. Chattopadhyay, 1997. Text book on pomology. Kalyani Publishers, New Delhi.
- R. E. Litz, 2009. The Mango 2nd Edn. Cabi Publishing, Willingford, U.K.
- K. L. Chadda, 2009. Advanced in Horticulture. Malhotra Publishing House, New Delhi.
- S.P. Singh, 2004. Commercial fruits. Kalyani Publishers, New Delhi.
- F.S. Davies and L.G.Albrigo, 2001. Citrus, Cab International.

10. FSC – 216 (Temperate Fruit Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of temperate fruits
2.	Apple: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
3.	Pear: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
4.	Peach: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
5.	Apricot: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
6.	Plum: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
7.	Cherry: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
8.	Persimmon: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed

1.	Identification and description of flowering annuals
2.	Identification and description of biennials
3.	Identification and description of herbaceous perennials
4.	Identification and description of climbers
5.	Identification and description of shrubs
6.	Identification and description of indoor plants
7.	Identification and description of ferns and selaginella
8.	Identification and description of palms and cycads
9.	Identification and description of cacti and other succulents
10.	Planning, designing and establishment of garden features- lawn
11.	Planning, designing and establishment of garden features- hedge and edge
12.	Planning, designing and establishment of garden features- rockery
13.	Planning, designing and establishment of garden features- water garden
14.	Planning, designing and establishment of garden features- carpet bedding
15.	Planning, designing and establishment of garden features- shade garden
16.	Planning, designing and establishment of garden features- roof garden
17.	Study and creation of terrariums
18.	Study and creation of vertical gardens
19.	Study and practice of different types of flower arrangements
20.	Preparation of floral bouquets
21.	Preparation of floral rangoli
22.	Preparation of veni
23.	Study of bonsai techniques
24.	Bonsai practice and training
25.	Visit to nurseries and floriculture units

Suggested Readings:

- Adriance GW and Brison FR. 2000. Propagation of Horticultural Plants. Biotech Books, New Delhi, India.
- Bose TK, Mitra SK and Sadhu M K. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkata, India.
- Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency, New Delhi, India. pp. 251.

22. PSMA – 313 (Medicinal and Aromatic crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics

1.	History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India.
2.	Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements viz. aswagandha, safed musli, tulsi, kalmegh, lemon grass, citronella, opium, asalio, isabgol, satawar, mentha spp
3.	Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants.viz. asgandh, safed musli, tulsi, kalmegh, lemon grass, citronella, opium, asalio, isabgol, satawar, mentha spp.
4.	Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants.
5.	Therapeutic and pharmaceutical uses of important species.
6.	Storage techniques of essential oils. Medicinal Plants: Withania, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy, Ammi majus, Belladonna, Cinchona, Pyrethrum and other medicinal crops relevant to local conditions.
7.	Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, mentha, musk, occimum and other species relevant to the local conditions. Marketing.

Topics in Practical:

S. No.	Topics
1.	Collection and conservation of medicinal and aromatic plants from their natural habitat and their study morphological description,
2.	Nursery techniques of medicinal and aromatic crops.
3.	Harvesting of medicinal and aromatic crops.
4.	Curing and processing techniques of medicinal and aromatic crops.
5.	Extraction of essential oils.

Suggested Readings:

- Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.
- Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants.
- United Press Limited.
- Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants.
- CSIR, New Delhi.
- Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford & IBH, New Delhi.
- Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.
- Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala soms and co-private Ltd, Bombay

681 ing House,Nagpur.

- Sehgal J. A., 2005. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
- Jaiswal, P.C., 2006. Soil, Plant and Water Analysis (2nd Edition), Kalyani Publishers, Ludhiana.
- Jackson M. L, 1967. Soil Chemical Analysis, Oxford and IBH Publishing Co., New Delhi.
- Richards L A, 1968. Diagnosis and Improvement of Saline and Alkaline Soils. Oxford and IBH publishing Co. New Delhi(USDA Hand Book No. 60)
- Chopra S.C. and Kanwar, J. S 1976. Analytical Agricultural Chemistry, Kalyani Publishers, Ludhiana.
- C. S. Piper. 2014, Soil and plant analysis, Scientific publishers India.
- Mushtaq A. Wan., 2014, Soil, plant and water analysis manual. Agrotech publishing company, Udaipur.
- P. K. Gupta., 2013, Soil, plant, water and fertilizer analysis. Agrobios, India.
- M. V. Durai., 2014, Hand book of Soil, plant, water, fertilizers and manure analysis. New India Publishing Agency.

26. AMT – 311 (Agro-meteorology and Climate Change)

Credit Hours: 2(1+1)

Topics in Theory:

S. No.	Topics
1.	Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology.
2.	Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role of meteorology.
3.	Basics of weather forecasting.
4.	Climate change-causes.
5.	Global warming-causes and remote sensing.
6.	Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere.
7.	Sources and sinks for greenhouse gases.
8.	Atmospheric chemistry.
9.	Plants sense and respond to changes in Co_2 concentration.
10.	Measurement of short-term effects and mechanisms underlying the observed responses in C3 and C4 species.
11.	Plant development affected by growth in elevated Co_2.
12.	Physiology of rising CO_2 on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO_2.

13.	Change in secondary metabolites and pest disease reaction of plants.
14.	The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress.
15.	Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere.
16.	Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Topics in Practical:

S. No.	Topics
1.	Site selection for Agromet observatory.
2.	Measurement of temperature.
3.	Measurement of rainfall.
4.	Measurement of evaporation (atmospheric/soil).
5.	Measurement of atmospheric pressure.
6.	Measurement of sunshine duration and solar radiation.
7.	Measurement of wind direction and speed and relative humidity.
8.	Study of weather forecasting and synoptic charts.
9.	Visit to Meteorological observatory, Visit to IMD meteorological observatory-Lay out plan of standard meteorological observatory.
10.	Recording of air and soil temperature.
11.	Measurement of radiation and components.
12.	Measurement of rainfall-different types of rain gauges.
13.	Measurement of wind speed and direction and atmospheric humidity.
14.	Recording of evaporation.
15.	Synoptic charts and weather reports, symbols, *etc*.

Suggested Readings:

- A.K. Srivastava and P. K. Tyagi, 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- D.Lenka, 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
- G. S. L. H. V. Prasad Rao, 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
- H.S.Mavi and Graeme J. Tupper, 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
- H.S.Mavi, 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

- H.V.Nanjappa and B.K.Ramachandrappa, 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
- S.R.Reddy, 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
- T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.
- Pattersen, S.1958. Introductionto Meteorology. Mc. Graw Hill Book Co. Inc., New York
- Tailor, J.T.1967. AgriculturalClimatology. Pergman Press Ltd., Headington Hill Hall, Oxford, England
- Trewarthe,T.G.1968. An Introduction to Climate. Mc Graw Hill Book Co. Inc., New York.
- Mavi,H.S.1985. Introduction to Agrometeorology. Oxford & IBH Publishing Co., New Delhi.

27. EVS – 122 (Environmental Studies and Disaster Management)#

Credit Hours: 3(2+1)

Topics in Theory:

S. No.	Topics
1.	Multidisciplinary nature of environmental studies. Definition, scope and importance.
2.	Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems.
3.	a)Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
4.	b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
5.	c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
6.	d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
7.	e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
8.	f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
9.	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.
10.	Ecosystems, Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers.
11.	Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.
12.	Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic-ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
13.	Biodiversity and its conservation:-Introduction, definition, genetic, species & ecosystem

	diversity and biogeographical classification of India.
14.	Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation.
15.	Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife Conflicts Endangered and endemic species of India.
16.	Conservation of biodiversity: In-situ and Exsitu
17.	Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and Thermal pollution and Nuclear hazards.
18.	Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
19.	Social Issues and the Environment: From Unsustainable to Sustainable development Urban problems related to energy, Water conservation, rain, water harvesting, watershed management, Environmental ethics: Issues and possible solutions.
20.	Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies.
21.	Wasteland reclamation, consumerism and waste products.
22.	Environment Protection Act, Air, Water, Wildlife and Forest Conservation acts, Issues involved in enforcement of environmental legislation and public awareness.
23.	Human Population and the Environment: population growth, variation among nations, population explosion.
24.	Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare.
25.	Role of Information Technology in Environment and human health.
26.	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.
27.	Climatic change: global warming, Sea level rise, ozone depletion.
28.	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire.
29.	Air pollution, water pollution, deforestation, industrial waste water Pollution, road accidents, rail accidents, air accidents, sea accidents.
30.	Disaster Management-Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.
31.	Concept of disaster management, national disaster management framework; financial arrangements.
32.	Role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Topics in Practical:

S. No.	Topics
1.	Visit to a local polluted site-Urban
2.	Visit to a local polluted site- Rural
3.	Visit to a local polluted site- Industrial
4.	Visit to a local polluted site- Agricultural
5.	Study of common plants
6.	Study of common insects
7.	Study of common birds
8.	Study of simple ecosystems-pond, river, hillslopes etc.
9.	Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem.
10.	Visit to industries to study pollution abatement techniques and case studies
11.	Solid waste management
12.	Human population and the Environment

Suggested Readings:

- Nandini, N. Suneetha and Sucharitha Tandon. Environmental Studies.
- Aswathanarayana, U. 1999. Soil resources and the environment. Oxford and IBH publishing Co., New Delhi. P. 173-195.
- D. D. Misra. Fundamental Concepts in Environmental Studies.680 Rep
- Diwan, P. and P. Diwan. 1998. Environmental Management Law and Administration. Variety Books International, New Delhi.
- Krishnamurthy. An Advanced Textbook on Biodiversity.
- S. Deshwal A. Deshwal. A Basic Course in Environmental Science.
- Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC,University press, Hyderabad.
- Manohara Chary and Jayaram Reddy 2004.Principles of Environmental studies BB publishers,Hyderabad.
- William, P. Cunning Ham and Mary Ann. Inquiry and applications Cunningham 2005.
- Principles of Environmental science. Tata MCG raw-hill publishing company limited, NewDelhi.
- Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India).Jodhpur.
- Spencer R. Weart. The discovery of global warming.
- Daniel B. Botkin, Edward A. Keller. Environmental Science.
- Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.
- Linfield C.Brown. Pollution prevention and control.

28. EVS – 313 (Introductory Agro-forestry)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry.
2.	Status of Indian forests and role in Indian farming systems.
3.	Agroforestry system, subsystem and practice: Agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral.
4.	Shifting cultivation, taungya, home gardens, alley cropping, intercropping. Wind breaks, shelterbelts and energy plantations.
5.	Planning for agroforestry – constraints, diagnosis and design methodology.
6.	Selection of tree crop species for agro-forestry. Agroforestry projects – national, overseas.
7.	MPTS and their management practices.
8.	Economics, cultivation, nursery and planting of *Acacia catechu.*
9.	Economics, cultivation, nursery and planting of *Dalbergiasissoo.*
10.	Economics, cultivation, nursery and planting of Tectona & Populus.
11.	Economics, cultivation, nursery and planting of Morus & Grewia.
12.	Economics, cultivation, nursery and planting of Eucalyptus & Quercus spp.
13.	Economics, cultivation, nursery and planting of bamboo.
14.	Economics, cultivation, nursery and planting of tamarind & neem.

Topics in Practical:

S. No.	Topics
1.	Identification and seeds and seedlings of multipurpose tree species.
2.	Nursery practices for poplar, Grewia Morus alba Acacia catechu and *Dalbergiasissoo,* robinia and leucaena.
3.	Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops, silvipastoral fields, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks.
4.	Visit to social forestry plantations – railway line plantations.
5.	Visit to canal plantations.
6.	Visit to industrial plantations.
7.	Visit to shelterbelts.
8.	Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages.
9.	Economics and marketing of products raised in agroforestry systems.

Suggested Readings:

- K. Patra, 2013. Agroforestry – Principles and Practices. New India publishing agency.
- P. Dwivedi, 1992. Agroforestry – Principles and Practices. Oxford and IBH Publishing company.
- Dadhwal et al., 2014. Practical Manual on Agroforestry. Jaya publishing house, Delhi.
- L.K. Jha, 2015. Advances in Agroforestry. APH Publishing corporation, New Delhi.
- Linford, Jenny, 2007. A Concise Guide to Trees. Parragon books service limited, Parragon.
- Negi, S.S., 2007. Agroforestry Hand book. International book distributer, New Delhi.
- P.S. Pathak and Ram Newaj, 2010. Agroforestry – Potentials and Opportunities. Agrobios, Jodhpur
- Pankaj Panwar & Sunil Puri, 2007. Agroforestry: Systems & Practices. New India publishing agency, New Delhi.
- Ramesh Umrani and C.K. Jain, 2010. Agroforestry – Systems & Practices. ABD Publishers, New Delhi.
- Ramachandran Nair, P.K. 1993. An Introductionto Agroforestry. First reprint in India–2008.Springer International Edition
- Tejawani, K.G. 1994. Agro forestry in India. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi
- Luna, R.K. 1989. Plantation forestry in India. International Book Distributors, Dehradun.
- Leda Satish. 2006. Biodiesel and Jatropha Plantations. AGROBIOS, Jodhpur.
- Chaturvedi, A.N. and Khanna, L.S. 1982. Forest Menstruation. Reprinted in 2006. International Book Distributors, Dehradun
- Negi,S.S.2006. Forest Tree Seed. Prashant Gahlotat Valley printers and publishers, Dehradun.
- Chundawat and S K Gautam.1996. A text book of Agroforestry. Oxford and IBH Publishing company Pvt. Ltd.

29. AEG – 211 (Farm Power and Machinery)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples.
2.	Farm Power in India - Human, Animal, Mechanical and Electrical Energy Sources And Their Use In Agriculture
3.	Two Stroke and Four Stroke Engines, Working Principles, Applications - Types, Power and Efficiency
4.	Different Systems of IC Engine – Cooling, Lubricating, Fuel Injection Systems
5.	Tractors, Power Tillers and Their Types and Uses.
6.	Tillage - Objectives and Types, Furrow Terminology and Methods of Ploughing, Field Capacity and Field Efficiency
7.	Primary Tillage - Objectives, Mould Board Plough , Disc Plough, Chisel Plough, Sub-

- Roth/Field. 1992. Introduction to Agricultural Engineering - Problem Solving Approaches, 2nd. Edition. CBS publishers & distributors Pvt. Ltd.
- Surendra Singh & Verma. 2009. Farm Machinery Maintenance & Management. ICAR Publication.
- M.M. Pandey & Others. 2012. Handbook of Agricultural Engineering. ICAR publication
- Jagadishwar Sahay.1992. Elements of Agricultural Engineering. Agro Book Agency,Patna.
- Michal AM and Ojha TP.1993.VolI. Principles of Agricultural Engineering. Jain Brothers,New Delhi.
- Kepner R A Roy Bainer and Barger BL.1978. Principles of Farm Machinery. CBS Publisher and Distributors, Delhi.
- Jain S C. 2003. Farm Machinery-An approach. Standard Publishers and Distributors, New Delhi.
- Nakra, C.P.1986. Farm Machinery and Equipment. Dhanpat Rai and Sons, New Delhi.
- Klenin, N.I.Popov, I.F.and Sakun,V.A.1985. Agricultural Machines. Amerind publishing Co. Pvt. Ltd., New Delhi.

30. AGR – 122 (Water Management in Horticultural Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of water.
2.	Water resources in India.
3.	Area of different crops under irrigation.
4.	Function of water for plant growth.
5.	Effect of moisture stress on crop growth.
6.	Available and unavailable soil moisture, distribution of soil moisture
7.	Water budgeting, rooting characteristics – moisture extraction pattern.
8.	Water requirement of horticultural crops, lysimeter studies.
9.	Plant water potential climatological approach.
10.	Use of pan evaporimeter.
11.	Factor for crop growth stages, Critical stages of crop growth for irrigation.
12.	Irrigation scheduling – different approaches.
13.	Methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation.
14.	Economic use of irrigation water, water management problem,
15.	Soils quality of irrigation water, irrigation management practices for different soils and crops.
16.	Layout of different irrigation systems, drip, sprinkler, layout of underground pipeline system.

Topics in Practical:

S. No.	Topics
1.	Measurements of irrigation water by using water measuring devices.
2.	Use of common formula in irrigation practices.
3.	Practicing of land levelling and land shaping implements.
4.	Layout for different methods of irrigation.
5.	Estimation of soil moisture contents and soil moisture by using different methods and instruments.
6.	Scheduling of irrigation- different approaches, practicing use of instruments.
7.	Estimation of irrigation efficiency and water requirements of horticultural crops.
8.	Irrigation planning and scheduling.
9.	Soil moisture conservation practices.

Suggested Readings:

- Rao, Y.P. and Bhaskar, S.R. 2008. Irrigation Technology.
- Dilip Kumar Majumdar. 2004. Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
- S.V. Patil & Rajakumar, G. R., 2016. Water Management in Agriculture and Horticultural Crops.
- Satish serial publishing House, Delhi.
- Carr M. K. V. and Elias Fereres. 2012. Advances in Irrigation Agronomy. Cambridge University Press.
- Michael, A.M. 2015. Irrigation Theory and Practices. Vikas publishing house Pvt., Ltd.

31. AGR – 313 (Introduction to Major Field Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of crops.
2.	Distribution of field crops.
3.	Definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping,
4.	Cultural practices for raising major cereals (rice, wheat, maize, barley)
5.	Cultural practices for raising major pulses (pigeonpea, chickpea, urid, moong linneed etc.)
6.	Cultural practices for raising major oil seeds (soybean, mustard, groundnut etc.)
7.	Cultural practices for raising major fodder crops (berseem, lucern etc.)
8.	Green manuring and crop rotation.

- Richards, O.W. and R.G. Davies. 1977. Imm's general text book of entomology, Vol.1&2, Chapman and Hall Publication, London, 1345p.
- Romoser, W.S. 1988. The Science of Entomology, McMillan, New York, 449p.
- Saxena, S.C. 1992. Biology of insects. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 366p.
- Srivastava, P.D. and R.P. Singh. 1997. An introduction to entomology, Concept Publishing Company, New Delhi, 269p.

38. ENT – 313 (Apiculture, Sericulture and Lac culture)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to beneficial insects
2.	Importance and History of apiculture
3.	Species of honey bees, Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination
4.	Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention
5.	Colony management in different seasons
6.	Equipment for apiary, types of bee hives and their description
7.	Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues
8.	Importance, History and development of sericulture in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands
9.	Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene
10.	Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs.
11.	Young age rearing /chawki rearing and old age rearing of silkworms
12.	Feeding, spacing, environmental conditions and sanitation. Cocoon characters- colour, shape, hardiness and shell ratio.
13.	Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture-Mulberry varieties, package of practices, Pests and diseases and their management
14.	Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac.
15.	Enemies of lac-insects.

Topics in Practical:

S. No.	Topics
1.	Honey bee colony, different bee hives and apiculture equipments.

2.	Summer and Winter management of colony.
3.	Honey extraction and bottling
4.	Study of pests and diseases of honeybees
5.	Establishment of mulberry garden
6.	Preparation of mulberry cuttings, planting methods under irrigated and rain fed conditions
7.	Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest
8.	Mulberry pests and diseases, their management and nutritional disorders
9.	Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipments for silkworm rearing.
10.	Mulberry silkworm rearing, room requirements, Rearing of silkworms-chawki rearing
11.	Rearing of silkworms -late age silkworm rearing and study of mountages
12.	Study of silkworm pests and their management.
13.	Study of silkworm diseases and its management
14.	Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac.
15.	Enemies of lac insects.

Suggested Readings:

- Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.
- Sunita, N.D, Guled ,M.B, Mulla S.R and Jagginavar,2003, Beekeeping, UAS Dharwad
- Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
- Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).
- Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)
- YA Shinde and BR Patel. Sericulture in India
- Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd
- M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
- Ganga,G. and Sulochana Chetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
- Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agrl. Services bulletin, Rome.

39. ENT – 222 (Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	General – economic classification of insects

2.	Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops
3.	pest surveillance
4.	Distribution, host range, bio-ecology, injury and integrated management of important insect pests affecting tropical fruits
5.	Distribution, host range, bio-ecology, injury and integrated management of important insect pests affecting sub-tropical fruits
6.	Distribution, host range, bio-ecology, injury and integrated management of important insect pests affecting temperate fruits
7.	Distribution, host range, bio-ecology, injury and integrated management of important insect pests affecting plantation crops- coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine etc
8.	Distribution, host range, bio-ecology, injury and integrated management of important insect pests affecting medicinal and aromatic crops- senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* etc
9.	Storage insects – distribution, host range, bio-ecology, injury and integrated management of important insect pests attacking stored fruits crops their processed products
10.	Storage insects – distribution, host range, bio-ecology, injury and integrated management of important insect pests attacking stored plantation crops and their processed products
11.	Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored medicinal and aromatic crops and their processed products
12.	Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Topics in Practical:

S. No.	Topics
1.	Study of symptoms of damage collection, identification, preservation, assessment of damage
2.	Population of important insect – pests affecting fruits in field
3.	Population of important insect – pests affecting plantation in field
4.	Population of important insect – pests affecting medicinal and aromatic crops in field
5.	Population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in storage.

Suggested Readings:

- Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.
- Ranjit, P. 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
- Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.
- Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.
- David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book

Department, Madras, 536p.

- David. V. Alford. Pest of fruit crops. A. M. Ranjith. Identification and management of Horticultural pest.
- Rachna and Benna kumari. Pest management and residual analysis in horticultural crop
- K. P. Srivastav and Y. S. Ahawat. Pest management in citrus
- Ramnivas Sharma. Identification and management of horticulture pest.
- Fryer. Insect pest of fruit crops S. Atwal. Agricultural pests of south Asia and their management Mark Vernon Slingerland and C. R. Crosby. Manual of fruit insects
- Metcalf,R.LandLuckman,W.H.1982. Introduction to Insect pest management. Wiley Inter Science Publishing ,New York
- Butani,D.K.1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi

40. ENT – 324 (Insect Pests of Vegetable, Ornamental and Spice Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Economic importance of insects in vegetable crops
2.	Economic importance of insects in ornamental crops
3.	Economic importance of insects in spice crops
4.	Ecology and pest management with reference to vegetable crops
5.	Ecology and pest management with reference to ornamental crops
6.	Ecology and pest management with reference to spice crops
7.	Pest surveillance in important vegetable, ornamental and spice crops
8.	Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetables
9.	Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting ornamental crops
10.	Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting spice crops
11.	Important storage insect-pests of vegetable, ornamental and spice crops and their host range, bio-ecology, injury and integrated management
12.	Insect –pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management
13.	Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

43. PHM – 323 (Processing of Horticultural Crops)

Credit Hours: 3 (1+2)

Topics in Theory:

S. No.	Topics
1.	Importance and scope of fruit and vegetable preservation industry in India
2.	Food pipe line: Losses in post-harvest operations, unit operations in food processing.
3.	Principles and guidelines for the location and establishment of processing units in India
4.	Principles and methods of preservation by heat- pasteurization, Canning of fruits and vegetables
5.	Methods of preparation of Juices, RTS, Nectar, Squashes, Cordials, Syrups
6.	Fermented beverages
7.	Methods of preparation of Jam, Jelly and Marmalade
8.	Preservation by using sugar and chemical preservatives
9.	Methods of preparation of candies, preserves, crystallized fruits
10.	Preservation with salt and vinegar
11.	Methods of preparation of pickles
12.	Methods of preparation of Chutneys and Sauces
13.	Methods of preparation of Tomato and mushrooms products
14.	Freezing preservation
15.	Processing of plantation crops and their products
16.	Spoilage in processed fruits and vegetables
17.	Quality control of processed products
18.	Govt. policy on import and export of processed fruit products
19.	Food laws.

Topics in Practical:

S. No.	Topics
1.	Equipments used in food processing units
2.	Physico-chemical analysis of fruits and vegetables
3.	Canning of fruits and vegetables
4.	Preparation of RTS, nectar, squash, cordial, syrup
5.	Preparation of jam, jelly, marmalade
6.	Preparation of fruit chutneys, sauces, pickles (hot and sweet)
7.	Preparation of candies and preserves
8.	Dehydration of fruits and vegetables, tomato product dehydration
9.	Refrigeration and freezing of fruit and vegetables
10.	Processing of plantation crops

11.	Cut-out analysis of processed foods
12.	Visit to processing units

Suggested Readings:

- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
- Dauthy, M. E. 1995. Fruits and Vegetables Processing- FAO Bulletin 119. International Book Distributing Co., Lucknow.
- Srivastava, R. P. & Sanjeev Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.
- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
- Vijay, K. 2001. Text Book of Food Sciences and Technology. ICAR, New Delhi.
- Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi
- FAO - Training Manual No.17/2. 2007. Prevention of post harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
- Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi.
- Khan, K. A., Goyal, M. R., and Kalne, A. A. 2018. Processing of Fruits and Vegetables: From Farm to Fork. In Book Series: Innovations in Agricultural and Biological Engineering, Apple Academic Press, USA.
- Srivastava,R. P.andSanjeevK.1998. Fruit and vegetable preservation principles practice. International Book Distributing Co.,Lucknow.
- Girdharilal, Siddappa, G. S. and Tandon, G. L.1998. Preservation of fruits and vegetables. ICAR, New Delhi.
- Dauthy and Mircea, E.1995. Fruit and vegetables processing. International Book Distribution Co, Lucknow.
- Kaysand Stanely,J. 1998. Postharvest physiology of perishable plant products. CBS Publishers, Distributors, New Delhi
- Bhatti, S 1995.Vame, Fruit and vegetable processing. CBS Publishers, Distributors, NewDelhi.

- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.

Department – Vegetable Science

44. VSC – 121 (Tropical and Subtropical Vegetables Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops.
2.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of tomato
3.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting yield, economics of cultivation, post-harvest handling, storage and marketing of brinjal
4.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting yield, economics of cultivation, post-harvest handling, storage and marketing of chilli
5.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting yield, economics of cultivation, post-harvest handling, storage and marketing of capsicum/Shimla Mirch
6.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, seed treatment, sowing, spacing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting yield, economics of cultivation, post-harvest handling, storage and marketing of okra
7.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of Amaranthus,
8.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of cluster bean,
9.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting,

	yield, economics of cultivation, post-harvest handling, storage and marketing of cowpea.
10.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of lablab bean.
11.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of snap bean.
12.	General description about cucurbits. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, sowing, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of cucumber.
13.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of bitter gourd.
14.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, sowing, spacing, planting systems, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of bottle gourd.
15.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of sponge gourd.
16.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of ridge gourd.
17.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of watermelon
18.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing

	of muskmelon
19.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of summer squash,
20.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of winter squash
21.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of pumpkin
22.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of round melon
23.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of long melon
24.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of ivy gourd
25.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of pointed gourd,
26.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, methods of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of spine gourd
27.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, method of propagation, nursery raising, planting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of moringa

28.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, method of propagation, nursery raising, planting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of curry leaf
29.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; sowing, time of sowing, spacing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of portulaca
30.	Description of varieties, climate and soil requirements, preparation of field, sowing, seed rate, spacing, planting systems, staking, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, post-harvest handling, storage, marketing and economics of cultivation of basella.
31.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, seed rate, spacing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of sorrel and roselle

Topics in Practical:

S. No.	Topics
1.	Identification and description of tropical and sub-tropical vegetable crops
2.	Nursery practices and transplanting of tropical and sub-tropical vegetable crops
3.	Preparation of field for tropical and sub-tropical vegetable crops
4.	Sowing/planting for direct sown and planted tropical and sub-tropical vegetable crops
5.	Herbicide use in tropical and sub-tropical vegetable crops
6.	Top dressing of fertilizers in tropical and sub-tropical vegetable crops
7.	Intercultural operations in tropical and sub-tropical vegetable crops
8.	Use of growth regulators in tropical and sub-tropical vegetable crops
9.	Identification of nutrient deficiencies, physiological disorders in tropical and sub-tropical vegetable crops
10.	Harvest indices and maturity standards in tropical and sub-tropical vegetable crops
11.	Harvesting in tropical and sub-tropical vegetable crops
12.	Post-harvest handling, storage and marketing of tropical and sub-tropical vegetable crops
13.	Cost of cultivation for tropical and sub-tropical vegetable crops
14.	Project preparation for commercial cultivation of tropical and sub-tropical vegetables

Suggested Readings:

➢ S. Thamburaj, 2014. Text Book of Vegetable, Tuber crops and Spices. ICAR, New Delhi

7.	Sowing/transplanting practice
8.	Identification of physiological and nutritional disorders and their corrections
9.	Post-harvest handling of temperate vegetable crops
10.	Cost of cultivation of temperate vegetable crops
11.	Field visits to commercial farms

Suggested Readings:

- S. Thamburaj. 2014. Text Book of Vegetable, Tuber crops and Spices. ICAR, New Delhi.
- B.R. Choudhary 2009.AText Book on Production Technology of Vegetables. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002.Vegetable Crops. Nayaprakash. Kolkata
- P. Hazra. 2011. Modern Technology in Vegetable Production. New India Publishing Agency.
- New Delhi.
- T.R.Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007.Vegetable Crop Production. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008.Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004.Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur.
- M.K. Rana, 2008.Olericulture in India. Kalyani Publishers. Ludhiana
- P. Hazra. 2006.Vegetable Science. Kalyani Publishers .Ludhiana
- Pratibha Sharma, 2007.Vegetables: Disease Diagnosis and Biomanagement. Avishkar
- Publishers. Jaipur
- Uma Shankar. 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994.Vegetables for the Tropical Regions. ICAR New Delhi
- K.L. Chadha. 1993.Advances in Horticulture. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash,
- Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

46. VSC – 223 (Precision Farming and Protected Cultivation)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Precision farming – concept of precision farming, importance and need, principles,
2.	Laser leveling,

3.	Mechanized direct seed sowing
4.	Seedling and sapling transplanting
5.	Mapping of soils and plant attributes
6.	Site specific input application
7.	Weed management
8.	Insect pests and disease management
9.	Yield mapping in horticultural crops
10.	Introduction of Green house technology
11.	Types of Green Houses
12.	Plant response to Greenhouse environment
13.	Planning and design of greenhouses
14.	Design criteria of greenhouse for cooling and heating purposes
15.	Green house equipments
16.	Material of construction for traditional and low-cost green houses
17.	Irrigation systems used in greenhouses
18.	Typical applications, passive solar green house, hot air greenhouse heating systems,
19.	Green house drying
20.	Cost estimation and economic analysis
21.	Choice of crops for cultivation under greenhouses
22.	Problems/constraints of greenhouse cultivation and future strategies.
23.	Growing media, soil culture, type of soil required,
24.	Drainage, flooding and leaching,
25.	Soil pasteurization in peat moss and mixtures, rock wool and other inert media,
26.	Nutrient film technique (NFT)/hydroponics.

Topics in Practical:

S. No.	Topics
1.	Study of different types of greenhouses based on shape
2.	Study of different types of construction and cladding materials
3.	Calculation of air rate exchange in an active summer cooling system
4.	Estimation of drying rate of agricultural products inside green house
5.	Testing of soil to study its suitability for growing crops in greenhouses
6.	Testing of water to study its suitability for growing crops in greenhouses
7.	The study of fertigation requirements for greenhouses crops
8.	Estimation of E.C. in the fertigation solution
9.	The study of various growing media used in raising of greenhouse crops
10.	Preparation of various growing media used in raising of greenhouse crops and their

	pasteurization/sterilization
11.	Nursery raising of vegetable crops in protected structures
12.	Use of walk-in tunnels and low tunnels for vegetable cultivation
13.	Visit to commercial green houses
14.	Economics of protected cultivation

Suggested Readings:

- Balraj Singh. 2006. Protected Cultivation of Vegetable Crops. Kalyani Publishers, Ludhiana.
- Brahma Singh, 2014. Advances in Protected Cultivation. New India Publishing Agency. New Delhi.
- Reddy P. Parvatha, 2003. Protected Cultivation. Springer Publications. USA.
- Reddy, P. Parvatha. 2011. Sustainable Crop Protection under Protected Cultivation. Springer Publications. USA.
- Jitendra Singh, 2015. Precision Farming in Horticulture. New India Publishing Agency. New Delhi.
- Prasad S. 2005. Greenhouse Management for Horticultural Crops. Agrobios. Jodhpur.
- Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. Precision forming in Horticulture. New India Publishing Agency, New Delhi.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N. Satheson. 2008. Management of Horticultural crops. New India Publishing Agency, New Delhi.
- Aldrich RA & Bartok JW. 1994. NRAES, Riley, Robb Hall. Green House Engineering. Cornell University, Ithaca, New York.
- Pant V Nelson. 1991. Green House Operation and Management. Bali Publ
- Srinivasan, Ancha (2006). Handbook of Precision Agriculture Principles and Applications, Taylor & Francis
- Zhang, Qin (2015). Precision Agriculture Technology for Crop Farming, CRC Press
- Krishna, K.R. (2016). Precision Farming Soil Fertility and Productivity Aspects, CRC Press
- Pedersen, Soren Marcus; Lind, Kim Martin (2017). Precision Agriculture: Technology and Economic Perspectives, Springer
- Tiwari, G.N. 2003. Greenhouse Technology for Controlled Environment. Narosa Publishing House, New Delhi.

Department – Social Science

51. EXT – 311 (Fundamentals of Extension Education)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history.
2.	Horticulture extension: process, principles and selected programmes of leading National and international forest institutes.
3.	People's participation in Horticulture programmes.
4.	Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work
5.	Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR
6.	Communication: meaning, definition, elements and selected models.
7.	Audio – visual aids: importance, classification and selection. Adoption and diffusion process
8.	Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods.
9.	Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA).
10.	Management and administration: meaning, definition, principles and functions. Concepts
11.	Human resource development (HRD), rural leadership. ICT in Extension education, ICT use in rural India.
12.	Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history.

Topics in Practical:

S. No.	Topics
1.	Visits to study structure, functions, linkages and extension programmes of ICFRE institutes.
2.	Voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR).
3.	Exercises on distortion of message, script writing for farm broadcasts and telecasts.
4.	Planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA.
5.	OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work.

6.	Evaluation of some selected case studies of forestry extension programmes.
7.	Preparation of Village Agricultural productions plan.

Suggested Readings:

- Adivi Reddy, A., 2001, Extension Education, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P., 1998, Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi
- Jalihal, K. A. and Veerabhadraiah, V., 2007, Fundamentals of Extension Education and Management in Extension, Concept publishing company, New Delhi
- Muthaiah Manoraharan, P. and Arunachalam, R., Agricultural Extension, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., Text Book On Rural Development, Entrepreneurship And
- Communication Skills, Kalyani Publications
- Rathore, O. S. et al., 2012, Handbook of Extension Education, Agrotech Publishing Academy,Udaipur.
- Ray, G. L., 1991 (1st Edition), Extension Communication and Management, Kalyani Publishers,Ludhiana {7th revised edition - 2010}.
- Supe, S. V., 2013 (2nd Edition), A Text Book of Extension Education, Agrotech Publishing
- Academy, Udaipur
- Van Den Ban, A. W. and Hawkins, H. S., Agricultural Extension, S. K .Jain for CBS Publishers& Distributors, New Delhi.
- M. Hilaris. Indian Agriculture and Information: Soundari, New century Publications, 2011and communication technology (ICT)

52. AEC – 111 (Economics and Marketing)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Theory: Nature and scope of economics, definition and concept, divisions of economics, economic systems, approaches to the study of economics.
2.	Consumption – theory of consumer behaviour, laws of consumption, classification of goods
3.	Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal
4.	Law of diminishing marginal utility, law of equi -marginal utility, in difference curve and its properties, consumer equilibrium
5.	Theory of demand, demand schedule and curve market demand
6.	Price income and cross elasticizes, Engil's law of family expenditure – consumer's surplus, theory of firm, factors of production – land and its characteristics
7.	Labour and division of labour, theories of population. Capital and its characteristics –

54. AEC – 323 (Entrepreneurship Development and Business Management)#

Credit Hours: 2 (1+ 1)

Topics in Theory:

S. No.	Topics
1.	Entrepreneurship Development: Assessing overall business environment in the Indian economy.
2.	Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics.
3.	Managing an enterprise; motivation and entrepreneurship development;
4.	Importance of planning, monitoring, evaluation and follow up, managing competition
5.	Entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship.
6.	Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures,
7.	Public-private partnerships. Supply chain management and total quality management.
8.	Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business. Communication Skills: meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills,
9.	Oral presentation skills developing organizational and managerial skills, problem solving skills. field diary and lab record; indexing, footnote and bibliographic procedures

Topics in Practical:

S. No.	Topics
1.	Listening and note taking, writing skills, oral presentation skills; field diary and lab record.
2.	Indexing, footnote and bibliographic procedures. Reading and comprehension of general.
3.	Technical articles, precis writing, summarizing, abstracting; Conducting market survey.
4.	Demand for product, preparing advertisements for popularization of product, news writing.
5.	Preparing project proposals, individual, group presentation, features of oral presentation.
6.	Presentation, evaluation of presentation and evaluation of sheet, dyadic communication-face to face conversation.
7.	Telephone conversation, rate of speech and clarity of voice, speaking and listening politeness, telephone etiquettes, organising general and group meeting, salient features of participation in seminars and conferences, conducting and participating in

	mock interviews

Suggested Readings:

- Benjamin MC Donald P. 1985, Investment Projects in Agriculture- Principles and Case studies. Longman Group Limited. Essex. UK
- Chole, R. R. et al., 2012, Entrepreneurship Development and Communication skills, Scientific publishers, Jodhpur
- Gittiner, J P., 1982, Economic Analysis of Agricultural Projects, The John Hopkins University Press Baltimore, USA
- Hopkins J A and Baker C B Danville, Financial Management in Agriculture, 6th ed Barry P J,IL Interstate Publishers
- Kotler Philip and Armstrong, Principles of Marketing. Prentice-Hall.
- Pandey U. K., An Introduction to Agricultural Finance
- Sagar Mondal and G. L. Ray, Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications
- Somani, L. L., Extension Education and Communication, Agrotech, Publishing Academy, Udaipur
- Dr.A.K.Singh,2009.Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
- S. Anil Kumar, S.C Poornima, M.K. Abhraham and K. Jayashree, 2008; Entrepreneurship Development. New Age International Publishers

55. ENG – 111 (Communication Skills and Personality Development)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to Word Classes
2.	Introduction to Word Classes (Parts of Speech-I)
3.	Introduction to Word Classes (Parts of Speech-II)
4.	Structure of Verbs in English (Verbs Finite and Non-finite)
5.	Tenses
6.	Voice
7.	Sentence Patterns
8.	Conversations of Different Situations in everyday Life-I
9.	Conversations of Different Situations in Everyday Life-II
10.	Vowels and Consonants and Syllable
11.	Stress: Primary and Secondary
12.	Silent Letters and Classification of Words Intonation and Falling, Rising and Falling Rising Tone
13.	Reading and Comprehension of General and Technical Articles

NON-GRADIAL COURSES

Semester I

Course Title: National Service Scheme I 2(0+2)

- **Introduction and basic components of NSS:**
- **Orientation**: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health
- **NSS programmes and activities**
- Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary
- **Understanding youth**
- Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change
- **Community mobilisation**
- Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership
- **Social harmony and national integration**
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building
- **Volunteerism and shramdan**
- Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism
- **Citizenship, constitution and human rights**
- Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information
- **Family and society**
- Concept of family, community (PRIs and other community-based organisations) and society
- **Importance and role of youth leadership**
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership
- **Life competencies**
- Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

- **Youth development programmes**
- Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations
- **Health, hygiene and sanitation**
- Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.
- **Youth health, lifestyle, HIV AIDS and first aid**
- Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- **Youth and yoga**
- History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method
- **Vocational skill development**
- To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list
- **Issues related environment**
- Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservation) and waste management
- **Disaster management**
- Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.
- **Entrepreneurship development**
- Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.
- **Formulation of production-oriented project**
- Planning, implementation, management and impact assessment of project
- **Documentation and data reporting**
- Collection and analysis of data, documentation and dissemination of project reports
- **Youth and crime**
- Sociological and psychological factors influencing youth crime, cyber-crime, pear mentoring in preventing crime and awareness for juvenile justice
- **Civil/self defence**

- Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self-defence.
- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
- Shoulder from the order and vice-versa, present from the order and vice-versa.
- Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa.
- Guard mounting, guard of honour, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.
- Loading, cocking and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
- Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
- Characteristics of Carbine and LMG.
- Introduction to map, scales and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
- Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
- Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defences obstacles, mines and mine lying. Bridging, watermanship
- Field water supplies, tracks and their construction.
- Nuclear, Chemical and Biological Warfare (NCBW)
- Judging distance. Description of ground and indication of landmarks.
- Recognition and description of target. Observation and concealment. Field signals. Section formations.
- Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
- Types of communication, media, latest trends and developments.

References

Cadet Hand Book (Army Wing)	Major R.C. Mishra
Cadet Hand Book (Army Wing)	Directorate General, NCC, Ministry of Defence, R.K. Puram, New Delhi

PROGRAMME (3-15)

M.Sc.

Agriculture & Horticulture

AGRON 501 Modern Concepts in Crop Production 3+0

Objective

To teach the nebasic concepts of soil management and crop production.

Theory

UNIT I

Crop growth analysis in relation to environment; Agro-ecological zones of India.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Suggested Readings

Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.

Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.

Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.

Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.

Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.

Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 504 Principles and Practices of Water Management 2+1

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

- Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus
- Soil-moisture characteristics curves. Water flow measurements using different devices
- Determination of irrigation requirements. Calculation of irrigation efficiency
- Determination of infiltration rate. Determination of saturated/ unsaturated hydraulic conductivity

Suggested Readings

Lenka D. 1999. *Irrigation and Drainage*. Kalyani

Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.

Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AGRON 511 Cropping Systems and Sustainable Agriculture 2+0

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

AGRON 512 Dryland Farming and Watershed Management 2+1

Objective

To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practical

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Moisture stress effects and recovery behaviour of important crops

- Estimation of moisture index and aridity index
- Spray of anti-transparent and their effect on crops
- Collection and interpretation of data for water balance equations
- Water use efficiency
- Preparation of crop plans for different drought conditions
- Study of field experiments relevant to dryland farming
- Visit to dryland research stations and watershed projects

Suggested Readings

Das NR. 2007. *Tillage and Crop Production*. Scientific Publishers.

Dhopte AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.

Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India*. ICAR.

Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.

Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA.

Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.

Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture.* Agrotech Publishing Company.

Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.

Singh RP.2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.

Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.

Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

AGRON 513 Principles and Practices of Organic Farming 2+1

Objective

To study the principles and practices of organic farming for sustainable crop production.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost. Making of vermicompost
- Identification and nursery raising of important agro-forestry tress and tress for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field
- Visit to an organic farm

- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.

Lampin N. 1990. *Organic Farming*. Press Books, lpswitch, UK.

Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice.* Scientific Publ.

Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishtana, Bangalore.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies.* PDBC, Bangalore.

SubbaRao NS. 2002. *Soil Microbiology*. Oxford & IBH.

Trivedi RN.1993. *A Text Book of Environmental Sciences*, Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture.* Association for Promotion of Organic Farming, Bangalore.

WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture.* WHO.

Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

Note : For minor courses please refer the concerned department's courses outline.

Suggested Readings

David M Kreps 1990. *A Course in Microeconomic Theory*. Princeton University Press.

Dewitt KK. 2002. *Modern Economic Theory*. Sultan Chand & Co.

Henderson JM & Quant RE. 2000. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.

Koutsoyiannis A. 2003. Modern Microeconomics. The Macmillan Press.

Silberberg E & Suen W. 2001. *The Structure of Economics– A Mathematical Analysis.*

McGraw-Hill.Varian Hal R. 1999. *Intermediate Microeconomics.* Affiliated East-West Press.

AG ECON 502 Macro Economics and Policy 2+0

Objective

Macro economics and Policy course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory, and implication of the macroeconomic policies.

Theory

UNIT I

Nature and Scope of Macro Economics - Methodology and Keynesian Concepts National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.

UNIT II

Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version- Classical theory Vs Keynesian theory – Un employment and Full employment.

UNIT III

Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.

UNIT IV

IS & LM frame work - General Equilibrium of product and money markets -Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy -Central banking.

UNIT V

Business cycles - Balance of Payment - Foreign Exchange Rate determination.

Suggested Readings

Ahuja HL. 2007. *Macroeconomics: Theory and Policy*. S. Chand & Co.

Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.

Gardner Ackely 1987. *Macro Economic: Theory and Policy*. Collier

Macmillan. Dornbusch. 2006. *Macroeconomics*. McGraw Hill Publication

AG ECON 503 Evolution of Economic Thought 1+0

Objective

To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.

Theory

UNIT 1

Approaches for the study of history of economic thought – Absolutist vs. Relativist approaches – Evolution of Economic Thought vs. Economic History. Ancient economic thought – medieval economic thought – mercantilism –physiocracy – Forerunners of Classical Political Economy.

UNIT II

Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) – Critics of Classical Thoughts- Socialist critics –

Socialist and Marxian Economic Ideas – Austrian School of Thought – Origins of Formal Micro economic Analysis – William Stanley Jevons, Cournot and Dupuit.

UNIT III

The birth of neoclassical economic thought – Marshall and Walras – General Equilibrium Theory - Welfare Theory – Keynesian economics.

UNIT IV

The Era of globalization – Experiences of developing world - Rigidity of the pastvs. emerging realism – The changing path of international Institutions to economic growth and development approaches.

UNIT V

Economic Thought in India – Naoroji and Gokhale – Gandhian Economics -Economic thought of independent India – Nehru's economic philosophy -Experiences of the Structural adjustment programmes of the post liberalization era.

Suggested Readings

Blaug M. 1964. *Economic Theory in Retrospect*. Heineman.

Blaug M. 1986. *Economic History and the History of Economic Thought*. Wheatsheaf Books, Brighton.

Ekelund RB & Hebert RF. 1975. *A History of Economic Theory and Methods*. McGraw-Hill.

John Mills A. 2002. *Critical History of Economics: Missed Opportunities*. Palgrave Macmillan.

Screpanti E & Zamagni S. 1995. *An Outline of the History of Economic Thought*. Clarendon Press, Oxford.

AG ECON 504 Agricultural Production Economics 1+1

Objective

To expose the students to the concept, significance and uses of agricultural production economics.

Suggested Readings

Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.

Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.

Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*. Vol. I. *Agricultural Production*. Elsevier. Heady EO. *Economics of Agricultural Production and Resource Use*. Prentice-Hall.

Sankayan PL. 1983. *Introduction to Farm Management*. Tata McGraw Hill.

AG ECON 505 Agricultural Marketing and Price Analysis 2+1

Objective

To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

Theory

UNIT I

Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.

UNIT II

Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -

Performance and Strategies – Market infrastructure needs, performance and Government role - Value Chain Finance.

UNIT III

Role of Information Technology and telecommunication in marketing of agricultural commodities - Market research-Market information service -electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.

UNIT IV

Spatial and temporal price relationship – price forecasting – time series analysis –time series models – spectral analysis. Price policy and economic development –non-price instruments.

UNIT V

Theory of storage - Introduction to Commodities markets and future trading -Basics of commodity futures - Operation Mechanism of Commodity markets –Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis -Role of Government in promoting commodity trading and regulatory measures.

Practical

Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis -quantitative estimation of supply chain efficiency - Market Intelligence –Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports –commodity outlook - Technical Analysis for important agricultural commodities -Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

Theory

UNIT I

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing -Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects.Net work Techniques – PERT and CPM.

UNIT V

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications.

Practical

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme-Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

Suggested Readings

Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India*. Sage Publ.

Gittinger JP 1982. *Economic Analysis of Agricultural Projects***.** The Johns Hopkins Univ. Press.

Gupta SC. 1987. *Development Banking for Rural Development*. Deep & Deep Publ.

Little IMD & Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries***.** Oxford & IBH Publ.

Muniraj R. 1987. *Farm Finance for Development*. Oxford & IBH Publ.

Note: For minor courses please refer the concerned department's courses outline.

Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population inlysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

Suggested Readings

Bruce A. 2004. *Essential Cell Biology*. Garland.

Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.

Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.

Lewin B. 2008. *IX Genes*. John Wiley & Sons

Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.

Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH F reeman & Co.

Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Schleif R. 1986. *Genetics and Molecular Biology*. Addison - Wesley Publ. Co.

GP 509 Biotechnology for Crop Improvement 2+1

Objective

To impart knowledge and practical skills to use biotechnological tools incrop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic

hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.),mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT IV

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Genepyramiding.

UNIT V

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation,selectable markers and clean transformation techniques, vector-mediatedgene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major

countries including India, ethical, legal and social issues; Intellectual property rights

UNIT IX

Bioinformatics & Bioinformatics tools.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media –interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gelelectrophoresis of proteins and isozymes, PCR-based DNA markers, gelscoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation.* 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning* - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani

GP 515 Maintenance Breeding and Concepts of Variety Release and Seed Production 1+1

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self &cross pollinated crops.

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties – safe guards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties indifferent crops; Hybrid seed production technology of important crops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants.* Department of Plant Breeding. CCS HAU Hisar.

Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC.

Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops*. Oxford & IBH.

Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

Note: For minor courses please refer the concerned department's courses outline

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL.1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests.* Phoenix Publ., New Delhi.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman & Hall, New York.

ENT 508 Toxicology of Insecticides 2+1

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of

organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

Unit IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning. Sprayers, dusters and other plant protection appliances.

Practical

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances: Principles, operation and maintenance. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford & IBH, New Delhi.

Gupta HCL. 1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

DEPARTMENT OF EXTENSION EDUCATION

EXT 501 Development Perspectives of Extension Education (1+1)

Theory

UNIT I

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension, Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centers, and NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. *Extension Education What? And What Not?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Processbased on Non-Formal Education Methods*. Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education*. Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.

Khan PM. 2002. *Textbook of Extension Education*. Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension*. 2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.

EXT 502: Development Communication and Information Management 2+1

Theory

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT II

Methods of communication: Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, Interpersonal communication, Organizational communication, Key communicators– Meaning, characteristics and their role in development.

UNIT III

Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People, Modern communication media– Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV

Agricultural Journalism as a means of mass communication, its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders, Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

Practical

Identification of characteristics of key communicators of villages, practical ways to improve oral presentation skill, preparation of bulletins and folders, scripting writing for newspapers, magazine, articles, radio and television. Preparation of Tele conferencing. Study of Barriers in Communication. Study the role of mass media & media mix in dissemination of Agricultural technology

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development.* Oxford & IBH.

Kothari CR. 1984. *Research Methodology, Methods and Techniques.* Chaitanya Publ. House.

Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in SocialSciences*. Himalaya Publ. House.

Mulay S & Sabaratnam VE. 1983. *Research Methods in Extension Education*. Manasavan.

Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.

Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.

Wilkinson TS & Bhandarkar PC. 1993. *Methodology and Techniques of Social Research*. Himalaya Publ. Home.

EXT 505 e- Extension 2+1

Theory

UNIT I

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities

UNIT II

ICTs projects, case studies in India and developing world. Different approaches

(Models) to ICTs, ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video Conferencing, Computer Aided Extension, Knowledge management, Information kiosks,

Multimedia, Online, Offline Extension, Tools-Mobile technologies, e-learning concepts

UNIT IV

ICT Extension: approaches-pre-requisites, information and science needs of farming community, Need integration, Human resource information, Intermediaries. Basic e-extension training issues, ICT enabled extension pluralism, emerging issues in ICT.

Practical

Agril. Content Analysis of ICT Projects, Handling of ICT tools, Designing extension content, online extension service, and project work on ICT enabled extension, Creation of extension blogs, Visit to ICT extension projects.

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development- Cases from India*. Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*. Ganga- Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information – A Guide to Information Technology*. The World Bank, Washington.

EXT 506 Entrepreneurship Development and Management in Extension (2+1)

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development, Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making,

Planning, Organizing, Coordinating and Marketing, Types of Entrepreneurs Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries, Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination: Concept, Need, Types, Techniques of Coordination, Interpersonal relations in the organization, Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles, Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication, Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision –Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision, Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions- Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.

Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.

Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.

Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.

Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.

Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

EXT 507 Human Resource Development 2+1

Theory

UNIT I

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

UNIT II

Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision making models, Management by Objectives; Behavioral Dynamics: Leadership styles – Group dynamics.

UNIT III

Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation, Facilities for training – Trainers training – techniques for trainees' participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

Practical

Visit to different training organizations to review ongoing activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees' welfare and improving quality of work life and Human resource information, Presentation of reports.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook*.Sage Publ.

David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.

Davis Keth & Newston W John 1989. Human Behaviour at Work. 8th Ed. McGraw-Hill.

Hersey Paul & Balanchard H Kenneth. 1992. *Management of Organizational Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.

Knoontz Harold & Weihhrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.

Lynton RP & Pareek U. 1993. *Training for Development*. DB. Taraporewale Sons & Co.

Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*. Kalyani Publ.

SOILS 503 Soil Chemistry 2+1

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

UNIT I

Chemical (elemental) composition of the earth's crust and soils.

UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layertheories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

UNIT IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI

Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII

Chemistry of salt-affected soils and amendments; soil pH, EC_e, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simpleadsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/ sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 504 Soil Mineralogy, Genesis, Classification and Survey 2+1

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT I

Fundamentals of crystallography, space lattice, coordination heory, isomorphism and polymorphism.

UNIT II

Classification, structure, chemical composition and properties of clayminerals; genesis and transformation of crystalline and non-crystalline clayminerals; identification techniques; amorphous soil constituents and other on-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT III

Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soilmaps – usefulness.

UNIT V

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes inthe framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Newbury HJ. 2003 Plant Molecular Breeding. Blackwell Publ.

Weising K, Nybom H, Wolff K & Kahl G. 2005. DNA Fingerprinting in Plants Principles, Methods and Applications. Taylor & Francis

MBB 510 BIOSAFETY, IPR AND BIOETHICS 2 (2+0)

Objective: To discuss about various aspects of biosafety regulations, IPR and bioethics concems arising from the commercialization of biotech products

Theory

UNIT I Biosafety and risk assessment issues, Regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm, Risk management issues - containment.

UNIT II General principles for the laboratory and environmental biosafety. Health aspects, toxicology, allergenicity, antibiotic resistance, etc, Impact on environment gene flow in natural and artificial ecologies, Sources of gene escape, tolerance of target organisms, creation of superweeds/super viruses, etc.

UNIT III Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics, Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV The WTO and other international agreements, Intellectual properties, copyrights. trademarks, trade secrets, patents, geographical indications, etc. Protection of plant variety and farmers right act, Indian patent act and amendments, patent filing. Convention on biological

diversity, Implications of intellectual property rights on the commercialization of biotechnology products

Suggested Readings

Singh BD 2007. Biotechnology Expanding Horizon. Kalyani.

MBB 513 NANO-BIOTECHNOLOGY 3 (3-0)

Objective: Understanding the molecular techniques involved in structure and functions of nano- biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT I Introduction to Biomacromolecules. The modern concepts to describe the conformationand dynamics of biological macromolecules scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT II Cellular engineering signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation

UNIT III Chemical, physical and biological properties of biomaterials and bioresponse biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and tructural proteins); Acrosol properties, application and dynamics, Statistical Mechanics in Biological Systems.

EVS 501: Fundamentals of Environmental Sciences (2+1)

Objective

To make students familiarize with the basic concepts and principles of environmental science, various ecosystems and its relationship with other components.

Theory

Unit 1

Concepts of Environmental Science

Definition, Scope and importance of Environmental studies – Environmental complex-inter relation to other disciplines-History on resource exploitation and conservation.

Unit 2

Ecosystems

Concept of an ecosystem-Ecosystem types and components-Physical, Chemical and Biological character-Structure and function of an ecosystem-Producers, Consumers and decomposers-distribution and abundance of living systems.

Unit 3

Environmental inter relationship and energy Flow

Interrelationship between environment, microbes, plant and animal systems-energy flow and nutrient cycling-food chain, food web and ecological pyramids- Ecological Succession-Ecological interaction and adaptation- periodicity and biological clock.

Unit 4

Environmental Legislation and Policies of the government

Aims and need of Legislation and Policies-Water Act (1974). Air Act (1981), Environmental protection Act (1986) – conservation of forest and wild life. Other major acts related to Solid wastes and Marine pollution.

Unit 5

Global Environmental Issues

Introduction to Environmental issues- Transboundary issues of Environment; Environmental issues in India; Land degradation- Deforestation – Drought – Desertification; of freshwater resources, over exploitation of ground water and Marine pollution – Environmental issues on the construction of big dams

Practical

Population of terrestrial ecosystem, grassland ecosystem – abiotic factors and biotic factors in terrestrial ecosystem- flora and fauna- aquatic ecosystems- biotic and abiotic factors. Forest ecosystem- flora and fauna- biotic factors influencing forest ecosystem. Energy flow and nutrient cycles in the biosphere. Visits to catchment area / dam site, Regulatory bodies, Water boards, Public health departments, Forest and wild life Departments (biosphere reserve areas), Social organizations, Environmental consultancy firms, etc, NGO's and ETP's of established industries.

Suggested Readings

Agarwala, S.P. 2006 Environmental Studies, Narosa Publishing House, New Delhi.

Erach Bharucha 2005. Text book of Environmental Studies. UGC Publication,

University Press Hydrabad

Prabu, P.C., C.Udayasoorian and G.Balasubramanian. 2009. An Introduction to Ecology and

Environmental Science Abhijeet Publications, New Delhi.

Sharma, P.D. 1995. Ecology and Environment. Restogi Publication, Pune

monitor the program and quality control aspects of this program are all covered in this course.

Theory

Unit I

Availability of different types of solid waste from different sources – its overall characteristics – classification of solid wasters based on their characteristics.

Unit II

Basic techniques in solid waste management program – composting – vermicomposting – energy production – value products – safe disposal of rejected materials.

Unit III

Infrastructure requirement for different solid waste management techniques- machineries involved – management unit plan and financial commitment.

Unit IV

Quality control measures for the product derived from solid waste management – Legislation to monitor solid waste program – Organization involved to monitor the solid waste management program.

Unit V

Legislation in solid waste management – Pollution control board norms – Responsibility of waste generators – impact of solid waste management on environment.

Practicals

Collection of different types of wastes – study the characteristics of waste – composting of biodegradable waste into organic manure and vermicompost – Estimation of nutrient content in the manure – Converting high calorie waste into energy – methane production – Briquette formation – estimation of calorie value – value products – brick making from fly ash – banana fiber extraction from banana waste – Project report preparation

for solid waste management program – visit to secured land filling unit – visit to solid waste management unit – Visit to quality control laboratory.

Suggested Readings

Diaz, I.F., M. de Bertoldi and W. Bidlingmaier 2007. Compsot science and technology, Elsevier pub., PP. 1-380.

Hammer, M.J. and M.J. Hammer Jr. 2003. Waste and Waste water Treatment Technology, Prentice Hall of India Pvt. Ltd.

Prabhakar, V.K. 2001. Solid Waste Management. Anmol Pub Pvt. Ltd., New Delhi, PP 286.

Uta Krogmann, Ina Kome and Luis F. Diaz 2010. Solid waste technology and management (Vo. 1 and 2). Blackwel Pub. Ltd. Wiley Online library.

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http://www.ec.europa.eu/environment/water/water-urbanwaste/index_en.html

http://www.gewater.com/wastewater-treatment.html

http://www.printsasia.in/book/solid-waste-management-v-k-prabhakar 8126109300-

EVS 505: Waste Water Management (2+1)

Objective

To make the students familiarize with various technologies available for managing the waste water and it's recycling

Theory

Unit I

Water resources and its contamination

Introduction to water resources – Drinking water – water quality in flowing water- impounded waters and ground water quality – Water quality standards – microbiological and chemical quality of drinking water

– Characterizations of domestic – industrial – infiltration and inflow and municipal waste water – Wastewater flows, sampling, monitoring and evaluation of waste water.

Unit II

Waste water biology and processing of waste water

Microbiology of waste water and waterborne diseases – Biological treatment systems and biological kinetics- Physical – chemical – biological processing of water.

Unit III

Sewage and industrial waste water

Sewage systems and sewage characteristics – Waste water treatment methods – Types of industrial wastes – sludge treatment and disposal – Microbial metabolism, growth kinetics, aeration and agitation – Bioreactors for waste water treatment – waste water economics – Biotechnology and hazardous waste removal.

Unit IV

Wastewater treatment

Microbiology and bioremediation of waste water treatment- aerobic / anaerobic – energy production – Limitations in conventional treatment – Advanced treatment technologies – Membrane technology – Reed bed systems – Biological nutrient removal.

Unit V

Recycling of wastewater

Monitoring the Quality of treated wastewater – Management options for utilization of treated wastewater for agriculture – Groundwater recharge.

Practicals

Sampling methods – Physical and chemical properties of water and waste water- Biological properties of wastewater – coliforms assay in water and wastewater – Aeration and activated sludge treatment of wastewater – Biomethanation potential of wastewater and microbial communities in waste water treatment system – Visit to sewage treatment plants- Visit to industrial waste treatment plant and biomethanation plants- Practical examination.

Suggested Readings

Arceivala, S.J. 2000. Wastewater Treatment for Pollution Control, Second Edition, TMH, New Delhi.

Drinan, J.E. and Spellman, F.R. 2012. Water and Waste water Treatment. A Guide for the Nonengineering Professional, Second Edition, CRC Press.

Goel, P.K. 2003. Advances in Industrial Wastewater Treatment. ADH Publishers, India.

Metcalf and Eddy, INC, Waterwater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-Hill Publishing company Limited, New Delhi 2003.

Cheremisinoff, N.P. 2002. Handbook of water and wastewater Treatment Technologies, Butterworth Helnemann, Melboume.

Hammer, M.J, and M.J. Hammer Jr. 2003. Waste and Waste water Treatment Technology, Prentice Hall of India Pvt. Ltd.

Spellmam, F.R. 2003. Handbook of water and wastewater Treatment plant operation. Lewis Publisher, ACRC Press Company London.

Udo Wiesmann, In Suchoi, and E.M.Donbrooski 2007. Fundamentals of Biological wastewater treatment. Wiley – VCH Verlage GmbH and co., KGaA, Weinheim

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http://www.water.uses.gov/edu/wuww.html
http://www.ge.com/in/water
http://www.fao.org/docrep/t0551e/t0551e05.htm
http://www.waterworld.com/waste-water.html
http://www.unwater.org/activities/task-forces/wastewater-management/en
http://www.epa.gov./rpdweb00/tenorm/water-treatment.html
http://www.ibwc.stage.gov/Organization/Operations/Field_Officers/Nogales.html
http://www.ec.europa.eu/environment/water/water-urbanwaste/index_en.html
http://www.gewater.com/wastewater-treatment.html
http://www.thermaxindia.com/water-and-waste-solutions/systems-and-solutions/industrial-effluent-treatment-and-recycling.aspx

EVS 507: Biodiversity & Conservation (1+1)

Objective

To provide a comprehensive knowledge on biodiversity, loss of biodiversity and conservation methods.

Theory

Unit I

Biodiversity and its importance

Biodiversity: Definition, Elements of Biodiversity, measuring biodiversity, Global distribution of flora and fauna, Values of biodiversity, Geographical diversity- Mapping biodiversity, Species-Area relationships; Mega Diversity Regions, Biodiversity Hot Spots, India's Biodiversity.

Unit II

Speciation and Extinction

Concepts of speciation- Anagenesis and cladogenesis –Patterns of Species Biodiversity. Theories on biodiversity – Ecological Niche, Keystone Species, 'K' and 'R' Strategists Species, Immigrant and Indicator Species, New Ecosystems, Endemism and Exotic Species. Historical extinction episodes- Evolution- Natural selection- Adaptive Radiation Causes and processes of extinction-Extinction in India.

Unit III

Agro- Biodiversity

Agro-Biodiversity- Microbial Biodiversity- Conceptual View and General Benefits- Agricultural Development and Biodiversity Links- Agro-Biodiversity Loss; Conflicts and Effects- Causes of Biodiversity losses linked to Agriculture Diversity through Sustainable Agriculture.

Unit IV

Conservation of Biodiversity

Conservation Methods- Protected Areas- Protected Areas Network In India- National parks and Wildlife Corridors- Biosphere Reserves- MAB- World Heritage-Biosphere Reserves In India- On-Fann and Home Garden Conservation Ex-Stnt Conservation- Tissue Culture and Germplasm Storage- Captive breeding and Reintroduction. Special projects for endangered wildlife- Conservation Plans in India- Sacred Groves.

Unit V

Convention on Biological Diversity

The Convention on Biological Diversity and milstones- CTTES- Free Trade and the Environment – WTO, The Ramsar Convention- IUCN Red List- India's Participation in the International Programmes- biodiversity act.

Practical

Measurement of biotic factors in the terrestrial eco-system- Quadrat method- minimum size of a Quadrat- minimum number of Quadrats- Frequency, abundance and density of plant species in terrestrial eco-system-Determination of biodiversity indices of plant species in terrestrial ecosystem- Line transect method- Belt transect method- Point frame method- Plotless sampling methods- Population size of invertibrates in terrestrial eco-system by mark and recapture methods –Assessment of Earthworm-Microbial diversity in terrestrial and aquatic eco-system- study of planktons in aquatic ecosystem.- Tissue culture and cryopreservation techniques for the conservation of biodiversity – Study tour to a wild life sanctuary (biosphere reserve). Indian Hot spot and polluted habitat.

Suggested Readings

Bhatti J.S. R.Lal, M.J. Apps and M.A.Price. 2007. Climate change and managed ecosystems, CRC Taylor and Francies, Newyork and London. PP. 1-446.

Dutta, A., S.Dutta and P.N. Pandey. 2005.Environmental Issues and Challenges, A.P.H. Pub. Corp. New Delhi. pp.1-351.

Gaston, K.J. and J.J. Spicer. 1998. Biodiversity: An Introduction. Blackwell Science Limited New York.

Magwaran. A.E. 1988. Ecological Diversity and its Measurement Croom Helm, London 167pp. Pullaiah,. T. 2011. Biodiversity in India Regency Publication

Singh. R.B. 2009. Biodiversity and Environment. Rawat Publications Wilson, D.E. and F.M.

Peter. 1988. Biodiversity. National Academy Press, Washington. 520pp.

World Convention Monitoring Centre (1992) Global Biodiversity: Status of Earth's Living

Resources. Chapman and Hall London.

e-Resources

http://www.nap.edu/catalog/989.html
http://indianbiodiversitytalk.blogspot.in/p/downloads.html

EVS 508: Global climate Change and Agriculture

Objective

To impart theoretical and practical knowledge about the evidence, causes and impact of climate change and its adaptation and mitigation options

Theory

Unit I

Definition and concept of climate change and variability; global warming and dimming; science and politics of climate change and international conventions; evidence, scenario and causes of climate change

Unit II Greenhouse gases and mechanism of their production and emission from various agro-ecosystems, source and sinks of GHG; warming potential and contribution of greenhouse gases to global warming, greenhouse effect; monitoring of greenhouse gases

Unit III

Impact assessment of rise in atmospheric temperature and CO_2 on growth, physiological processes, productivity and quality of different crops, soil health, water availability, insect pest dynamics, crop-weed competition, milk and inland and marine fish production; climate change and loss of biodiversity; spatial and temporal changes in agricultural production in context of climate change.

Unit IV

Evidence and causes of global dimming; causes of global dimming; impact assessment of global dimming on crop productivity, quality and crop- pest interaction.

Unit V

Adaptation and mitigation options to climate change; carbon sequestration; modeling climate change and its impact on crops; International summit, conferences, protocols and negotiations on climate change; clean development mechanism; carbon trading, credits, footprints and govt. strategies and policies on climate change management.

Practicals

Measurement of CO_2 from crop fields, Measurement of CH_4 from crop fields, Measurement of N_2O from crop fields, Measurement of O_3 from crop fields, Recent techniques for assessing the impact of high temperature on crops, Recent techniques for assessing the impact of CO_2 fertilization on crops, Recent techniques for assessing the impact of elevated O_3 on crops, Modelling impact of high temperature and CO_2 on crop yield, Modelling impact of high temperature on soil and water, Modelling impact of high CO_2 on soil and water

Suggested Reading

Climate change and global crop productivity ed. by K.R. Reddy and H.F. Hodges, CABI Publishing

Climate change Journal

Climate Change: Source, impact and policy, Proceeding of 2nd World Climate Conference. Ed. by J. Jager and H.L. Ferguson, Cambridge University Press, 1993

Global Warming (Fourth edition) by John Houghton, Cambridge Press

Greenhouse gas emission from agricultural system, Published by IPCC- USEPA IPCC Assessment Report 2007

EVS 511: Environmental Monitoring Systems and Impact Assessment (1+1)

Objective

To help the students acquire fundamental knowledge on environmental impact assessment and its importance in environmental protection.

Theory

Unit I

Concept of environmental impact assessment

Types of environmental impacts – natural impacts – impacts due to developmental activities.

Unit II

Methods of EIA

Economic, environmental and ecological consequences of common property ecosystem degradation.

Unit III

Current status of EIA

EIA in developed countries – steps and processes in EIA study – predication and assessment of different environments – soil, air, water, noise – biological, socioeconomic and cultural appraisal of EIA.

Unit IV

Economic development

Concept, trend and dimension. Criteria for evaluating environment related projects – review of EIA – status of EIA in India.

Unit V

Case studies for EIA

Conflict between industrialization and environmental preservation – effect of global trade on environment – role of Government in resource and natural management.

Practicals

Defining the problem in different ecosystems – quarry mining – coastal catchment ecosystem – deforestation – industrial conservation – highways – study on physical, chemical and biological properties – EIA: assessing the economic loss due to land, water and resources degradation –

visit to coal mine area – industrial area and silent valley – management aspects of EIA.

Suggested Readings

Basile, R.M. 1971. In: Conservation of Natural Resources (Ed. G.H.Smith). John Wiley and sons, New York. 133.

Munn, R.E.1975. Environmental Impact Assessment: Principles and Procedures. Scope report 5. Coronto, Canada.

Royston, M. 1978. In: Managing the Environment (eds. D.Bandhu, V.Bhardwaj and J.C.Bhat).
IES, New Delhi.

Sembrook, J. and D.W. 2011. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3.

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http://web.pdx.edu/~maserj/ESR 429_529/ESR 429-529.htm
http://www.naep.org/mc/page.do?sitepageId=91299andorgId=naep
http://www.sasanet.org/documents/tools/social impact assessment methodology.pdf
http://www.snh.gov./ebooks/A1198363 EIA handbok.pdfuk

EVS 513: Agroforestry (2+0)

Objectives

To give an overview to the students on the importance of agroforestry in agriculture and environment

Theory

Unit I

Agroforestry- its definition, concept, scope and advantage; classification of agroforestry; selection of plant species; plant species interaction; growth & production of tree plant; agroforestry & resource utilization

Unit II

Agroforestry models for various land use systems; agri-silviculture system, silvi-agrivulture system, silvi-pasture system, agri-silvi-pasture system, regeneration of tree crops

Unit III

Agroforestry options for sustainable land use; relationships between agro forestry, farm forestry and social forestry; agroforestry research in agricultural research system; environmental education as a tool for sustainable agroforestry

Unit IV

Agroforestry, biodiversity and sustainability; carbon sequestration through agroforestry; techniques to improve biomass production and climate change mitigation; biofuel production; agroforestry and sustainability

Unit V

Natural resources and environment management through ecosystem approach; biotic and abiotic components of ecosystem and their linkages; economics of agroforestry system

Suggested Readings

A Text book of Agroforestry by B.S.Chandawat and S.K.Gautam

Agroforestry: Principles and Practices by A.P. Dwivedi

Advances in Agrforestry by L.K. Jha

Agrforestry for Sustainable Land Use by P.Singh, P.S.Pathak and M.M. Roy

Environmental Services of Agroforestry Systems by Florencia Montagnini

Handbook on Agroforestry: Management Practices and Environmental Impact by Lawrence R. Kellimore (Editor)

Potential Application of Agroforestry System from Indian Subcontinent to the Analogous Ecozones of Africa by G.B. Singh (ICAR).

Note : For minor courses please refer the concerned department's courses outline.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

Objective: To acquaint the students about the basics of commonly used techniques in laboratory.

Practical Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0 (e-Course)

Objective To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary

Agencies/Non Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0 (e-Course)

Objectives To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

FSC 501 Tropical and Dry Land Fruit Production 2+1

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

Crops

UNIT I:	Mango and Banana
UNIT II:	Citrus and Papaya
UNIT III:	Guava, Sapota and Jackfruit
UNIT IV:	Pineapple, Annonas and Avocado
UNIT V:	Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards.

Suggested Readings

Bose T.K., Mitra S.K. & Rathore D.S. (Eds.). 1988. Temperate Fruits - Horticulture. Allied Publ.

Bose T.K., Mitra SK & Sanyal D. 2001. (Eds.). Fruits -Tropical and Subtropical. Naya Udyog.

Chadha K.L. & Pareek O.P. 1996. (Eds.). Advances in Horticulture. Vols. III-V. Malhotra Publ. House.

Nakasone, H.Y. & Paul, R.E. 1998. Tropical Fruits. CABI.

Peter, K.V. 2008. (Ed.). Basics of Horticulture. New India Publ. Agency.

Pradeep kumar T., Suma B., Jyothibhaskar & Satheesan K.N. 2008. Management of Horticultural Crops. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

Singh H.P., Negi, J.P. & Samuel J.C. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.

Singh H.P., Singh, G, Samuel, J.C. & Pathak, R.K. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502 Subtropical and Temperate Fruit Production 2+1

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of

flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

Crops

UNIT I	:	Apple, pear, quince, grapes
UNIT II	:	Plums, peach, apricot, cherries, hazelnut
UNIT III	:	Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV	:	Nuts- walnut, almond, pistachio, pecan
UNIT V	:	Minor fruits- mangosteen, carambola, bael, wood apple, fig, amun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

Bose, T.K., Mitra, S.K. & Sanyol, D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha, K.L. & Pareek, O.P. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.

Chadha, K.L. & Shikhamany, S.D. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.

Janick, J. & Moore, J.N. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons.

Nijjar, G.S. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.

Radha, T. & Mathew, L. 2007. Fruit Crops. New India Publ. Agency.

Singh, S., Shivankar, V.J., Srivastava, A.K. & Singh, I.P. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

FSC 503 Biodiversity and Conservation of Fruit Crops 2+1

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*

UNIT III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

Frankel, O.H. & Hawkes, J.G. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.

Peter, K.V. & Abraham, Z. 2007. Biodiversity in Horticultural Crops. Vol. I. Daya Publ. House.

Peter, K.V. 2008. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House.

FSC 504 Canopy Management in Fruit Crops 1+1

Objective

To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

UNIT V

Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application; experiments in breaking and induction of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

Bleasdale JKA. (1984). *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.

Gupta US. (1978). *Crop Physiology*. Oxford & IBH.

Krishnamoorti HN. (1981). *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill.

Peter KV. (2008). *Basics of Horticulture*. New India Publ. Agency, New Delhi.

Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (2001). *Laboratory Manual of Analytical Techniques in Horticulture*. Agrobios.

Wien HC. (1997). *The Physiology of Vegetable Crops*. CABI.

VSC 505 Seed Production Technology of Vegetable Crops 2+1

Theory

UNIT I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behavior, seed development and maturation; methods of hybrid seed production.

UNIT III

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT VI

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops;

seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

Agrawal PK & Dadlani M. (1992). *Techniques in Seed Science and Technology*. South Asian Publ.

PSMA 501 Production of Plantation Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Wattle and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

Suggested Readings

Anonymous, 1985. *Rubber and its Cultivation*. The Rubber Board of India.

Chopra VL & Peter KV. 2005. *Handbook of Industrial Crops*. Panima.

Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.

Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.

Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.

Peter KV. 2002. *Plantation Crops*. National Book Trust.

Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Part I, II. New India Publ. Agency.

Rai PS & Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS, Research Series No.6, Bangalore.

Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.

Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH.

Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

PSMA 502 Production Technology of Spice Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision

farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V

Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ.

Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.

Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

UNIT VIII

Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.

UNIT IX

Institutional support and international promotion of essential oil and perfumery products.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Aromatic Plants*. RRL, CSIR, Jammu.

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Farooqi AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Khan IA & Khanum A. *Role of Bio Technology in Medicinal and Aromatic Plants*. Vol. IX. Vkaaz Publ.

Kurian A & Asha Sankar M. 2007. *Medicinal Plants*. Horticulture Science Series, New India Publ. Agency.

Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.

Prajapati SS, Paero H, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.

Ramawat KG & Merillon JM. 2003. *BioTechnology-Secondary Metabolites*. Oxford & IBH.

Skaria P Baby, Samuel Mathew, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aomatic Plants*. New India Publ. Agency.

PSMA 504 Breeding of Plantation Crops and Spices 2+1

Objective

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

Species and cultivars, cytogenetics, survey, collection, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection, bioinformatics, IPR issues, achievements and future thrusts.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Black pepper and cardamom

UNIT VI: Ginger and turmeric

UNIT VII: Fenugreek, coriander, fennel, celery and ajwoain

UNIT VIII: Nutmeg, cinnamon, clove and allspice

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.

Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502 Production Technology of Cut Flowers 2+1

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops

Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture.* Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.52

Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 503 Production Technology for Loose Flowers 2+1

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nelson PV. 1978. *Green House Operation and Management*. Reston Publ. Co.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 506 Value Addition in Flowers 2+1

Objective

To develop understanding of the scope and ways of value addition in flowers.

Theory

UNIT I

Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.

UNIT II

Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.

UNIT III

Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.

UNIT IV

Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Practical

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0 (e-Course)

Objective To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/Non

Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0 (e-Course)

Objectives To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. oil fire, air pollution, water pollution,

deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

Narasaiah ML. 2004. *World Trade Organization & Agriculture*.Sonali Publ.

Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.

Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.

Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

AGRON 604 Advances in Crop Growth and Productivity 2+1

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial

measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas

Suggested Readings

Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford and IBH.

Delvin RM & Vitham FH. 1986. *Plant Physiology*. CBS Publ.

Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.

Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.

Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Gupta US. 1988. *Progress in Crop Physiology*. Oxford and IBH.

Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.* Academic Press.

Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.

Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publishers.

AGRON 605 IrrigationManagement 2+1

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT I

Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.

Michael AM. 1978. *Irrigation: Theory and Practice*.Vikas Publ.

Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.

Panda SC. 2003. *Principles and Practices of Water Management.* Agrobios.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 608 Soil Conservation and Watershed Management 2+1

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT I

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT V

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum*lands and measures to prevent soil erosion.

Practical

- Study of different types of erosion
- Field studies of different soil conservation measures

- Run-off and soil loss measurements
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.,* Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering.* Kalyani.

Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

Note : For minor courses please refer the concerned department's courses outline.

Varian HR. 992. *Microeconomic Analysis*. WW Norton & Co.

Varian HR. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AG ECON 602 Advanced Macro Economics Analysis 2+0

Objective

Advanced macroeconomics course will be offered to PhD students of Agricultural Economics with the following Course Objective.

- to understand the macroeconomic theory
- to examine the macroeconomic Policy issues
- to analyze the macroeconomic Policy implications

Theory

UNIT I

Review of Macro Economics concepts-Comparative statistics-Keynesian theory-Consumption Function and Theories of Consumption -Saving Function and Theories of Saving.

UNIT II

Theories of Investment-Savings and Investment Equality - IS - LM Framework and its mand for and Supply of Money-Monetary Policy in the static model –Inflation.

UNIT III

Stagflation and Supply side Economics - Theory of Unemployment – Phillips Curve controversy - Inflation, Productivity and distribution - Fiscal policy: Effectiveness and Problems.

UNIT IV

Social Accounting Matrix Framework - General Equilibrium Analysis - Neo classical Macro Economics - Stochastic Macro Economics.

UNIT V

BOP & Adjustment Policies - Foreign Exchange Policy - Foreign sector : Capital and Current Account - Impact of WTO on Indian Economy - Impact of IMF &IBRD on Indian Economy - Review of Macro Economic Policies in India.

Suggested Readings

Diulio EA. 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.

Frogen RT. 1999. *Macro Economic: Theory and Policies*. 6th Ed. Prentice Hall.

Samuelson PA & Nordhaus WD. 2004. *Economics*. McGraw-Hill.

Shapiro E. 1989. Macro Economic Analysis. Galgotia Publ.

AG ECON 603 Advance Econometrics

Objective

The Course Objective of the course is to impart knowledge on advanced econometric tools to the Research Scholars of agricultural economics. Training in advanced econometrics will help the Research Scholars to analyze the economic problem by applying quantitative techniques.

Theory

UNIT I

Review of classical regression model – review of hypothesis testing – restrictionson parameters – single equation techniques.

UNIT II

Ordinary least squares – weighted least squares - generalized least squares –method of principal components – instrumental variables method - maximum
likelihood method - errors in variables, non-linearity and specification tests – nonspherical error terms.

UNIT III

Dummy variables - Qualitative and truncated dependent variables – limited dependent variables –LPM, probit and logit models, their multinomial extensions.

UNIT IV

Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.

UNIT V

Simultaneous equation methods –identification – estimation by indirect leastsquares 2SLS, PIML, SURE, 3SLS.

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gelelectrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

Suggested Readings

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1st Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., NewDelhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*.Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

ENT 612 AdvancedIntegrated Pest Management 2+0

Objective

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

Theory

Unit I

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

Unit II

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

Unit III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real time situations.

Unit IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management– Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management-Potential, Constraints and Challenges.* CABI, London.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

Note : For minor courses please refer the concerned department's courses outline.

EXT 601 Advances in Agricultural Extension 2+1

UNIT I

Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

UNIT II

Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension - Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership, Stakeholder's analysis in Extension, Main streaming gender in Extension - Issues and Prospects.

UNIT III

Implications of WTO - AOA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve efficiency of extension.

UNIT IV

Extension and contemporary issues: Extension and issues related to rural poverty, Privatization of Extension, Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups, Organization innovations in Extension - ATIC, IVLP, Kisan Call Centers.

Practical

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension, Analysis of ATMA and SREP, Practicing bottom up planning. Visit to Public-Private –Farmer partnership, Leanings from Food and Nutritional Security and bio-diversity Projects and Programmes.

Suggested Readings

Bagchi J. 2007. *Agriculture and WTO Opportunity for India*. Sanskruti.

Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.

Crouch BR & Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.

John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ.Co.

Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.

Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.

Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.

Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.

Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

EXT 602 Advanced Designs and Techniques in Social Science Research 2+1

UNIT I

Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of

GP 601 Plant Genetic Resources and Pre-Breeding 2+0

Objective

To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

Theory

UNIT I

Historical perspectives and need for PGR conservation; Importance of plantgenetic resources; Taxonomical classification of cultivated plants; Genepool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes.

UNIT II

Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.

UNIT III

Germplasm conservation- *in situ, ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources.

UNIT IV

PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

UNIT V

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and

21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

UNIT VI

Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

UNIT VII

Post-genomic tools for genetic enhancement of germplasm; Prebreeding through chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.

UNIT VIII

Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.

Suggested Readings

Frankel OH & Bennett E. 1970. *Genetic Resources in Plants – their Exploration and Conservation*. Blackwell.

Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. *Plant Germplasm Collecting: Principles and Procedures*. NBPGR, New Delhi.

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.

Puzone L & Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

GP 608 Advances in Breeding of Major Field Crops 3+0

Objective

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

Theory

UNIT I

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

UNIT II

Breeding objectives in rice, wheat, maize, pearlmillet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

UNIT III

Breeding for value addition and resistance to abiotic and biotic stresses.

UNIT IV

Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT V

National and International accomplishments in genetic improvement of major field crops and their seed production.

Suggested Readings

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice*. Oxford & IBH.

Davis DD. 1978. *Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30: 129-157.

Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.

Khairwal, IS, Rai KN & Harinaryanan H. (Eds.). 1999. *Pearl Millet Breeding*. Oxford & IBH.

Khairwal I, Ram C & Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.

Nagarajan S, Singh G & Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.

Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.

Rao VS, Singh G & Misra SC. 2004. *Wheat: Technologies for Warmer Areas*. Annamaya Publ.

Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.

Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS & Josi AB. 1960. *Cotton in India – A Monograph*. Vol. I. ICAR.

Singh BD. 2006. *Plant Breeding - Principles and Methods*. Kalyani.

Singh P & Singh S. 1998. *Heterosis Breeding in Cotton*. Kalyani.

Singh P. 1998. *Cotton Breeding*. Kalyani.

Singh S & Singh P. 2006. *Trends in Wheat Breeding*. Kalyani Publ.

Note : For minor courses please refer the concerned department's courses outline.

Stacey G & Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

PL PATH 605 Principles and Procedures ofCertification1+0

Objective

To acquaint with certification procedures of seed and planting material.

Theory

UNIT I

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control.

UNIT II

Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc.

UNIT III

Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

Suggested Readings

Association of Official Seed Certifying Agencies. http://www.aosca.org/index.htm.

Hutchins D & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, UK.

ISHI-v*eg Manual of Seed Health Testing Methods.* http://www.worldseed.org/enus/international_seed/ishi_vegetable. html ISHI-F *Manual of Seed Health Testing Methods*.

http://www.worldseed.org/en-us/international_seed/ishi_f.html ISTA *Seed Health Testing Methods*. http://www.seedtest.org/en/content---1--1132--241.html

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.US National Seed Health System. http://www.seedhealth.org/

PL PATH 606 Plant Biosecurity and Biosafety 2+0

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008. www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory Biosecurity Guidance. http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.* http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf *Biosecurity Australia.* www.daff.gov.au/ba; www.affa.gov.au/biosecurityaustralia Biosecurity *New Zealand*. www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status andStrategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production. http://www.fao.org/biosecurity/ CFIA. http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml87

Note: For minor courses please refer the concerned department's courses outline.

SOIL 606 Land use Planning and Watershed Management 2+0

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT III

Agro-ecological regions/sub-regions of India and their characteristics inrelation to crop production.

UNIT IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

Suggested Readings

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.

FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.

USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

SOIL505 Soil Erosion and Conservation 2+1

Objective

To enable students to understand various types of soil erosion and measures to be taken for controlling soil erosion to conserve soil and water.

Theory

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; Rainfall erosivity - estimation as EI_{30} index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT III

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT IV

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT V

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT VI

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices - suspension percentage,
- dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio,
- percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI_{30}) using rain gauge data
- Visits to a watersheds

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Note: For minor courses please refer the concerned department's courses outline.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Gowen S. 1996. *Banana and Plantains*. Chapman & Hall.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. (Ed.). 1977. *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

Stover RH & Simmonds NW. 1991. *Bananas*. Longman.

FSC 602 Advances in Production of Fruit Crops 2+1

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops

UNIT I : Mango and banana

UNIT II: Papaya, grapes and citrus

UNIT III: Guava, sapota, pomegranate and aonla

UNIT IV: Pineapple, avocado, jack fruit and fig

UNIT V: Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and Subtropical*. Naya Udyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture.* Vol. I. Naya Prokash.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vols. IIIV. Malhotra Publishing House.

Chadha KL. 2001. *Handbook of Horticulture*. ICAR.

Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 603 Advances in Growth Regulation of Fruit Crops 2+1

Objective

Appraisal on the advances in growth regulation of fruit crops.

VSC 601 Advances in Vegetable Production 2+1

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I : Tomato, brinjal, chilli, sweet pepper and potato

UNIT II : Cucurbits, cabbage, cauliflower and knol-khol

UNIT III :Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV :Carrot, beet root and radish

UNIT V : Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dry land techniques for rainfed vegetable production; production constraints;

analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI. FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.

Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

VSC 602 Advances in Breeding of Vegetable Crops 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

PGS 503 INTELLECTUAL PROPERTY AND ITS 1+0

(e-Course) MANAGEMENT IN AGRICULTURE

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual

Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographicalindications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS 1+0 (e-Course) AND RURAL DEVELOPMENT PROGRAMMES

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme,

Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0

(e-Course)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

AGRONOMY

Course Title : Modern Concepts in Crop Production

Course Code :Agron 501

Credit Hours : 3+0

Aim of the course : To teach the basic concepts of soil management and crop production.

Theory

Unit I

Crop growth analysis in relation to environment; geo-ecological zones of India.

Unit II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

Unit III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

Unit IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition.

Unit V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.Modern crop production

concepts: soil less cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome

Basic knowledge on soil management and crop production

Suggested Reading

- Balasubramaniyan P and Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
- Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran S and Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.
- Alvin PT and kozlowski TT (ed.). 1976. *Ecophysiology of Tropical Crops*. Academia Pul., New York.
- Gardner PP, Pearce GR and Mitchell RL. 1985. *Physiology of Crop Plants*. Scientific Pub. Jodhpur.
- Lal R. 1989. Conservation tillage for sustainable agriculture: Tropics versus Temperate Environments. *Advances in Agronomy* 42: 85-197.
- Wilsie CP. 1961. *Crop Adaptation and Distribution*. Euresia Pub., New Delhi.

Course Title : Principal and Practices of Soil Fertility and Nutrient Management

Course Code :Agron 504

Credit Hours : 2+1

Aim of the course : To teach the principles of water management and practices to enhance the water productivity

Theory

Unit I

Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in India and concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states.

Unit II

Field water cycle, water movement in soil and plants; transpiration; soil-waterplant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Water availability and its relationship with nutrient availability and losses.

Unit III

Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation; management of water in controlled environments and polyhouses. Irrigation efficiency and water use efficiency.

Unit IV

Water management of crop and cropping system, Quality of irrigation water and management of saline water for irrigation, water use efficiency, Crop water requirement- estimation of ET and effective rainfall; Water management of the major crops and cropping systems. Automated irrigation system.

Unit V

Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage, their layout and spacing; rain water management and its utilization for crop production.

Unit VI

Quality of irrigation water and management of saline water for irrigation, water management in problem soils

Unit VII

Soil moisture conservation, water harvesting, rain water management and its utilization for crop production.

Unit VIII

Hydroponics,

Unit IX

Water management of crops under climate change scenario.

Practical

- Determination of Field capacity by field method
- Determination of Permanent Wilting Point by sunflower pot culture technique
- Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus
- Determination of Hygroscopic Coefficient
- Determination of maximum water holding capacity of soil
- Measurement of matric potential using gauge and mercury type tensiometer
- Determination of soil-moisture characteristics curves
- Determination of saturated hydraulic conductivity by constant and falling head method
- Determination of hydraulic conductivity of saturated soil below the water table by auger hole method
- Measurement of soil water diffusivity

• Estimation of unsaturated hydraulic conductivity.
Estimation of upward flux of water using tensiometer and from depth ground water table
• Determination of irrigation requirement of crops (calculations)
• Determination of effective rainfall (calculations)
• Determination of ET of crops by soil moisture depletion method
• Determination of water requirements of crops
• Measurement of irrigation water by volume and velocity-area method
• Measurement of irrigation water by measuring devices and calculation of irrigation efficiency
• Determination of infiltration rate by double ring infiltrometer

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment and field visit

Learning outcome

Basic knowledge on water management for optimization of crop yield

Suggested Reading

• Majumdar DK. 2014. Irrigation Water Management: Principles and Practice. PHL Learning private publishers
• Mukund Joshi. 2013. A Text Book of Irrigation and Water Management Hardcover, Kalyani publishers
• Lenka D. 1999. Irrigation and Drainage. Kalyani.
• Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
• Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi. • Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
• Prihar SS and Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
• Reddy SR. 2000. Principles of Crop Production. Kalyani.
• Singh Pratap and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ.

Course Title : Cropping Systems and Sustainable Agriculture

Course Code :Agron 511

Classroom teaching with AV aids, group discussion, assignment.

VIII. Learning outcome

Basic knowledge on cropping system for sustainable agriculture.

IX. Suggested Reading

• Panda SC. 2017. Cropping Systems and Sustainable Agriculture. Agrobios (India)
• Panda SC. 2018. Cropping and Farming Systems. Agrobios.
• Palaniappan SP and Sivaraman K. 1996. Cropping Systems in the Tropics; Principles and Management. New Age.
• Panda SC. 2003. Cropping and Farming Systems. Agrobios.
• Reddy SR. 2000. Principles of Crop Production. Kalyani.
• Sankaran S and Mudaliar TVS. 1997. Principles of Agronomy. The Bangalore Printing & Publ. Co.
• Singh SS. 2006. Principles and Practices of Agronomy. Kalyani
• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1997. Soil Fertility and Fertilizers. Prentice Hall.

Course Title : Dryland Farming and Watershed Management

Course Code. :Agron 512

Credit Hours : 2+1

Aim of the course : To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

Unit I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

Unit II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

Unit III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

Unit IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

Unit V

Concept of watershed resource management, problems, approach and components.

Practical

- Method of Seed Priming
- Determination of moisture content of germination of important dryland crops
- Determination of Relative Water Content and Saturation Deficit of Leaf
- Moisture stress effects and recovery behaviour of important crops
- Estimation of Potential ET by Thornthwaite method
- Estimation of Reference ET by Penman Monteith Method
- Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index)
- Classification of climate by Koppen Method

- Estimation of water balance by Thornthwaite method
- Estimation of water balance by FAO method
- Assessment of drought
- Estimation of length of growing period
- Estimation of probability of rain and crop planning for different drought condition
- Spray of anti-transpirants and their effect on crops
- Water use efficiency
- Visit to dryland research stations and watershed projects

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment.

Learning outcome

Basic knowledge on dry land farming and soil moisture conservation.

Suggested Reading

- Reddy TY. 2018. Dryland Agriculture Principles and Practices, Kalyani publishers
- Das NR. 2007. Tillage and Crop Production. Scientific Publ.
- Dhopte AM. 2002. Agrotechnology for Dryland Farming. Scientific Publ.
- Dhruv Narayan VV. 2002. Soil and Water Conservation Research in India. ICAR.
- Gupta US. (Ed.). 1995. Production and Improvements of Crops forDrylands. Oxford & IBH.
- Katyal JC and Farrington J. 1995. Research for Rainfed Farming. CRIDA.
- Rao SC and Ryan J. 2007. Challenges and Strategies of Dryland Agriculture. Scientific Publ.
- Singh P and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ. Company.
- Singh RP. 1988. Improved Agronomic Practices for Dryland Crops. CRIDA.
- Singh RP. 2005. Sustainable Development of Dryland Agriculture in India. Scientific Publ.
- Singh SD. 1998. Arid Land Irrigation and Ecological Management. Scientific Publ.

• Venkateshwarlu J. 2004. Rainfed Agriculture in India. Research and Development Scenario. ICAR.

Course Title : Principles and Practices of Organic Farming

Course Code :Agron 513

Credit Hours : 2+1

Aim of the course : To study the principles and practices of organic farming for sustainable crop production.

Theory

Unit I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; principles of organic agriculture; organics and farming standards; organic farming and sustainable agriculture; selection and conversion of land, soil and water management - land use, conservation tillage; shelter zones, hedges, pasture management, agro-forestry.

Unit II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, bio-fertilizers and biogas technology.

Unit III

Farming systems, selection of crops andcrop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

Unit IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.

Unit V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Method of making compost by aerobic method
- Method of making compost by anaerobic method
- Method of making vermicompost
- Identification and nursery raising of important agro-forestry trees and trees for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field
- Visit to a biogas plant
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment. exposure visit

Learning outcome

Basic knowledge on organic farming for sustainable agriculture and development of entrepreneurship on organic inputs.

Suggested Reading

- Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.
- Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO.
- Joshi M. 2016. New Vistas of Organic Farming. Scientific Publishers
- Lampin N. 1990. Organic Farming. Press Books, lpswitch, UK.
- Palaniappan SP and Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.

• Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, ParisaraprajnaParishtana, Bangalore.
• Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
• Sharma A. 2002. Hand Book of Organic Farming. Agrobios.
• Singh SP. (Ed.). 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.
• Subba Rao NS. 2002. Soil Microbiology. Oxford & IBH. • Trivedi RN. 1993. A Text Book of Environmental Sciences, Anmol Publ.
• Veeresh GK, Shivashankar K and Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.
• WHO. 1990. Public Health Impact of Pesticides Used in Agriculture. WHO.
• Woolmer PL and Swift MJ. 1994. The Biological Management of Tropical Soil Fertility. TSBF & Wiley.

Note :For minor courses please refer the concerned department's courses outline.

• Lectures. • Case studies. • Assignments (Group/individual).
• Group Discussions on price volatility and control measures prevailing.
• Power point presentations by students on government schemes.
• Visit to eNAMmandies, Warehouses, etc.

Learning outcome

After the completion of this course the student will be able to–
• Understand the whereabouts of agricultural marketing.
• The different forms of marketing existing in this sector.
• Gain expertise in market intelligence and price forecasting.

Suggested Reading

• Acharya SS &Agarawal NL. 2004. Agricultural Marketing in India. Oxford and IBH Publishing company Pvt. Ltd. New Delhi.
• Acharya SS &Agarawal NL. 1994. Agricultural Prices-Analysis and Policy. Oxford and IBH Publishing company Pvt. Ltd. New Delhi.
• Richard H Kohls and Joseph N. Uhl: Marketing of Agricultural products by Collier MacMillan International.

Course Title : Macro Economics and Policy

Course Code : AEC-504

Credit Hours : 2+0

Why this course?

The economy of the nation is governed by certain rules, regulation and principles. The students has to gain knowledge of the mechanism through which the large economies are controlled and ensure that welfare prevails. They are entitled to know the transactions between different markets and policies framed to keep value of money under control.

Aim of the course

The course envisages the concepts and principles of macroeconomics from classical to Keynesian theories. The other component deals with the monetary systemmoney, credit and banking system, value of money and economic activities, national income accounting and approaches to estimate national income theory of income and employment determination and inflation.

Organization of the course

The course is organised as follows:

No Block	Unit
1. ConceptualisingMacro economics	1. Introduction: Measurement and Concepts
2. Theories of macroeconomics	1. Classical Macroeconomics 2. Income and spending: Keynesian Framework
3 Money, Consumption and Inflation	1. Money, Interest and Income 2. Theories of Aggregate Consumption and Investment 3. Inflation and Unemployment

Theory

Block 1: Conceptualising Macro Economics

Unit 1: Introduction: Measurement and Concepts

Basic concepts and scope of Macro-economics, National Income Accounting: Methods of measurement of key macro-economic aggregates, relationship of national income and other aggregates (with numerical exercises), real and nominal income

Block 2: Theories of macroeconomics

Unit 1: Classical Macroeconomics

Say's Law, Quantity Theory of Money, aggregate labour supply and demand of labour, Classical theory of determining output, wages and prices.

Unit 2. Income And Spending: Keynesian Framework

Simple Keynesian model of income determination; Keynesian Multiplier- aggregate spending, taxation, transfer payments, foreign spending, balanced budget; budget surplus (with numerical exercises).

Block 3- Money, Consumption and Inflation

Unit 1: Money, Interest and Income

Goods market equilibrium-IS curve; Demand for Money, the Liquidity Preference.Theory – Liquidity Trap; asset market equilibrium- LM curve; simultaneous equilibrium in goods and asset market- effect of fiscal and monetary policy

Unit 2: Theories of Aggregarte Consumption and Investment

Absolute Income Hypothesis, Relative Income Hypothesis, Fisher's Inter-temporal Choice Model, Life-Cycle and Permanent Income Hypotheses; Profits and Accelerator Theory.

Unit 3: Inflation and Unemployment Inflation: Nature, Effects and control; Types of inflation – demand pull, cost pushstagflation, core inflation, hyperinflation; Phillips curve.

Teaching Methods/ Activities

• Lectures. • Case studies.
• Assignments (Group/individual).
• Group Discussions on inflation.

Learning outcome

After the completion of the course the student will be able to-Understand the concepts of national income, theories build up to understand macroeconomics. Understand better about the policies and government steps taken to control the economic transaction of the nation. Workout how the investment acts as a catalyst in national development.

Suggested Reading

• Stonier &Hegue. A Text Book of Economic Theory
• Samuelson PA. 1948. Foundation of Economic Analysis. Harvard University Press
• MC VaishAllid. 1983. Macro–Economics Theory
• Gardner Ackley. 1961. Macro–Economics Theory: Macmillan, New York.
• TF Dernburg& DM Mcdougali-Macro Economics
• G. Sirkin – Introduction to Macro–Economics Theory
• RL Heibroker-Understanding Macro–Economics
• JK Mehta –Macro Economics
• Michael R Edgemand – Macro-Economics: Theory & Policy
• David' W Pearce –The dictionary of modern Economics

Course Title : Econometrics

Course Code : AEC 505

Credit Hours : 2+1

Why this course?

Development of analytical skills is imperative to make students proficient in conducting quality research work. The knowledge of variables, their models, and problems encountered when dealing with variables will build up a compatibility with the analytical aspects.

Aim of the course

• Testing and managing Multicollinearity
• Estimation of regressions with dummy variables

Teaching Methods/ Activities
• Lectures.
• Assignments (Group/individual).

Learning outcome
After the completion of the course, the student will be able to-understand the variables and the properties of regression models. Identify the problems in variables and remove them before conducting the analysis and avoid biased results.

Suggested Reading
• Dorfman R. 1996. Linear Programming and Economic Analysis. McGraw Hill.
• Greene WH. 2002. Econometric Analysis. Pearson Education.
• Johnston J and Dinardo J. 2000. Econometric Methods. Mc Graw-Hill.
• Koutseyianis, A. 1997. Theory of Econometrics. Barner& Noble.
• Maddala GS. 2002. Econometrics. Mc Graw-Hill.
• Pinndyck RS and Rubinfeld DL. 1990. Econometric Models and Econometric Forecasts. McGraw Hill.

Course Title : Agricultural Finance and Project Management

Course Code : AEC 507

Credit Hours : 2+1

Why this course?
Money is the fuel of driving all the economic activities. India is a land of small and marginal farmers. The financial conditions of the farmers is not so strong that they can finance themselves. They require credit to meet the requirements of inputs. Thus, the student should know the sources, principles involved and types of credit available. The institutions involved and on what grounds the finance is given to the farmer. What are the risks involved and how to overcome them.

Aim of the course
This course is designed with an objective to deliver knowledge of the principles, procedures, problems and policies relating to financing agricultural

firms. In addition to this the students are also given knowledge about the research developments in the subject. The approach is analytic.

Organization of the course
The course is organised as follows:

No	Block	Unit
1	Introduction to Agricultural Finance	1. Basic Concepts: A review
2.	Credit and financial analysis	1. Credit and its aspects
		2. Financial analysis
3	Project and risk management	1. Project Overview
		2. Risk and its Management

Theory Block 1: Introduction to Agricultural Finance

Unit 1: Basic concepts: A Review

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

Block 2: Credit and Financial Analysis

Unit 1: Credit and its aspects

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

Unit 2: Financial analysis

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/ firm.

Block 3- Project and Risk Management

Unit 1: Project Overview Project

Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques –

Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

Unit 2: Risk and its Management

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes - yield loss and weather based insurance and their applications.

Practical

• Development of Rural Institutional Lending;

Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving;

• An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme;

• Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions;

• Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements;

• Performance of Micro Financing Institutions;

• NGO's and Self-Help Groups, Identification and formulation of investment projects;

• Project appraisal techniques – Undiscounted Measures and their limitations;

• Project appraisal techniques – Discounted Measures;

• Network techniques – PERT and CPM for project management;

• Case Study Analysis of an Agricultural project;

• Financial Risk and risk management strategies – crop insurance schemes;

• Financial instruments and methods – E banking, Kisan Cards and core banking.

IX. Teaching Methods/ Activities

• Lectures

• Case studies

• Assignments (Group/individual)

• Group Discussions on inflation

Learning outcome

After the completion of the course the student will be able to-Understand the key issues of finance in Agriculture. Learn the techniques of assessing the worth of a project.

Suggested Reading

• E Die Sollem H and Heady EO. (Ed.). Capital and Credit Needs in Changing Agriculture, Bauman.
• Hopkins A Barry, Peter Jo and Baker CB. Financial Management in Agriculture.
• Murray WG and Nelson AG. 1960. Agricultural Finance. Iowa State University
• Chanona C. 1969. Agricultural Finance in India: Role of Commercial Banks. Marketing and Economics Research Bureau, New Delhi.
• Gittinger JP. 1972. Economic analysis of agricultural projects, John Hopkins Univ. Press, Baltimore.
• Little IMD and JA Mirrless. 1974, Project appraisal and planning for developing countries, Oxford and IBH publishing Co. New Delhi.
• Arnold CH. 1972. Project Evaluation, collected papers, Macmillan.

Course Title : Linear Programming

Course Code : AEC-508

Credit Hours : 1+1

Theory

Unit I

Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

Unit II

Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non farm problems as linear programming models and solutions.

Unit III

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

Unit IV

(3rd Ed.).ELBS/ Longman, London. Mather K and Jinks JL.1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London. Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. Roy D. 2000. Plant Breeding: Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi. Sharma JR. 2006. Statistical and Biometrical Techniques in Plant Breeding. New Age International Pvt. Ltd. Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. Singh RK and Chaudhary BD. 1987. Biometrical Methods in Quantitative Genetic analysis. Kalyani Publishers, New Delhi. Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates. Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter. e-Suggested Reading www.iasri.icar.gov.in www.hau.ac.in/OPstat

Course Title : Varietal Development and Maintenance Breeding

Course Code : GPB 504

Credit Hours : 2(1+1)

Why this course?

It is an indispensable course which apprise the students about various practices and procedures in the development of a variety and steps to maintain the purity of varieties/ hybrids. Further, it provides basics of nucleus and breeder seed production techniques.

Aim of the course

The purpose of this course is to make students well acquainted with the techniques and procedures of varietal development. He will be associated with development of variety so the course aims is to provide knowledge on DUS testing, protocols of various breeding techniques, procedures of release of variety, maintenance of the variety and production of nucleus and breeder seed of variety/ hybrids.

Theory

Unit I

Variety Development systemsand Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, landraces, hybrid, and population; Variety testing, release and notification systems and norms in India and abroad.

Unit II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production.

Unit III

Maintenance of varieties in self and cross pollinated crops, isolation distance; Principles of seed production; Methods of nucleus and breeder seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified.

Unit IV

Quality seed production technology of self and cross-pollinated crop varieties, viz., cereals and millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi, etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton/ jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).

Unit V

Seed certification procedures; Seed laws and acts, plant variety protection regulations in India and international systems.

Practical

• Identification of suitable areas/ locations for seed production;

• Ear-to-row method and nucleus seed production;

• Main characteristics of released and notified varieties, hybrids and parental lines;

• PGMS and TGMS;

• Identification of important weeds/ objectionable weeds;

• Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops;

• Hybrid seed production technology of important crops;

• DUS testing and descriptors in major crops;

• Variety release proposal formats in different crops.

Teaching methods

• Power point presentation

• Chalk and Board • Smart board

• Lectures • Assignments, quiz

• Group tasks, student's presentations

Learning outcome

Pass out student will have complete knowledge on the various procedures linked with the development and release of variety. This course will also enable student how to maintain and multiply variety for large scale distribution. It will also make student acquainted with the seed laws and acts related to plant variety protection.

Suggested Reading

Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman. McDonald MB Jr and Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall. Poehlman JM and Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH. Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani. 2015 Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill

Course Title : Principles of Cytogenetics

Course Code : GPB 505

Credit Hours : 3 (2+1)

Course Title : Molecular Breeding and Bioinformatics*

Course Code : GPB 506

Credit Hours : 3(2+1)

Why this course?

The course will provide deep knowledge to the students on genotyping and kinds of markers including biochemical and molecular, mapping populations, allele mining. This will also add ways to perform marker-assisted selection and gene pyramiding to evolve superior varieties.

Aim of the course To impart knowledge and practical skills to use innovative approaches and Bioinformatics in Plant Breeding.

Theory

Unit I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.

Unit II

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.

Unit III

Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.

Unit IV

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases; Biotechnology applications in male sterility/ hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.

Practical

• Requirements for plant tissue culture laboratory;

• Techniques in plant tissue culture;

• Media components and media preparation;

• Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations;

• Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration;

• Hardening of regenerated plants; Establishing a greenhouse and hardening procedures;

• Visit to commercial micropropagation unit;

• Transformation using Agrobacterium strains;

• GUS assay in transformed cells/ tissues;

• DNA isolation, DNA purity and quantification tests;

• Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship;

• Construction of genetic linkage maps using computer software;

• NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, Expasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder;

• Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl);

• Primer designing- Primer 3/ Primer BLAST.

Teaching methods

• Power point presentation

• Chalk and Board

• Smart board

• Lectures

• Assignments, quiz

• Group tasks, student's presentations

Learning Outcome The knowledge of this course will enable the student to know about various molecular tools and approaches for genotyping and marker assisted breeding, intellectual property rights, bioinformatics tools and their uses in crop improvement.

Suggested Reading

Azuaje F and Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley and Sons. Brown TA. 1991. Essential Molecular Biology: a practical Approach. Oxford university press, 2002, 2nd edition Chawala HS. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ. Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co. Jollès P and Jörnvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis. Birkhäuser. Lewin B. 2017. Genes XII. Jones & Bartlett learning, 2017. Robert NT and Dennis JG. 2010. Plant Tissue Culture, Development,

• Examination and count of insect haemocytes; preparation and evaluation of various diets;
• Consumption, utilization and digestion of natural and artificial diets.

Learning outcome

• Students are expected to have a thorough understanding of insect growth and development, physiology of exoskeleton, endoskeleton and different organ systems; action and role of hormones, pheromones, physiology of nutrition and its application.

Suggested Reading

Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi. Gullan PJ and Cranston PS. 2000. The Insects: An Outline of Entomology, 2nd Ed. Blackwell Science, UK. Kerkut GA and Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York. Patnaik BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, Physiology and Development. Chapman and Hall, New York. Simpson SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier), London, UK. Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman and Hall, New York.

Course Title : Insect Taxonomy

Course Code : ENT 503

Credit Hours : 3 (1 + 2)

Aim of the course

To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same. To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects with an emphasis on the practical aspects.

Theory

Unit I

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions subjects of descriptions, characters, nature of characters, analogy

v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism. Brief evolutionary history of insectsintroduction to phylogeny of insects and Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained. International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses. Process of speciation and interbreeding allopatric species. Molecular systemnatics, DNA barcoding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

Unit II

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

Unit III

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

• Study of Orders of insects and their identification using taxonomic keys;
• Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera;
• Field visits to collect insects of different orders.

Learning outcome

• Students are expected to know the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification
• Acquire working skills for collecting, mounting, and preserving insects

•Understand the basic concepts of taxonomic hierarchy, identification, taxonomic characters, variations, taxonomic keys and preparation of taxonomic papers
• Identify insects of economic importance up to family levels, taking up the insect orders of agriculture and veterinary importance

Suggested Reading

CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca. Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi. Gullan PJ and Cranston PS. 2010. The Insects: An outline of Entomology. 4th Ed. Wiley-Blackwell Publications, West Sussex, UK. Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw Hill, New Delhi. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London. Ross HH.1974. Biological Systematics. Addison Wesley Publ. Company. Triplehorn CA and Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/ Australia.

Course Title : Biological Control of Insect Pests And Weeds

Course Code : ENT 505

Credit Hours : 3 (2+1)

Aim of the course

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Theory

Unit I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control-importation, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

Unit II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi,

2003. Biological Control of Insect Pests. Anmol Publ., New Delhi. Van Driesche and Bellows TS. Jr. 1996. Biological Control. Chapman and Hall, New York.

Course Title : Toxicology of Insecticides

Course Code : ENT 506

Credit Hours : 3 (2+1)

Aim of the course

To orient the students with structure and mode of action of important insecticidesbelonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticidessynergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. bioassay definition, objectives, criteria, factors, problems and solutions.

Unit IV

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

- Insecticide formulations and mixtures;
- Laboratory and field evaluation of bio-efficacy of insecticides;
- Bioassay techniques;
- Probit analysis;
- Evaluation of insecticide toxicity;
- Toxicity to beneficial insects;
- Pesticide appliances;
- Working out doses and concentrations of pesticides;
- Procedures of residue analysis.

Learning outcome

- Students are expected understand the concept of toxicity, bio-efficacy, insecticide formulations, modes of action of insecticides, estimation of insecticide residues and have significant know-how about the functioning of various types of spray equipments.

Suggested Reading

Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford and IBH, New Delhi.Dodia DA, Petel IS and Petal GM. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India), Jodhpur. Dovener RA, Mueninghoff JC and Volgar GC. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur. Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi. Ishaaya I and Degheele D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi. Krieger RI. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida. Mathews GA. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York. Otto D and Weber B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., UK. Pedigo LP and Marlin ER. 2009. Entomology and Pest Management, 6th Edition, Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A. Perry AS, Yamamoto I, Ishaaya I and Perry

R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publication, New York. Roy NK. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.

Course Title : Concepts of Integrated Pest Management

Course Code : ENT 508

Credit Hours : 2 (2+0)

Aim of the course

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL and implementing IPM programmes.

Theory

Unit I

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

Unit II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; costbenefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

Unit IV

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Learning outcome

• Students are expected to have significant knowledge of IPM concepts, estimation of losses due to insect pests, computation of ETL, EIL and should be able take management decisions.

Suggested Reading

Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi. Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi. Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

Course Title : Pests of Field Crops

Course Code : ENT 509

Credit Hours : 3 (2+1)

Aim of the course

To familiarize the students about nature of damage and seasonal incidence of pestiferous insects that cause loss to major field crops and their effective management by different methods.

Theory Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pest scenario in relation to climate change.

Unit I

Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs, etc.). Insect pests of cereals and millets and their management.

Unit II

Insect pests of pulses, tobacco, oilseeds and their management.

Unit III

Insect pests of fibre crops, forage crops, sugarcane and their management.

Practical

• Field visits, collection and identification of important pests and their natural enemies; • Detection and estimation of infestation and losses in different crops; • Study of life history of important insect pests.

Learning outcome

• Students are expected to acquire knowledge of insect pests of field crops, their nature of damage, life history traits and effective management.

Suggested Reading

David, BV and Ramamurthy, VV. 2001. Elements of Economic Entomology. Popular Book Depot, Chennai. Dhaliwal GS, Singh R and Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi. Dunston AP. 2007. The Insects: Beneficial and Harmful Aspects. Kalyani Publishers, New Delhi Evans JW. 2005. Insect Pests and their Control. Asiatic Publ., New Delhi. Nair MRGK. 1986. Insect and Mites of Crops in India. ICAR, New Delhi. Prakash I and Mathur RP. 1987. Management of Rodent Pests. ICAR, New Delhi. Saxena RC and Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Udaipur.

Note: For minor courses please refer the concerned department's courses outline.

AGRICULTURAL EXTENSION EDUCATION

Course Title : Extension Landscape

Course Code : EXT 501

Credit Hours : 2+0

Why this course?

Extension and advisory services (EAS) need to support farmers to deal with several new challenges they face currently. To effectively support farmers, EAS should perform several new functions and it should have capacities to perform these functions. EAS have evolved considerably especially during the

last 3 decades. Several new approaches have emerged and many new funding and delivery models emerged in response to reforms (economic policies and new governance structure) implemented in several countries. Apart from these, new insights from communication and innovation studies have also started to influence the practice of extension. There is a lot of interest globally in strengthening pluralistic EAS and enhancing its contribution towards development of an effective Agricultural Innovation System (AIS). Keeping these in view, there is a need to orient students of extension on how extension is shaped globally and the policy level challenges it faces so that the extension students fit well to the global demand for competent extension professionals who can appreciate and understand this changing context.

Aim of the course

The aim of this course is to introduce the new challenges before extension and how extension is evolving globally. It presents the new capacities that are needed by EAS providers to provide a much wider support to farmers and it orient students to the new insights from communication and innovation studies that are influencing the practice of extension globally. The course also help students to appreciate the process and the impact of extension reforms implemented in many countries, the new approaches that are evolving globally in different regions and the policy challenges in managing a pluralistic extension system. The course is organized as follows:

No	Blocks	Units
1	Globally,What is new in Extension?	1. Challenges Before Extension and Advisory Services
		2. New Functions and New Capacities
		3. Pluralism in EAS
2.	Insights from Communication & Innovation Studies & New	1. From the Linear Paradigm To Systems Paradigm
	Extension Approaches	2.Evolving Extension Approaches
3	Extension Reforms And Policy Challenges	1.Changes In Governance, Funding and Delivery of EAS

2. Challenges In Managing Pluralistic EA

Learning outcome

After successful completion of this course, the students are expected to be able to:

– Appreciate the changing global extension landscape

– Broaden their understanding on the role of EAS in agricultural innovation system

– Critically evaluate the reforms in extension and the evolving approaches in extension

– Analyse the policy level challenges in extension funding and delivery

Block 1: Globally, What Is New In Extension?

Unit 1:Challenges before Extension and Advisory Services (EAS)

Extension and Advisory Services (EAS)- Meaning (embracing pluralism and new functions) New Challenges before farmers and extension professionals: Natural Resource Management-Supporting farmers to manage the declining/deteriorating water and soil for farming; Gender Mainstreaming-How extension can enhance access to new knowledge among women farmers; Nutrition- Role of extension in supporting communities with growing nutritious crop and eating healthy food; Linking farmers to markets- Value chain extension including organizing farmers, strengthen value chain and supporting farmers to respond to new standards and regulations in agri-food systems; Adaptation to climate changes-How extension can contribute to up-scaling Climate Smart Agriculture; Supporting family farmsstrengthening the capacities of family farms; Migration-Advising farmers to better respond to opportunities that emerge from increasing mobility and also supporting migrants in enhancing their knowledge and skills; Attracting and Retaining Youth in Agriculture including promotion of agripreneurship and agri-tourism; Urban and peri-urban farming- How to support and address issues associated with urban and peri-urban agriculture; Farmer distress, suicides- Supporting farmers in tackling farm distress.

Unit 2: New Functions and New Capacities

Beyond transfer of technology: Performing new functions to deal with new challenges; Organising producers into groups-dealing with problems that need collective decision making such as Natural Resource Management (NRM) and access to markets; Mediating conflicts and building consensus to strengthen collective decision making; Facilitating access to credit, inputs and services-including development of service providers; Influencing policies to promote new knowledge at a scale Networking and partnership development including convening multi-stakeholder platforms/ innovation platforms.

New Capacities needed by extension and advisory services at different levels –at the individual (lower, middle management and senior management levels), organizational and enabling environment levels; –Core competencies at the individual level; Varied mechanisms for capacity development (beyond training).

Unit 3:

Pluralism in EAS Pluralism in Extension Delivery: Role of private sector (input firms, agri-business companies, consultant firms and individual consultants)- Trends in the development of private extension and advisory services in India and other countries; challenges faced by private extension providers; Role of Non-Governmental Organizations (National/international)/ Civil Society Organizations (CSOs) in providing extensionExperiences from India and other countries; Producer Organizations- Role in strengthening demand and supply of extension services; their strength andweaknesses-experiences from different sectors; Role of Media and ICT advisory service providers; global experiences with use of media and ICTs in advisory services provision.

Block 2:Insights From Innovation Studies and New Extension Approaches

Unit 1:From the Linear Paradigm to Systems Paradigm

Diffusion of Innovations paradigm- strengths and limitations; multiple sources of innovation-farmer innovation, institutional innovation; farmer participation in technology generation and promotion; strength and limitations; Agricultural Knowledge and Information Systems (AKIS); strength and limitations; Agricultural Innovation Systems (AIS); Redefining Innovation- Role of Extension and Advisory Services in AIS-From information delivery to intermediation across multiple nodes; Role of brokering; Innovation Platforms,

Innovation Management; Strength and weaknesses of AIS. Rethinking Communication in the Innovation Process – Network building, support social learning, dealing with dynamics of power and conflict.

Unit 2:Evolving Extension Approaches

Evolution and features of extension approaches: Transfer of technology approach; educational approach, farmer participatory extension approach, demand-driven extension, market led extension (value chain extension), extension for climate smart agriculture, gender sensitive extension, extension for entrepreneurship Extension systems in different regions: Asia-Pacific, Europe, Latin America, Australia, North America Networking for Strengthening EAS: GFRAS (Global Forum for Rural Advisory Services) and its regional networks.

Block 3: Extension Reforms and Policy Challenges

Unit 1: Changes in Governance, Funding and Delivery

Reduction in public funding: public withdrawal from extension provision (partial/ full); Examples/Cases; Privatization: Public funding and private delivery; cost sharing and cost recovery; Examples/Cases; Decentralisation of extension services; Examples/ Cases; Lessons from extension reforms in different countries; Extension and Sustainable Development Goals (SDGs).

Unit 2:Challenges in Managing Pluralistic Extension Systems

Pluralism: Managing pluralism and Co-ordination of pluralistic extension provision; Public private partnerships in extension (including the role of local governments/ panchayats and producer organisations); Examples, challenges in co-ordination; Achieving convergence in extension planning and delivery, Financing Extension: Mobilising resources for extension: public investments, donor support (grants/loans); Monitoring and Evaluation of Extension: Generating appropriate data for Assessment and Evaluation of pluralistic extension; Strengthening extension policy interface; generating evidence on impact of extension and policy relevant communication.

Teaching methods/activities

– Lecture

– Assignment (Reading/Writing)

– Book Review by students

– Student presentation

– Group Work

Suggested Reading

Adolph B. 2011. Rural Advisory Services World wide: A Synthesis of Actors and Issues. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/knowledge/gfras-publications.html? download=6: rural-advisory-services-worldwide&start=40

Ashok G, Sharma P, Anisha S and Prerna T. 2018. Agriculture Extension System in India Review of Current Status, Trends and the Way Forward. Indian Council for Research on International Economic Relations (ICRIER). http://icrier.org/pdf/Agriculture-ExtensionSystem-in-India-2018.pdf Barber J, Mangnus E and Bitzer V. 2016. Harnessing ICT for agricultural extension. KIT Working Paper 2016: 4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wp-content/ uploads/sites/2/2016/11/KIT_WP2016- 4_Harnessing-ICT-for-agricultural-extension.pdf

Bentley J, Chowdhury A and David S. 2015. Videos for Agricultural Extension. Note 6. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/6-video-for-agricultural-extension.html #SNote1

Bingen RJ and Simpson BM. 2015. Farmer Organizations and Modernizing Extension and Advisory Services. MEAS Discussion Paper. http://meas.illinois.edu/wp-content/uploads/ 2015/04/Bingen-Simpson-2014-FarmerOrganizations-MEAS-Discussion-Paper.pdf

Bitzer V, Wennink B and de Steenhuijsen PB. 2016. The governance of agricultural extension systems. KIT Working Paper 2016:1.http://213ou636sh0ptphd141fqei1.wpengine.netdnacdn.com/sed/wpcontent/uploads/sites/2/2016/03/WPS_1-2016-web.pdf

Bitzer V, Wongtschowski M, Hani M and Blum M. 2016. New directions for inclusive Pluralistic Service Systems. In New Directions for Inclusive Pluralistic Service Systems Rome (Italy). FAO. http://www.fao.org/3/a-i6104e.pdf Burton ES & Kristin D. 2014. Status of Agricultural Extension and

Rural Advisory Services Worldwide. GFRAS: Lindau, Switzerland. http://www.g-fras.org/en/knowledge/gfraspublications.html?download=391: status-of-agricultural-extension-and-rural-advisoryservices-worldwide

Christoplos I. 2010. Mobilizing the potential of rural and agricultural extension. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/012/ i1444e/i1444e.pdf

Colverson KE. 2015. Integrating Gender into Rural Advisory Services. Note 4. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/integrating-gender-into-rural-advisoryservices.html#SNote1

David S. 2018. Migration and rural advisory services. GFRAS Issues Paper 2. Global Forum for Rural Advisory Services. https://www.g-fras.org/en/knowledge/gfras-publications/category/ 97-gfras-issues-papers.html?download=856: migration-and-rural-advisory-services

Davis K and Heemskerk W. 2012. Coordination and Collective Action for Agricultural Innovation Overview Module 1 Investment in Extension and Advisory Services as Part of Agricultural Innovation Systems. In Agricultural Innovation Systems: An Investment Sourcebook. Agricultural and Rural Development. World Bank. © World Bank. http://siteresources.worldbank.org/INTARD/Resources/335807-1330620492317/ 9780821386842ch3.pdf

FAO. 2016. New directions for inclusive Pluralistic Service Systems. Report of FAO Expert Consultation. Food and Agriculture Organization of the United Nations and Royal Tropical Institute, Rome. http://www.fao.org/3/ai6103e.pdf

FAO.2017. Climate-Smart Agriculture Sourcebook. Available at: http://www.fao.org/3/ai3325e.pdf

Faure G, Pautrizel L, de Romémont A, Toillier A, Odru M and Havard M. 2015. Management Advice for Family Farms to Strengthen Entrepreneurial Skills. Note 8. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.gfras.org/en/good-practice-notes/management-advice-for-family-farms-to-strengthenentrepreneurial-skills.html#SNote8

Francis J, Mytelka L, Van Huis A and Röling N (eds.). 2016. Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers. Technical Centre for Agricultural and Rural Cooperation (CTA) and Wageningen University and Research (WUR)/ Convergence of Sciences Strengthening Innovation Systems (CoS-SIS), Wageningen. https:/ /publications.cta.int/media/publications/downloads/1829_PDF.pdf

GFRAS. 2012. Building Knowledge Systems in Agriculture Five Key Areas for Mobilising the Potential of Extension and Advisory Services. Global Forum for Rural Advisory Services. http://www.fao.org/uploads/media/1_gfras_positionpaper_final2_websmallpdf % 20com%20(1).pdf

GFRAS. 2015. Producer organisations in rural advisory services: Evidence and experiences. Position Paper. Lindau: Global Forum for Rural Advisory Services. http://www.g-fras.org/ en/593-producer-organisations-in-rural-advisory-servicesevidence-and-experiences.html

GFRAS. 2016. Five Key Areas for Mobilising the Potential of Rural Advisory Services. GFRAS Brief 1. Global Forum for Rural Advisory Services. https://www.g-fras.org/en/knowledge/ gfras-publications.html?download=4: five-key-areas-for-mobilising-the-potential-of-ruraladvisory-services.

GFRAS.2016. The New Extensionist Learning Kit. http://g-fras.org/en/knowledge/newextensionist-learningkit-nelk.html#module-1-introduction-to-the-new-extensionist

GRFAS. 2014. Policy Compendium. http://www.g-fras.org/en/policy-compendium.html Gwyn EJ and Garforth C. nd. The history, development, and future of agricultural extension. FAO. Rome. http://www.fao.org/docrep/W5830E/w5830e03.htm

Jennings JR, Packham RG and Woodside D. 2011. Shaping change: natural resource management, agriculture and the role of extension. Australasia Pacific Extension Network. http://www.apen.org.au/shaping-change

Leeuwis C with A W van den Ban. 2004. Communication for rural innovation: Rethinking agricultural extension.

John Wiley & Sons. Magdalena Blum and Sanne Chipeta. 2016. Innovative Financing Mechanisms for Demanddriven Agricultural Advisory Services.

Gfras good practice note for extension and advisory services 21. Global Forum for Rural Advisory Services. https://www.g-fras.org/en/goodpractice-notes/20-innovative-financing-mechanisms.html#SNote8

Manfre C, Rubin D and Nordehn C. 2017. Assessing How Agricultural Technologies can Change Gender Dynamics and Food Security Outcomes. A three part toolkit. Integrating Gender and Nutrition within Agricultural Extension Services (INGENAES). http:// www.culturalpractice.com/wp-content/uploads/Introduction-to-the-Toolkit-Final-10_17.pdf

Mittal N, Sulaiman RV and Prasad RM. 2016. Assessing capacity needs of Extension and Advisory Services: A Guide for Facilitators. Agricultural Extension in South Asia (AESA). http:// crispindia.org/wpcontent/uploads/2015/09/Facilitators-Guide-Final-LR.pdf

Posthumus H and Wongtschowski M. 2014. Innovation Platforms. Note 1. GFRAS good practice note for extension and advisory services. GFRAS: Lindau, Switzerland. https://www.gfras.org/en/good-practice-notes/innovation-platforms.html#SNote1

Rajalahti R, Janssen W and Pehu E. 2008. Agricultural innovation systems: From diagnostics toward operational practices. Agriculture & Rural Development Department, World Bank. https://agrilinks.org/sites/default/files/resource/files/ARDDiscussionPaper38.pdf

Rao S. 2015. Using Radio in Agricultural Extension. Note 18. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/ en/good-practice-notes/using-radio-in-agricultural-extension.html#SNote8

Rivera W and Zijp W. 2002. Contracting for Agricultural Extension-International Case Studies and Emerging Practices. CABI Publishing.

Saravanan R and Suchiradipta B. 2015. mExtension – Mobile Phones for Agricultural Advisory Services. Note 17. Gfras good practice note for extension and advisory services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/mextension.html#SNote17

Saravanan R, Suchiradipta B, Meera SN, Kathiresan C and Anandaraja N. 2015. Web Portals for Agricultural Extension and Advisory Services. Note 16.

GFRAS Good Practice Notesfor Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/

en/good-practice-notes/16-web-portals-for-agricultural-extension-and-advisoryservices.html#SNote8 Saravanan R, Sulaiman RV, Davis K and Suchiradipta B. 2015. Navigating ICTs for Extension and Advisory Services. Note 11. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://agrilinks.org/sites/default/files/resource/files/ gfras-ggp-note11_navigating_icts_for_ras_1.pdf

Sulaiman RV 2015. Agricultural Innovation Systems. Note 13. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/ en/good-practice-notes/agricultural-innovation-systems.html#SNote8

Sulaiman RV and Davis K. 2012. The New Extensionist: Roles, strategies, and capacities to strengthen extension and advisory services. In Lindau, Switzerland: Global Forum for Rural Advisory Services. http://www.g-fras.org/en/157-thenew-extensionist

Suvedi M and Kaplowitz MD. 2016. What Every Extension Worker Should Know: Core Competency Handbook. Michigan State University. Department of Community Sustainability. https://agrilinks.org/library/what-every-extensionworker-should-know-corecompetency-handbook

Swanson BE and Rajalahti R. 2010. Strengthening Agricultural Extension and Advisory Systems: Procedures for Assessing. Transforming, and Evaluating Extension Systems. Agriculture and Rural Development Discussion Paper; No. 45. World Bank, Washington, DC. © World Bank. http://siteresources.worldbank.org/INTARD/Resources/Stren_combined_web.pdf

Swanson BE. 2008. Global Review of Good Agricultural Extension and Advisory Service Practices. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/ pdf/011/i0261e/i0261e00.pdf

Terblanche S and H Ngwenya. 2017. Professionalisation of Rural Advisory Services. Note 27. GFRAS Global Good Practice Notes for Extension and Advisory Services. GFRAS: Lausanne, Switzerland. https://www.g-fras.org/en/good-practice-notes/27-professionalisation.html#SNote27

• Simulation exercise to understand decision-making under different situations
• Exercise in rational decision-making.

Teaching methods/activities

– Lecture cum discussion

– Class exercises

– Group Presentation

Learning outcome

The students should:

• Understand the biological and cognitive processes determining human behaviour

• Understand the process of learning under different context

• Develop competencies in influencing the human decision process in various contexts

• Design effective strategies to influence attitude and behaviour

Suggested Reading

Eiser J, Richard. 2011. Social Psychology: Attitudes, Cognition and Social Behaviour. Cambridge: Cambridge University Press.(First Edition, 1986)) Eysenck MW and Keane M T. 2010. Cognitive psychology: A student's handbook. Sixth Edition, Hove: Psychology Press. Feldman RS. 2008. Essentials of understanding psychology (7th ed.). Boston: McGraw-Hill. Gilovich T, Keltner D, and Nisbett RE. 2011. Social psychology. New York: W.W. Norton & Co. Moreno R. 2010. Educational Psychology. Hoboken, NJ: John Wiley & Sons Inc. Nevid JS. 2012. Essentials of psychology: Concepts and applications Belmont, CA: Wadsworth, Cengage Learning. Rachlin H. 1989. Judgment, decision, and choice: A cognitive/behavioral synthesis. New York: W.H. Freeman.

Course Title :Organisational Behavior and Development

Course Code : EXT 503

Credit Hours : 2+1

Why this course?

various applications for effectively deploying these in EAS provision. This course will provide knowledge and hands-on-experience on ICT applications relevant for EAS.

Aim of the course

• To discuss different ICT initiatives, knowledge management process and application aspects

• To orient students on advances in smart/ disruptive technologies and data analytics

• Hands on experience in navigating ICTs The course is organized as follows:

No	Blocks	Units
1.	Introduction to Information and Communication Technologies (ICTS) and e-Extension	1.ICTs- Concepts and Status 2.ICTs in Knowledge Management 3.e-Extension initiatives in Agriculture and allied sectors
2.	Application of ICTs in Extension and advisory services	1. ICT Applications 2. ICT Expert Systems 3. ICT Networks
3.	Knowledge management and Standards	1. Policies in Knowledge Management 2. Web Standards 3. Social Media Applications to engage audience
4.	Smart and disruptive Technologies and advanced analytics for agricultural extension	1. Smart Technologies 2. Human Computer Interactions

Theory

Block 1: Introduction to Information and Communication Technologies (ICTs) and E-extension

Unit 1: ICTs- Concepts and Status

ICTs- meaning, concepts, basics of ICTs, global and national status, types and functions of ICTs, innovations, meaning of e-Governance, e-learning, mLearning, advantages and limitations of ICTs.

Unit 2: ICTs in Knowledge Management

Knowledge management-meaning, approaches and tools. Role of ICTs in Agricultural Knowledge Management.

Unit 3: e-Extension initiatives in Agriculture and allied sectors

e-Extension, overview on Global and national e-extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGO initiatives in India.

Block 2: Application of ICTs in Extension and Advisory Services

Unit 1: ICT Applications

Knowledge centres (tele centres), digital kiosks, websites and web portals, community radio, farmers call centres, mobile phone based advisory services and mobile applications (mExtension, mLearning), Self-learning CDs on Package of practices, social media, digital videos, Market Intelligence and Information Systems- ICT enabled Supply-Chains and Value-Chains/ e-Marketing (e-NAM, Agmarknet, etc.).

Unit 2: ICT Expert Systems

Expert System/ Decision Support System/ Management Information Systems, Farm Health Management & Intelligence System for Plant Health, Animal Health, Soil Health, Fishery, Water, Weather, etc.

Unit 3: ICT Networks

Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Course CCRA, EduEx, etc), e-Governance Systems; digital networks among extension personnel, Farmer Producers Organisations (FPOs)/ SHGs/ Farmers Groups.

Block 3: Knowledge Management and Standards

Unit 1: Policies in Knowledge Management

Global policy/ Standards on e-Governance, National policy on e-governance, Open Data / Open Gov Standards and Open Source etc; Language Technology Applications; National e-Agriculture policy/ Strategies/ guidelines.

Unit 2: Web Standards

Web standards, creating and writing for webportals, development of mobile applications, developing digital videos- story board- video recording- video editing, types of blogs and writing guidelines.

Unit 3: Social Media Applications to engage audience

Video conference, live streaming and webinars, types and functions of social media applications, guidelines for preparing social media content, engaging audience and data-analytics.

Block 4: Smart and Disruptive Technologies and Advanced Analytics for Agricultural Extension

Unit 1: Smart Technologies

Open technology computing facilities, System for data analytics/ mining/ modelling/ Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU); disruptive technologies- Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), block chain technology, social media and Big Data analytics for extension.

Unit 2: Human Computer Interactions

Human Centered Learning/Ergonomics/ Human Computer Interactions-Meaning; Theories of multimedia learning - Sweller's cognitive load theory, Mayer's cognitive theory of multimedia learning, Schnotz's integrative model of text and picture comprehension, van Merriënboer's four-component instructional design model for multimedia learning; Basic Principles of Multimedia Learning - Split-attention, Modality, Redundancy, Coherence, Signaling, segmenting, pre-training, personalisation, voice embodiment; Advanced principles - Guided discovery, worked examples, Self-explanation, drawing, feedback, multiple representation, Learner control, animation, collaboration, prior knowledge, and working memory. Designing ICT gadgets based on human interaction principles - Interactive design-Meaning, importance; Approaches of interactive design - user-centered design,

activitycentered design, systems design, and genius design; Methods of interactive design - Usability testing methods.

Practicals

• Content and client engagement analysis

• Designing extension content for ICTs

• Creating and designing web portals, blogs, social media pages

• Developing digital videos

Live streaming extension programmes and organising webinars

• Working with Farmers call centres

• Engaging with professional digital networks • Writing for digital media

Teaching methods/activities

– Lecture

– Guest Lectures

–Assignment (Reading/Writing/ developing mApps/ media management/Social media initiatives)

– Student's Book/Publication Review

– Student presentation

– Group Work

– Student's interview of ICT practitioners/ champions

– Documenting good practices and case studies

– Review of ICT policy documents and guidelines/ standards

– Short internship with ICT projects

Learning outcome

After successful completion of this course, the students are expected to be able to:

– Appreciate the importance of the ICTs in EAS

– Understand the ICT application aspects

– Critically evaluate ICT initiatives and smart/disruptive technologies

– To execute extension functions by applying ICTs and

– Engage stakeholders in knowledge management process

Suggested Reading

Andres D and Woodard J. 2013. Social media handbook for agricultural development practitioners. Publication by FHI360 of USAID. http://ictforag.org/toolkits/ social/ SocialMedia4 AgHandbook.pdf Barber J, Mangnus E and Bitzer V. 2016. Harnessing ICT for agricultural extension. KIT Working Paper 2016: 4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wp-content/uploads/sites/ 2/2016/11/KIT_WP2016-4_Harnessing-ICT-for-agricultural-extension.pdf Bheenick K and Bionyi I. 2017. Effective Tools for Knowledge Management and Learning in Agriculture and Rural Development. CTA Working paper. https://publications.cta.int/media/publications/downloads/1986_PDF.pdf Fafchamps M and Minten B. 2012. Impact of SMS based Agricultural Information on Indian Farmers. The World Bank Economic Review, Published by the Oxford University Press on behalf of the International Bank for Reconstruction and Development. FAO 2011. E-learning methodologies a guide for designing and developing e-learning courses. Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/015/i2516e/i2516e.pdf George T, Bagazonzya H, BallantyneP, Belden C, Birner R, Del CR and Treinen S. 2017. ICT in agriculture: connecting smallholders to knowledge, networks, and institutions. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12613 16 Heike Baumüller. 2018. The little we know: An exploratory literature review on the utility of mobile phone enabled services for smallholder farmers. Journal of International Development. 30, 134–154. Laurens K. 2016. NELK Module 6: Basic Knowledge Management and Extension, New Extensionist Learning Kit (NELK), Global Forum for Rural Advisory Services (GFRAS). http://www.g-fras.org/en/knowledge/new-extensionist-learning-kit-nelk.html# module-6-

basic-knowledge-management-and-extension Mayer RE. 2005. The Cambridge handbook of multimedia learning. New York: University of Cambridge. MEAS & Access Agriculture 2013. A Guide to Producing Farmer-to-Farmer Training Videos.

• Plant virus purification (clarification, concentration, centrifugation, high resolution separation and analysis of virions), Electron microscopy for studying viral particle morphology;
• Antisera production, Detection and diagnosis of plant viruses with serological (ELISA), nucleic acid (Non-PCR–LAMP, Later flow micro array and PCR based techniques);
• Exposure to basic bio-informatic tools for viral genome analysis and their utilization in developing detection protocols and population studies (BLASTn tool, Primer designing software, Bioedit tool, Claustal X/W, MEGA Software).

Suggested Reading

Bos L. 1964. Symptoms of Virus Diseases in Plants. Oxford & IBH., New Delhi. Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ and Watson L. 1995. Virus of Plants: Descriptions and Lists from VIDE Database. CABI, Wallington. Gibbs A and Harrison B. 1976. Plant Virology – The Principles. Edward Arnold, London. Hull R. 2002. Mathew's Plant Virology. 4th Ed. Academic Press, New York. Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Oxford & IBH, New Delhi. Wilson C. 2014. Applied Plant Virology. CABI Publishing England.

Course Title : Plant Pathogenic Prokaryotes
Course Code : PL PATH 503
Credit Hours : 2+1
Aim of the course

To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

V. Theory

Unit I Prokaryotic cell: History and development of Plant bacteriology, history of plant bacteriology in India. Evolution of prokaryotic life, Prokaryotic cytoskeletal proteins. Structure of bacterial cell. Structure and composition of gram negative and gram positive cell wall; synthesis of peptidoglycan; Surface proteins; Lipopolysaccaride structure; Membrane transport; fimbrae and pili (Type IV pili); Mechanism of flagellar rotatory motor and locomotion, and bacterial movement; Glycocalyx (Slayer; capsule); the bacterial chromosomes and plasmids; Operon and other structures in cytoplasm; Morphological feature of fastidious bacteria, spiroplasmas and Phytoplasmas.

Unit II Growth and nutritional requirements. Infection mechanism, role of virulence factors in expression of symptoms. Survival and dispersal of phytopathogenic prokaryotes.

Unit III Taxonomy of phytopathogenic prokarya: Taxonomic ranks hierarchy; Identification, Classification and nomenclature of bacteria, phytoplasma and spiroplasma. The codes of Nomenclature and characteristics. Biochemical and molecular characterization of phytopathogenic prokaryotes.

Unit IV Variability among phytopathogenic prokarya: general mechanism of variability (mutation); specialized mechanisms of variability (sexual like process in bacteriaconjugation; transformation; transduction); and horizontal gene transfer.

Unit V Bacteriophages, L form of bacteria, plasmids and bdellovibrios: Structure; Infection of host cells; phage multiplication cycle; Classification of phages, Use of phages in plant pathology/ bacteriology, Lysogenic conversion; H Plasmids and their types, plasmid borne phenotypes.Introduction to bacteriocins. Strategies for management of diseases caused by phytopathogenic prokaryotes.

Practical

• Study of symptoms produced by phytopathogenic prokaryotes;
• Isolation, enumeration, purification, identification and host inoculation of phytopathogenic bacteria; • Stains and staining methods;
• Biochemical and serological characterization;
• Isolation of genomic DNA plasmid;
• Use of antibacterial chemicals/ antibiotics;
• Isolation of fluorescent Pseudomonas;
• Preservation of bacterial cultures;
• Identification of prokaryotic organisms by using 16S rDNA, and other gene sequences;
• Diagnosis and management of important diseases caused by bacteria and mollicutes.

Suggested Reading

Goto M. 1990. Fundamentals of Plant Bacteriology. Academic Press, New York. Jayaraman J and Verma JP. 2002. Fundamentals of Plant Bacteriology. Kalyani Publishers, Ludhiana. Mount MS and Lacy GH. 1982. Phytopathogenic Prokaryotes. Vols. I, II Academic Press, New York. Salle AJ. 1979. Fundamental Principles of Bacteriology 7th edn. Verma JP, Varma A

and Kumar D. (Eds). 1995. Detection of Plant Pathogens and their Management. Angkor Publ., New Delhi.

Course Title : Plant Nematology
Course Code : PL PATH 504
Credit Hours : 2+1
Aim of the course
To project the importance of nematodes in agriculture and impart basic knowledge on all aspects of plant nematology.
V. Theory
Unit I Characteristics of Phylum Nematoda and its relationship with other related phyla, history and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.
Unit II Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.
Unit III Types of parasitism; nature of damage and general symptomatology; interaction of plant-parasitic nematodes with other organisms.
Unit IV Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.
Unit V Principles and practices of nematode management; integrated nematode management.
Unit VI Emerging nematode problems, Importance of nematodes in international trade and quarantine.
Practical
• Studies on kinds of nematodes- free-living, animal, insect and plant parasites;
• Nematode extraction from soil;
• Extraction of migratory endoparasites, staining for sedentary endoparasites;
• Examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.
Suggested Reading
Dropkin VH. 1980. An Introduction to Plant Nematology. John Wiley & Sons, New York. Maggenti AR. 1981. General Nematology. Springer-Verlag, New York. Perry RN and Moens M. 2013. Plant Nematology. 2nd Ed. CABI Publishing: Wallingford, UK. Perry RN, Moens M, and Starr JL. 2009. Root-knot nematodes, CABI Publishing: Wallingford, UK. Sikora RA, Coyne D,

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil physical properties and processes in relation to plant growth.

Suggested Reading

• Baver LD, Gardner WH and Gardner WR. 1972. Soil Physics. John Wiley & Sons.
• Ghildyal BP and Tripathi RP. 2001. Soil Physics. New Age International.
• Hanks JR and Ashcroft GL. 1980. Applied Soil Physics. Springer Verlag.
• Hillel D. 1972. Optimizing the Soil Physical Environment toward Greater Crop Yields. Academic Press.
• Hillel D. 1980. Applications of Soil Physics. Academic Press.
• Hillel D. 1980. Fundamentals of Soil Physics. Academic Press.
• Hillel D. 1998. Environmental Soil Physics. Academic Press.
• Hillel D. 2003. Introduction to Environmental Soil Physics. Academic Press.
• Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSS, New Delhi.
• Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley-Interscience.
• Kohnke H. 1968. Soil Physics. McGraw Hill.
• Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
• Oswal MC. 1994. Soil Physics. Oxford & IBH.

Course Title : Soil Fertility and Fertilizer Use
Course Code : Soil 502
Credit Hours : 3+1

Aim of the course

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

Unit I

Soil fertility and soil productivity; fertility status of major soils group of India; nutrient sources – fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiency symptoms, Nutrient uptake, nutrient interactions in

soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity.

Unit II Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

Unit III Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid andalkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soilsand management under field conditions. Potassium - forms, equilibrium in soils and its agriculturalsignificance; mechanism of potassium fixation; management of potassium fertilizers under fieldconditions.

Unit V Sulphur - source, forms, fertilizers and their behavior in soils; roleincropsandhuman health; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

Unit VI Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

Unit VII Common soil test methods for fertilizer recommendations; quantity–intensity relationships; soil test crop response correlations and response functions.

Unit VIII Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; speciality fertilizers concept, need and category. Current status of speciality fertilizers use in soils and crops of India;

Unit IX Soil fertility evaluation - biological methods, soil, plant and tissue tests; soilquality in relation to sustainable agriculture, Determination of critical limit, DRIS

Unit X Definition and concepts of soil health and soil quality; Longterm effects of fertilizers and soil quality.

Practical

- Soil and plant sampling and processing for chemical analysis
- Determination of soil pH, total and organic carbon in soil
- Chemical analysis of soil for total and available nutrients(major and micro)

• Analysis of plants for essential elements(major and micro)

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

Suggested Reading

• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
• Kabata-Pendias A and Pendias H. 1992. Trace Elements in Soils and Plants. CRC Press.
• Kannaiyan S, Kumar K and Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
• Leigh J G. 2002. Nitrogen Fixation at the Millennium. Elsevier.
• Mengel K and Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland.
• Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
• Pierzinsky GM, Sims TJ and Vance JF. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press.
• Stevenson FJ and Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.
• Tisdale SL, Nelson SL, Beaton JD and Havlin JL. 1999. Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.
• Troeh FR and Thompson LM. 2005. Soils and Soil Fertility. Blackwell.

Course Title : Soil Chemistry
Course Code : Soil 503
Credit Hours : 2+1

Suggested Reading

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

Theory

Unit I Chemical (elemental) composition of the earth's crust, soils, rocks and minerals

Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm, Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved, Determination of titratable acidity of an acid soil by BaCl2-TEA method, Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement of an alkali soil.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of chemical behaviour of soil and their utility in research for solving field problem.

Suggested Reading

• Bear RE. 1964. Chemistry of the Soil. Oxford and IBH.
• Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
• Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
• Greenland DJ and Hayes MHB. Chemistry of Soil Constituents. John Wiley & Sons.
• McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
• Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford University Press. • Sposito G. 1984. The Surface Chemistry of Soils. Oxford University Press.
• Sposito G. 1989. The Chemistry of Soils. Oxford University Press.
• Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley & Sons.
• Van Olphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

Course Title : Soil Mineralogy, Genesis and Classification

Course Code : Soil 504

Credit Hours : 2+1

Aim of the course

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis interms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

Unit I Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

Unit II Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystal line and non-crystal line clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils, role of clay minerals in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

Unit III Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

Unit IV Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

Practical

- Separation of sand, silt and clay fraction from soil
- Determination of specific surface area and CEC of clay
- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different land forms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soil susing available database in terms of soil quality

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil taxonomy and genesis and and their utility in research for solving field problem.

Suggested Reading

• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu. Buol EW, Hole ED, MacCracken RJ and Southard RJ. 1997. Soil Genesis • and Classification. 4th Ed. Panima Publ.

• Dixon JB and Weed SB. 1989. Minerals in Soil Environments. 2nd Ed. Soil Science Society of America, Madison.

• Grim RE. 1968. Clay Mineralogy. McGraw Hill.

• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. • Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi
• Sehgal J. 2002. Pedology - Concepts and Applications. Kalyani.
• USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
• Wade FA and Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH. • Wilding LP and Smeck NE. 1983. Pedogenesis and Soil Taxonomy: II. The Soil Orders. Elsevier.
• Wilding NE and Holl GF. (Eds.). 1983. Pedogenesis and Soil Taxonomy. I.

Course Title : Soil Erosion and Conservation
Course Code : Soil 505
Credit Hours : 2+1
Aim of the course
To enable students to understand various types of soil erosion and measures to betaken for controlling soil erosion to conserve soil and water.
Theory
Unit I History, distribution, identification and description of soil erosion problems in India.
Unit II Forms of soil erosion; effects of soil erosion and factors affecting soilerosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affectingwater erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties andprecipitation.
Unit III Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.
Unit IV Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.
Unit V Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.
Unit VI Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to

monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds, sediment measurement

Practical

• Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index
• Computation of kinetic energy of falling rain drops
• Computation of rainfall erosivity index (EI30) using rain gauge data
• Land capability classification of a watershed
• Visits to a watersheds

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil conservation and their utility in research for solving field problem.

Suggested Reading

• Biswas TD and Narayanasamy G. (Eds.) 1996. Soil Management in Relation to Land Degradation and Environment. Bull. Indian Society of Soil Science No. 17.
• Doran JW and Jones AJ. 1996. Methods of Assessing Soil Quality. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
• Gurmal Singh, Venkataramanan C, Sastry G and Joshi BP. 1990. Manual of Soil and Water Conservation Practices. Oxford & IBH.
• Hudson N. 1995. Soil Conservation. Iowa State University Press.
• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. • Oswal MC. 1994. Soil Physics. Oxford & IBH.

Course Title : Soil Biology and Biochemistry
Course Code : Soil 506
Credit Hours : 2+1

Aim of the course

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

• Paul EA and Clark FE. Soil Microbiology and Biochemistry.
• Lynch JM. Soil Biotechnology
• Willey JM, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.
• Subba Rao NS. Advances In Agricultural Microbiology.

Course Title : Soil Survey and Land Use Planning
Course Code : Soil 513
Credit Hours : 2+0
im of the course

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/ excessive rain-water in the catchment area for agricultural purposes in a watershed.

V. Theory

Unit I

Soil survey and its types; soil survey techniques- conventional and modern; soil series–characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; thematic soil maps, cartography, mapping units, techniques for gene ration of soil maps, application of remote sensing and GIS in soil survey and mapping of major soil group of India

Unit II

Landform–soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT)–concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Unit III

Concept and techniques of land use planning; factors governing present land use; Land evaluation method sand soil-site suitability evaluation for different crops; land capability classification and constraints in application.

Unit IV

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production. Status of LUP in India.

VI. Practical

• Aerial photo and satellite data interpretation for soil and land use

• Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in differentscales

• Land use planning exercises using conventional and RS tools

VII. Teaching methods/activities

Classroom teaching with AV aids, group discussion, field visit and exposure visit

VIII. Learning outcome

Planning for land use in proper way for higher crop productivity.

IX. Suggested Reading

• Boul SW, Hole ED, MacCraken RJ and Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ.

• Brewer R. 1976. Fabric and Mineral Analysis of Soils. John Wiley & Sons.

Note : For minor courses please refer the concerned department's courses outline.

HORTICULTURE (FRUIT SCIENCE)
Course Contents M.Sc. (Hort.) in Fruit Science

I. Course Title : Tropical Fruit Production

II. Course Code : FSC 501

III. Credit Hours : (2+1)

Why this course ?

Tropical fruits occupy a distinct place in global fruit production. Apart from ecological specificities, tropical fruits enjoy favour among masses being delicious and nutritious. As such, the course has been designed to provide update knowledge on various production technologies of tropical fruits on sustainable basis.

Aim of the course

To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	I Importance and Background
2	Agro-Techniques	I Propagation, Planting and Orchard Floor Management
3	Crop Management	I Flowering, Fruit-Set and Harvesting

Theory

Block 1: Introduction

Unit I:

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-techniques

Unit I:

Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Unit I:

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Crops

Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.

Practicals

• Distinguished features of tropical fruit species, cultivars and rootstocks (2);

• Demonstration of planting systems, training and pruning (3);

• Hands on practices on pollination and crop regulation (2);

• Leaf sampling and nutrient analysis (3);

• Physiological disorders-malady diagnosis (1);

• Physico-chemical analysis of fruit quality attributes (3);

• Field/ Exposure visits to tropical orchards (1);

• Project preparation for establishing commercial orchards (1).

Teaching Methods/ Activities

• Class room Lectures

• Laboratory/ Field Practicals

• Student Seminars/ Presentations

• Field Tours/ Demonstrations

• Assignments

Learning outcome

The students are expected to equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits.

Suggested Reading

Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International. Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical.3rd Edn. Naya Udyog, Kolkata. Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi. Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principlesand Practices. IBDC Publishers, New Delhi. Litz RE. 2009. The Mango: Botany, Production and Uses. CAB International. Madhawa Rao VN. 2013. Banana. ICAR, New Delhi. Midmore D. 2015. Principles of Tropical Horticulture. CAB International. Mitra SK and Sanyal D. 2013. Guava, ICAR, New Delhi. Morton JF. 2013. Fruits of Warm Climates. Echo Point Book Media, USA. Nakasome HY and Paull RE. 1998. Tropical Fruits. CAB International. Paull RE and Duarte O. 2011. Tropical Fruits (Vol. 1). CAB International. Rani S, Sharma A and Wali VK. 2018. Guava (Psidium guajava L.). Astral, New Delhi. Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International. Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi. Schaffer B, Wolstenholme BN and Whiley AW. 2013. The Avocado: Botany, Production and Uses. CAB International. Sharma KK and Singh NP. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi. Valavi SG, Peter KV and Thottappilly G. 2011. The Jackfruit. Stadium Press, USA.

Course Title : Subtropical and Temperate Fruit Production

Course Code : FSC 502

Credit Hours : (2+1)

Why this course ?

Agro-climatic diversity in India facilitates growing a wide range of fruits extending from tropical to subtropical to temperate fruits and nuts. To highlight their ecological specificities, seasonal variations and pertinent cultural practices, a course is designed exclusively for subtropical and temperate fruits. V. Aim of the course To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	Importance and Background
2	Agro-Techniques	Propagation, Planting and Orchard Floor Management
3	Crop Management	Flowering, Fruit-Set and Harvesting

Theory

Block 1: Introduction

Unit I:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Block 2: Agro-Techniques

Unit I:

Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Unit I:

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Crops

Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

Practicals

• Distinguished features of fruit species, cultivars and rootstocks (2);

• Demonstration of planting systems, training and pruning (3);

• Hands on practices on pollination and crop regulation (2);

• Leaf sampling and nutrient analysis (3);

• Physiological disorders-malady diagnosis (1);

• Physico-chemical analysis of fruit quality attributes (3);

• Field/ Exposure visits to subtropical and temperate orchards (1);

• Project preparation for establishing commercial orchards (1).

Teaching Methods/ Activities

• Class room Lectures

• Laboratory/ Field Practicals

• Student Seminars/ Presentations

• Field Tours/ Demonstrations

• Assignments

Learning outcome

After successful completion of the course, the student are expected to equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate, etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit, etc.) and nuts (almond, walnut, pecan, etc.)

Suggested Reading

Chadha KL and Awasthi RP. 2005. The Apple. Malhotra Publishing House, New Delhi. Chadha TR. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi Childers NF, Morris JR and Sibbett GS. 1995. Modern Fruit Science: Orchard and Small Fruit Culture. Horticultural Publications, USA. Creasy G and Creasy L. 2018. Grapes. CAB International. Davies FS and Albrigo LG. 1994. Citrus. CAB International. Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi. Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International. Ladanyia M. 2010. Citrus Fruit: Biology, Technology and Evaluation. Academic Press. Layne DR and Bassi D. 2008. The Peach: Botany, Production and Uses. CABI. Menzel CM and Waite GK. 2005. Litchi and Longan: Botany, Production and Uses. CAB International. Pandey RM and Randey SN. 1996. The Grape in India. ICAR, New Delhi. Rajput CBS, and Haribabu RS. 2006. Citriculture, Kalyani Publishers, New Delhi. Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi. Sharma RM, Pandey SN and Pandey V. 2015. The Pear – Production, Post-harvest Management and Protection. IBDC Publisher, New Delhi. Sharma RR and Krishna H. 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi. Singh S, Shivshankar VJ, Srivastava AK and Singh IP. 2004. Advances in Citriculture. NIPA, New Delhi. Tromp J, Webster AS and Wertheim SJ. 2005. Fundamentals of Temperate Zone Tree Fruit Production.Backhuys Publishers, Lieden, The Netherlands. Webster A and Looney N. Cherries: Crop Physiology, Production and Uses. CABI. Westwood MN. 2009. Temperate Zone Pomology:Physiology and Culture. Timber Press, USA.

Course Title : Propagation and Nursery Management in Fruit Crops

HORTICULTURE (PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS)

I. Course Title : Production of Plantation Crops
II. Course Code : PSM 501
III. Credit Hours : (2+1)
IV. Why this course ?

Plantation crops play an important role in the national economy of India. These crops also provide livelihood security to a large section of farmers. This course willimpart theoretical as well as hands-on experience to the learner on scientificproduction technology of various plantation crops in Indian perspectives. It willprovide comprehensive knowledge in this regard.

V. Aim of the course

The course is designed to provide both basic and applied knowledge on various aspects of production technology of plantation crops grown in India.

The course is organized as follows:

No	Blocks	Units
1	Importance of Plantation Crops	I Role of plantation crops
		II Export potential
		III Promotional programmes
2	Production Technology	I Varietal wealth
		II Propagation and nursery management
		III Agro techniques
3	Harvest and Post-harvest management	I Maturity indices and harvest
		II Post harvest management

VI. Theory

Block 1: Importance of Plantation Crops

Unit 1: Role of plantation crops: Role of plantation crops in national economy, area-production statistics at national and international level,classification, clean development mechanism and carbon sequestrationpotential of plantation crops.

Unit 2: Export potential: Export potential, problems and prospects and IPR issues in plantation crops.

Unit 3: Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation crops.

Block 2: Production Technology

Unit 1: Varietal wealth: Botany, taxonomy, species, cultivars and improved varieties in plantation crops.

Unit 2: Propagation and nursery management: Plant multiplication including *in-vitro*multiplication, nursery techniques and nursery management in plantation crops.

Unit 3: Agro techniques: Systems of cultivation, cropping systems, multitiercropping, climate and soil requirements, systems of planting, high densityplanting, nutritional requirements, water requirements, fertigation,moisture conservation, role of growth regulators, macro and micronutrients, nutrient deficiency symptoms, physiological disorders, shaderegulation, weed management, training and pruning, crop regulation,plant protection, management of drought, precision farming.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods,harvesting seasons and mechanized harvesting in plantation crops.

Unit 2: Post harvest management: Post harvest handling including primaryprocessing, grading, packaging, storage and benefit cost analysis ofplantation crops.

Crops

Coconut, Arecanut, Oilpalm, Cashew, Coffee, Tea, Cocoa, Rubber, Palmyrah, Betel vine

VII. Practical

- Description of botanical and varietal features;
- Selection of mother palms and seedlings;
- Nursery techniques;
- Soil and water conservation measures;
- Nutrient deficiency symptoms;
- Manuring practices;
- Pruning and training methods;
- Maturity standards;
- Harvesting;
- Project preparation for establishing plantations;
- GAP in plantation crops;
- Exposure visits to commercial plantations, research institutes.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/ Writing)

• Demonstration
• Exposure visits

IX. Learning outcome

After successful completion of this course, the students are expected to:
• Develop the technical skill in commercial cultivation of plantation crops
• Be able to start plantation crop-based enterprises

X. Suggested Reading

Afoakwa EO. 2016. *Cocoa Production and Processing Technology*. CRC Press.
Anonymous. 1985. *Rubber and its Cultivation*. The Rubber Board of India.
Chopra VL and Peter KV. 2005. *Handbook of Industrial Crops*. Panima.
Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. *Biotechnology of Plantation Crops*.
Daya Publishing House, New Delhi
Choudappa P, Niral V, Jerard BA and Samsudeen K. 2017. *Coconut*. Daya Publishing House,
New Delhi.
*e-manual*on Advances in Cashew Production Technology. ICAR –Directorate of Cashew
Research, Puttur –574 202, DK, Karnataka.
Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.
Joshi P. 2018. *Text Book on fruit and plantation crops*. Narendra Publishing House, New Delhi
Kurian A and Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.
Nair MK, Bhaskara Rao EVV, Nambia KKN and Nambiar MC. 1979. *Cashew*. CPCRI,
Kasaragod.
Panda H. 2013. *The Complete Book on Cashew*. Asia Pacific Business Press Inc.
Panda H. 2016. *The Complete Book on Cultivation and Manufacture of Tea* (2nd Revised Edition).
Asia Pacific Business Press Inc.
Peter KV. 2002. *Plantation Crops.* National Book Trust.
Pillay PNR. 1980. *Handbook of natural rbber production in India*. Rubber Research Institute,
Kottayam. pp.668.

Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2007. *Management of Horticultural Crops.* Parts I, II. New India Publ. Agency.
Ramachandra *et al.* 2018. *Breeding of Spices and Plantation crops*. Narendra Publishing House, New Delhi.
Ranganathan V. 1979. *Hand Book of Tea Cultivation.* UPASI, Tea Res. Stn. Cinchona.
Sera T, Soccol CR, Pandey A, Roussos S *Coffee Biotechnology and Quality*. Springer, Dordrecht.
Sethuraj MR and Mathew NT. 1992. *Natural Rubber: Biology, Cultivation and Technology (Developments in Crop Science)*. Elsevier Science.
Sharangi AB and Datta S. 2015. *Value Addition of Horticultural crops: Recent trends and Future directions*. SPRINGER; ISBN: 978-81-322-2261-3.
Sharangi AB and Acharya SK. 2008. *Quality management of Horticultural crops*. Agrotech Publishing House, Udaipur; ISBN: 81-8321-090-2.
Srivastava HC, Vatsaya and Menon, KKG. 1986. *Plantation Crops – Opportunities and Constraints.* Oxford and IBH.
Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford and IBH.

I. Course Title : Production of Spice Crops
II. Course Code : PSM 502
III. Credit Hours : (2+1)
IV. Why this course ?

Spice crops play an important role in the national economy of India. These cropsalso provide livelihood security to a large section of farmers. This course willimpart theoretical as well as hands-on experience to the learner on scientificproduction technology of various spice crops in Indian perspectives. It will providecomprehensive knowledge in this regard.

V. Aim of the course

The course is designed to provide both basic and applied knowledge on variousaspects of production technology of spice crops grown in India.The course is organized as follows:

No	Blocks	Units
1	Importance of Spice Crops	I Role of spice crops
		II Classification of spice crops
2	Production Technology	I Varietal wealth
		II Propagation and nursery management
		III Agro techniques
3	Harvest and Post harvest management	I Maturity indices and harvest
		II Post harvest management

VI. Theory

Block 1: Importance of spice crops

Unit 1: Role of Spice crops: Introduction, importance of spice crops,pharmaceutical significance, historical accent, present status – national and international, future prospects, role of Spices board and otherdevelopment agencies.

Unit 2: Classification of spice crops: Major spices, minor spices, seed spices,tree spices, herbal spices.

Block 2: Production Technology

Unit 1: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops.

Unit 2: Propagation and nursery management: Seed, vegetative and micropropagationmethods, nursery techniques and nursery managementpractices.

Unit 3: Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment,nutritional and irrigation requirements, intercropping, mixed cropping,intercultural operations, weed control, mulching, plant protection,precision farming, physiological disorders, protected cultivation.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods,harvesting seasons, mechanized harvesting.

Unit 2: Post harvest management: Post harvest management including primaryprocessing, grading, packaging and storage, GMP in major spice crops.

Crops

Black pepper, small and large Cardamom, Turmeric, Ginger, Garlic, Coriander,

Fenugreek, Cumin, Fennel, Ajwain, Saffron, Vanilla, Nutmeg, Clove, Cinnamon,Allspice, Tamarind, Garcinia

VII. Practical

• Identification of seeds and plants;
• Botanical description of plant;
• Varietal features;
• Planting material production;
• Field layout and method of planting;
• Cultural practices;
• Harvest maturity, harvesting;
• Drying, storage, packaging;
• Primary processing;
• GAP in spice crops;
• GMP in spice crops;
• Short term experiments on spice crops;
• Exposure visits to spice farms, research institutes.

VIII. Teaching Methods/ Activities

• Lecture
• Assignment (Reading/ Writing)
• Demonstration
• Exposure visits

IX. Learning outcome

After successful completion of this course, the students are expected to:
• Develop the technical skill in commercial cultivation of spice crops
• Be able to start spice-based enterprises

X. Suggested Reading

Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed Spices: Production, Quality, Export.* Pointer
Publ.
Arya PS. 2003. *Spice Crops of India.* Kalyani.
Bose TK, Mitra SK, Farooqi SK and Sadhu MK. Eds. 1999. *Tropical Horticulture.* Vol.I. Naya
Prokash.
Chadha KL and Rethinam P. Eds. 1993. *Advances in Horticulture.* Vols. IX-X. *Plantation Crops*
and Spices. Malhotra Publ. House.

Gupta S. Ed. *Hand Book of Spices and Packaging with Formulae.* Engineers India Research
Institute, New Delhi.
Kumar NA, Khader P, Rangaswami and Irulappan I. 2000. *Introduction to Spices, Plantation*
Crops, Medicinal and Aromatic Plants. Oxford and IBH.
Nybe EV, Miniraj N and Peter KV. 2007. *Spices.* New India Publ. Agency.
Parthasarthy VA, Kandiannan V and Srinivasan V. 2008. *Organic Spices.* New India Publ.
Agency.
Peter KV. 2001. *Hand Book of Herbs and Spices.* Vols. I-III. Woodhead Publ. Co. UK and CRC
USA.
Ponnuswami V *et al.* 2018. *Medicinal Herbs and Herbal Cure*. Narendra Publishing House,
New Delhi.
Pruthi JS. Ed. 1998. *Spices and Condiments.* National Book Trust.
Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post HarvestTechnology*.
ICAR.
Purseglove JW, Brown EG, Green CL and Robbins SRJ. Eds. 1981. *Spices.* Vols. I, II. Longman.
Ramachandra *et al.* 2018. *Breeding of Spices and Plantation crops*. Narendra Publishing House,
New Delhi.
Ravindran PN. 2000. *Black pepper, Piper nigrum*. CRC press.
Ravindran PN. 2002. *Cardamom, the genusElettaria*. CRC press
Ravindran PN. 2003. *Cinnamon and cassia.* CRC press
Ravindran PN. 2004. *Ginger, the genus Zingiber*. CRC press
Ravindran PN. 2007. *Turmeric, the genus curcuma*. CRC press
Ravindran PN. 2017. *The Encyclopedia of Herbs and Spices*. CABI
Shanmugavelu KG, Kumar N and Peter KV. 2002. *Production Technology of Spices and*
Plantation Crops. Agrobios.
Sharangi AB, Datta S and Deb P. 2018. Spices "*Agrotechniques for quality produce*". Apple
Acadamic Press (Tylor and Francis Groups), New Jersey, USA.

Sharangi AB. 2018. Indian Spices "*The legacy, production and processing of India's treasured*
export." Springer International publishing AG, Part of Springer Nature 2018, Cham,
Switzerland.
Sharangi AB and Datta S. 2015. *Value Addition of Horticultural crops: Recent trends and*
Future directions. SPRINGER; ISBN: 978-81-322-2261-3.
Sharangi AB and Acharya SK. 2008. *Quality Management of Horticultural crops*. Agrotech
Publishing House, Udaipur; ISBN: 81-8321-090-2.
Thamburaj S and Singh N. Eds. 2004. *Vegetables, Tuber Crops and Spices,* ICAR.
Tiwari RS and Agarwal A. 2004. *Production Technology of Spices*. International Book Distr.Co.

I. Course Title : Production of Medicinal and Aromatic Crops
II. Course Code : PSM 503
III. Credit Hours : (2+1)
IV. Why this course ?
Medicinal and aromatic crops play an important role in the national economy ofIndia. These crops also provide health security to all. This course will impart theoretical as well as hands-on experience to the learner on scientific productiontechnology of various medicinal and aromatic crops in Indian perspectives. It willprovide comprehensive knowledge in this regard.
V. Aim of the course
To impart comprehensive knowledge on the production technology of importantmedicinal and aromatic crops
The course is organized as follows:
No Blocks Units
1 Importance of Medicinal and I Classification of medicinal
Aromatic Crops and aromatic crops
II Medicinal plant based industry
III Aromatic plant based industry
2 Production technology I Varietal wealth
II Propagation and nursery management
III Agro techniques

3 Harvest and Post harvest I Maturity indices and harvest management II Post harvest management

Theory

Block 1: Importance of Medicinal and Aromatic Crops

Unit 1: Classification of medicinal and aromatic crops: Importance of medicinalplants, Importance of aromatic plants, Role in national economy, utilitysectors of medicinal and aromatic crops, classification of medicinal and aromatic crops, role of institutions, Medicinal Plant Board andNGO's in research and development of medicinal and aromatic crops.

Unit 2: Medicinal and plant based industry: Indian system of medicine,traditional systems of medicine, tribal medicine, medicinal industry,source of medicinal plants, area, production, export and import ofmajor crops, problems, prospects and challenges, IPR issues.

Unit 3: Aromatic plant based industry: Essential oils, classification, physical and chemical properties and storage of essential oils. Indian perfumeryindustry,area, production, export and import status of major aromaticcrops, history and advancements, problems, prospects and challenges,IPR issues.

Block 2: Production technology of medicinal and aromatic crops

Unit 1: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in medicinal and aromatic crops.

Unit 2: Propagation and nursery management: Seed, vegetative and micropropagationmethods, nursery techniques and nursery managementpractices.

Unit 3: Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment,nutritional and irrigation requirements, intercropping, mixed cropping,intercultural operations, weed control, mulching, plant protection.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods,harvesting seasons in medicinal and aromatic crops.

Unit 2: Post harvest management: Post harvest management including primary processing, extraction, grading, packaging and storage, GMP inmedicinal and aromatic crops.

Crops

A. Medicinal crops: Senna, periwinkle, medicinal coleus, aswagandha, glory lily,sarpagandha, *Dioscorea* sp., *Aloe vera*, *Andrographis paniculata*,

Digitalis, medicinalsolanum, isabgol, opium poppy, safedmusli, *Stevia rebaudiana, Mucuna pruriens,Piper longum, Plumbago zeylanica*

B. Aromatic crops: Palmarosa, lemongrass, citronella, vetiver, mentha, patchouli,sweet flag, jasmine, geranium, artemisia, lavender, *Ocimum* sp., eucalyptus, sandal

VI. Practical

• Description of botanical and varietal features;
• Nursery techniques;
• Lay out and planting;
• Manuring practices;
• Maturity standards;
• Harvesting;
• Primary processing;
• Extraction of oils;
• Herbarium preparation;
• Project preparation for establishing herbal gardens;
• GAP in medicinal and aromatic crops;
• GMP in medicinal and aromatic crops;
• Exposure visits to institutes, herbal gardens and industries.

VII. Teaching Methods/ Activities

• Lecture
• Assignment (Reading/ Writing)
• Demonstration
• Exposure visits

VIII. Learning outcome

After successful completion of this course, the students are expected to:

• Develop the technical skill in commercial cultivation of medicinal and aromaticcrops
• Be able to start medicinal and aromatic crop-based enterprises

IX. Suggested Reading

Atal CK and Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR,
Jammu.

Barche S. 2016. *Production technology of spices, aromatic, medicinal and plantation crops*.
New India Publishing Agency, New Delhi.

Das K. 2013. *Essential oils and their applications*. New India Publishing Agency, New Delhi
Farooqi AA and Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*.
Orient Longman Publ.
Farooqi AA, Khan MM and Vasundhara M. 2001. *Production Technology of Medicinal and*
Aromatic Crops. Natural Remedies Pvt. Ltd.
Gupta RK. 2010. *Medicinal and Aromatic plants*. CBS publications.
Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books. Jain SK. 2000. *Medicinal Plants.*
National Book Trust.
Khan IA and Khanum A. 2001. *Role of Biotechnology in Medicinal and Aromatic Plants*. Vol.
IX. Vikaaz Publ.
Kurian A and Asha Sankar M. 2007. *Medicinal Plants.* Horticulture Science Series, New India
Publ. Agency.
Panda H. 2002. *Medicinal Plants Cultivation and their Uses.* Asia Pacific Business Press.
Panda H. 2005. *Aromatic Plants Cultivation, Processing and Uses.* Asia Pacific Business Press.
Ponnuswami *et al.* 2018. *Medicinal Herbs and Herbal Cure*. Narendra Publishing House, New
Delhi.
Prajapati SS, Paero H, Sharma AK and Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro
Bios.
Ramawat KG and Merillon JM. 2003. *BioTechnology – Secondary Metabolites*. Oxford and IBH.
Shankar SJ. 2018. *Comprehensive post harvest technology of flowers, medicinal and aromatic*
plants. Narendra Publishing House, New Delhi.
Skaria PB, Samuel M, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aromatic Plants*.
New India Publ. Agency.

HORTICULTURE (PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS)

PSMA 501 Production of Plantation Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Wattle and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

Suggested Readings

Anonymous, 1985. *Rubber and its Cultivation*. The Rubber Board of India.

Chopra VL & Peter KV. 2005. *Handbook of Industrial Crops*. Panima.

Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.

Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.

Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.

Peter KV. 2002. *Plantation Crops*. National Book Trust.

Pradeep Kumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008.*Management of Horticultural Crops*. Part I, II. New India Publ. Agency.

Rai PS &Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS, Research Series No.6, Bangalore.

Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.

Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH.

Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

PSMA 502 Production Technology of Spice Crops 2+1

Objective

To impart basic knowledge about the importance and productiontechnology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection

Gupta S. (Ed.). *Hand Book of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.

Kumar NA, Khader P, Rangaswami&Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.

Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.

Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.

Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. WoodheadPubl. Co. UK and CRC USA

Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust

Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management andPost Harvest Technology*. ICAR.

Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.

Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co.

Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

PSMA 503 Production Technology for Medicinal and Aromatic Crops 2+1

Objective

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

UNIT I

Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production.

UNIT II

Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, *Dioscorea*sp., *Aloe vera*, *Phyllanthus amarus,Andrographis paniculata.*

UNIT III

Production technology for Medicinal solanum, Isabgol, Poppy, Safed musli, *Stevia rebaudiana, Mucuna pruriens, Ocimum sp.*

UNIT IV

Post harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products.

UNIT V

Influence of biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials, Phytochemical extraction techniques.

UNIT VI

Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VII

Production technology for palmarosa, lemongrass, citronella, **v**ettiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

UNIT VIII

Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional

plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.

UNIT IX

Institutional support and international promotion of essential oil and perfumery products.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

Suggested Readings

Atal CK &Kapur BM. 1982. *Cultivation and Utilization of Aromatic Plants*. RRL, CSIR, Jammu.

Atal CK &Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Farooqi AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Khan IA & Khanum A. *Role of Bio Technology in Medicinal and Aromatic Plants*. Vol. IX. Vkaaz Publ.

Kurian A & Asha Sankar M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.

Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.

cosmos,dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.

Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502 Production Technology of Cut Flowers 2+1

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops

Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.52

Lauria A &Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S &Misra RL. 2007. *HightechFloriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 503 Production Technology for Loose Flowers 2+1

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective: To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.

3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PROGRAMME-16

Ph.D.

AGRONOMY

Course Title : Current Trends in Agronomy

Course Code :Agron 601

Credit Hours : 3+0

Aim of the course

To acquaint the students about recent advances in agricultural production.

Theory

Unit I

Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.

Unit II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures and ITK in organic farming.

Unit III

Crop residue management in multiple cropping systems; latest developments in plant managementMechanizationin crop production: modern agricultural precision tools and technilogies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

Unit IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

Unit V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Recent advances in agricultural production

Suggested Reading

• Agarwal RL. 1995. Seed Technology. Oxford & IBH.

• Dahiya BS and Rai KN. 1997. Seed Technology. Kalyani.

• Govardhan V. 2000. Remote Sensing and Water Management in Command Areas: AgroecologicalProspectives. IBDC.

• ICAR. 2006. Hand Book of Agriculture. ICAR.

• Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.

• Palaniappan SP and Annadurai K. 2006. Organic Farming - Theory and Practice. Scientific Publ.

• Sen S and Ghosh N. 1999. Seed Science and Technology. Kalyani.

• Tarafdar JC, Tripathi KP and Kumar M. 2007. Organic Agriculture Scientific Publ.

• Kumar, R, Swarnkar KS, Singh KS and Narayan S. 2016. A Text Book of Seed Technology. Kalyani Publication.

• Reddy SR and Prabhakara G. 2015. Dryland Agriculture. Kalyani Publishers.

• Gururajan B, Balasubhramanian R and Swaminath V. 2013. Recent Strategies on Crop Production. Kalyani Publishers.

• Venkateswarlu B and ShankerArun K. 2009. Climate change and agriculture: Adaptation and mitigation strategies. Indian Journal of Agronomy 54(2): 226-230.

Course Title : Recent Trends in Crop Growth and Productivity

Course Title :

Course Code :Agron 602

Credit Hours : 2+1

Aim of the course

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

Unit I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

Unit II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

Unit III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

Unit IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

• Field measurement of root-shoot relationship in crops at different growth stages

• Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth

• Computation of harvest index of various crops

• Assessment of crop yield on the basis of yield attributing characters

• Construction of crop growth curves based on growth analysis data

• Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping

• Senescence and abscission indices

• Analysis of productivity trend in un-irrigated areas

• Analysis of productivity trend in irrigated areas

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of crop growth for agricultural production

Suggested Reading

• Chopra VL and Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH.

• Delvin RM and Vitham FH. 1986. Plant Physiology. CBS Publ.

• Evans LT. 1975. Crop Physiology. Cambridge Univ. Press.

• Evans LT. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press.

• Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH.

• Gupta US. 1988. Progress in Crop Physiology. Oxford & IBH.

• Kramer PJ and Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press.

• Mukherjee S and Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill.

• Narwal SS, Politycka B and Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Pub.

• Tiaz L. and Zeiger E. 2006. Plant Physiology. Sinauer Associates, Inc.

Course Title : Irrigation Management

Course Code :Agron 603

Credit Hours : 2+1

Aim of the course

To teach students about optimization of irrigation in different crops under variable agro climatic conditions.

Theory

Unit I

Global water resources; Water resources of India, irrigation projects during pre and post independence period and their significance in crop production; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

Unit II

Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, general equation of saturated and unsaturated flow of water in soil.

Soil-plant-water relationships, evaporation, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity

Unit III

Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

Unit IV

Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ET by mulching and use of anti-transpirents; fertilizer use in relation to irrigation.

Unit V

Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability.

Unit VI

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

Unit VII

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

Unit VIII

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Unit IX

Economic analysis of irrigation and crop planning for optimum use of irrigation water

Unit X

Crop water production function

Practical

• Determination of water infiltration characteristics and water holding capacity of soil profiles.

• Determination Moisture extraction pattern of crops

• Determination of water balance component of transplanted rice by drum culture technique

• Determination of consumptive use and water requirement of a given cropping pattern

• Determination of crop efficient of one important crop

• Planning, designing and installation of drip irrigation system

• Planning, designing and installation of sprinkler irrigation system

• Designing of drainage channel

• Measurement of irrigation efficiencies

• Determination of irrigation timing under different methods of irrigation

• Visit to irrigation command area

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Management of irrigation water for sustainable agriculture

Suggested Reading

• MP. Singh 2017. Recent advances in Irrigation water management. Kalyani Publishers

• FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.

• Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.

Learning outcome

After successful completion of the course, the student will be able to- Understand the different market competition. Work out strategies for attaining equilibrium in the market.

Suggested Reading

• Henderson JM and Quandt RE. Microeconomic Theory: A Mathematical Approach Tata McGraw Hill Publishing Co Ltd
• Koutsoyiannis A. Modern Micro Economics. Macmillan Press Ltd
• Ferguson and Gould. Micro Economic Theory. Richard D Erwin Inc USA

Course Title : Advanced Macro Economics
Course Code : AEC-602
Credit Hours : 2+0

Why this course?

A deeper understanding of the conceptual and structural framework is imperative to develop vision of a student about how the knowledge of various macroeconomic models is applied in real economy.

Aim of the course

To understand the functioning of national economy, its history and models. The policies governing the modern economic system and concerned institutions.

Organization of the course

The course is organised as follows–

No Block	Unit
1. Introduction	1. Overview
2. Economic Models	1. Open Economy Models
	2. Dynamic Macroeconomic Models
3. Business cycle and pollicies	1. Business Cycles
	2. Macroeconomic Polices

Theory

Block 1- Introduction

Unit 1: Overview Conceptual framework - Classical, Keynesian, Neo-Classical, and Neo-Keynesian macroeconomics; Review of Keynes-Classical Synthesis; Aggregate Demand and Supply in the closed economy with fixed

and variable price level- determination of wage, prices, output and employment

Block 2- Economic Models

Unit 1:Open Economy Models

Exchange rate determination; purchasing power parity; asset market approach; Short-run open economy models; Mundell-Fleming model- exchange rate regime: perfect capital mobility under fixed and flexible exchange rate; effectiveness of fiscal policy and monetary policy; Dornbusch's overshooting model; monetary approach to balance of payments; international financial markets

Unit 2: Dynamic Macroeconomic Models

Introduction to dynamic macroeconomic Models; Dynamic aggregate demand and supply – short and long term equilibrium- rational expectations approach

Block 3: Business Cycle and Policies

Unit 1:Business Cycles

Business cycle and its alternative equilibrium model, Stability analysis Economics of Great Events-Depression, Hyperinflation and Deficits; Advances in Business Cycle Theory; Real Business Cycles & Neo-Keynesian Economics

Unit 2: Macroeconomic Polices

Monetary policy - Design of Monetary Policy; Inflation Targeting, Fiscal Policy - Government Budget Constraint: The Arithmetic of Deficits and Debt, Current versus Future Taxes, the Evolution of Debt-to-GDP Ratio; Public Borrowing-Internal and external aid, Deficit financing, Development Financing; BOP & Adjustment Policies - Foreign Exchange Policy - International macro-economic policies, IMF, IBRD, UNCTAD.

Teaching Methods/ Activities

• Lectures. • Case studies. • Assignments (Group/individual). • Group Discussions

Learning outcome

After successful completion of this course the student will be able to-Figure out how policies are framed to safe guard the national economy. Understand the rationale behind the working of different economy.

Suggested Reading

• Heibroker RL. Understanding Macro Economics.

ENTOMOLOGY

Course Title : Insect Phylogeny and Systematics

Course Code : ENT 601

Credit Hours : 3 (1+2)

Aim of the course

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. Detailed study about the International Code of Zoological Nomenclature; ethics and procedure for taxonomic publications.

Theory

Unit I

Detailed study of three schools of classification- numerical, evolutionary and cladistic. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography.

Unit II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

Unit III

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures.

Unit IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular sytematics.

Practical

• Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, and construction of taxonomic keys for the selected group;

• Development of descriptions, photographing, writing diagrams, and preparation of specimens for "type like" preservation, Submission of the collections made of the group;

• Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms;

• Rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

Learning outcome

• Scholars are expected to understand the concepts of taxonomic hierarchy, study taxonomic characters, variations, intra-specific phenotypic plasticity; prepare taxonomic keys for specific groups and write taxonomic papers and reviews.

• Scholars should be able to identify insects of economic importance up to family/ generic levels and specialize in any one group of insects up to species level identification.

Suggested Reading

CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca. Dakeshott J and Whitten MA. 1994. Molecular Approaches to Fundamental and Applied Entomology. Springer-Verlag, Berlin. Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi. Hennig W. 1960. Phylogenetic Systematics. Urbana Univ. Illinois Press, USA. Hoy MA. 2003. Insect Molecular Genetics: An Introduction to Principles and Applications. 2nd Ed. Academic Press, New York. Mayr E and Ashlock PD. 1991. Principles of Systematic Zoology. 2nd Ed. McGraw Hill, New York. Mayr E.1969. Principles of Systematic Zoology. McGraw-Hill, New York. Quicke DLJ. 1993. Principles and Techniques of Contemporary Taxonomy. Blackie Academic and Professional, London. Ross HH. 1974. Biological Systematics. Addison Wesley Publ. Co., London. Wiley EO. 1981. Phylogenetics: The

microplot techniques, infester row technique, spreader row technique and plant nurseries; • Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

Learning outcome

• Scholars are expected to identify sources of resistance in different crops and varieties; their utilization in resistance breeding programmes involving screening techniques for specific pests.

Suggested Reading

Panda N. 1979. Principles of Host Plant Resistance to Insects. Allenheld, Osum and Co., New York.
Rosenthal GA and Janzen DH. (Eds.). 1979. Herbivores – their Interactions with Secondary Plant Metabolites. Vol. I, II. Academic Press, New York. Sadasivam S and Thayumanavan B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, New York. Smith CM, Khan ZR and Pathak MD. 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, Boca Raton, Florida.

Course Title : Integrated Pest Management

Course Code : ENT 610

Credit Hours : 2 (2+0)

Aim of the course

To acquaint the students with recent concepts of integrated pest management; surveillance and data base management; successful national and international case histories of integrated pest management, non-conventional tools in pest management.

Theory

Unit I

Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

Unit II

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

Unit III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management-case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

Unit IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Learning outcome

• Having gained sufficient experience in advanced studies of IPM the scholars should be able to independently frame IPM schedules for major crops/ cropping ecosystems (cereal/ pulse crop/ oilseed crop based/ vegetable crop based agro-ecosystems).

Suggested Reading

Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi. Dhaliwal GS, Singh R and Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi. Flint MC and Bosch RV. 1981. Introduction to Integrated Pest Management. Springer, Berlin. Koul O and Cuperus GW. 2007. Ecologically Based Integrated Pest Management. CABI, London. Koul O, Dhaliwal GS and Curperus GW. 2004. Integrated Pest Management –Potential, Constraints and Challenges. CABI, London. Maredia KM, Dakouo D and Mota-Sanchez D. 2003. Integrated Pest Management in the Global Arena. CABI, London. Metcalf RL and Luckman WH. 1982. Introduction to Insect Pest Management. John Wiley and Sons, New York. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi. Pedigo RL. 1996. Entomology and Pest Management. Prentice Hall, New Delhi. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York

AGRICULTURAL EXTENSION EDUCATION

Course Title : Policy Engagement and Extension

Course Code : EXT 601

Credit Hours : 2+1

Why this course?

Extension's performance in any country to a large extent is dependent on the wider policy and institutional context prevailing at the national level. At the organizational level, extension should have capacities to influence policies that affect their performance. To effectively influence policies, extension professionals need to generate not only sound evidence of its impact, but also capacities to engage with policy relevant actors especially at various levels. While few countries have developed specific extension policies, there has been very limited success in translating these policies into programmes and operational guidelines. Lack of policy relevant research to generate evidence on extension's impact; poor documentation of successful initiatives, and lack of training on engaging with policy relevant actors have all contributed to this. Extension professionals, often encounter situations where existing policy constraints development interventions or where new policies could better support development. This course is aimed at developing these capacities to successfully engage with policy actors and bringing about desirable policy changes to strengthen extension.

Aim of the course

• To orient students on the importance of policies in shaping extension's performance • To discuss ways of generating policy relevant evidence to influence policies • To develop capacities to engage with policy actors and the policy development process

The course is organized as follows:

No Blocks	Units
1. Why policies matter?	1. Understanding Policy
	2. Policy Advocacy and Tools
	3. Policy Analysis

	4. Policy Development Process
2. Using evidence to influence	1. Influencing Policy Change Policy Change
	2. Global Experience with Extension Policy

Theory

Block 1: Why Policies Matter?

Unit 1: Understanding Policy

Why policies are important for extension? Role in providing structure, ensure funding and framework for providing functions-examples; Policy: definitions and types: Is policy a product or a process or both? Policies and institutions- How these influence defining organisational roles and performance in extension organizationsRole of policies in upscaling knowledge-Role of extension in influencing policies to enable innovation.

Unit 2: Policy Advocacy and Tools

Definition of advocacy, Approaches to policy advocacy-Advising, Media campaigning, Lobbying, Activism, Information Education Communication (IEC) and Behavior Change Communication (BCC); Advocacy for Rural Advisory Services (RAS); Policy advocacy strategy

Unit 3: Policy Analysis

Explain the meaning and use of policy analysis in decision- making; Describe different types of policy analysis- empirical, evaluative or normative policy analysis, retrospective/ prospective policy analysis, predictive/prescriptive/descriptive policy analysis; How to do policy analysis? - understand the process of policy analysis, highlight the different methods and techniques used in policy analysis, doing ethical policy analysis; Tools for policy impact- research tools, context assessment tools, communication tools, policy influence tools

Unit 4: Policy Development Process

Policy development process: Who drives policy change?: National Governments, Donors, Civil Society-varied experiences: Understanding the

environment and key actors in policy space- problem identification-policy adoption, implementation and evaluation; stakeholder mapping, identifying opportunities and barriers, mobilising financial resources; Dealing with policy incoherence: identifying contradictions and challenges in policy implementation

Block 2: Using Evidence to Influence Policy Change

Unit 1: Influencing Policy Change

Generating evidence: Role of policy research; analyzing the usefulness and appropriateness of the evidence; Using evidence in policy advocacy; Understanding your audience: analyzing channels of influence; creating alliances; identifying policy champions; Defining goals and objectives; Developing advocacy messages: Policy papers, Policy briefs, good practice notes, etc.: Good practices in influencing policies Organising policy dialogues: Policy engagement strategy-Engaging with policy makers: GO and NGO experiences; Policy working groups; advisory panels; use of committees: Use of media including ICTs and social media for influencing policies.

Unit 2: Global Experience with Extension Policy

Extension policy in different countries: Explicit extension policy Vs extension as part of Agriculture Policy, Challenges in policy implementation: lack of capacities, financial resources, ownership, lack of stakeholder consultations: Strengthening capacities in extension to influence policies: Global Forum for Rural Advisory Services (GFRAS)'s efforts in strengthening extension policy advocacy: policy compendium, training modules, training for strengthening capacities to influence policies.

Practicals

• Analysis of country/state level agricultural/extension policy to understand the policy intentions from strengthening EAS • Analysis of extension policy of other countries: policy intentions, processes adopted in development of the policy and mechanisms of policy implementation • Interview key policy actors in EAS arena at the state/national level (eg: Director of Agriculture, Director of Extension in SAU, Chairman/Managing Director of Commodity Board. Member Agriculture, State Planning Board) to explore policy level challenges in EAS • Identify what evidence policy makers look for from extension

research? Is the evidence available? If so what form? (Reports, Briefs etc), If not, develop a plan • Explore how different stakeholders influence policies (eg: policy advocacy of prominent NGOs, private sector and public sector) -What mechanisms and tools they use • Identify policy level bottlenecks that constrain effective EAS delivery at the district level- Eg: Issues around linkages between KVK and ATMA; inter-departmental collaboration; public private partnerships; joint action etc.

Teaching methods/activities

– Lecture – Assignment (Reading/Writing) – Student's Book/Publication Review – Student presentation – Group Work – Student's interview of key policy makers – Case Analysis – Guest Lectures – Review of policy documents – Short attachments

Learning outcome

After successful completion of this course, the students are expected to be able to: – Appreciate the role of policies in shaping performance of extension – Understand how to generate and communicate policy relevant evidence – Critically evaluate extension policies in different countries – How to engage in policy advocacy.

Suggested Reading

AEPF. 2015. Report on the Policy Forum by Ghana Directorate of Agricultural Extension Services, Ministry of Food and Agriculture; Modernizing Extension and Advisory Services and Agriculture Policy Support Project, Ghana. http://www.g-fras.org/en/knowledge/documents/category/18-policy.html?download=490: report-on-the-ghana-agricultural-extension-policy-forum-2015 Amosa, MDU. 2018. Policy Analysis and Engagement Toolkit. A guide for Pacific Non-government Organizations in the Fisheries Sector.WWF. http://d2ouvy59p0dg6k.cloudfront.net/downloads/policy_analysis_toolkit_quality.pdf Anonymous.N.d. Policy analysis. http://www.egyankosh.ac.in/bitstream/123456789/25760/1/Unit-19.pdf Anonymous. N.D. Policy analysis. https://web.csulb.edu/~msaintg/ppa670/670steps.htm Bardach E. A Practical Guide for Policy Analysis The Eightfold Path to More Effective Problem

– The scholars should develop critical skills in conducting systematic and objective research by using robust methods while minimising biases and errors – The students should intelligently choose and apply advanced methods and tools at every stage of research and execute them in a objective way by managing the actors and processes effectively – The students should develop expertise in designing tests, scales and indexes along with other tools to measure the socio-psychological processes at individual, group and community levels

Suggested Reading

Berg B. 2009. Qualitative Research. Methods for the Social Sciences. Boston: Allyn& Bacon. Creswell JW .2007. Qualitative inquiry and research design: Choosing among five approaches (2nd ed.). Thousand Oaks, CA: SAGE Pub. Edwards AL. 1957. Techniques of attitude scale construction. East Norwalk, CT, US: AppletonCentury-Crofts. Furr, RM. 2011. Scale construction and psychometrics for social and personality psychology. Los Angeles: SAGE Pub. Malhotra, NK. 2010. Marketing research: An applied orientation. Sixth Edition. Upper Saddle River, NJ: Prentice Hall Pub. Netemeyer RG, Bearden WO and Sharma S. 2003. Scaling procedures: issues and applications. Thousand Oaks: SAGE Publications. Nunnally, JC, and Bernstein IH. 1994. Psychometric theory (3rd ed.). New York, NY: McGrawHill Rao, C.R. and Sinharay S. 2007. Handbook of Statistics, Vol. 26: Psychometrics, The Netherlands; Elsevier Science B.V. Raykov T and Marcoulides GA. 2010. Introduction to Psychometric Theory. New York, NY: Taylor & Francis Scott J and Carrington PJ. 2011. The SAGE handbook of social network analysis. London: SAGE. Sekaran U and Bougie R. 2013. Research Methods for Business A Skill-Building Approach. 6th Edition, Wiley, New York. Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. Good Practices in Agricultural extension Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia. Centre for research on innovation and science and policy (CRISP), Hyderabad. India. http://www.aesanetwork.org/ wp-content/uploads/2018/07/6.pdf

Course Title : Technology Commercialisationand Incubation

Course Code : EXT 603

Credit Hours : 2+1

Why this course?

The technology commercialisation and incubation is an emerging area which links technology development, transfer and commercialisation processes with entrepreneurship development. Technology commercialisation aims to realize the value of agricultural technologies developed at the research establishments, by maximising their utility to stakeholders. With the increasing awareness of protecting and commercialising the Intellectual Property Resources (IPR) in the free market economy, there is a need to understand the organic relationship between protection and commercialisation IPR, and entrepreneurship development.

Aim of the course

This course is aimed to develop a critical understanding among extension students about how the technology commercialisation process is linked to IPR management and entrepreneurship development.

The course is organized as follows:

No Blocks	**Units**
1. Technology commercialisation and Commercialisation the modern context	1. Basics of Technology 2. Nature of Agricultural Technology 3. Basics of Technology Transfer and Commercialisation
2. Intellectual Property Resources (IPR) Management	1. Overview of Intellectual Property Resources 2. Systems for protecting IP 3. Management of IPR 4. Protection and Management of Biological Resources 5. Protection, Management and Commercialisation of Grass root and

	Farmers Innovations, Traditional and Indigenous Knowledge 6. Geographical Indications (GI) and Appellation of Origin 7. Genetically Modified Organisms (GMO), Agriculture and Biosafety
3. Technology commercialisation	1. Technology Assessment and Refinement 2. Technology Valuation 3. Technology Commercialisation Strategies 4. Scaling up of Technologies 5. Technology Licensing 6. Technology Takers and Entrepreneurship 7. Policy Support for Technology Commercialisation and Entrepreneurship Development
4. Technology Incubation	1. Basics of Technology Incubation 2. Technology Incubation in India
5. Technology promotion and essential skills for technology commercialisation	1. Technology Promotion 2. Dealing with Entrepreneurs, Agripreneurscommercialisation and Other Stakeholders
6. Emerging approaches in technology commercialisation and incubation	1. Technology Scouting

Theory

Block 1: Technology Commercialisation and the Modern Context

Unit 1: Basics of technology commercialisation

Technology - Definition, functions, process of technological advancement – invention, discovery, innovation and technology; types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation; Technology transfer and commercialisation

Unit 2: Nature of Agricultural Technology

Agricultural technology – meaning, types; technology generation system; technology life cycle

Unit 3: Basics of Technology transfer and commercialisation

Technology transfer Vs Commercialisation; Technology commercialisation process – elements, models, systems and processes; Technology transfer model – research, disclosure, development and commercialisation

Block 2: Intellectual Property Resources (Ipr) Management

Unit 1: Overview of Intellectual Property Resources

Introduction to IPR; Overview & Importance; Genesis; IPR in India and IPR abroad; Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design; Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC.

Unit 2: Systems for Protecting IP

IPR protection laws and systems – National IPR Policy; and IPR laws; procedures for filing IP protection; Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders

Unit 3: Management of IPR

Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure; IP portfolio management; Infringement management

Unit 4: Protection and Management of Biological Resources

Introduction; National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Rights Act (2001); Guidelines for registration and transfer of biological resources; Farmers rights; Mechanisms of documenting/ collecting, protecting and commercialising farmers varieties and other biological resources; National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India. Access to Genetic Resources and Sharing of Benefits

Unit 5: Protection, Management and Commercialisation of Grassrootand Farmers Innovations, Traditional and Indigenous Knowledge

Traditional and Indigenous Knowledge, Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialisation. Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers (CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network.

Unit 6: Geographical Indications (GI) and Appellation of Origin

Geographical indications and appellation of origin – meaning, origin; Geographical Indications of Goods (Registration and Protection) Act (1999); Documentation, registration and commercialisation of GI protected materials and processes.

Unit 7: Genetically Modified Organisms (GMO), Agriculture and Biosafety

The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety; Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC). Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998; Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006

Block 3: Technology Commercialisation

Unit 1: Technology Assessment and Refinement

Meaning; Importance; Approaches and methods of assessment and refinement of various technologies – stakeholder oriented approaches including participatory technology assessment and refinement; assessment and refinement of traditional and indigenous knowledge and grassroot innovations

Unit 2: Technology Valuation

Returns to investment; IP Valuation-Oxford context, IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with Monte Carlo Simulation and Real Options Theory; Market approach - Industry Standards Method, Rating/Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty rate method

Unit 3: Technology Commercialisation Strategies

Meaning- approaches for technology commercialisation – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation

Unit 4: Scaling up of Technologies

Meaning, types and stages of technology scaling up; mechanisms

Unit 5: Technology Licensing

Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process

Unit 6: Technology Takers and Entrepreneurship

Meaning; types of technology takers; Technology Taking as a Strategy; Types of entrepreneurship – agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters and other forms of entrepreneurship

Unit 7: Policy support for Technology Commercialisation and Entrepreneurship

Development Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices;

Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others; Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India

Block 4: Technology Incubation

Unit 1: Basics of Technology Incubation

Meaning, functions and types; stakeholder oriented incubation process – Livelihood incubation, village incubators

Unit 2: Technology Incubation in India

System of technology incubation- incubation process; its effectiveness; Managing profit oriented and non-profit incubators; Schemes for promoting incubators in India

Block 5: Technology Promotion And Essential Skills For Technology Commercialisation

Unit 1: Technology Promotion

Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows

Unit 2: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders

Business communication; Business Etiquette; business networking

Block 6: Emerging Approaches in Technology Commercialisation and Incubation

Unit 1: Technology Scouting

Technology Scouting and Innovations in technology incubation

Practicals

• Understanding the technology commercialisation process – Visit to Technology Commercialisation Unit of ICAR Institute/ Agricultural University • Understanding the IPR protection practices – Visit to Patent Attorney office • Hands-on experience in drafting IPR application – Patent/Copyright/

Trademark • Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection • Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge • Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications • Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods • Hands on experience in technology valuation • Hands on experience in technology licensing process including drafting agreements • Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator • Hands on experience in planning and organising technology promotion events • Hands on experience in various techniques in business communication and Business etiquette

Teaching methods/activities

– Lecture cum discussion – Cases – Class exercises – Assignment (Reading/Writing) – Student's Book/Publication Review – Group Presentation

Learning outcome

At the end of the course the students are expected to develop competencies in: – Enabling stakeholders to protect and manage their IPR – Managing IPR to maximise their value realisation through commercialisation, and – Providing mentoring and handholding support to agripreneurs, rural entrepreneurs, start-ups, Farmer Organisations and other forms of entrepreneurs through incubation

Suggested Reading

Bandopadhyay D. 2018. Securing Our Natural Wealth: A Policy Agenda for Sustainable Development in India and for Its Neighbouring Countries. Singapore; Springer. Ghosh, S. and Joshi, A. 2017. Handbook for Non-Profit Incubator Managers. New Delhi: Deutsche GesellschaftfürInternationale. Gupta AK. 2016. Grassroots Innovation: Minds on the margin are not marginal minds. Gurgaon: Penguin Books. ICAR.2018. ICAR Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization (Revised in 2018). Indian Council of Agricultural Research, New Delhi. Pandey N and Dharni K. 2014. Intellectual Property

Clark MS and Wall WJ. 1996. Chromosomes: The Complex Code. Chapman & Hall. 30 June 1996 Conger BV. (Ed.). 1981. Cloning Agricultural Plants via in-vitro Techniques. CRC Press. 31 January 2018 Constabel F and Vasil IK. (Eds.). 1988. Cell Culture and Somatic Cell Genetics of Plants. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press. Gupta P K. 2006. Cytogenetics. Rastogi Publisher Lal R and Lal S. (Eds.). 1990. Crop Improvement Utilizing Biotechnology. CRC Press. Mantel SH and Smith H. 1983. Plant Biotechnology. Cambridge University Press. Sen SK and Giles KL. (Eds.). 1983. Plant Cell Culture in Crop Improvement. Plenum Press. 13 July 2013 Yao-Shan F. 2002. Molecular Cytogenetics: Protocols and Application. Human Press

Course Title : Plant Genetic Resources, Conservation and Utilization

Course Code : GPB 604

Credit Hours : 2(2+0)

Why this course?

This course is needed to make the student aware about the importance of Plant Genetic Resources its Conservation and Utilization in crop improvement.

Aim of the course

To impart knowledge on the methods of germplasm conservation and its utilization

Theory

Unit I

Concept of natural reserves and natural gene banks; In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation; in situ conservation of agro-biodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

Unit II

Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for seed multiplication and exchange to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling, clonal repositories, genetic stability under long term storage condition.

Unit III

In-vitro storage, maintenance of in-vitro culture under different conditions, in-vitro bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/ suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of in-vitro gene bank.

Unit IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrant-cryoprotectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/ dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops. Problems and prospects; challenges ahead.

Unit V

Concept and procedure for PGR management, germplasm characterization, evaluation and utilization; Concept of core and mini core; collections and registration of plant germplasm.

Teaching methods

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations.

Learning outcome

After the completion of this course the student will be able to know about the various techniques of conservation of Plant Genetic Resources and its Utilization in crop improvement.

Suggested Reading

Ellis RH, Roberts EH and White Head J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO/ IBPGR Pl. Genet. Resources News 41-3-18. Frankel OH and Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge. Paroda RS and Arora RK.1991. Plant Genetic resource Conservation and management, NBPGR, New-Delhi. Simmonds NW. 1979. Principles of Crop Improvement, Longman. Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository. Processed Report. USDA-ARS and Oregon State Univ. Oregon, USA. Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep. IBPGR, Rome, Italy.

Course Title : Genomics in Plant Breeding*

Course Code : GPB 605

Credit Hours : 3(3+0)

Why this course?

The knowledge of recent trends in plant genomics, genome sequencing, molecular maps, and concepts of high-throughput proteomics, metabolomics and phenomics is essential in rapid crop improvement programmes.

Aim of the course

JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology— Basic Experiments in Gene and Manipulation. 2nd Ed. Benjamin Publication Co. Primose SB and Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th Ed. Wiley-Blackwell Publishing. Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Laboratory Press. Singh BD. 2005. Biotechnology: Expanding Horizons. Kalyani Publishers, New Delhi. Somers DJ, Langridge P, Gustafson JP. 2009. Plant Genomics: Methods and Protocols. Springer.

e-Resources

http://gramene.org https://www.arabidopsis.org https://wheat.pw.usda.gov http://ncbi.nlm.nih.gov http://www.maizegenetics.net

Course Title : IPR and Regulatory Mechanism (e-course)*

Course Code : GPB 609

Credit Hours : 1(1+0)

Why this course?

Biodiversity conservation and its judicious utilization are important in sustainable plant breeding programs. Breeders' and farmers' rights are important in scenario of globalization of agriculture so knowledge of IPRs is essential for a plant breeder to protect his varieties.

Aim of the course

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledgebased economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

Teaching methods

• Power point presentation • Smart board • Assignments, quiz • Group tasks, student's presentations

Learning outcome

The students will have acquaintance of intellectual property rights, national and international laws on biodiversity and sustainable use of plant genetic resources through transfer and sharing. Can assist in follow up of various treatises and laws for research collaborations at international levels.

Suggested Reading

Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

York. Pirone TP and Shaw JG. 1990. Viral Genes and Plant Pathogenesis. Springer Verlag, New York. Roger Hull. 2002. Mathew's Plant Virology (4th Ed.). Academic Press, New York. Thresh JM. 2006. Advances in Virus Research. Academic Press, New York.

Course Title : Advances in Plant Pathogenic Prokaryotes

Course Code : PL PATH 603

Credit Hours : 2+1

Aim of the course

To learn about the latest developments in all the plant pathogenic prokaryotes as a whole.

Theory

Unit I

Prokaryotic cell: Molecular basis for origin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition (bacteria) cell wall/ envelop, Types of secretion systems (TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterial chromosomes and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes (Embden-Meyerhof-Parmas (EMP) pathway, Phosphoketolase Pathway and EntnerDoudoroff Pathway).

Unit II

Current trends in taxonomy and identification of phytopathogenicprokarya: International code of nomenclature, Polyphasic approach, New/ special detection methods for identification of bacterial plant pathogens. Taxonomic ranks hierarchy; Identification, Advances in classification and nomenclature.

Unit III

Bacterial genetics: General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome.

Unit IV

Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/ bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker, etc. Immunization, induced resistance/ Systemic Acquired Resistance,

Quorum sensing. Bacterial pathogenicity and virulence: Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymes that degrade the cell walls, Role of hrp/ hrc genes and TALE effectors. Synthesis and regulation of EPSs.

Unit V

Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR cas9.

Practical

• Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using species/ pathovar specific primers; • Basic techniques in diagnostic kit development, Molecular tools to identify phytoendosymbionts; • Important and emerging diseases and their management strategies.

Suggested Reading

Dale JW and Simon P. 2004. Molecular Genetics of Bacteria. John Wiley & Sons, New York. Garrity GM, Krieg NR and Brenner DJ. 2006. Bergey's Manual of Systematic Bacteriology: The Proteobacteria. Vol. II. Springer Verlag, New York. Gnanamanickam SS. 2006. Plant-Associated Bacteria. Springer Verlag, New York. Mount MS and Lacy GH. 1982. Plant Pathogenic Prokaryotes. Vols. I, II. Academic Press, New York. Sigee DC. 1993. Bacterial Plant Pathology: Cell and Molecular Aspects. Cambridge Univ. Press, Cambridge. Starr MP. 1992. The Prokaryotes. Vols. I–IV. Springer Verlag, New York.

Course Title : Molecular Basis of Host-pathogen Interaction
Course Code : PL PATH 604
Credit Hours : 3 (2+1)
Aim of the course

To understand the concepts of molecular biology and biotechnology in relation to host plant- pathogen interactions.

Theory
Unit I

Chet I. 1993. Biotechnology in Plant Disease Control. John Wiley & Sons, New York. Gurr SJ, McPohersen MJ and Bowlos DJ. (Eds.). 1992. Molecular Plant Pathology – A Practical Approach. Vols. I & II, Oxford Univ. Press, Oxford. Mathew JD. 2003. Molecular Plant Pathology. Bios Scientific Publ., UK. Ronald PC. 2007. Plant-Pathogen Interactions: Methods in Molecular Biology. Humana Press, New Jersey. Stacey G and Keen TN. (Eds.). 1996. Plant Microbe Interactions. Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

Course Title : Principles and Procedures of Certification
Course Code : PL PATH 605
Credit Hours : 1 (1+0)
Aim of the course
To acquaint with the certification procedures of seed and planting material.
Theory
Unit I
Introduction to certification. International scenario of certification and role of ISTA, Restructured and EPPO, OECD, etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc. Fixing tolerance limits for diseases and insect pests in certification and quality control programmes.
Unit II
Methods used in certification of seeds, vegetative propagules and in-vitro cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.
Reference
Association of Official Seed Certifying Agencies. Hutchins D and Reeves JE. (Eds.). 1997. Seed Health Testing: Progress Towards the 21st Century. CABI, UK. ISHI-veg Manual of Seed Health Testing Methods. ISHI-F Manual of Seed Health Testing Methods. ISTA Seed Health Testing Methods. Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Department of Agriculture and Cooperation,

Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System.

e-Resources

http://www.aosca.org/index.htm.
http://www.worldseed.org/enus/international_seed/ishi_vegetable.html
http://www.worldseed.org/en-us/international _seed/ ishi_f.html
http://www.seedtest.org/en/content—1—1132—241.html
http://www.seedhealth.org

Course Title : Plant Biosecurity and Biosafety
Course Code : PATH 606
Credit Hours : 2 (2+0)
Aim of the course

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory
Unit I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases. Introduction and History of biosecurity and its importance.

Unit II

National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

Unit III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/ resurgence of pests and diseases in the changing scenario of climatic conditions. Issues related to release of genetically modified crops.

Suggested Reading

Biosecurity: A Comprehensive Action Plan. Biosecurity Australia. Biosecurity for Agriculture and Food Production. FAO Biosecurity Toolkit 2008. Grotto Andrew J and Jonathan B Tucker. 2006. Biosecurity Guidance. Khetarpal RK and Kavita Gupta 2006. Plant Biosecurity in India – Status and Strategy. Asian Biotechnology and Development Review 9(2): 3963. Randhawa GJ, Khetarpal RK, Tyagi RK and Dhillon BS (Eds.). 2001. Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi.

e-Resources

http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf http://www.americanprogress.org/kf/biosecurity_ a_comprehensive_ action_plan.pdf www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/ index.htm www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia Biosecurity New Zealand. http://www.fao.org/biosecurity/ CFIA.

List of Journals

• Annals of Applied Biology – Cambridge University Press, London • Annals of Plant Protection Sciences- Society of Plant Protection, IARI, New Delhi • Annual Review of Phytopathology – Annual Reviews, Palo Alto, California • Annual Review of Plant Pathology – Scientific Publishers, Jodhpur • Canadian Journal of Plant Pathology – Canadian Phytopathological Society, Ottawa • Indian Journal of Biotechnology – National Institute of Science Communication and Information Resources, CSIR, New Delhi • Indian Journal of Mycopathological Research – Indian Society of Mycology, Kolkata. • Indian Journal of Plant Protection – Plant Protection Association of India, NBPGR, Hyderabad. • Indian Journal of Virology – Indian Virological Society, New Delhi • Indian Phytopathology-Indian Phytopathological Society, IARI New Delhi. • Journal of Mycology and Plant Pathology – Society of Mycology and Plant Pathology, Udaipur. • Journal of Plant Disease Science-Association of Plant Pathologists (Central India) PDKV, Akola. • Journal of Phytopathology – Blackwell Verlag, Berlin • Mycologia – New York Botanical Garden, Pennsylvania • Mycological Research – Cambridge University Press, London • Physiological Molecular Plant Pathology – Academic Press, London – Phytopathology – American Phytopathological

Unit II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

Unit III

Nutrient transformation–N, P, S; tracemetal interaction with humic substances, significance of chelation reactions in soils.

Unit IV

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clayorganic matter complexes.

Unit V

Humus-pesticide interactions in soil, mechanisms.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil biochemistry on research for solving field problems.

Reading Materials

• Lynch JM, Willey JM. Soil Biotechnology. • Paul EA and Clark FE. Soil Microbiology and Biochemistry • Sherwood LM and Woolverton CJ. Prescott's Microbiology. • Subba Rao NS. Advances In Agricultural Microbiology

Course Title : Soil Resource Management

Course Code : Soil 606

Credit Hours : 3+0

Aim of the course

To impart the students basic holistic knowledge on soil resource and latest developments in its sustainable use.

Unit I

Relevance of soil management to sustainable agriculture; soil as a natural resource for biomass production, filtering, buffering, transportation of solutes,

genereserves, and geogenic source of raw materials; soil as a source and sink of greenhouse gases.

Unit II

Concept of sustainable land management (SLM); spatial variability of soils; soil quality and food security; soil quality indices, conservation agriculture in relation to soil quality; soil resilience and resistance.

Unit III

Types, factors and causes of land degradation and desertification; GLASOD classification; application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation; history, distribution, identification and description of soil erosion problems in India; forms of soil erosion; impact of soil erosion-on-site and off-site effects; strategies for erosion control and conservation; soil conservation in hilly, arid, semiarid, coastal and diaralands. Management of forest, peat and muck soils.

Unit IV

Soil conservation planning; land capability classification; soil conservation in special problem are as such as hilly, arid and semi-arid regions, waterlogged and wetlands; land restoration and conservation techniques–erosion control, reclamation of salt affected soils; mine land reclamation, afforestation, organic products, soil fauna and biodegradation.

Unit V

Watershed management-concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds.

Unit VI

Agro-ecological regions of India; potentials and constraints of soils of different regions; land evaluation and rationalizing land use, decision support system with relation to land management; national and international soil policy considerations.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil resources on research for solving field problems.

VII. Suggested Reading

• Abrol IP and Dhruvanarayana VV. 1990. Technology for Wasteland Development. ICAR, New Delhi. • Andriesse JP. 1988. Nature and Management of Tropical Peat Soils, Soil Resources, FAO Soils Bulletin 59, Management and Conservation Service, Land and Water Development Division, FAO, Rome • Blackwell, Dent D and Young A. 1981. Soil Survey and Land Evaluation. George Allen and Unwin, London. • Burrough A and McDonnell RK. 1998.Principles of Geographical Information System. Oxford University Press. • Dan Binkley D and Fisher R. 2012. Ecology and Management of Forest Soils,4th Edition, Wiley. • FAO. 1996. Land Quality Indicators and their Use in Sustainable Agriculture and Rural Development. FAO Land and Water Bulletin.5. FAO, Rome. • Faroq M and Siddique K. (Ed.). 2015. Conservation Agriculture, Springer Nature, Chennai, India. • FESL. 1993. An International Framework for Evaluating Sustainable Land Management, FAO World Soil Resources Report No. 73, Land Development Division, FAO, Rome. • ISSS. 1994. Management of Land and Water Resources for Sustainable Agriculture and Environment. Diamond Jubilee Symposium Publication, Indian Society of Soil Science, New Delhi. • Lal R, Blum WEH, Valentine C and Stewart BA. (Editors). 1988. Methods for Assessment of Soil Degradation. CRC Press, Boca Raton. • Mulders MA. 1987. Remote Sensing in Soil Science. Elsevier Science Publishers, Amsterdam. • Sehgal J. 2014. A Text Book of Pedology Concepts and Application. Kalyani publishers, New Delhi. • SSSA 1996. Methods for Assessing Soil Quality. SSSA Publication Number 49, Madison, Wisconsin, USA.

Note: For minor courses please refer the concerned department's courses outline.

• Classroom Lectures • Assignment (written and speaking) • Student presentation • Hands on training of different procedure • Group discussion

IX. Learning outcome

After successful completion of this course, the students are expected to: • Acquire the knowledge about effect of different abiotic stresses on vegetables • Methods to mitigate abiotic stress in vegetables

Suggested Reading

Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House. Dwivedi P and Dwivedi RS. 2005. Physiology of abiotic stress in plants. Agrobios. Janick JJ. 1986. Horticultural science. 4th Ed. WH Freeman and Co. Kaloo G and Singh K. 2001. Emerging scenario in vegetable research and development. Research periodicals and book publ. house. Kaloo G. 1994.Vegetable breeding. Vols. I-III. Vedams eBooks. Lerner HR. (Eds.). 1999. Plant responses to environmental stresses. Marcel Decker. Maloo SR. 2003. Abiotic stresses and crop productivity.Agrotech Publ. Academy. Narendra T. et al. 2012. Improving crops resistance to abiotic stress. Wiley and Sons.US. Peter KV and Pradeep Kumar T. 2008. Genetics and breeding of vegetables. (Revised Ed.). ICAR. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume II.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume III. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p. Ram HH. 2001. Vegetable breeding. Kalyani. Rao NK. (Eds.). 2016. Abiotic stress physiology of horticultural crops. Springer publication.

Course Title : Seed Certification, Processing and Storage of Vegetable Seeds

Course Code : VSC 604

Credit Hours : (2+1)

Why this course ?

Every farmer should able to access healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds plays a vital role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient

certification procedures plays a major role in the increase of food production of our country. To ensure this, the Government has prescribed standards and has brought in seed production techniques, testing, certification and marketing procedures through the Seeds Act, 1966. In the current scenario, the demand for good quality certified seeds far exceed the availability in the market. This manual provides details about production and procurement of good quality seeds.

Aim of the course

To impart the knowledge on seed certification, processing and storage of vegetable seeds

Theory

Unit I

Seed certification, history, concepts and objectives, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, Planning and management of seed certification programmes.

Unit II

Principles and procedures of field inspection, seed sampling, testing and granting certification, OECD certification Schemes.

Unit III

Principles of seed processing, Methods of seed drying and cleaning, seed processing plant- Layout and design, seed treatment, seed quality enhancement, packaging and marketing.

Unit IV

Principles of Seed Storage, orthodox/ recalcitrant seeds, types of storage (open, bulk, controlled, germplasm, cryopreservation), factors affecting seed longevity in storage (Pre and post harvest factors).

Unit V

Seed aging and deterioration, maintenance of seed viability and vigor during storage, storage methods, storage structures, transportation and marketing of seeds.

Practical

• General procedures of seed certification; • Field inspection and standards; • Isolation and rouging; • Inspection and sampling at harvesting, threshing and processing; • Testing physical purity, germination and moisture, grow-out test;

• Visit to regulatory seed testing and plant quarantine laboratories; • Seed processing plants and commercial seed stores.

Teaching Methods/ Activities

• Classroom Lectures • Assignment (written and speaking) • Student presentation individual or in group • Hands on training of different procedure • Group discussion

Learning outcome

After successful completion of this course, the students are expected to: • Acquire the knowledge on seed certification • Acquire the knowledge on seed processing and storage

Suggested Reading

Agarwaal PK and Anuradha V. 2018. Fundamentals of seed science and technology. Brilliant publications, New Delhi. Basra AS. 2000. Hybrid seed production in vegetables. CRC press, Florida, USA. Bench ALR and Sanchez RA. 2004. Handbook of seed physiology. Food products press, NY/ London. Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. Testing of distinctiveness, uniformity and stability for plant variety protection. IARI, New Delhi Copland LO and McDonald MB. 2004. Seed science and technology, Kluwer academic press. Fageria MS, Arya PS and Choudhry AK. 2000. Vegetable crops: breeding and seed production Vol 1. Kalyani publishers, New Delhi. George RAT. 1999. Vegetable seed production (2nd Edition). CAB International. Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani publishers, Ludhiana, 459p Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. Seed: A global perspective. Associated publishing company, New Delhi. Singhal NC. 2003. Hybrid seed production. Kalyani publishers, New Delhi.

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior

TITLE

Programme outcomes (POs), and Course Outcomes (COs) for the courses of following programs

- Program-1 B.Sc. (Hons) Agriculture
- Program-2 B.Sc. (Hons) Horticulture
- Program-(3-15) M.Sc. Agriculture & Horticulture
- Program-16 Ph.D. Program

PROGRAMME-1

B.Sc. (Hons.)

Agriculture

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of B.Sc. (Hons.) Agriculture Programme – Old Syllabus

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1	:	Comprehensive understanding of scientific principles of modern and ancient agriculture and allied system.
PSO2	:	To develop proficiency in utilizing modern agricultural technologies and tools to enhance productivity and efficiency in agriculture.
PSO3	:	To demonstrate the ability to identify agricultural problems to ensure

techno- economic empowerment and global food security.

PSO4 : Adhere to ethical standards and demonstrate professionalism in entrepreneurial skill-based knowledge and job opportunities in various sectors.

Course Outcomes (COs)

Department – Agronomy

1. AGR – 111 (Fundamentals of Agronomy)

CO1 : Understand the agro-climatic zones of India and Madhya Pradesh, and grasp the importance of agriculture.

CO2 : Explore the meaning and scope of agronomy, including types of seeds, dormancy, viability, and seed treatment methods.

CO3 : Learn various sowing methods, plant density, nursery bed techniques, and transplanting practices for optimal plant population.

CO4 : Study tillage types, including minimum and no-till methods, and understand the characteristics of good tilth.

CO5 : Gain knowledge of crop nutrition and the use of manures, compost, fertilizers, and integrated nutrient management (INM).

2. AGR – 112 (Agriculture Heritage)

CO1 : Understand the historical roots of Indian agriculture and its significance in the present context.

CO2 : Explore ancient agricultural practices and their relevance to contemporary farming methods.

CO3 : Analyse the status of agriculture and farmers in society, both historically and in the present day.

CO4 : Trace the evolution of Indian agriculture from ancient times to the modern era, including its development and challenges.

CO5 : Examine the scope and importance of agriculture in India and assess the current national agricultural setup, challenges, and future prospects.

3. AGR – 211[Crop Production Technology-I (Kharif Crops)]

CO1 : Understand the origin, geographical distribution and economic importance of major kharif crops

CO2 : Analyse the soil and climatic requirements necessary for the successful cultivation of each crop.

CO3 : Identify different varieties of each crop and comprehend their characteristics.

CO4 : Implement cultural practices specific to each crop, including sowing, irrigation, fertilization, weed management and harvesting techniques to enhance yield.

CO5 : Acquire knowledge about the package of practices for Urd bean, Moong

bean, Sesame, Castor, Napier, minor millets, Panicum, Lasiuras, Cenchrus, Sunhemp, and Jute.

4. AGR – 221 [Crop Production Technology-II (Rabi Crops)]

CO1 : Understand the origin and geographical distribution of Rabi crops.
CO2 : Analyse the economic importance of Rabi crops.
CO3 : Evaluate the soil and climatic requirements suitable for the cultivation of Rabi crops.
CO4 : Apply appropriate cultural practices for maximizing yield in Rabi crop cultivation.
CO5 : Implement a package of practices for the cultivation of Rabi crops including techniques for optimal growth, pest management, and harvesting.

5. AGR – 222 (Farming Systems and Sustainable Agriculture)

CO1 : Understand the scope, importance, and concept of farming systems, including their relevance to sustainable agriculture and resource optimization.
CO2 : Analyse the types and systems of farming, considering factors affecting their classification, and evaluate their efficiency and productivity.
CO3 : Identify farming system components and develop maintenance strategies to optimize productivity and sustainability.
CO4 : Evaluate cropping systems, patterns, and multiple cropping systems for efficiency and sustainability, using tools to determine production and efficiencies.
CO5 : Apply conservation agriculture strategies, including LEIA, LEISA, HEIA, and IFS to address sustainability challenges, optimize resource use, and mitigate environmental impact.

6. AGR – 223 (Introductory Agro-meteorology & Climate Change)

CO1 : Understand the meaning and scope of agricultural meteorology, and its significance in agricultural production and management.
CO2 : Analyse the Earth's atmosphere, including its composition, extent, structure, and atmospheric weather variables.
CO3 : Identify atmospheric phenomena such as cyclones, anticyclones, land and sea breezes, and their effects on agricultural activities.
CO4 : Evaluate the energy balance of the Earth, including atmospheric temperature, humidity, precipitation types and their implications for agriculture.
CO5 : Apply knowledge of weather hazards to develop strategies for mitigating their impact on crop and livestock production, and utilize weather forecasting techniques for agricultural planning and management.

7. AGR – 311 [Practical Crop Production-I (Kharif Crops)]

CO1	:	Understand the fundamentals of crop planning and the process of allotting fields for cultivation.
CO2	:	Gain knowledge of crop selection, variety selection, seed treatment, and the process of sowing seeds.
CO3	:	Learn about intercultural operations such as hoeing and weeding, as well as water management techniques including irrigation methods.
CO4	:	Learn the techniques involved in harvesting, threshing, winnowing, and storage of agricultural produce.
CO5	:	Gain insight into marketing strategies for agricultural produce, including market analysis and selling techniques.

8. AGR-312 Geo-informatics and Nano-technology for Precision Farming

CO1	:	Understand the concepts and techniques of precision agriculture and its relevance, issues, and concerns for Indian agriculture.
CO2	:	Explore the definition, concepts, tools, and techniques of geo-informatics and their applications in precision agriculture.
CO3	:	Gain knowledge of remote sensing concepts and their application in agriculture, along with image processing and interpretation techniques.
CO4	:	Learn about the global positioning system (GPS), its components, and functions in precision agriculture.
CO5	:	Explore the introduction to crop simulation models and their uses for optimizing agricultural inputs, as well as the STCR approach for precision agriculture.

9. AGR – 321 [Practical Crop Production-II (Rabi Crops)]

CO1	:	Understand the process of land allotment, field preparation, and the selection of crops and varieties for optimal crop cultivation.
CO2	:	Evaluate various sowing methods, seed treatment techniques, and seedbed preparation to ensure proper germination and yield.
CO3	:	Demonstrate proficiency in seedbed preparation, crop sowing, thinning, and gap filling to establish proper plant spacing and stand density.
CO4	:	Implement fertilizer application practices, including top dressing, to enhance nutrient availability and support crop growth and development.
CO5	:	Perform intercultural operations such as hoeing, weeding, and moisture conservation practices to maintain weed-free fields and optimize crop yields.

10. AGR – 322 (Principles of Organic Farming)

CO1	:	Understand the principles and scope of organic farming in India, including its ecological, economic, and social aspects.
CO2	:	Evaluate the initiatives undertaken by government agencies, NGOs, and other organizations to promote organic agriculture at both central and

state levels.

CO3 : Examine the concepts of organic ecosystems and their importance in sustainable agriculture.

CO4 : Identify organic nutrient resources and strategies for fortification, as well as understand the restrictions on nutrient use in organic farming.

CO5 : Analyse the selection of crops and varieties suitable for organic farming, considering factors such as adaptability, resilience, and market demand.

11. AGR – 323 (Rainfed Agriculture and Watershed Management)

CO1 : Understand the concept of rainfed agriculture, its history, and its importance in India, with a focus on Rajasthan.

CO2 : Identify and analyse the problems associated with dryland agriculture, including climate, soil, technological, and socio-economic challenges.

CO3 : Learn about soil and water conservation techniques to mitigate the impact of drought and water scarcity in rainfed areas.

CO4 : Explore the effects of water deficit on physio-morphological characteristics of plants and the use of antitranspirants to manage crop yield under water stress conditions.

CO5 : Gain knowledge of crop adaptation and mitigation strategies to cope with drought conditions including integrated watershed management principles.

12. AGR – 324 (Weed management)

CO1 : Understand the concept of weeds, including their characteristics and classification, and differentiate between harmful and beneficial effects on ecosystems.

CO2 : Analyse the reproduction, dissemination, and dormancy mechanisms of weeds, and evaluate their implications for weed management.

CO3 : Examine crop-weed competition and the principles of weed management, including physical, cultural, chemical, and biological methods of control.

CO4 : Evaluate herbicide classification, active ingredients, formulations, application techniques, mode of action, selectivity, fate, and the concept of adjuvants in weed control.

CO5 : Explore the concept of bio-herbicides, integrated weed management, and specific weed management strategies for various crops and aquatic environments.

Department – Agricultural Economics and Farm Management

13. AEC – 121 (Fundamentals of Agricultural Economics)

CO1 : Understand the fundamentals of economics and subject matter, with a focus on micro and macroeconomic analysis.

CO2 : Explore economic theory, including the rationality assumption, equilibrium concept, and economic laws as generalizations of human

behavior.

CO3 : Examine agricultural economics, its characteristics, importance in economic development, and the planning and development initiatives in the country.

CO4 : Analyse demand theory, including the law of demand, utility theory, consumer equilibrium, elasticity of demand, and its determinants.

CO5 : Study production theory and the role of money, taxation, public finance, and economic systems in the economy.

14. AEC – 211 (Agricultural Finance and Co-operation)

CO1 : Understand the meaning, scope, and significance of agricultural finance, including its role in Indian agriculture.

CO2 : Analyse the credit needs of Indian agriculture and the classification of agricultural credit, along with credit analysis techniques such as the 3 R's, 5 C's, and 7 P's.

CO3 : Evaluate the sources of agricultural finance, including institutional and non-institutional sources, with a focus on commercial banks, micro-financing, Lead Bank Scheme, and RRBs.

CO4 : Examine the scale of finance, unit cost, and introduction to higher financing institutions like RBI, NABARD, ADB, IMF, and World Bank, along with crop insurance schemes.

CO5 : Analyse recent developments in agricultural credit, financial statement preparation and analysis, guidelines for project reports, and financial instruments/methods.

15. AEC – 221 (Agricultural Marketing, Trade and Prices)

CO1 : Understand the concepts and definitions of market, marketing, and agricultural marketing.

CO2 : Analyse the features of perfectly competitive and imperfect markets.

CO3 : Evaluate demand, supply, and producer's surplus of agricultural commodities.

CO4 : Explore the product life cycle (PLC), competitive, pricing and promotion strategies.

CO5 : Examine the marketing process and functions, government's role in agricultural marketing, theories of advantage, GATT, WTO, and implications of agreements on Indian agriculture.

16. AEC – 321 (Farm Management, Production & Resource Economics)

CO1 : Understand the meaning and concept of farm management, its objectives, and its interdisciplinary relationship with other sciences.

CO2 : Identify different types of farms, their characteristics, and factors determining their types and sizes.

CO3 : Analyse the principles of farm management, including the concept of the

production function and its application in decision-making.

CO4 : Evaluate the significance of costs in farm management and understand their importance in estimating various farm incomes.

CO5 : Examine farm business analysis, technical and economic efficiency measures, and the importance of maintaining farm records and accounts.

Department – Agricultural Engineering

17. AEG – 121 (Soil and Water Conservation Engineering)

CO1 : Understand the concepts of soil and water conservation and the causes of soil erosion.

CO2 : Identify the definition of soil erosion and its agents, focusing on water erosion and its various forms.

CO3 : Learn about gully erosion, its classification, and control measures, including soil loss estimation using the Universal Soil Loss Equation.

CO4 : Explore principles and techniques for controlling water erosion.

CO5 : Gain knowledge of wind erosion mechanics, types of soil movement, and techniques for wind erosion control.

18. AEG – 211 (Farm Machinery and Power)

CO1 : Evaluate the status of farm power in India and Madhya Pradesh, along with an analysis of the sources of farm power available.

CO2 : Understand the components and working principles of Internal Combustion (I.C.) engines and related terminology.

CO3 : Examine the air cleaning system, cooling system, fuel supply system, and lubricating system of I.C. engines.

CO4 : Analyse the power transmission system of a tractor along with cost analysis of tractor power and attached implements.

CO5 : Familiarize with various primary and secondary tillage implements as well as implements for sowing, intercultural operations, planting, plant protection, harvesting and threshing equipment.

19. AEG – 221 (Renewable Energy and Green Technology)

CO1 : Understand the classification of energy sources and their contribution to the agricultural sector.

CO2 : Familiarize with different types of biogas plants and comprehend biogas production techniques and various uses of biogas.

CO3 : Explore biomass gasification and different types of gasifiers and their applications in energy production.

CO4 : Learn about bio-alcohol, biodiesel, and bio-oil production, and their utilization as bioenergy resources.

CO5 : Introduce solar energy collection methods and applications as well as wind energy and its applications.

20. AEG – 321 (Protected Cultivation and Secondary Agriculture)

CO1 : Gain an understanding of greenhouse technology, including the types of greenhouses and how plants respond to the greenhouse environment.

CO2 : Learn the principles and methods involved in planning and designing greenhouses to optimize plant growth and productivity.

CO3 : Understand the design criteria of greenhouses for cooling and heating purposes, including the selection of appropriate materials and equipment.

CO4 : Explore various irrigation systems used in greenhouses to ensure efficient water management and plant health.

CO5 : Familiarize with passive solar greenhouse and hot air greenhouse heating systems and learn about cost estimation and economic analysis related to greenhouse operations.

Department – Entomology

21. ENT – 121 (Fundamental of Entomology)

CO1 : Understand the definition and significance of entomology, tracing its historical development in India, and analysing the factors influencing insect abundance.

CO2 : Classify arthropods up to classes with examples, highlighting their relationship with class Insect, and dissect the structure and functions of insect body segmentation, cuticle, and moulting.

CO3 : Examine the structure and modifications of antennae, mouth-parts, legs, wings, male and female genital organs, digestive and circulatory systems in insects.

CO4 : Analyse the structure and functions of excretory and respiratory systems, nervous system, and major sensory organs, while exploring types of metamorphosis, diapause, larvae, and pupae.

CO5 : Define and appreciate the importance of insect ecology, dissecting the components of the environment and Integrated Pest Management (IPM) techniques, including chemical, biological, and modern methods.

22. ENT – 311 (Pests of Crops & Stored Grains and their Management)

CO1 : Identify common pests affecting various types of crops including their scientific names, distribution, host range, nature of damage and biology.

CO2 : Understand the causes of grain deterioration in storage and the role of physical, mechanical, chemical, and biological factors.

CO3 : Familiarize with the scientific names, systematic positions, distributions, host ranges, identifications, nature of damage, and biology of various stored grain pests.

CO4 : Learn about storage structures like traditional, PUSA bin, and warehouses, along with the principles of stored grain management and preventive and curative measures for stored grain pests.

CO5 : Gain knowledge about the scientific names, systematic positions, distributions, host ranges, identifications, nature of damage, biology, and

management of pests affecting various vegetables, fruits, crops and trees.

23. ENT – 321 (Management of Beneficial Insects)

CO1 : Understand the importance of beneficial insects, particularly honey bees, in agriculture, and recognize various species of honey bees

CO2 : Demonstrate knowledge of beekeeping equipment, hive structures, and commercial methods of bee rearing.

CO3 : Implement seasonal management practices for bee colonies considering various environmental conditions.

CO4 : Identify bee pasturage, pollinating plants, and understand bee foraging behavior and communication skills in honey bees.

CO5 : Evaluate the natural enemies of bees and their management strategies as well as understand the significance of sericulture including the identification and management of natural enemies.

Department – Agricultural Extension and Communication

24. EXT – 111 (Rural Sociology and Educational Psychology)

CO1 : Understand the significance of sociology in agriculture, including its meaning, scope, and importance.

CO2 : Explore rural sociology's role in extension education, encompassing its definition, scope, and relevance.

CO3 : Differentiate between rural and urban societies, and analyse the essential characteristics of Indian rural society.

CO4 : Examine the concept of social groups, their types, roles in agricultural extension, and group characteristics.

CO5 : Investigate social stratification, cultural aspects such as material and non-material culture, social institutions, social change and development and intelligence factors in agricultural contexts.

25. EXT – 121 (Fundamentals of Agricultural Extension Education)

CO1 : Comprehend the diverse types of education, including formal, normal, and informal, and analyse their significance in societal development.

CO2 : Understand the concept, scope, and principles of extension education, examining its role in disseminating agricultural knowledge and fostering community development.

CO3 : Explore the process and principles of extension program planning, emphasizing objectives and steps in program development to address agricultural challenges effectively.

CO4 : Evaluate the evolution of the extension system in India, from pre-independence initiatives

CO5 : Analyse contemporary trends in agricultural extension, assessing their advantages and disadvantages in enhancing agricultural outreach and technology transfer.

26. EXT – 122 (Communication Skills and Personality Development)

CO1	:	Grasp the fundamental concepts of communication, identifying and overcoming common communication barriers using established models.
CO2	:	Recognize the importance and need for effective communication skills in both personal and professional contexts.
CO3	:	Differentiate between verbal and non-verbal communication, understanding their meanings, definitions, and various types, with a focus on enhancing comprehension and expression.
CO4	:	Understand the significance of active listening, its various types, and its role in effective communication
CO5	:	Develop proficiency in essential writing skills and explore techniques for oral presentations using audio-visual aids for impactful communication.

27. EXT – 311(Entrepreneurship Development and Business Communication)

CO1	:	Understand the concept, meaning, and definition of entrepreneurship, assessment of entrepreneurial skills, including opportunities for rural entrepreneurship.
CO2	:	Define an entrepreneur, identify types of entrepreneurs, analyse characteristics of entrepreneurs, and distinguish between an entrepreneur and a manager.
CO3	:	Explore the meaning and definition of an enterprise and the principles of enterprise management.
CO4	:	Learn about SWOT analysis, its concept, meaning, and practical application in assessing business strategies.
CO5	:	Gain insight into entrepreneurship development phases and understand entrepreneurial behavior dimensions.

Department – Genetics and Plant Breeding

28. GPB – 121 (Fundamentals of Genetics)

CO1	:	Understand pre and post Mendelian concepts of heredity, including Mendelian principles and cell division processes such as mitosis and meiosis.
CO2	:	Apply probability and Chi-square analysis in genetic studies, examining dominance relationships and gene interactions.
CO3	:	Explore various types of epistatic gene interactions and their examples, including complementary, supplementary, duplicate, masking, inhibitory, polymeric, and additive interactions.
CO4	:	Analyse pleiotropism, pseudoalleles, multiple alleles, and blood group genetics, as well as sex determination and linkage.
CO5	:	Investigate mechanisms of chromosome crossing over, mapping, structural and numerical changes in chromosomes and the use of haploids and

mutagenic agents in genetics research.

29. GPB – 211 (Fundamentals of Plant Breeding)

CO1 : Understand the concept, nature, objectives, and role of plant breeding in improving crop characteristics.

CO2 : Analyse the historical development of plant breeding and its impact on agriculture.

CO3 : Examine the principles of genetics as they relate to plant breeding, including major achievements and future prospects.

CO4 : Identify the processes of domestication, acclimatization, introduction, and centres of origin/diversity in plant breeding.

CO5 : Evaluate different modes of reproduction and pollination and male sterility, and their genetic consequences in breeding programs.

30. GPB – 221 (Principles of Seed Technology)

CO1 : Understand the importance of seeds and seed technology in agriculture

CO2 : Identify causes of deterioration in crop varieties and implement control measures to maintain genetic purity during seed production.

CO3 : Evaluate seed quality characteristics and differentiate between different classes of seeds.

CO4 : Analyse the phases and procedures involved in seed certification.

CO5 : Apply various techniques for varietal identification, understand issues related to GM crops and organic seed production techniques.

31. GPB – 222 (Commercial Plant Breeding)

CO1 : Understand the types of crops and their modes of plant reproduction, including self-pollinated, cross-pollinated, and hybrid seed production systems.

CO2 : Master line development and maintenance breeding techniques in self and cross-pollinated crops for the development of hybrids and seed production.

CO3 : Evaluate genetic purity tests of commercial hybrids and advances in hybrid seed production for major crops.

CO4 : Explore alternative strategies for line and cultivar development while understanding intellectual property rights (IPR) issues in commercial plant breeding.

CO5 : Analyse the principles and techniques of quality seed production for vegetable crops under both open and protected environments as well as variety testing and registration of varieties under the PPV & FR Act.

32. GPB – 311 [Crop Improvement – I (Kharif crops)]

CO1 : Understand the centres of origin and distribution of species, including wild relatives in different Kharif crops.

CO2 : Gain knowledge about plant genetic resources, their utilization, and

conservation strategies for Kharif crops.

CO3 : Study the genetics of qualitative and quantitative characters, focusing on important breeding concepts for Kharif self-pollinated, cross-pollinated, and vegetatively propagated crops.

CO4 : Learn major breeding objectives and procedures for the development of Kharif hybrids and varieties to achieve quality improvement.

CO5 : Explore the ideotype concept for Kharif crops and the development of climate-resilient crop varieties for future agricultural sustainability.

33. GPB – 312 (Intellectual Property Rights)

CO1 : Understand the concept and significance of intellectual property, including an overview of international organizations such as GATT, WTO, TRIPs, and WIPO.

CO2 : Learn about treaties for intellectual property protection, including the Madrid Protocol, Berne Convention, Budapest Treaty, and others.

CO3 : Gain knowledge of the various types of intellectual property and the legislations covering intellectual property rights (IPR) in India.

CO4 : Explore the Patents Act of 1970 and the patent system in India.

CO5 : Understand the origin and history of protection for plant varieties, the PPV & FR Act of India, focusing on plant breeders' rights, registration of plant varieties and the rights of traditional knowledge holders.

34. GPB – 321 [Crop Improvement – II (Rabi Crops)]

CO1 : Understand the centres of origin and distribution of species, cereals, pulses, oilseeds, fibres, fodders, cash crops, vegetables and horticultural crops of rabi season.

CO2 : Evaluate plant genetic resources and their utilization and conservation strategies specifically tailored for Rabi crops.

CO3 : Analyse the genetics of qualitative and quantitative characters in Rabi crops.

CO4 : Explore major breeding objectives and methodologies, encompassing conventional and modern innovative approaches for developing Rabi hybrids and varieties.

CO5 : Investigate breeding strategies for imparting abiotic and biotic stress tolerance as well as improving the quality of Rabi crops.

Department – Horticulture

35. HORT – 111 (Fundamentals of Horticulture)

CO1 : Comprehend horticulture's definition, branches, and importance, including botanical classifications, climate, and soil needs for crops.

CO2 : Utilize various plant propagation techniques and structures, mastering seed dormancy, germination, and orchard establishment.

CO3 : Apply training, pruning methods, and understand concepts like juvenility,

flower bud differentiation, pollination and fertilization.

CO4 : Acknowledge the significance of medicinal and aromatic plants, and the function of plant bio-regulators in horticulture.

CO5 : Showcase expertise in irrigation methods and fertilizer application specific to horticultural crops.

36. HORT – 211 (Production Technology for Vegetables & Spices)

CO1 : Understand the importance of vegetables and spices in human nutrition and the national economy.

CO2 : Classify vegetables based on their characteristics and uses.

CO3 : Identify and implement different types of vegetable gardening methods, particularly focusing on kitchen gardening.

CO4 : Analyse the origin, area, climate, and soil requirements for various vegetables.

CO5 : Apply cultivation practices such as sowing, transplanting, spacing, fertilization, irrigation, weed management, harvesting, and yield enhancement techniques for vegetables.

37. HORT – 221 [Production Technology for Ornamental Crops, MAP (Medicinal and Aromatic Plants) and Landscaping]

CO1 : Understand the importance and scope of ornamental crops, medicinal and aromatic plants (MAPs), and landscaping in agriculture and horticulture.

CO2 : Comprehend the principles of landscaping, including the landscape uses of trees, shrubs, climbers, and other ornamental plants.

CO3 : Analyse the production technology of important cut flowers under both protected and open conditions.

CO4 : Implement package of practices for loose flowers under open conditions and optimizing production techniques for yield and quality.

CO5 : Learn production technology for important medicinal plants focusing on cultivation, harvesting, and post-harvest processing techniques for value addition.

38. HORT – 222 (Production Technology for Fruit and Plantation Crops)

CO1 : Understanding the importance and scope of fruit and plantation crop industry and importance of rootstocks in India.

CO2 : Study the production technologies for the cultivation of mango, banana, citrus, grape, guava and papaya.

CO3 : Study the production technologies for the cultivation of litchi, sapota, apple, pear, peach, walnut, almond, date palm and ber.

CO4 : Study the production technologies for the cultivation of pineapple, aonla, pomegranate, jackfruit, strawberry, custard apple.

CO5 : Study the production technologies for the cultivation of bael, coconut, arecanut, cashew, tea, coffee, and rubber.

39. HORT – 321 (Post-harvest Management and Value Addition of Fruits and Vegetables)

CO1 : Understand the significance of post-harvest processing in preserving the quality and extending the shelf life of fruits and vegetables

CO2 : Analyse pre-harvest factors that influence post-harvest quality, including maturity, ripening, and physiological changes during ripening.

CO3 : Examine the role of respiration and ethylene in post-harvest physiology and understand the factors affecting respiration rates in fruits and vegetables.

CO4 : Identify common post-harvest diseases and disorders, and evaluate strategies for their prevention and control.

CO5 : Demonstrate knowledge of harvesting techniques, field handling practices, and various storage methods and understand their impact on the quality and shelf life of produce.

Department – Mathematics and Statistics

40. AST – 111 (Elementary Mathematics)

CO1 : Numerical approach on different forms of straight line.

CO2 : Familiarization with different mathematical aspects of a circle.

CO3 : Solutions to mathematical problems based on differential calculus.

CO4 : Study of different methods of integration, definite integrals and area under curves.

CO5 : Introduction to different types of matrices, matrix algebra, determinants along with minor and co-factor of determinant elements.

41. AST – 211 (Agri-Informatics)

CO1 : Understand the anatomy of computers, including memory concepts and units of memory.

CO2 : Define and differentiate between DOS and Windows operating systems.

CO3 : Utilize MS-Office applications for document creation, editing (MS-Word), data handling and presentation (MS-Excel), and presentations (MS-PowerPoint).

CO4 : Apply statistical analysis techniques such as mean, standard deviation, correlation, and regression using Excel.

CO5 : Comprehend the concepts, types, and uses of databases in agriculture, including the use of DBMS like MS-Access.

42. AST – 212 (Statistical Methods)

CO1 : Understand the application of statistics in agriculture and its significance in data analysis and decision-making processes.

CO2 : Master graphical representation techniques such as histograms, frequency polygons, and frequency curves for visualizing agricultural data.

CO3 : Analyse measures of central tendency including arithmetic mean, median

and mode for both ungrouped and grouped data.

CO4 : Interpret measures of dispersion, their merits and demerits, as well as moments, skewness, and kurtosis.

CO5 : Gain proficiency in probability concepts, correlation and regression analysis, hypothesis testing, sampling methods, and apply them to agricultural data analysis and interpretation.

Department – Plant Pathology

43. PPT – 121 (Fundamentals of Plant Pathology)

CO1 : Understand the significance of plant diseases and the objectives of Plant Pathology, tracing the historical development with emphasis on Indian contributions.

CO2 : Define and comprehend key terms and concepts in Plant Pathology, including the disease triangle and tetrahedron models.

CO3 : Classify plant diseases and identify important plant pathogenic organisms, including fungi, bacteria, viruses, viroids, algae, protozoa, phanerogamic parasites, and nematodes.

CO4 : Explore the morphology, reproduction, and classification of fungi, bacteria, mollicutes, viruses, and nematodes, and recognize the symptoms and damage caused by plant parasitic nematodes.

CO5 : Understanding the principles and methods of plant disease management and the nature and classification of fungicides and antibiotics.

44. PPT – 311 (Diseases of Field and Horticultural Crops and their Management-I)

CO1 : Understand the symptoms, etiology, disease cycle and management strategies for major diseases affecting the field and horticultural crops.

CO2 : Identify and manage diseases such as blast, brown spot, bacterial blight, sheath blight, false smut, khaira, tungro, stalk rots, downy mildew, smuts, grain mold, anthracnose, ergot, early and late leaf spots, wilt etc.

CO3 : Analyse disease management techniques including cultural, chemical, and biological control methods, and integrated disease management approaches for horticultural crops .

CO4 : Develop skills in disease diagnosis, prevention, and control strategies, considering specific disease characteristics, host plants, and environmental conditions.

CO5 : Apply acquired knowledge to identify, prevent, and manage diseases effectively, promoting crop health and productivity in agricultural and horticultural systems.

45. PPT – 321 (Diseases of Field and Horticultural Crops and their Management-II)

CO1 : Identify common diseases affecting wheat, sugarcane, cotton, oilseed,

sunflower, and pulses

CO2 : Analyse the symptoms and signs of various fungal and bacterial diseases in fruits such as mango, citrus, grapevine, apple, peach, and strawberry

CO3 : Evaluate the impact of diseases on the yield and quality of vegetables like potato, cucurbits, onion, garlic, and chillies

CO4 : Develop strategies for disease management and control in various crops, including the use of resistant varieties, cultural practices, and chemical treatments.\

CO5 : Demonstrate understanding of disease cycles, epidemiology, and integrated pest management principles in the context of diverse crop production systems.

46. PPT – 312 (Principles of Integrated Pest and Diseases Management)

CO1 : Gain an understanding of computers, including their anatomy, memory concepts, and units of memory.

CO2 : Explore operating systems, focusing on DOS and Windows, understanding their definitions and types.

CO3 : Learn to utilize MS-Office applications for document creation and editing in MS-Word, data handling and presentation in MS-Excel and creating presentations in MS-Power Point.

CO4 : Master statistical analysis techniques such as mean, standard deviation, correlation, and regression using mathematical expressions and analysis tools in Excel.
Familiarize with database concepts and types, using DBMS (MS-Access)

CO5 : Familiarize with database concepts and types, using DBMS (MS-Access) in agriculture, exploring World Wide Web (WWW) and introduction to computer programming languages for basic operations in BASIC.

Department - Biochemistry/Physiology/Microbiology/ Environmental Science

47. EVS-111 (Fundamentals of Plant Biochemistry and Biotechnology)

CO1 : Recognize the vital role of Biochemistry in diverse biological processes.

CO2 : Demonstrate understanding of water properties, pH, and buffering mechanisms.

CO3 : Recognize the importance of carbohydrates and lipids, including their classification and structural features.

CO4 : Analyse the significance and classification of proteins, along with the structural arrangement of amino acids.

CO5 : Apply plant biotechnology concepts like organ culture, micro-propagation, and recombinant DNA techniques, understanding their roles in crop enhancement and regulatory frameworks.

48. EVS – 112 (Introduction to Forestry)

CO1	:	Understand fundamental forestry terminology and concepts.
CO2	:	Comprehend the objectives of silviculture, forest classification, and key features of Indian Forest Policies.
CO3	:	Learn about forest regeneration methods, including natural regeneration from seed and vegetative parts, root suckers.
CO4	:	Objectives of artificial regeneration techniques and essential preliminary factors for choice between natural and artificial methods.
CO5	:	Gain proficiency in forest management practices such as crown classification, tending operations and various thinning techniques.

49. EVS – 113 (Introductory Biology)

CO1	:	Understand the fundamentals of living organisms, diversity and distinguishing characteristics from non-living entities.
CO2	:	Explore the origin of life, examining fossil evidence, early Earth conditions, and RNA metabolism, proteins, and lipids.
CO3	:	Examine eugenics, its meaning, types, and development, alongside the mechanisms and outcomes of evolution.
CO4	:	Learn binomial nomenclature and classification rules, and understand the differences and functions of plant and animal cells.
CO5	:	Study the morphology of flowering plants, inflorescence types, seed structures and the systematic classification of plant families such as Brassicaceae, Fabaceae, Solanaceae, and Poaceae.

50. EVS - 121 (Fundamentals of Crop Physiology)

CO1	:	Understand the concept of crop physiology and its significance in agriculture and horticulture.
CO2	:	Explore the structure and functions of plant cells and their organelles.
CO3	:	Differentiate between diffusion and osmosis and recognize their importance in plant physiology.
CO4	:	Analyse plant water relationships, including water absorption mechanisms and the concept of transpiration.
CO5	:	Study mineral nutrition criteria, nutrient functions, deficiency symptoms, and absorption mechanisms and the role of plant growth regulators in agricultural crops.

51. EVS - 122 (Agricultural Microbiology)

CO1	:	Understand the diversity of microbes, distinguishing between prokaryotic and eukaryotic microorganisms.
CO2	:	Explore the cell structure, metabolic pathways, and growth characteristics of bacteria.
CO3	:	Analyse bacterial genetics, including mechanisms of genetic recombination like transformation, conjugation, and transduction, and the

roles of plasmids and transposons.

CO4 : Examine the diversity of soil organisms, both macro and micro, and their impacts on soil health, considering both beneficial and harmful effects.

CO5 : Evaluate the significant role of microbes in soil fertility and crop production and the contributions of organisms like Azolla, blue-green algae, and mycorrhiza.

52. EVS – 211 (Environmental Studies and Disaster Management)

CO1 : Understand the multidisciplinary nature of environmental studies and its definition, scope, and importance.

CO2 : Analyse the various types of natural resources and associated problems such as deforestation, over-exploitation, and conflicts over water.

CO3 : Examine the environmental effects of extracting and using mineral resources and the challenges associated with food resources.

CO4 : Evaluate the growing energy needs and the importance of renewable and non-renewable energy sources, along with the use of alternate energy sources.

CO5 : Comprehend the concept of ecosystems and the characteristics of different types of ecosystems such as forest, grassland, desert, and aquatic ecosystems.

53. EVS – 321 (Principles of Food Science and Nutrition)

CO1 : Understand the fundamental concepts of food science, including definitions, measurements, density, phase change, pH, osmosis, surface tension, and colloidal systems.

CO2 : Analyse the composition and chemistry of food, including water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, and miscellaneous bioactive.

CO3 : Evaluate food microbiology, including the characteristics of bacteria, yeast, and molds, and their roles in food spoilage and the production of fermented foods.

CO4 : Explore the principles and methods of food processing and preservation, including the use of heat, low temperature, chemicals, radiation, and drying.

CO5 : Examine food and nutrition topics such as malnutrition, nutritional disorders, energy metabolism, balanced/modified diets and emerging trends in food science and nutrition.

Department - Soil Science and Agricultural Chemistry

54. SAC – 111 (Fundamentals of Soil Science)

CO1 : Grasp soil concepts, including its composition, profile, and pedological and edaphological aspects.

CO2 : Study soil genesis, encompassing the influence of rocks, minerals,

weathering, and factors shaping soil formation.

CO3 : Analyse soil physical properties like texture, structure, density, porosity, colour, and taxonomy, alongside Indian soil varieties.

CO4 : Explore soil water dynamics, covering retention, movement, and availability, and their impact on plant growth.

CO5 : Examine soil characteristics and understand their effects on nutrient availability and plant development.

55. SAC – 221 (Problematic Soils and Their Management)

CO1 : Understand the concept of soil quality and health, including factors influencing soil health and indicators of soil quality.

CO2 : Identify and categorize waste lands and problem soils in India based on their properties

CO3 : Analyse techniques for the reclamation and management of problematic soils and explore the utilization of saline water in agriculture.

CO4 : Utilize remote sensing and GIS technologies for the diagnosis and management of problem soils.

CO5 : Evaluate land capability and suitability classifications, and their implications for agricultural productivity and sustainability.

56. SAC – 311 (Manures, Fertilizers and Soil Fertility Management)

CO1 : Understand the significance of organic manures in agriculture and their importance for soil health and fertility.

CO2 : Explore the properties and methods of preparation of both bulky and concentrated organic manures, including green/leaf manuring techniques.

CO3 : Evaluate fertilizer recommendation approaches, including integrated nutrient management strategies, for optimal crop nutrition and productivity.

CO4 : Analyse the classification, composition, properties, and uses of chemical fertilizers.

CO5 : Learn about the history of soil fertility and plant nutrition, factors affecting nutrient availability, soil fertility evaluation, and NUE under different agro-climatic conditions.

57. SAC – 312 (Bio-pesticides & Bio-fertilizers)

CO1 : Understand the history and concept of bio-pesticides and their importance in modern agriculture.

CO2 : Explore the scope and potential of bio-pesticides in pest management and sustainable agriculture practices.

CO3 : Learn about the definitions, concepts, and classification of bio-pesticides, including pathogen-based, botanical, and bio-rational pesticides.

CO4 : Gain knowledge of botanical pesticides and their uses in pest control, emphasizing their natural origins and applications.

CO5	**:**	Understand the mass production technology of bio-pesticides, including techniques for large-scale production to meet agricultural demands effectively.

Department - Veterinary Science and Animal Husbandry

58. LPM – 211 (Livestock and Poultry Management)

CO1	**:**	Understand the role of livestock in the national economy and the significance of various breeds of cattle, buffalo, sheep, goats, swine, and poultry in India.
CO2	**:**	Identify and analyse important Indian and exotic breeds of cattle, buffalo, sheep, goats, swine, and poultry, including their characteristics and contributions to the livestock sector.
CO3	**:**	Evaluate reproduction processes in farm animals and poultry, including incubation, hatching, brooding, and management of young animals.
CO4	**:**	Apply housing principles and space requirements for different species of livestock and poultry, ensuring proper management practices.
CO5	**:**	Comprehend the management practices for livestock and poultry through vaccination schedules and disease management strategies.

Department - English Language

59. ENG – 111 (Comprehension and Communication Skills in English)

CO1	**:**	Grasp the themes in literary works delving into societal challenges and language subtleties.
CO2	**:**	Improve reading comprehension and vocabulary, recognizing antonyms, synonyms, and commonly confused words.
CO3	**:**	Expand vocabulary through TOEFL-focused exercises and functional grammar tasks.
CO4	**:**	Hone writing abilities, covering paragraphs, precision, reports, and proposals, with an emphasis on professional style.
CO5	**:**	Understanding the significance of professional writing, crafting compelling resumes, and grasping interview processes.

60. HVE – 112 (Human Values and Professional Ethics)

CO1	**:**	Grasp the necessity, content, and processes involved in Value Education.
CO2	**:**	Explore self-exploration and continuous happiness as fundamental human aspirations.
CO3	**:**	Cultivate right understanding and harmonious relationships, both internally and externally.
CO4	**:**	Understand the harmony between the sentient 'I' and the material 'Body', and the importance of self-care and moderation.
CO5	**:**	Recognize the significance of trust, respect, and values in human relationships, as well as the broader harmony within society and nature.

Non-Gradial Courses

61. NSS/NCC/Physical Education & Yoga Practices

CO1	:	Understand the components and objectives of NSS as well as the responsibilities and code of conduct for volunteers.
CO2	:	Participate in various NSS programmes and activities, including regular activities, special camping, and community engagement initiatives.
CO3	:	Gain insights into youth demographics, issues, and opportunities, recognizing their potential as agents of social change.
CO4	:	Mobilize communities effectively, utilizing methods that involve youth-adult partnerships and are culturally sensitive.
CO5	:	Appreciate the importance of social harmony, national integration, volunteerism, citizenship, constitution, and human rights in building a cohesive and inclusive society.

PROGRAMME-2

B.Sc. (Hons.)

Horticulture

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of B. Sc. (Hons.) Horticulture Programme – Old Syllabus

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Comprehensive understanding of scientific principles of modern and ancient agriculture and allied system.

PSO2 : To develop proficiency in utilizing modern agricultural technologies and tools to enhance productivity and efficiency in agriculture

PSO3 : To demonstrate the ability to identify agricultural problems to ensure technoeconomic empowerment and global food security.

PSO4 : Adhere to ethical standards and demonstrate professionalism in

entrepreneurial skill-based knowledge and job opportunities in various sectors.

Department- Agronomy

1. AGR-313 |(Introduction to major field crop)

CO1 : Understand the classification of crops based on various criteria.

CO2 : Analyze the distribution patterns of field crops.

CO3 : Define and differentiate between multiple cropping, mixed cropping, intercropping, relay cropping, and alley cropping.

CO4 : Implement cultural practices for raising major cereals, pulses, oilseeds, and fodder crops.

CO5 : Apply green manuring and crop rotation techniques for sustainable crop production.

2. AGR-124 (Organic farming)

CO1 : Understand the introduction and concept of organic farming, including its relevance in the present context.

CO2 : Identify the requirements for organic production, including biological intensive nutrient management techniques.

CO3 : Analyze methods for recycling organic residues and the use of biofertilizers for soil improvement and amendments in organic farming.

CO4 : Explore strategies for diseases and pest management in organic farming, including the use of biocontrol agents, biopesticides, pheromones, trap crops, and bird perches.

CO5 : Investigate integrated weed management techniques in organic farming and understand quality considerations, certification, labeling, etc.

3. AGR-122 (Water management in Horticultural crops)

CO1 : Understand the importance of water in agriculture and its role in plant growth and crop production.

CO2 : Explore water resources in India and the area of different crops under irrigation.

CO3 : Analyze the function of water for plant growth and the effects of moisture stress on crop development.

CO4 : Evaluate water budgeting techniques and rooting characteristics to determine water requirements of horticultural crops and plant water potential .

CO5 : Examine irrigation scheduling approaches, methods of irrigation and their suitability, merits, and limitations along with the concept of fertigation.

4. AGR-212 (Weed management in Horticultural crops)

CO1 : Understand the introduction to weeds, their harmful and beneficial effects.

CO2 : Classify weeds based on their characteristics.

CO3 : Analyze the propagation, dissemination, biology, and ecology of weeds.

CO4 : Evaluate the concepts of weed prevention, control, and eradication, including crop-weed association, competition, and allelopathy.

CO5 : Implement various methods of weed control as well as integrated weed management strategies.

Department – Agricultural Economics and Farm Management

5. AEC 111 (Economics and Marketing)

CO1 : Understand the nature and scope of economics

CO2 : Explain the theory of consumer behavior, including laws of consumption and utility measurement

CO3 : Analyze the theory of demand, including demand schedule and market demand

CO4 : Evaluate factors of production and theories of population

CO5 : Discuss market equilibrium and theories of rent, wage, interest, and profit

6. AEC 323 (Entrepreneurship Development and Business Management)

CO1 : Assess the overall business environment in the Indian economy and understand the implications of social, political, and economic systems on decision-making for entrepreneurs.

CO2 : Explore the concept of entrepreneurship, entrepreneurial and managerial characteristics.

CO3 : Learn about the importance of planning, monitoring, evaluation, and follow-up in managing an enterprise.

CO4 : Analyze government schemes, incentives, policies on Small and Medium Enterprises (SMEs).

CO5 : Understand communication skills, verbal and non-verbal communication, oral presentation skills, and problem-solving skills, etc.

7. AEC – 322 (Horti-Business Management)

CO1 : Understand the definition, nature, characteristics, and scope of farm management.

CO2 : Analyze production functions, technical relationships, cost concepts, and factors influencing production and costs in farming.

CO3 : Explore principles of opportunity cost, equi-marginal returns, comparative advantages, and time value of money in farm management.

CO4 : Learn about economics of scale, returns to scale, cost of cultivation and production, break-even analysis, and decision-making under risk and uncertainty.

CO5 : Understand farming systems and types, planning methods and steps, organizational principles, functional areas of management.

Department – Agricultural Engineering

8. AEG 211 (Farm Power and Machinery)

CO1 : Understand the basic concepts of energy forms, force, energy, and power, with practical calculations and examples.

CO2 : Analyze the various sources of farm power in India, including human, animal, mechanical, and electrical energy, and their applications in agriculture.

CO3 : Describe the working principles and applications of two-stroke and four-stroke engines, as well as different systems of internal combustion engines.

CO4 : Evaluate the types, uses, and components of tractors, power tillers, and implements for tillage and intercultural operations in agriculture.

CO5 : Demonstrate knowledge of equipments and tools for different operations in horticultural crops, along with cost analysis and selection criteria for agricultural machinery.

9. AMT 311 (Agrometeorology and Climate Change)

CO1 : Understand the fundamentals of agricultural meteorology and its practical applications.

CO2 : Analyze the composition and structure of the atmosphere and its impact on weather and climate.

CO3 : Identify and interpret various aspects of weather and climate including temperature, solar radiation, humidity, rainfall, and atmospheric pressure.

CO4 : Explore the basics of weather forecasting and the causes of climate

change, including global warming.

CO5 : Evaluate the effects of climate change on horticulture, including changes in greenhouse gases, atmospheric chemistry, and plant responses to elevated CO2 levels.

Department – Entomology

10. ENT 211 (Fundamentals of Entomology)

CO1 : Understand the basics of Phylum Arthropoda and the significance of Class Insect within it.

CO2 : Analyze the dominance of insects in various ecosystems and their historical importance in India.

CO3 : Recognize the importance of entomology across different fields of study and applications.

CO4 : Define and explore the divisions and scope of entomology, including a comparative account of external morphology.

CO5 : Describe the structure, function, and systems of insects' anatomy as well as different modes of reproduction and post-embryonic development

11. ENT 324 (Insect Pests of Vegetable, Ornamental and Spice Crops)

CO1 : Understand the economic importance of insects in vegetable, ornamental, and spice crops.

CO2 : Explore the ecology of insect pests and their management strategies specific to vegetable crops.

CO3 : Analyze the ecology of insect pests and their management strategies specific to ornamental crops.

CO4 : Examine the ecology of insect pests and their management strategies specific to spice crops.

CO5 : Learn about pest surveillance techniques and their application in important vegetable, ornamental, and spice crops.

12. ENT 222 (Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops)

CO1 : Understand the economic classification of insects.

CO2 : Analyze bio-ecology and implement insect-pest management strategies in fruit, plantation, medicinal, and aromatic crops.

CO3 : Conduct effective pest surveillance techniques.

CO4 : Implement integrated management approaches for important insect pests

affecting tropical, sub-tropical, and temperate fruits, as well as plantation crops.

CO5 : Evaluate and manage insecticide residue problems in fruit, plantation, medicinal, and aromatic crops, adhering to maximum residue limits (MRLs).

Department – Agricultural Extension and Communication

13. EXT-311 (Fundamentals of Extension Education)

CO1 : Understand the meaning, definition, nature, scope, objectives, principles, approaches, and history of extension education.

CO2 : Explore the process, principles, and selected programs of leading national and international forest institutes in horticulture extension.

CO3 : Analyze the role of people's participation in horticulture programs and strategies for motivating farmers, rural youth, and voluntary organizations.

CO4 : Explore the meaning, objectives, and genesis of rural development, including technology transfer programs.

CO5 : Understand the concepts, principles, and elements of communication, including the importance, classification, and selection of audio-visual aid.

Department – Genetics and Plant Breeding

14. GPB 314 (Breeding of Vegetable, Tuber and Spice Crops)

CO1 : Understand breeding objectives and important concepts for self-pollinated, cross-pollinated, and vegetatively propagated crops.

CO2 : Explore plant genetic resources, their conservation, and utilization in crop improvement.

CO3 : Analyze breeding strategies for insect resistance, disease resistance, and abiotic resistance in crops.

CO4 : Explore the utilization of male sterility and self-incompatibility in developing hybrids.

CO5 : Investigate the origin, distribution, and wild relatives of various vegetable crops, and understand breeding procedures.

15. FLA – 324 (Breeding and Seed Production of Flower and Ornamental Plants)

CO1 : Understand the history of improvements in ornamental plants.

CO2 : Identify objectives and techniques in ornamental plant breeding, including introduction, selection, hybridization, mutation, and

biotechnological techniques

CO3 : Analyze breeding for disease resistance and the development of promising cultivars of important ornamental plants.

CO4 : Explore the role of heterosis and its exploitation in ornamental plant breeding, as well as the production of F1 hybrids and utilization of male sterility.

CO5 : Learn about the production of open-pollinated seeds, harvesting, processing, storage of seeds, and seed certification in ornamental plant cultivation.

16. GPB – 122 (Principles of Plant Breeding)

CO1 : Understand the objectives and aims of plant breeding as a dynamic science.

CO2 : Explore the classical and quantitative genetic basis of plant breeding.

CO3 : Examine the molecular genetic basis of plant breeding.

CO4 : Analyze the achievements, limitations, and future goals of plant breeding in India.

CO5 : Investigate the various aspects of plant reproduction, including cross and self-pollination, asexual reproduction, and pollination mechanisms.

17. GPB – 111 (Principles of Genetics and Cytogenetics)

CO1 : Understand the historical background of genetics, including the development of theories and hypotheses in the field.

CO2 : Describe the physical basis of heredity, including the role of cell reproduction, mitosis, and meiosis, and their significance in genetic inheritance.

CO3 : Explain gametogenesis and syngamy in plants, and their contribution to genetic variation.

CO4 : Analyze Mendel's principles of heredity and deviations from Mendelian inheritance, such as pleiotropy, co-dominance, and penetrance.

CO5 : Discuss advanced concepts in genetics.

Department – Horticulture

18. FSC-111 (Fundamentals of Horticulture)

CO1 : Understand the branches and general features of horticulture.

CO2 : Evaluate the importance and scope of horticulture in various contexts.

CO3 : Analyze the nutritive value of fruits and vegetables, including the role of

essential minerals and vitamins.

CO4 : Assess the present scenario of horticulture globally, in India, and in the state, considering area, production, productivity, export, and import.

CO5 : Apply principles of nursery management, including site selection, structure types, and plant propagation methods.

19. FSC 112 (Plant Propagation and Nursery management)

CO1 : Understand the necessity and potential benefits of plant multiplication techniques

CO2 : Differentiate between sexual and asexual methods of propagation, highlighting their respective advantages and disadvantages

CO3 : Describe the types of seed dormancy and the methods used to overcome dormancy, such as scarification and stratification

CO4 : Identify various propagation structures and their functions in plant multiplication

CO5 : Apply knowledge of growth regulators and propagation techniques like cutting, layering, and grafting in plant propagation practices

20. FLA – 111 (Principles of Landscape Architecture)

CO1 : Understand the history of gardening and recognize famous gardens in India and abroad.

CO2 : Identify different types and styles of gardens, including their historical, cultural, and architectural influences.

CO3 : Apply basic themes of garden design and the steps involved in creating an effective garden layout.

CO4 : Analyze the principles of landscape design and recognize the elements essential for creating aesthetically pleasing outdoor spaces.

CO5 : Discuss bio-aesthetic planning and its role in integrating ecological principles with landscape design practices.

21. FSC-124 (Tropical and Subtropical Fruits)

CO1 : Analyze the horticultural classification of fruits, including genome classification, and understand the horticultural zones of India.

CO2 : Conduct a detailed study of specific fruits covering areas such as area, production, export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, aftercare, training and pruning.

CO3 : Evaluate management practices for water, nutrients, and weeds, and

understand special horticultural techniques.

CO4 : Discuss physiological disorders and post-harvest technology for each fruit, including harvest indices, harvesting methods, grading, packaging, and storage.

CO5 : Investigate special production problems and diseases for specific fruits such as mango, banana, grape, citrus, papaya, and their control measures.

22. VSC-121 (Tropical and Subtropical Vegetables)

CO1 : Analyze the area, production, economic importance, and export potential of tropical and sub-tropical vegetable crops.

CO2 : Understand the description of varieties and hybrids for various vegetables.

CO3 : Evaluate the crop management practices

CO4 : Discuss the methods of harvesting, yield estimation, and economic aspects of cultivation for different vegetable crops.

CO5 : Understand the principles of storage, marketing, and economics of cultivation for various vegetables.

23. FSC 123 (Growth and Development of Horticultural crops)

CO1 : Understand the concepts of growth and development in horticultural crops.

CO2 : Analyze the stages of growth and development in horticultural crops, studying growth curves and employing growth analysis techniques.

CO3 : Explore the role of plant bio-regulators in various aspects of crop growth and development.

CO4 : Investigate the factors affecting flowering in horticultural crops along with the principles of seed development, maturation and dormancy.

CO5 : Examine the physiology of fruit growth, development, setting, and ripening, considering both climacteric and non-climacteric fruits, and explore post-harvest storage techniques.

24. FSC-216 (Temperate Fruit Crops)

CO1 : Understand the classification of temperate fruits.

CO2 : Analyze the detailed requirements for production, including climate and soil conditions for temperate fruits.

CO3 : Implement proper techniques for propagation, planting density and cropping systems for temperate fruits.

CO4	:	Demonstrate knowledge of aftercare practices, including training, pruning, and the use of growth regulators.
CO5	:	Identify and apply appropriate measures for managing nutrient levels, weeds, pests, diseases, and special production problems.

25. FSC-215 (Temperate Vegetable Crops)

CO1	:	Understand the importance and export potential of temperate vegetable crops.
CO2	:	Analyze the nutritive value of various vegetables.
CO3	:	Evaluate the production, export potential, and characteristics of specific vegetable crops.
CO4	:	Demonstrate knowledge of the origin, climate, soil requirements, production technologies, post-harvest handling, and marketing strategies for vegetable crops
CO5	:	Apply appropriate production and marketing techniques for temperate vegetable crops to maximize yield and profitability.

26. FLA 212 (Commercial Floriculture)

CO1	:	Understand the scope and importance of commercial floriculture in India.
CO2	:	Apply production techniques for specific flower crops and foliage filler materials.
CO3	:	Implement protected cultivation methods for commercial flower crops.
CO4	:	Apply post-harvest technology practices for cut flower crops to maintain quality and prolong shelf life.
CO5	:	Demonstrate knowledge of dehydration techniques for drying flowers and production techniques for bulbous plants.

27. VSC-224 (Spices and Condiments)

CO1	:	Understand the history, scope, and importance of spices and condiments in the national economy.
CO2	:	Describe the production techniques for various spices including soil and climate requirements, propagation methods, nutritional management, irrigation practices, and weed control.
CO3	:	Analyze the harvesting, post-harvest technology, packaging, storage, and value-added products for different spice crops.
CO4	:	Evaluate the economics of cultivation for various spices and condiments, and understand the roles of institutions and research centers .

CO5 : Demonstrate knowledge of the export promotion and marketing strategies for spice crops.

28. PSMA 222 Plantation Crops

CO1 : Understand the history, development, scope, and importance of various palm and plantation crops in the national and state economy.

CO2 : Describe the soil and climate requirements, varieties, and propagation methods for coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, date palm, and rubber

CO3 : Analyze the principles and practices of seed, vegetative, and micropropagation of various palm and plantation crops.

CO4 : Evaluate the role of growth regulators, soil management techniques, liming practices, tipping practices, top working, and management of physiological disorders for palm and plantation crops.

CO5 : Demonstrate knowledge of harvesting, post-harvest handling and processing, packaging, marketing, yield, and economics for various palm and plantation crops .

19. GPB – 223 (Breeding of Fruit and Plantation Crops)

CO1 : Understand the history, development, and importance of fruit breeding.

CO2 : Analyze breeding strategies and hybridization for fruit crop improvement, along with resistance breeding for biotic and abiotic stresses.

CO3 : Evaluate the role of genetic engineering and biotechnology in enhancing fruit crop improvement.

CO4 : Describe the crop improvement methods specific to mango, banana, citrus, grapes, sapota, pomegranate, guava, anola, ber, and strawberry.

CO5 : Understand the history, importance, origin, distribution, domestication, and adoption of plantation crops, and evaluate breeding strategies.

30. FSC 227 (Dryland Horticulture)

CO1 : Understand the definition, importance, and limitations of dry land horticulture, and assess its present status and future scope.

CO2 : Identify and analyze the constraints encountered in dry lands.

CO3 : Apply techniques and management strategies for dry land horticulture, including watershed development, soil and water conservation methods like terraces and contour bunds.

CO4 : Implement methods for controlling and impounding run-off water as well

as in-situ water harvesting methods like micro catchment and tree basins.

CO5 : Evaluate methods for reducing evapotranspiration and techniques for improving water use efficiency through need-based, economic, and conjunctive use of water, micro systems of irrigation, and selection of drought-resistant plants.

31. VSC – 222 (Precision Farming and Protected Cultivation)

CO1 : Understand the concept, importance, and principles of precision farming.

CO2 : Implement laser leveling techniques for land preparation.

CO3 : Apply mechanized direct seed sowing and seedling/sapling transplanting methods.

CO4 : Utilize mapping techniques for analyzing soil and plant attributes in precision farming.

CO5 : Implement site-specific input application for optimized crop management in precision agriculture.

32. FLA – 223 (Ornamental Horticulture)

CO1 : Explore the history of gardening in India.

CO2 : Understand the scope and significance of gardening.

CO3 : Identify and classify different types and styles of gardens.

CO4 : Apply principles of landscape gardening in garden design.

CO5 : Recognize and utilize various components, features, and adornments in garden design.

33. FSC 318 (Orchard and Estate management)

CO1 : Understand the importance, objectives, merits, and demerits of orchard and estate management.

CO2 : Analyze various cultivation techniques such as clean cultivation, sod culture, sod mulch, and mulching with herbicides, inorganic, and organic materials.

CO3 : Explore tropical, sub-tropical, and temperate horticultural systems.

CO4 : Evaluate the biological efficiency of cropping systems in horticulture, including different irrigation methods.

CO5 : Implement soil management practices to optimize nutrient and water uptake, and mitigate their effects on soil environment.

34. PSMA313 (Medicinal and Aromatic crops)

CO1 : Understand the historical background, scope, opportunities, and constraints in cultivating and maintaining medicinal and aromatic plants in India.

CO2 : Identify the importance, origin, distribution, climatic and soil requirements, propagation techniques, cultural practices, and nutritional needs of various medicinal and aromatic plants.

CO3 : Implement plant protection measures, harvesting, and processing techniques for important medicinal and aromatic plants.

CO4 : Analyze the chemical composition of select medicinal and aromatic plants, and explore their extraction methods, uses, and economic aspects of drugs and essential oils.

CO5 : Explore the therapeutic and pharmaceutical uses of important medicinal and aromatic plants, and study storage techniques for essential oils.

35. VSC – 313 (Potato and Tuber Crops)

CO1 : Understand the origin, area, production, economic importance, and export potential of potato and tuber crops.

CO2 : Describe the varieties, climate and soil requirements, cultivation practices of different tuber crops.

CO3 : Analyze post-harvest handling and storage techniques, as well as field and seed standards for various tuber crops.

CO4 : Explore marketing strategies and considerations for potato and other tuber crops.

CO5 : Identify nutrient deficiencies and understand the use of chemicals and growth regulators in the cultivation of tuber crops.

36. VSC 324 (Seed production of vegetable, tuber and spice crops)

CO1 : Understand the introduction and history of the seed industry in India.

CO2 : Define seed, differentiate between classes/types of seed, and identify differences between grain and seed.

CO3 : Explore the importance and scope of vegetable seed production in India.

CO4 : Analyze the principles of vegetable seed production and factors affecting quality seed production, including the role of temperature, humidity, and light.

CO5 : Learn about the different processes involved in cultivation of various vegetable crops, spices, tuber crops, and exotic vegetables.

37. PHM 323 (Processing of Horticultural Crops)

CO1 : Understand the importance and scope of the fruit and vegetable preservation industry in India.

CO2 : Identify the losses occurring in post-harvest operations and comprehend unit operations in food processing.

CO3 : Learn the principles and guidelines for selecting suitable locations and establishing processing units in India.

CO4 : Acquire knowledge of various preservation methods including heat pasteurization and canning for fruits and vegetables.

CO5 : Explore different techniques for preparing juices, jams, jellies, marmalades, candies, pickles, sauces, and other processed products.

38. PHM322 (Post Harvest Management of Horticultural Crops)

CO1 : Understand the importance of Postharvest Technology in preserving the quality of horticultural crops.

CO2 : Identify maturity indices and optimal harvesting techniques for horticultural crops.

CO3 : Apply grading standards for fruits, vegetables, and cut flowers in both local and export markets.

CO4 : Analyze pre-harvest factors influencing the quality of horticultural crops and implement appropriate interventions.

CO5 : Evaluate various storage methods and packaging techniques to maintain the freshness and extend the shelf life of horticultural produce.

Department – Mathematics and Statistics

39 STAT 111 (Elementary Statistics and Computer Application)

CO1 : Understand the limitations of statistics

CO2 : Construct frequency distributions and tables

CO3 : Interpret graphical representations of data such as bar diagrams and histograms

CO4 : Calculate measures of central tendency and dispersion

CO5 : Apply basic probability concepts and laws

40. STAT 122 (Information and Communication Technology)

CO1 : Understand the importance of Information Technology (IT) and its various applications in modern society.

CO2 : Familiarize with different IT tools and their functionalities, including their

usage in IT-enabled services.

CO3 : Analyze the impact of IT-enabled services on society, considering their implications and benefits.

CO4 : Gain foundational knowledge in computer fundamentals, covering hardware, software, input and output devices, and word and character representation.

CO5 : Explore principles of programming, including algorithms and flowcharts, and understand the advantages and disadvantages of different programming languages.

Department – Plant Pathology

14. EVS 122 (Environmental Studies and Disaster Management)

CO1 : Understand the multidisciplinary nature of environmental studies, including its definition, scope, and importance.

CO2 : Analyze the various natural resources and associated problems such as deforestation, water conflicts, and land degradation.

CO3 : Explore the concept of ecosystems with a focus on different types such as forest, grassland, desert, and aquatic ecosystems.

CO4 : Examine the biodiversity of India, its conservation strategies, and the threats posed to it, including habitat loss, poaching, and man-wildlife conflicts.

CO5 : Evaluate environmental pollution, its causes, effects, control measures and the role of individuals in pollution prevention.

42. NEM-211 (Nematode Pests of Horticultural Crops and Their Management)

CO1 : Understand the historical development and economic importance of nematology.

CO2 : Identify the general characteristics, morphology, taxonomy, and classification of plant parasitic nematodes

CO3 : Describe the biology and symptomatology of plant parasitic nematodes.

CO4 : Implement control measures for important plant parasitic nematodes affecting various crops, including fruits, vegetables, tubers, ornamentals, spices, and plantation crops.

CO5 : Evaluate the role of nematodes in plant disease complexes and apply integrated nematode management strategies.

43. PPT 211 (Fundamentals of Plant Pathology)

CO1 : Understand the science of phytopathology, including its objectives, scope, and historical background.

CO2 : Identify and classify plant diseases based on symptoms, signs, and related terminology.

CO3 : Describe the parasitic causes of plant diseases, including fungi, bacteria, viruses, phytoplasma, protozoa, flowering parasitic plants, and non-parasitic causes.

CO4 : Analyze the infection process, survival, and dispersal mechanisms of plant pathogens.

CO5 : Apply principles and methods of plant disease management, including integrated disease management and the use of fungicides, bactericides and nematicides.

44. PPT 323 (Diseases of Vegetables, Ornamentals and Spice Crops)

CO1 : Understand the etiology, symptoms, mode of spread, and epidemiology of diseases affecting various vegetables, ornamental, and spice crops.

CO2 : Learn about integrated management strategies for diseases such as early blight, late blight, bacterial wilt and viral diseases in different crops.

CO3 : Identify the specific diseases affecting various vegetables, ornamental, and spice crops.

CO4 : Explore post-harvest diseases affecting vegetables and ornamental crops and their management techniques.

CO5 : Gain knowledge of disease prevention and control methods to ensure optimal crop health and yield.

45. PPT 323 (Diseases of Vegetables, Ornamentals and Spice Crops)

CO1 : Identify the etiology, symptoms, and mode of spread of diseases affecting various vegetable, ornamental, and spice crops.

CO2 : Understand the epidemiology of diseases and their impact on crop production.

CO3 : Learn integrated management strategies for controlling diseases in tomato, brinjal, chillis, bhindi, and other crops

CO4 : Explore specific disease management techniques for crucifers like cabbage, cauliflower, and knol-khol, as well as legumes like pea and beans.

CO5 : Gain knowledge of post-harvest diseases in vegetables and ornamental crops and their effective management strategies.

46. PPT-222 (Disease of Fruit, Plantation, Medicinal and Aromatic Crops)

CO1	:	Understand the etiology and symptoms of various diseases affecting fruits, plantations, medicinal, and aromatic crops.
CO2	:	Analyze the mode of spread and epidemiology of common diseases in fruits, plantations, medicinal, and aromatic crops.
CO3	:	Apply integrated management techniques for controlling diseases like powdery mildew, anthracnose, shooty mould, fruit rot, wilt, leaf spot, collar rot, rust, and damping off in various crops
CO4	:	Develop strategies for the prevention and management of post-harvest diseases in fruits, plantations, medicinal, and aromatic crops.
CO5	:	Evaluate the effectiveness of disease management practices in sustaining crop health and productivity.

Department - Biochemistry/Physiology/Microbiology/ Environmental Science/|Food science

47. PPT-111 (Introductory Microbiology)

CO1	:	Understand the historical background and scope of microbiology.
CO2	:	Describe the differences between prokaryotic and eukaryotic cells with a specific emphasis on plant pathogenic bacteria.
CO3	:	Explain microscopy and specimen preparation techniques, including bright field microscopy, fixation, staining methods, and differential staining.
CO4	:	Analyze the types of culture media and pre-culture techniques, as well as microbial growth dynamics in bacterial, yeast, and mycelial growth curves.
CO5	:	Evaluate the importance of various microorganisms, including viruses, bacteriophages, plant growth-promoting microorganisms, and industrially important microorganisms.

48. EVS -111 (Introductory Crop Physiology)

CO1	:	Understand the role of water in plant metabolism and the processes of osmosis, imbibition and diffusion.
CO2	:	Explain the concept of water potential and its components, and the methods for measuring water potential in plants.
CO3	:	Describe the absorption of water by plants, including the mechanism of absorption and the ascent of sap.
CO4	:	Analyze the structure, distribution, and mechanism of opening and

closing of stomata

CO5 : Evaluate the various methods and mechanisms of transpiration, and factors affecting transpiration, including drought stress.

49. PBC 121 (Elementary Plant Biochemistry)

CO1 : Understand the occurrence, classification, and structure of carbohydrates.

CO2 : Explore the classification of lipids, important fatty acids, triglycerides, and essential fatty acids.

CO3 : Examine the structure and function of plant pigments, focusing on chlorophyll and carotenoids.

CO4 : Analyze the role of sterols, particularly brassinosterols, in plants, including their basic structure and significance.

CO5 : Investigate the classification, function, solubility, and structure of proteins, amino acids, and enzymes.

50. EPB – 221 (Elementary Plant Biotechnology)

CO1 : Understand the concepts of Plant Biotechnology, including its historical development and importance in crop improvement.

CO2 : Analyze the techniques and principles behind Plant Tissue Culture and Plant Genetic Engineering.

CO3 : Explain the processes of totipotency, morphogenesis, and the nutritional requirements of in-vitro cultures.

CO4 : Demonstrate proficiency in various in-vitro culture techniques such as micropropagation, anther culture, pollen culture, ovule culture, and embryo culture.

CO5 : Evaluate the applications and achievements of plant biotechnology, including somaclonal variation, DNA fingerprinting and nanotechnology, and their implications in crop improvement.

51. PHM211 (Fundamentals of Food Technology)

CO1 : Understand the role of food and its physico-chemical properties in human nutrition.

CO2 : Apply food preparation techniques and nutrition knowledge to promote good health.

CO3 : Identify characteristics of well-nourished and malnourished populations

CO4 : Analyze energy requirements and the total energy needs of the body, including determination methods.

CO5 : Evaluate the importance of macro and micro-minerals, vitamins, and balanced diets in meeting nutritional requirements for different age groups.

52. EVS-313(Introductory Agro-forestry)

CO1 : Define agroforestry and explore its objectives and potential.

CO2 : Differentiate between agroforestry and social forestry.

CO3 : Understand the status of Indian forests and their role in farming systems.

CO4 : Identify various agroforestry systems and practices including agri-silviculture, silvipastoral, horti-silviculture, and horti-silvipastoral.

CO5 : Analyze planning considerations for agroforestry, including constraints, diagnosis, design methodology, and tree species selection.

Department - Soil Science and Agricultural Chemistry

53. SAC 111 (Fundamental of Soil Science)

CO1 : Understand the composition of the earth's crust and the formation of various soils through eluviation and alleviation processes.

CO2 : Analyze the physical parameters of soil, including texture, bulk density, pore space, and soil color, and their significance in soil classification and management.

CO3 : valuate the chemical properties of soil and their importance in soil fertility and plant nutrition.

CO4 : Explore soil biology, including its benefits and harmful effects, and its role in soil fertility and ecosystem functioning.

CO5 : Apply methods of soil survey, including remote sensing techniques and understand the objectives of soil science research institutes in India for soil management and conservation.

54. SAC 122 (Soil Fertility and Nutrient Management)

CO1 : Understand the classification and sources of plant nutrients, including essential and beneficial elements, and the criteria of essentiality.

CO2 : Explore the different forms of nutrients in soil and mechanisms of nutrient transport to plants.

CO3 : Examine measures to overcome deficiencies and toxicities of nutrients in plants.

CO4 : Analyze soil fertility evaluation techniques to determine critical nutrient

levels in plants and soil.

CO5 : Evaluate factors influencing nutrient use efficiency and scheduling of nutrients for different soils and crops grown under varying conditions, including rainfed and irrigated settings.

55. SAC 223 (Soil, Water and Plant Analysis)

CO1 : Understand and apply methods for soil and plant sampling and processing for analysis.

CO2 : Analyze hydraulic mobility through diffusion and mass flow characterization.

CO3 : Implement techniques to estimate oxygen diffusion rate and redox potential.

CO4 : Evaluate the importance of soil micro-organisms and their role in soil health.

CO5 : Appraise and manage saline, alkali, acid, waterlogged, and sandy soils, considering their chemical and mineral composition, and implement appropriate management strategies.

Department - English Language

56. ENG 111 (Communication skills and personality Development)

CO1 : Understand the basic word classes and their functions in sentences.

CO2 : Identify and classify parts of speech, including nouns, pronouns, adjectives, adverbs, verbs, prepositions, conjunctions, and interjections.

CO3 : Analyze finite and non-finite verbs and their usage in sentences.

CO4 : Comprehend the concept of tenses and their significance in indicating time in sentences.

CO5 : Explore the active and passive voice constructions and their applications in different contexts.

Non-Gradial Courses

57. NSS111 (National Service Scheme)

CO1 : Understand the history, objectives, and principles of NSS including its symbol and badge, and the organizational structure.

CO2 : Analyze NSS programs and activities, and understand the basis for adopting villages/slums and conducting surveys.

CO3 : Explore the concept of youth, including their profile, categories, issues, challenges, and opportunities for social change.

CO4 : Discuss community mobilization strategies.

CO5 : Evaluate the importance of youth leadership, including its meaning, types, traits, qualities of good leaders, and the roles of youth leadership in society.

58. PHE 211 (Physical and health education)

CO1 : Understand the fundamentals of physical education, including its importance in promoting overall well-being and fitness.

CO2 : Learn exercises and techniques for improving posture and physical fitness, focusing on agility, strength, coordination, endurance, and speed.

CO3 : Gain knowledge of the rules and regulations of important games and develop skills in one selected game through practical training sessions.

CO4 : Acquire an understanding of the rules and regulations governing athletic events and participate in coaching sessions to enhance proficiency.

CO5 : Engage in activities promoting overall physical development and leisure.

PROGRAMME (3-15)

M.Sc.

Agriculture & Horticulture

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Agronomy Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

AGRON 501 (Modern Concepts in Crop Production)

CO1 : Analysis the crop growth agro-ecological zones of India.

CO2 : Study of different quantitative approaches and laws of crop production

CO3 : optimizing different plant patterns and resources for effective environment and sustainability

CO4 : To understand the principles of crop production

CO5 : Application of balanced approach of nutrient management

AGRON 502 (Principles and practices of Soil fertility & Nutrient Management)

CO1 : To identify the factor this will be responsible for positive and negative impact on soil fertility and productivity

CO2 : To understand essential plant nutrient and their function for crop production

CO3 : Application or preparation of different type of compost and its impact on crop production

CO4 : Analysis of different parameters related to the nutrient management of fertilizer

CO5 : Adaptation or functional knowledge about different method of fertilizer application

AGRON 503 (Principles and practices of weed management)

CO1 : To identify weed and their management.

CO2 : Functional knowledge about herbicide for effective weed management.

CO3 : To increase the knowledge about the trait of herbicide

CO4 : Analysis of different approaches of weed control for crop production

CO5 : To increase the awareness about resent advances of weed management for long life learning

AGRON 504 (Principles and Practices of Water Management)

CO1 : To analyses the quality of irrigation water and resources

CO2 : To acquire the knowledge of different recommended plant relationship

CO3 : To the adaptation of different irrigation scheduling and methods

CO4 : Calculation or analytical approach of water use efficiency under quality parameters.

CO5 : To construct ideologies pertaining to water management in problem soils

5. AGRON 511 (Cropping System & Sustainable Agriculture)

CO1 : To gain knowledge as well as develop eco-friendly farming system models.

CO2 : Analysis the mechanism of different cropping systems

CO3 : Application of low cost technologies for sustainability

CO4 : Role of elements to maintain the ecosystems under Crop diversification

CO5 : Plant ideotypes for effective cropping.

AGRON 512 (Dry land farming and watershed management)

CO1 : To know about the dryland farming and rainfed agriculture.

CO2 : To increase the knowledge about drought and its impact on crop production.

CO3 : To increase the knowledge about contingent plan/ farming under rainfed agriculture

CO4 : Analysis of the impact tillage and cultural practices on crop production under rainfed areas

CO5 : To know about watershed management and its usefulness under rainfed condition.

AGRON 513 (Principles and practices of organic Farming)

CO1 : To clear the concept and thinking about organic farming

CO2 : To increase the awareness of organic elements to increase soil fertility

CO3 : Adaptation of different farming system along with soil productivity

CO4 : Functional knowledge of different approaches of weed control

CO5 : Impact of social and economical aspects of organic farming

Minor Subjects

SOILS 506 (Soil Biology and Biochemistry)

CO1 : To understand the soil biota, soil microbial-ecology and types of organisms in different soils of India

CO2 : Course gives the knowledge of microbiology and biochemistry of root-soil interface

CO3 : Soil enzymes, origin, activities and importance and their effect on growth and activity of microflora

CO4 : The students will acquire good knowledge of preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost and their chemical composition

CO5 : Biological indicators of soil quality, bioremediation of contaminated soils and microbial transformations of heavy metals in cultivated soil

SOILS 502 (Soil Fertility and Fertilizer Use)

CO1 : To identify the deficiency and functions of essential plant nutrients,

dynamics and their management

CO2 : To understand about macro and micro nutrient availability their role in soil plant system

CO3 : STCR method for fertilizer recommendations and improving fertilizer use efficiency

CO4 : Soil fertility evaluation methods in relation to sustainable agriculture

CO5 : To understand and improve soil health and soil quality

SOILS 509 (Soil Water and Air Pollution)

CO1 : Knowledge on problem of soil, water and air pollution, their nature, estimation techniques for water quality

CO2 : Knowledge on remediation of contaminated soils

CO3 : Ability to conduct various qualitative and quantitative tests for waste samples collected from the locality

CO4 : Students will understand the procedures to determine the chemical and biochemical oxygen demand, nutrients and heavy metals that are being polluting our environment

CO5 : Students will learn about the management of pollution

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Vegetable Science Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

VSC 501 (Production of Cool Season Vegetable Crops)

CO1 : Appreciate the scope and scenario of cool season vegetable crops in India

CO2 : Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops

CO3 : Calculate the economics of vegetable production in India

CO4 : Production technology for vegetable legume crops with post-harvest handling and Hi-tech cultivation practices

CO5 : Gain in techniques of the management of leafy vegetables that further enhance productivity and skill development

VSC 502 (Production of warm season Vegetable Crops)

CO1 : Understand scope, scenario and production technology for solanaceous (fruit vegetable) crops with PHM and Hi- Tech Cultivation practices

CO2 : Insight of Production technology for vegetable legume crops with PHM and Hi- Tech Cultivation practices

CO3 : Acquire knowledge about the package and practices for cucurbitaceous crops with post-harvest handling and processing

CO4 : Understanding the production technology for Tuber Crops with PHM and Hi- Tech Cultivation practices with its economics

CO5 : Gain in technique of the management of leafy vegetables that further enhance productivity and skill development

VSC 503 (Breeding of Vegetable Crops)

CO1 : Understanding the fundamental concepts of vegetable breeding and learning approaches of evolving new varieties that contributing to food security and nutrition crops in India

CO2 : Understanding of yield improvement techniques along with genetic and nutria diversity learning contribute to more sustainable and resilient food system

CO3 : To understand the basic knowledge and its application of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development

CO4 : Better understanding of new varieties, crop productivity , quality and resilience to meet the demands of farmers and consumer ensuring sustainable practices

CO5 : Sensitize the learners about the basic knowledge and principles of biotech approaches and molecular techniques in vegetable improvement to make profitable agricultural system

VSC 504 (Growth and Development of Vegetable crops)

CO1 : Acquire knowledge of growth analysis and physiology of phyto-hormones

CO2 : Better understanding of Physiology of dormancy and germination in vegetable crop production

CO3 : Understanding the integrated practical knowledge for affect of abiotic factors on flowering and sex expression in vegetable crops

CO4 : Analytical approaches for understanding the physiology of growth and development in vegetable crops

CO5 : Morphogenesis and tissue culture techniques in vegetable crops for skill development and employment generation

VSC 505 (Seed Production Technology of Vegetable Crops)

CO1 : Acquire knowledge of the new seed policies and vegetable seed industry in India ensure quality assurance, technology adoption, and sustainable agriculture

CO2 : To understand the basic knowledge of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development

CO3 : Understanding of maintenance of seed standards and law enforcement of seed act for plant quarantine promote agriculture sustainability, food security and economic development

CO4 : Integrated knowledge of seed processing and storage including cryopreservation and synthetic seed technology supporting sustainable agriculture, food security, biodiversity conservation efforts globally

CO5 : Learning about agro techniques for seed production of vegetable crops for skill development and agri-preneurs

VSC 507 (Production Technology of Underexploited Vegetable Crops)

CO1 : Better understanding of improved technology and understanding of stem and bulb crops that contribute to food security, income generation and overall agricultural sustainability

CO2 : Better understanding of improved technology and understanding of Cole and salad crops that contribute to food security, income generation and overall agricultural sustainability

CO3 : Better understanding of improved technology and understanding of leafy vegetables that contribute to food security, income generation and overall agricultural sustainability

CO4 : Better understanding of improved technology and understanding of cucurbitaceous crops that contribute to food security, income generation and overall agricultural sustainability

CO5 : Better understanding of improved technology and understanding of yam and bean crops that contribute to food security, income generation and overall agricultural sustainability

VSC 508 (Organic Vegetable Production Technology)

CO1	:	To equip students with the skills and knowledge necessary for effective handling and management of vegetables after harvest
CO2	:	To understand the implementation of strategies to minimize losses during harvesting and transportation of post-harvest losses in vegetable production
CO3	:	Encompass understanding of quality grading and sorting techniques to develop skills in managing packing house operations efficiently
CO4	:	Understanding the skills to implement integrated disease management strategies to minimize post harvest losses and ensure food safety and quality
CO5	:	Acquiring skills in selecting the most appropriate storage method and mastering techniques to maintain optimal storage condition to extend the shelf life and preserve quality

Minor Subjects

FSC 501 (Tropical and dry Land Fruit Production)

CO1	:	Understanding of more resilient and productive cultivation with better economic return practices
CO2	:	Better conservation of different traits by adopting the hi-tech propagation techniques that contribute to future generation of plants
CO3	:	Expansion of lifespan of fruit plants, improve quality traits leading to orchard health and profitability
CO4	:	To gain knowledge of pre harvest management value chain optimizing the fruit yield, quality, market value and ultimately good services reached to consumer level
CO5	:	Aware about the management practices for quality improvement and market linkages of tropical fruit crops for skill development and employment generation

FSC 506 (Canopy Management in Fruit Crops)

CO1	:	By the approach of canopy management techniques improve the fruit quality that ensure the marketability and profitability
CO2	:	Better management techniques of fruit crops reduces the infestation of insect pest and diseases
CO3	:	Leveraging geometry and LUT in canopy management result in improved quality, enhanced efficiency and potentially increase profitability
CO4	:	By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability
CO5	:	Analytical approach to understand canopy development and management for entrepreneurship skill development

FSC 505 (Propagation and Nursery management for fruit crops)

CO1 : To ensure the successful propagation and quality of fruit crops ultimately impacting fruit yield and crop success

CO2 : To maintain the desired traits along with rapid propagation and provide specific skills and resources that increase the plant protection measures

CO3 : By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability

CO4 : Micro propagation and micro grafting offers practical benefits in pomology by providing a reliable and efficient means of producing high quality planting material with desirable traits

CO5 : Learning about nursery management practices and regulations for skill development and employment generation

FSC 508 (Growth and Development of Horticulture crops)

CO1 : Acquire knowledge of growth analysis and physiology of phyto-hormones

CO2 : Better understanding of Physiology of dormancy and germination in Horticulture crop production

CO3 : Understanding the integrated practical knowledge for effect of abiotic factors on flowering and sex expression in Horticulture crops

CO4 : Analytical approaches for understanding the physiology of growth and development in Horticulture crops

CO5 : Morphogenesis and tissue culture techniques in Horticulture crops for skill development and employment generation

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Fruit Science Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Comprehensive understanding of scientific principles of Fruit Science and allied systems

PSO2 : Development of the ability to identify problems of fruit crops and ensure empowerment for techno-economic solutions.

PSO3 : Demonstration of proficiency in utilizing modern horticultural technologies and tools to enhance efficiency in utilizing resources and increasing productivity with sustainability in horticulture system particularly fruit crops as well as taking care of environmental and global nutritional security

PSO4 : Infusion of entrepreneurial skills with adherence to ethical standards and professionalism for job opportunities in various sectors

Course Outcomes (COs)

Major Subjects

FSC 501 (Tropical and Dry Land Fruit Production)

CO1 : Students will be able to develop the skills on different practices involved in cultivation and management of different tropical and dry land fruits crops.

CO2 : Students will be able to identify the suitable commercial varieties of regional, national and international importance including export potential varieties.

CO3 : Students will be able to identify the biotic and abiotic factors limiting fruit production in tropical and dryland regions.

CO4 : Students gain knowledge about various management practices to improve fruit quality including maturity index, harvesting, grading, packing, storage and ripening techniques.

CO5 : Acquaint the students with plan for mega food parks and development of instructional fruit orchard with hi-tech interventions.

FSC 502 (Subtropical and Temperate Fruit Production)

CO1 : To impart basic Knowledge about the importance and management of Subtropical and Temperate fruits grown in India

CO2 : Understanding export potential, Agri Export Zones and industrial support, problems and prospects in Sub Tropical and Temperate fruit crops.

CO3 : Students able for plant multiplication including in vitro techniques and nursery management

CO4 : Students understand the basic knowledge of recent trends in Planting System, Crop management and Canopy management, physiological disorders and biotic and abiotic factors limiting fruit production

CO5 : Comprehensive understanding of Post harvest handling including primary processing, precooling, grading, packaging, storage and transportation techniques.

FSC 503 (Biodiversity and Conservation of Fruit Crops)

CO1 : Students will be acquainted with understanding of biodiversity, center of origin of cultivated fruit crops including maintenance of PGR diversity.

CO2 : Students will learn about biodiversity, conservation issues and exploitation of the biological diversity through crop management in in-situ and exsitu.

CO3 : Students will be acquainted with the Intellectual property rights,

regulatory horticulture and PPFVR in fruit crops

CO4 : Students will learn the importance of biodiversity of fruit crops in the breeding program and conservation of crops in in-situ and ex-situ.

CO5 : Students will learn the importance of GIS and documentation of local biodiversity, Geographical Indication, GI Tag.

FSC 505 (Propagation and Nursery management of fruit crops)

CO1 : Students understand the principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

CO2 : Students develop skills in germination test, viability test, vigor test ,moist test, genetic and physical purity test, I.D. test and health.

CO3 : Students develop skills in multiplication of plants through sexual and asexual means with rapid propagation techniques to produce genuine and true-to-type planting material.

CO4 : Students develop skills in multiplication of plants through micro propagation and micro grafting

CO5 : Students learn about the nursery management practices and regulations for skill development and employment generation.

FSC 504 (Canopy Management in Fruit Crops)

CO1 : Students learn importance and advantages; factors affecting canopy development.

CO2 : Students gain knowledge about the different structures of canopy and importance of light interceptions (PAR) in canopies of fruit crops.

CO3 : Students will be acquainted with the knowledge of Spacing and utilization of land area through management of canopy.

CO4 : Students will learn Canopy management through PGR, training & pruning and management root and shoot system.

CO5 : Canopy development and management of quality fruit in temperate fruit crops.

FSC 506 (Breeding of Fruit Crops)

CO1 : Students understand the origin, distribution and taxonomical status of species and cultivars of fruit crops.

CO2 : Students able to acquainted with floral biology and breeding objectives of fruit crops.

CO3 : Students gain knowledge about crop improvement through conventional and modern methods and improvement of quality traits.

CO4 : Students gain knowledge about resistance breeding for biotic and abiotic stresses including biotechnological interventions.

CO5 : Students gain knowledge about achievements and future thrust.

FSC 508 (Growth and Development of Horticultural Crops)

CO1	:	Understanding the parameters of growth and development, growth dynamics and morphogenesis.
CO2	:	Knowledge about environmental impact on growth and development of horticultural crops, photosynthesis and photoperiodism, vernalisation and thermoperiodism.
CO3	:	Learning about the influence of water and mineral nutrition on growth and development and biosynthesis of plant growth regulators.
CO4	:	Knowledge about developmental physiology and biochemistry during growth and development phases of horticultural crops
CO5	:	Acquaint the students with growth and developmental process during stress including manipulation of growth and development and their impact.

VSC 501 (Production of Cool Season Vegetable Crops)

CO1	:	Appreciate the scope and scenario of cool season vegetable crops in India
CO2	:	Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops
CO3	:	Calculate the economics of vegetable production in India
CO4	:	Production technology for vegetable legume crops with post-harvest handling and Hi-tech cultivation practices
CO5	:	Gain in techniques of the management of leafy vegetables that further enhance productivity and skill development

VSC 508 (Organic Vegetable Production Technology)

CO1	:	To equip students with the skills and knowledge necessary for effective handling and management of vegetables after harvest
CO2	:	To understand the implementation of strategies to minimize losses during harvesting and transportation of post-harvest losses in vegetable production
CO3	:	Encompass understanding of quality grading and sorting techniques to develop skills in managing packing house operations efficiently
CO4	:	Understanding the skills to implement integrated disease management strategies to minimize post-harvest losses and ensure food safety and quality
CO5	:	Acquiring skills in selecting the most appropriate storage method and mastering techniques to maintain optimal storage condition to extend the shelf life and preserve quality

VSC 505 (Seed Production Technology of Vegetable Crops)

CO1	:	Acquire knowledge of the new seed policies and vegetable seed industry in India ensure quality assurance, technology adoption, and sustainable

agriculture

CO2	:	To understand the basic knowledge of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development
CO3	:	Understanding of maintenance of seed standards and law enforcement of seed act for plant quarantine promote agriculture sustainability, food security and economic development
CO4	:	Integrated knowledge of seed processing and storage including cryoprservation and synthetic seed technology supporting sustainable agriculture, food security, biodiversity conservation efforts globally
CO5	:	Learning about agro techniques for seed production of vegetable crops for skill development and agri-preneurs

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Plantation, Spices, Medicinal and Aromatic Plants Science Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

PSMA 501 (Production of Plantation Crops)

CO1	:	To impart the basic and applied knowledge on various aspects of production technology.
CO2	:	To impart basic knowledge of role of plantation crops in national economy and clean development mechanism as well as carbon sequestration potential.
CO3	:	Understanding of export potential, problems and prospects and IPR issues in plantation crops
CO4	:	To know the role of commodity boards and directorates in the development programmes.
CO5	:	Entrepreneurship skill development in plantation crop industry for plant multiplication including in vitro and nursery techniques of plantation crops

PSMA 502 (Production of Spice Crops)

CO1	:	To impart theoretical as well as hands-on experience to the learner on scientific production technology of various spice crops
CO2	:	Understand the role of spices in employment generation, Value addition and Marketing of value added products.
CO3	:	Be able to post harvest management including primary processing, grading, packaging and storage, GMP in major spice crops.
CO4	:	To know about the quality control, pharmaceutical significance and protected cultivation of spices.
CO5	:	To impart comprehensive knowledge of propagation and nursery management of major spices.

PSMA 503 (Production Technology of Medicinal and Aromatic Crops)

CO1	:	To impart comprehensive knowledge about theoretical as well as hands-on experience on commercial cultivation of MAPs in Indian perspectives
CO2	:	To develop the technical skill to start medicinal and aromatic crop-based enterprises.
CO3	:	Understand the enriched herbal formulations for the healthcare system, quality seeds and planting materials and co products of MAP waste to boost economy.
CO4	:	To get exposure on botany, classification, harvesting and post-harvest management in MAPs.
CO5	:	Understands the role of institutions, Medicinal Plant Board and NGOs in research and development of MAPs.

PSMA 504 (Breeding of Plantation Crops and Spices)

CO1	:	To impart comprehensive knowledge on the theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods and breeding achievements in various plantation and spice crops.
CO2	:	Understanding the fundamental concepts of molecular breeding and biotechnological approaches for climate resilience Crops.
CO3	:	Thoughtful of yield improvement techniques along with biotic and abiotic factors in plantation and spices.
CO4	:	To understand the basic knowledge and its application of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development.
CO5	:	Be able to start plantation and spice crop-based seed production/ nursery centres

VSC 501 Production Technology of Cool Season Vegetable Crops

CO1	:	Appreciate the scope and scenario of cool season vegetable crops in India
CO2	:	Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops
CO3	:	Calculate the economics of vegetable production in India
CO4	:	Production technology for vegetable legume crops with post-harvest handling and Hi-tech cultivation practices
CO5	:	Gain in techniques of the management of leafy vegetables that further enhance productivity and skill development

VSC 504 Growth and Development of Vegetable Crops

CO1	:	To impart comprehensive knowledge on the growth, developmental stages and crop regulation to increase the productivity in PSMAs
CO2	:	To facilitate deeper understanding on growth, development, assimilate partitioning and plant bio regulators in PSMAs.
CO3	:	To know about the canopy management for conventional and high density planting pruning and training in PSMAs.
CO4	:	Understanding the developmental physiology and biochemistry during dormancy, bud break and juvenility in PSMAs.
CO5	:	Understanding the physiology of flowering and stress hormones in PSMAs.

PSMA 505 Breeding of Medicinal and Aromatic Crops

CO1	:	To impart comprehensive knowledge on the technical skill in breeding of medicinal and aromatic plants.
CO2	:	Better understanding of plant bio-diversity, conservation of germplasm and IPR issues.
CO3	:	Be able to start medicinal and aromatic crop-based seed production/

nursery centres to make profitable horticultural system.

CO4 : To impart the current approaches for improvement of quality traits, resistance breeding for biotic and abiotic stresses with the help of biotechnological tools.

CO5 : To know about the breeding achievements in terms of released varieties, parentage and salient features.

PSMA 506 Processing of Plantation Crops, Spices, Medicinal and Aromatic Crops

CO1 : To impart basic knowledge about the principle and practices in canopy management of fruit crops

CO2 : Special emphasis on geometry of planting, canopy manipulation for optimum utilization of light

CO3 : To provide basic knowledge of about canopy management through plant growth inhibitors, training and pruning and management practices

CO4 : To facilitate understanding about spacing and utilization of land area, canopy classification, management through rootstock and scion

CO5 : Comprehensive understanding of canopy development and management in relation to growth, flowering, fruiting and fruit quality of fruit crops

PSMA 507 Organic Spice and Plantation Crop Production Technology

CO1 : The students will be able to understand the different style and types of garden.

CO2 : The students will be able to understand the different components, bio-aesthetic planning, eco-tourism, theme parks, indoor gardening and therapeutic gardening.

CO3 : Students will gain skill in preparation, establishment and maintenance of special types of gardens

CO4 : The student will have knowledge on fundamental principles of garden, drawing skill and steps in preparation of garden design

CO5 : The students will become capable of designing and execution of landscape project for different specific situations and prepare the cost economics

VSC 505 Seed Production Technology of Vegetable Crops

CO1 : The student will be able to understand the role of value addition in flowers in national and global scenario and know how women empowerment possible through value added products making

CO2 : The students must be able to demonstrate important value addition processes in flower crops.

CO3 : Students will gain skill in production of floral crafts, dry flower making and proficiency in floral arrangements.

CO4	:	Students will gain skill in extraction of pigments and nutraceuticals, and also understand with significance of natural pigments as nutraceuticals.
CO5	:	Students will gain skill in extraction of concrete and essential oils, and also understand with aromatherapy, synthetic and natural dyes.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Floriculture and Landscape Architecture Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

FLS 501 (Breeding of Flower crop Ornamental Plants)

CO1 : To impart comprehensive knowledge on the evolution of varieties, origin, distribution, genetic resources of ornamental crops. Understanding the fundamental concept of IPR and plant breeder right

CO2 : The student will be able to understand the fundamental concepts of genetic inheritance of different traits of ornamental crops

CO3 : To impart comprehensive knowledge on the theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods in ornamental crops

CO4 : Thoughtful of breeding constraints and achievements made in ornamental crops

CO5 : The student will be able to understand the basic knowledge of biotechnology and its role for improving yield and quality traits of ornamental crops that contribute in entrepreneurship skill development

FLS 502 (COMMERCIAL PRODUCTION OF CUT FLOWERS)

CO1 : The students will be able to understand the national and international scenario of cut flower production, varietal wealth and nursery management practices

CO2 : The student will have knowledge on advanced production technologies in growing cut flower crops.

CO3 : The students will be able to diagnose production problems in cut flowers.

CO4 : The students will become capable of managing a floriculture unit for year round flowering

CO5 : The students will have knowledge on harvest indices, harvesting techniques, post-harvest handling, marketing and export potential cut flowers

FLS 503 (Commercial Production of loose flowers)

CO1 : To understand the national and international scenario of loose flower production, varietal wealth and nursery management practices

CO2 : The student will have knowledge on advanced production technologies in growing loose flower crops

CO3 : The students will be able to diagnose production problems in loose flowers.

CO4 : The students will become capable of managing a floriculture unit for year round flowering.

CO5 : The students will have knowledge on harvest indices, harvesting techniques, post-harvest handling, marketing and export potential of loose flowers

FLS 504 (Landscaping and Ornamental gardening)

CO1 : The students will be able to understand the different style and types of garden

CO2 : The students will be able to understand the different components, bio-aesthetic planning, eco-tourism, theme parks, indoor gardening and therapeutic gardening

CO3 : Students will gain skill in preparation, establishment and maintenance of special types of gardens

CO4 : The student will have knowledge on fundamental principles of garden, drawing skill and steps in preparation of garden design

CO5 : The students will become capable of designing and execution of landscape project for different specific situations and prepare the cost economics

FSC 501 (Tropical and dry Land Fruit Production)

CO1 : Understanding of more resilient and productive cultivation with better economic return practices

CO2 : Better conservation of different traits by adopting the hi-tech propagation techniques that contribute to future generation of plants

CO3 : Expansion of lifespan of fruit plants, improve quality traits leading to orchard health and profitability

CO4 : To gain knowledge of pre harvest management value chain optimizing the fruit yield, quality, market value and ultimately good services reached to consumer level

CO5 : Aware about the management practices for quality improvement and market linkages of tropical fruit crops for skill development and employment generation

FSC 505 (Propagation and Nursery management for fruit crops)

CO1 : To ensure the successful propagation and quality of fruit crops ultimately impacting fruit yield and crop success

CO2 : To maintain the desired traits along with rapid propagation and provide specific skills and resources that increase the plant protection measures

CO3 : By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability

CO4 : Micro propagation and micro grafting offers practical benefits in pomology by providing a reliable and efficient means of producing high quality planting material with desirable traits

CO5 : Learning about nursery management practices and regulations for skill development and employment generation

FLA 505 Protected Floriculture

CO1 : The students will be able to understand the types, designs, erection of protected structures and suitable flower crops for protected cultivation

CO2	:	The student will have knowledge on advanced production technologies in environment control green houses
CO3	:	The students will be able to diagnose production problems in protected structures
CO4	:	The students will become capable of managing a protected floriculture unit for year round production
CO5	:	The students will have knowledge on harvest indices, harvesting techniques, post-harvest handling, marketing, export potential and APEDA regulations for export of flowers

FLA 506 Value Addition in Flowers

CO1	:	The student will be able to understand the role of value addition in flowers in national and global scenario and know how women empowerment possible through value added products making
CO2	:	The students must be able to demonstrate important value addition processes in flower crops
CO3	:	Students will gain skill in production of floral crafts and dry flower making
CO4	:	Will gain skill and proficiency in floral arrangements
CO5	:	Students will gain skill in extraction of concrete and essential oils, and also understand with aromatherapy, synthetic and natural dyes

FLA 507 Turfing and Turf Management

CO1	:	The student will have knowledge on prospects of landscape industry
CO2	:	The student will have vast knowledge on
CO3	:	The students will become capable of establishment of turfs
CO4	:	The students will able to manage turf in commercial units.
CO5	:	students will be able to prepare a turf establishment project and to execute the same

FSC 504 Canopy Management in Fruit Crops

CO1	:	By the approach of canopy management techniques improve the fruit quality that ensure the marketability and profitability
CO2	:	Better management techniques of fruit crops reduces the infestation of insect pest and diseases
CO3	:	Leveraging geometry and LUT in canopy management result in improved quality, enhanced efficiency and potentially increase profitability
CO4	:	By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability
CO5	:	Analytical approach to understand canopy development and management for entrepreneurship skill development

FSC 508 Growth and Development of Horticultural Crops

CO1	:	Acquire knowledge of growth analysis and physiology of phyto-hormones
CO2	:	Better understanding of Physiology of dormancy and germination in Horticulture crop production
CO3	:	Understanding the integrated practical knowledge for effect of abiotic factors on flowering and sex expression in Horticulture crops
CO4	:	Analytical approaches for understanding the physiology of growth and development in Horticulture crops
CO5	:	Morphogenesis and tissue culture techniques in Horticulture crops for skill development and employment generation

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Soil Science Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-cantered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

SOIL 503 (Soil chemistry)

CO1 : Introduction about composition of the earth's crust and thermodynamics equilibrium

CO2 : Classification and properties of soil colloids

CO3 : To understand the ion exchange processes in soil

CO4 : Potassium, phosphate and ammonium fixation in soils and their management aspects

CO5 : Chemistry of Problematic soil and their management

SOIL 504 (Soil Mineralogy, Genesis, Classification)

CO1 : Introduction of crystallography including isomorphism and polymorphism

CO2 : To know about classification and chemical composition of clay minerals and its impact in plant nutrition

CO3 : Pedogenic processes of soil formation special reference to Indian soils

CO4 : To acquire the knowledge of modern systems of soil classification with special emphasis on soil taxonomy

CO5 : To increase the knowledge about soil mineralogy and soil maps through latest software – usefulness

SOIL 506 (Soil Biology and Biochemistry)

CO1 : To understand the soil biota, soil microbial-ecology and types of organisms in different soils of India

CO2 : Course gives the knowledge of microbiology and biochemistry of root-soil interface

CO3 : Soil enzymes, origin, activities and importance and their effect on growth and activity of microflora

CO4 : The students will acquire good knowledge of preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost and their chemical composition

CO5 : Biological indicators of soil quality, bioremediation of contaminated soils and microbial transformations of heavy metals in cultivated soil

SOIL 510 Remote sensing and GIS techniques for soil and crop studies

CO1 : Familiar with basic concepts, principle and components of Remote Sensing GPS and GIS

CO2 : Explain the role of Remote sensing and GIS for analysis of variability of different soil properties with classical and geostastical techniques

CO3 : Apply remote sensing and GIS techniques on soil, plant health and yield forecasting of the crop

CO4 : Illustrate the benefits of remote Sensing and GIS for the sustainable agriculture

CO5 : Evaluate and Interpret the remote sensing and GIS data for crop

management practices

SOIL 501 (Soil Physics)

CO1 : Fundamental of physical Characterization of different soils

CO2 : Physical properties of soil and alleviation of soil physical constraints for crop production

CO3 : Soil water dynamics: Retention, Flow regimes and plant availability

CO4 : Soil atmosphere interactions: Composition, Gas exchange and plant health management

CO5 : To learn about soil thermal properties and their influence on plant growth and development

SOIL 502 (Soil Fertility and Fertilizer use)

CO1 : To identify the deficiency and functions of essential plant nutrients, dynamics and their management

CO2 : To understand about macro and micro nutrient availability their role in soil plant system

CO3 : STCR method for fertilizer recommendations and improving fertilizer use efficiency

CO4 : Soil fertility evaluation methods in relation to sustainable agriculture

CO5 : To understand and improve soil health and soil quality

SOIL 509 Soil water and air pollution

CO1 : Knowledge on problem of soil, water and air pollution, their nature, estimation techniques for water quality

CO2 : Knowledge on remediation of contaminated soils

CO3 : Ability to conduct various qualitative and quantitative tests for waste samples collected from the locality

CO4 : Students will understand the procedures to determine the chemical and biochemical oxygen demand, nutrients and heavy metals that are being polluting our environment

CO5 : Students will learn about the management of pollution

Minor Subjects

AGRON 502 (Principles and practices of Soil fertility)

CO1 : To identify the factor this will be responsible for positive and negative impact on soil fertility and productivity

CO2 : To understand essential plant nutrient and their function for crop production

CO3 : Application or preparation of different type of compost and its impact on crop production

CO4 : Analysis of different parameters related to the nutrient management of fertilizer

CO5 : Adaptation or functional knowledge about different method of fertilizer application

AGRON-512 Dry land farming

CO1 : To know about the dryland farming and rainfed agriculture.

CO2 : To increase the knowledge about drought and its impact on crop production.

CO3 : To increase the knowledge about contingent plan/ farming under rainfed agriculture

CO4 : Analysis of the impact tillage and cultural practices on crop production under rainfed areas

CO5 : To know about watershed management and its usefulness under rainfed condition.

AGRON 504 (Principles and Practices of Water Management)

CO1 : To analyses the quality of irrigation water and resources

CO2 : To acquire the knowledge of different recommended plant relationship

CO3 : To the adaptation of different irrigation scheduling and methods

CO4 : Calculation or analytical approach of water use efficiency under quality parameters.

CO5 : To construct ideologies pertaining to water management in problem soils

AGRON 512 (Dry land farming and watershed management)

CO1 : To know about the dryland farming and rainfed agriculture.

CO2 : To increase the knowledge about drought and its impact on crop production.

CO3 : To increase the knowledge about contingent plan/ farming under rainfed agriculture

CO4 : Analysis of the impact tillage and cultural practices on crop production under rainfed areas

CO5 : To know about watershed management and its usefulness under rainfed condition.

AGRON 513 (Principles and practices of organic Farming)

CO1 : To clear the concept and thinking about organic farming

CO2 : To increase the awareness of organic elements to increase soil fertility

CO3 : Adaptation of different farming system along with soil productivity

CO4 : Functional knowledge of different approaches of weed control

CO5 : Impact of social and economic aspects of organic farming

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Genetics and Plant Breeding Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
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PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

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Course Outcomes (COs)

Major Subjects

GPB 501 (Principles of Genetics)

CO1 : Mendelian genetics and its extensions.

CO2 : Population genetics.

CO3 : Genetics at DNA and molecular level.

CO4 : Gene: Isolation, cloning, sequencing and its modification.

CO5 : Study of omics and transgenics.

GPB 505 (Principles of Cytogenetics)

CO1 : Structure variation of chromosomes, types and its evolutionary significance.

CO2 : Numerical variations of chromosomes,& its evolutionary significance

CO3 : Fertilization barriers in crop plants, role of polyploids

CO4 : Interspecific hybridization and synthesis of new crops.

CO5 : Chromosome manipulation; & its production

GPB 502 (Principles of Plant Breeding)

CO1 : Pre & Post Mendelian era; Plant Introduction & Role of PGR in PB

CO2 : Genetic basis of Self-pollinated and Cross-pollinated crops.

CO3 : SI and Male sterility and their commercial exploitation

CO4 : Special breeding techniques.

CO5 : Varietal development with plant breeders' rights & plant variety protection and farmers rights.

GPB 508 Cell Biology and Molecular genetics

CO1 : Pre & Post Mendelian era; Plant Introduction & Role of PGR in PB

CO2 : Genetic basis of Self-pollinated and Cross-pollinated crops.

CO3 : SI and Male sterility and their commercial exploitation

CO4 : Special breeding techniques.

CO5 : Varietal development with plant breeders' rights & plant variety protection and farmers rights.

GPB 509 Biotechnology for Crop improvement

CO1 : Pre & Post Mendelian era; Plant Introduction & Role of PGR in PB

CO2 : Genetic basis of Self-pollinated and Cross-pollinated crops.

CO3 : SI and Male sterility and their commercial exploitation

CO4 : Special breeding techniques.

CO5 : Varietal development with plant breeders' rights & plant variety protection and farmers rights.

GPB 504 Principles of Quantitative Genetics

CO1 : Study of quantitative inheritance, analysis and variability parameters.

CO2 : Designs, Principles and application of plant breeding experiments.

CO3 : Assessment of polygenic variation and determination of yield components.

CO4 : Study of gene action assessment of varietal adaptation.

CO5 : QTL mapping and MAS.

GPB 515 Maintenance Breeding and Concept of Variety release seed production

CO1 : Variety Development and maintenance

CO2 : DUS testing and maintenance breeding

CO3 : Factors responsible for genetic deterioration of varieties

CO4 : Principles of seed production

CO5 : Generation system of seed multiplication

ENT 511 Pests of Field Crops

CO1 : Knowledge of life history of important insect pests

CO2 : Gain knowledge on nature of damage and seasonal incidence of pestiferous insects

CO3 : Knowledge on insect pests of field crops and effective management

CO4 : Acquaint with collection methods and identification of important pests and their natural enemies

CO5 : Detection and estimation of infestation and losses in different crops

PL PATH 508 Detection and Diagnosis of Plant Diseases

CO1 : Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases.

CO2 : Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms .

CO3 : Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens.

CO4 : Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis.

CO5 : Interpret diagnostic test results and make informed decisions regarding disease management strategy.

PL PATH 513 Disease resistance in plants

CO1 : Understanding of the basic concept of plant resistance and diversity of plant pathogens

CO2 : Capability to understand defence mechanisms responses to pathogen invasion including recognition, signal transduction and defence activation

CO3	:	Understanding of genetic and molecular basis of host-pathogen interaction and disease resistance mechanism
CO4	:	Capability to evaluate the resistance of plants to pathogen through field evaluation, greenhouse assay and molecular markers
CO5	:	Develop collaboration skill, critically evaluate scientific data, design experiments, analyse data and propose innovative solutions to plant disease problem

PL PATH 516 Integrated disease management

CO1	:	Understanding of basic and strategic principles of the integrated disease management
CO2	:	Knowledge of disease epidemiology and competence in integrated disease management
CO3	:	Applications of sustainable practices and research, innovation in integrated disease management
CO4	:	Practical approaches of package of practice for holistic management of diseases of field and horticultural crops
CO5	:	Proficiency in integrated plant disease management, analytical skills, pesticide use, equitable access to agricultural resources and professional development

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Agricultural Extension Education Programme – Old Syllabus

Programme Outcomes (POs)

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PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-cantered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
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Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

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Course Outcomes (COs)

Major Subjects

EXT 501 Development Perspectives of Extension Education

CO1	:	To developing an understanding about the concept of extension education and its importance in Agriculture development,
CO2	:	To know the ongoing Rural development programmes,
CO3	:	To know the new innovations being brought into the Agricultural extension in India
CO4	:	To have details about the various poverty alleviation programmes
CO5	:	To make aware the students about current approaches in extension (ATIC, KCC, NAIP)

EXT 502 Development Communication and Information Management

CO1	:	To understand the concept, meaning and process of communication, modern media of communication, information management and journalistic writing of various information
CO2	:	To provide knowledge about write news for farm newspaper/magazines/ articles.
CO3	:	To find out the various types of communicators in agriculture
CO4	:	Handling of communication and recording equipments.
CO5	:	To learn about various computer applications, modern communication media and its applications.

EXT 503 Diffusion and Adoption of Innovations

CO1	:	To Understand agricultural innovations, its diffusion and adoption
CO2	:	To get functional knowledge about how to develop and transfer of an innovation through various extension system
CO3	:	To get familiar about the adoption process and its factor that breaks the dissemination of an innovation
CO4	:	To understand the adopter and its various attributes
CO5	:	To sensitize the students about how diffusion of an innovation is happens

EXT 504 Research Methods in Behavioral Sciences

CO1	:	Get better understanding, knowledge and skills in methods of behavioural science research.
CO2	:	Learn about various statistical packages for social sciences.
CO3	:	Selection and formulation of research problem and research articles
CO4	:	Learn about presentation of reports, report writing, thesis writing and scientific article writing
CO5	:	To provide knowledge and skills in methods of behavioural sciences research and learn the appropriate statistics for data analysis.

EXT 505 e-Extension

CO1	:	To develop skills in agricultural content analysis of ICT projects
CO2	:	To provides knowledge about handling of ICT Tools
CO3	:	To get insight regarding E- Learning approach
CO4	:	To acquainted about various artificial intelligence tools likes expert system used in agriculture
CO5	:	To learn about creating and designing web portals, blogs, and social media pages

EXT 506 Entrepreneurship Development and Management in Extension

CO1	:	To understand the theories of entrepreneurship and business development.
CO2	:	To understand the key resources required to develop an existing business such as ideas and finance, launch a new venture, or initiate a business enterprise.
CO3	:	To understand and evaluate the key factors needed to develop a successful business.
CO4	:	To understand the central role of opportunity recognition and marketing to business development.
CO5	:	To understand the creation of business sustainability

EXT 507 Human Resource Development

CO1	:	To build an understanding and perspective of Human Resource Development as discipline appreciating learning.
CO2	:	To learn the skills of developing a detailed plan for need and implementation of HRD program in the organization.
CO3	:	To learn role of learning in action as an individual, group and an organization in order to develop creative strategies to organizational problems
CO4	:	To develop a perspective of HRD beyond organizational realities including national HRD.
CO5	:	To understand contemporary realities of HRD and its interface with technology.

AG.ECON-503 Evolution of Economic Thought

CO1	:	Concepts of decision making, quantitative tools, and linear programming
CO2	:	Formulation of farms and non-farm problems as linear programming models and solutions.
CO3	:	Concept of simplex Method, solving profit maximization and cost minimizations problems.
CO4	:	Extension of Linear Programming Models.

CO5 : Concepts of game theory

AG.ECON-504 Agricultural Production Economics)

CO1 : Nature, scope and significance of agricultural Production economics

CO2 : Factors of production , its classification and factor substitution

CO3 : Theories of cost functions its components and application

CO4 : Economies and diseconomies of scale

CO5 : Technology in agricultural production, nature and effects in agricultural production

AG.ECON-505 Agricultural Marketing and Price Analysis

CO1 : Basic concepts of agricultural marketing.

CO2 : Marketing Co-operatives, market infrastructure needs and Government role in marketing regulations

CO3 : Role of Information Technology and Market Intelligence in marketing of agricultural commodities

CO4 : Spatial and temporal price relationships and demand mgt. in supply chain.

CO5 : Introduction to commodities markets and future trading.

AG.ECON-509 Agricultural Finance and Project Management

CO1 : Role and importance of Agricultural finance and various financial institutions in rural credit.

CO2 : Technical feasibility and Economic viability of credit and concept of 3c, 7p, &3R.

CO3 : Financial decisions, Preparation of financial statements, and assessing the performance of farm/ firm.

CO4 : Identification, preparation, appraisal, financing and implementation of projects.

CO5 : Risks in financing agriculture, and its management strategies and coping mechanism.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc.(Ag.) Agricultural Economics Programme – Old Syllabus

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PSO1 : Functional knowledge of crop production and soil management

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Course Outcomes (COs)

Major Subjects

AG. ECON 501(Micro Economic Theory and Applications)

CO1 : Basics of micro economics i.e. Demand & Supply

CO2 : Various types of economic approaches according to consumer choice

CO3 : Consumer behavior in different economic situations and price and demand correlation.

CO4 : Overview of Market: Firms behavior and different market types

CO5 : Concepts of Factor Market i.e. Market structures, components and resource interaction

AEC 502 (Macro Economics and Policy)

CO1 : Concepts, scopes and principles of macroeconomics from classical to Keynesian theories.

CO2 : Laws and theories about supply, demand, money, labour, wages and prices

CO3 : Model of income determination, Keynesian Multiplier- aggregate spending, and concepts of taxation, transfer payments, foreign spending, balanced budget.

CO4 : Theories of Aggregate Consumption and Investment.

CO5 : Concepts, nature and effect of Inflation and Unemployment

AG.ECON-503 Evolution of Economic Thought

CO1 : History, approaches and evolution of economic thought.

CO2 : Development of different school of thoughts and origin of micro economic analysis.

CO3 : concept of neoclassical economic thought and Keynesian economics.

CO4 : Globalization era, economic growth and development approaches

CO5 : Economic thought of pre-independent and post independent India

AG.ECON-504 Agricultural Production Economics

CO1 : Nature, scope and significance of agricultural Production economics

CO2 : Factors of production , its classification and factor substitution

CO3 : Theories of cost functions its components and application

CO4 : Economies and diseconomies of scale

CO5 : Technology in agricultural production, nature and effects in agricultural production

AEC 505 (Agricultural Marketing and Price Analysis)

CO1 : Basics of dynamics of agricultural marketing.

CO2 : Problems in agricultural marketing, market intermediaries and their role, need for regulation

CO3 : Market structure, conduct and performance analysis and integration in market.

CO4 : Introduction to Commodities markets and future trading.

CO5 : Role of Information Technology and Market Intelligence in marketing of agricultural commodities

AG.ECON-506 Research Methodology for Social Sciences

CO1 : Importance and scope of research in agricultural economics.

CO2 : Hypothesis: Framing and Testing

CO3 : Sampling theory and sampling design

CO4 : Data collection – assessment of data needs – sources of data collection – discussion of different situations.

CO5 : Data coding, tabulation, cleaning, Universal procedures for preparation of bibliography – writing of research articles.

AG.ECON-507 Econometrics.

CO1 : Introduction of economic theory and its concepts, methodology of econometrics-regression analysis.

CO2 : Concepts of regression classification, estimation and its interpretation

CO3 : Identification, consequences and remedies of various econometric models.

CO4 : Use of dummy variables, specification, estimation and interpretation.

CO5 : Identification and approaches to estimation of simultaneous equation model.

AEC 507 (Agricultural Finance and Project Management)

CO1 : Knowledge about the principles, procedures, problems and policies relating to financing agricultural firms.

CO2 : Financial Institutions and credit flow to rural/priority sector.

CO3 : Financial decisions, Preparation of financial statements, and assessing the performance of farm/ firm.

CO4 : Identification, preparation, appraisal, financing and implementation of projects.

CO5 : Risks in financing agriculture, and its management strategies and coping mechanism.

AEC 508 (Linear Programming)

CO1 : Concepts of decision making, quantitative tools, and linear programming

CO2 : Formulation of farms and non-farm problems as linear programming models and solutions.

CO3 : Concept of simplex Method, solving profit maximization and cost minimizations problems.

CO4 : Extension of Linear Programming Models.

CO5 : Concepts of game theory

Minor Subjects

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CO1 : To understand the concept, meaning and process of communication, modern media of communication, information management and journalistic writing of various information

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CO3 : To understand and evaluate the key factors needed to develop a successful business.

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CO5 : To understand the creation of business sustainability

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of HRD program in the organization.

CO3	:	To learn role of learning in action as an individual, group and an organization in order to develop creative strategies to organizational problems
CO4	:	To develop a perspective of HRD beyond organizational realities including national HRD.
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Course Outcomes (COs)

Major Subjects

PL PATH 501 (Mycology)

CO1 : Basic understanding about the plant disease causing fungi.

CO2 : Ultra Morphological identification and detection of different orders of fungi.

CO3 : Economic importance of plant pathogenic fungi and its role in various ecosystem.

CO4 : Etiological understanding about the soil, air and seed inhabitant fungi.

CO5 : Integration of conceptual understanding of fungi for the better management.

PL PATH 502 (Plant Virology)

CO1 : Conceptual understanding about the diversity transmission and detection.

CO2 : Symptomatological, Molecular, Serological diagnosis of plant viruses.

CO3 : Understanding about the virus-vector relationship, biology and spread of plant viruses.

CO4 : Economic importance of viral diseases and its role in various ecosystem.

CO5 : Integrating the conceptual understanding about the plant viruses for formulating management option.

PL PATH 503 (Plant Bacteriology)

CO1 : Basic understanding about the Bacterial diversity, host pathogen interaction and role in various ecosystem.

CO2 : Etiological understanding the Bacterial survival mode of infection and Economic importance.

CO3 : Explore the role of bacteria as Nitrogen fixing, PGPR and bio control.

CO4 : Ethical understanding in the use of genetically modifies bacteria and their application in Agriculture.

CO5 : Integrating the conceptual understanding about the bacteria for formulating management option.

PL PATH 505 (Principles of Plant Pathology)

CO1 : Understanding of the fundamental principles of plant diseases.

CO2 : Gain proficiency in identifying and classifying plant pathogens including fungi, Bacteria, Viruses, Nematode and Parasitic Plants.

CO3 : Learn the mechanism for plant disease development, spread epidemiology, host susceptibility and pathogen biology.

CO4 : Explore various strategies for integrated management of plant disease.

CO5 : Appreciate the economic, environmental, social impact, surveillance, forecasting and biosecurity of plant disease.

PL PATH 506 (Techniques in Detection and Diagnosis of Plant Diseases)

CO1	:	Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases
CO2	:	Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms
CO3	:	Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens
CO4	:	Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis
CO5	:	Interpret diagnostic test results and make informed decisions regarding disease management strategy

PL PATH 510 (Seed Health Technology)

CO1	:	Understanding of the basic and strategic concept/methodology of seed pathology
CO2	:	Proficiency in seed health testing and identification and assessment of seed borne pathogens
CO3	:	Understanding about the plant quarantine, SPS, and assess the impact of seed quality on human, animals and plant health
CO4	:	To assess the risk assessment, mitigation and regulatory compliance
CO5	:	Conducting research and innovation in seed science and communicate seed health issues and solution to various stock holder

PL PATH 513 Disease resistance in plants

CO1	:	Understanding of the basic concept of plant resistance and diversity of plant pathogens
CO2	:	Capability to understand defence mechanisms responses to pathogen invasion including recognition, signal transduction and defence activation
CO3	:	Understanding of genetic and molecular basis of host-pathogen interaction and disease resistance mechanism
CO4	:	Capability to evaluate the resistance of plants to pathogen through field evaluation, greenhouse assay and molecular markers
CO5	:	Develop collaboration skill, critically evaluate scientific data, design experiments, analyse data and propose innovative solutions to plant disease problem

PL PATH 516 Integrated disease management

CO1	:	Understanding of basic and strategic principles of the integrated disease management
CO2	:	Knowledge of disease epidemiology and competence in integrated disease management

CO3 : Applications of sustainable practices and research, innovation in integrated disease management

CO4 : Practical approaches of package of practice for holistic management of diseases of field and horticultural crops

CO5 : Proficiency in integrated plant disease management, analytical skills, pesticide use, equitable access to agricultural resources and professional development

NEMA 510 Subject Name Nematode management

CO1 : Understanding of concept of plant pathogenic nematode management

CO2 : Practicability to assess the losses, pest risk analysis, ecological relationship of nematode

CO3 : Familiar with IPM strategies for nematode management including cultural, biological, physical and chemical methods

CO4 : Gain knowledge on legal methods, quarantine regulations and application of bionematicides

CO5 : Competencies to perform scientific designing of the experiments, collection and analysing of data and skills to convey nematode research

ENT 504 Classification of Insects

CO1 : To understand the principles of insect pest management, including concept and philosophy of IPM

CO2 : Knowledge on computation of ETL, EIL, and implementation of IPM programmes

CO3 : Estimation of losses due to insect pests

CO4 : Acquaintance with ITKs for Integrated pest management.

CO5 : Knowledge of the Pest survey, surveillance and forecasting.

ENT 507 (Biological Control of Insect Pests and Weeds)

CO1 : Understanding the theory and practice of biological control

CO2 : Knowledge on techniques for mass production of quality bio-agents and their usage

CO3 : Impart knowledge on role of natural enemies in pest and weed management

CO4 : Gain knowledge on role of insect pathogenic microorganisms

CO5 : knowledge of semiochemicals in biological control

ENT 510 (Principles of Integrated Pest Management)

CO1 : Understanding the principles of insect pest management, including concept and philosophy of IPM

CO2 : Concepts of ETL, EIL and their implementation in IPM programmes

CO3 : Knowledge on tools of pest management and their integrated usage

CO4 : Knowledge of the Pest survey, surveillance, forecasting and pest risk analysis

CO5 : Estimation of losses due to insect pests

ENT 511 (Pests of Field Crops)

CO1 : Knowledge of life history of important insect pests

CO2 : Gain knowledge on nature of damage and seasonal incidence of pestiferous insects

CO3 : Knowledge on insect pests of field crops and effective management

CO4 : Acquaint with collection methods and identification of important pests and their natural enemies

CO5 : Detection and estimation of infestation and losses in different crops

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Entomology Programme – Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-cantered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

ENT 501 (Insect Morphology)

CO1 : To acquaint the students with external morphology of the insect's body

CO2 : Understanding the functions of various body parts of the insects

CO3 : Knowledge about the insect's sense organs and other morphological traits which will be used in applied entomology

CO4 : To familiarize students with various developmental stages of insects

CO5 : To increase analytical thinking among students by taking cues from modification of insect morphology with changing environment

ENT 502 (Insect Anatomy, Physiology and Nutrition)

CO1 : Understanding on the physiology of insect integument, insect growth and metamorphosis

CO2 : Knowledge on physiology and mechanism of various organ systems of insects

CO3 : Understanding nutritional physiology in insects and knowledge about artificial diets

CO4 : Gain knowledge on thermodynamics, exocrine and endocrine glands of insects

CO5 : Understanding on electroantennogram response for semiochemicals and their role in physiology

ENT 503 (Classification of Insects)

CO1 : Understanding the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification

CO2 : Understanding distinguishing characters, general biology, habits and habitats of insect orders including economically important families

CO3 : Attainment of skills on collecting, mounting, and preserving insects

CO4 : Knowledge on taxonomic keys and its importance in taxonomy

CO5 : Identification of insects of major orders

ENT 505 Insect Ecology

CO1 : Understanding concepts of ecology, systemic approach to ecology and abiotic factors and their generalised action on insects

CO2 : Imparting knowledge on basic concept of insect abundance, population growth models and population dynamics

CO3 : Gain knowledge on biotic factors, defence mechanism, interspecific interactions, concept of niche

CO4 : Understanding community ecology, concept of diversity and pest management as applied ecology

CO5 : Learning methods of insects sampling and calculation of diversity indices like Shannon's, Simpson's, etc.

ENT 507 (Biological Control of Insect Pests and Weeds)

CO1 : Understanding the theory and practice of biological control

CO2 : Knowledge on techniques for mass production of quality bio-agents and their usage

CO3 : Impart knowledge on role of natural enemies in pest management and their field evaluation

CO4 : To understand role of insect pathogenic microorganisms

CO5 : knowledge of semiochemicals in biological control

ENT 508 (Toxicology of Insecticides)

CO1 : Knowledge on structure and mode of action of important insecticides belonging to different groups

CO2 : Understand the concept of toxicity, bio-efficacy, insecticide formulations, etc.

CO3 : Attaining knowledge on insecticide residues, their significance and environmental implications, and insecticide residue analysis

CO4 : Understand insecticide resistance development, resistance management and pest resurgence

CO5 : Knowledge of Insecticide Act, insecticide registration procedures, safe use of insecticides, diagnosis and treatment of insecticide poisoning

ENT 510 (Principles of Integrated Pest Management)

CO1 : Understanding the principles of insect pest management, including concept and philosophy of IPM

CO2 : Concepts of ETL, EIL and their implementation in IPM programmes

CO3 : Knowledge on tools of pest management and their integrated usage

CO4 : Knowledge of the Pest survey, surveillance, forecasting and pest risk analysis

CO5 : Estimation of losses due to insect pests

ENT 511 (Pests of Field Crops)

CO1 : Knowledge of life history of important insect pests

CO2 : Gain knowledge on nature of damage and seasonal incidence of pestiferous insects

CO3 : Knowledge on insect pests of field crops and effective management

CO4 : Acquaint with collection methods and identification of important pests and their natural enemies

CO5 : Detection and estimation of infestation and losses in different crops

ENT 515 (Techniques in Plant Protection)

CO1	:	Skills of appropriate use of plant protection equipments and its related techniques
CO2	:	Imparting knowledge of concepts of different plant protection equipments.
CO3	:	Concept of tissue culture techniques in plant protection
CO4	:	Understand calibration and formulation of pesticides.
CO5	:	Knowledge on application of drones in plant protection

Minor Subjects

PL PATH 503 (Plant Bacteriology)

CO1	:	Basic understanding about the Bacterial diversity, host pathogen interaction and role in various ecosystem.
CO2	:	Etiological understanding the Bacterial survival mode of infection and Economic importance.
CO3	:	Explore the role of bacteria as Nitrogen fixing, PGPR and bio control.
CO4	:	Ethical understanding in the use of genetically modifies bacteria and their application in Agriculture.
CO5	:	Integrating the conceptual understanding about the bacteria for formulating management option.

PL PATH 505 (Detection and Diagnosis of Plant Diseases)

CO1	:	Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases.
CO2	:	Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms .
CO3	:	Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens.
CO4	:	Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis.
CO5	:	Interpret diagnostic test results and make informed decisions regarding disease management strategy.

PL PATH 513 Disease resistance in plants

CO1	:	Understanding of the basic concept of plant resistance and diversity of plant pathogens
CO2	:	Capability to understand defence mechanisms responses to pathogen invasion including recognition, signal transduction and defence activation
CO3	:	Understanding of genetic and molecular basis of host-pathogen interaction and disease resistance mechanism
CO4	:	Capability to evaluate the resistance of plants to pathogen through field

evaluation, greenhouse assay and molecular markers

CO5 : Develop collaboration skill, critically evaluate scientific data, design experiments, analyse data and propose innovative solutions to plant disease problem

PL PATH 516 Integrated disease management

CO1 : Understanding of basic and strategic principles of the integrated disease management

CO2 : Knowledge of disease epidemiology and competence in integrated disease management

CO3 : Applications of sustainable practices and research, innovation in integrated disease management

CO4 : Practical approaches of package of practice for holistic management of diseases of field and horticultural crops

CO5 : Proficiency in integrated plant disease management, analytical skills, pesticide use, equitable access to agricultural resources and professional development

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Molecular Biology and Biotechnology Programme – Old Syllabus

Programme Outcomes (POs)

PO1 :	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 :	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 :	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 :	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 :	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 :	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7 :	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

MBB 501 Principles of Biotechnology

CO1 : Understand the Foundations and Scope of Biotechnology

CO2 : Master Specializations in Agricultural Biotechnology

CO3 : Comprehend Basic Concepts in Biotechnology

CO4 : Explore Advanced Techniques in Biotechnology

CO5 : Engage with Modern Applications and Emerging Topics in Biotechnology

MBB 502 Fundamentals of Molecular Biology

CO1 : Historical Developments and Fundamental Concepts in Molecular Biology

CO2 : Comprehend DNA Structure, Replication, and Repair Mechanisms

CO3 : Explore Transcription and Post-Transcriptional Processing

CO4 : Understand Translation and Protein Modification

CO5 : Evaluate Gene Regulation Mechanisms in Prokaryotes and Eukaryotes

MBB 504 Plant Tissue Culture and Genetic Transformation

CO1 : Understand the Principles and Techniques of Micropropagation and Virus Elimination

CO2 : Protoplast and Cell Culture Techniques for Biotechnological Applications

CO3 : Explore the Diversity and Applications of Somatic Embryogenesis and Androgenesis/Gynogenesis

CO4 : Analyse Commercial Applications and Economic Viability of Plant Tissue Culture

CO5 : Understand Quality Management and Genetic Fidelity Testing in Tissue Culture Plants

MBB 505 Techniques in Molecular Biology

CO1 : Students will understand good lab practices and principles of laboratory instruments

CO2 : Students will understand DNA isolation, quantification and PCR

CO3 : Students will understand DNA fingerprinting methods and applications

CO4 : Students will understand genetic transformation and cloning

CO5 : Students will understand chromatography and blotting

MBB 507 Molecular Breeding

CO1 : Students will understand qualitative and quantitative traits inheritance

CO2 : Students will understand molecular markers and genetic map

CO3 : Students will understand association mapping, and advance GWAS

CO4 : Students will understand marker assisted selection and sequencing

CO5 : Students will understand allele mining

MBB 510 Biosafety, IPR and Bioethics

CO1 : Students will understand about trade secrets, patents and trademarks

CO2 : Students will understand regulation and guidelines of biosafety and biohazards

CO3 : Students will understand about environment, food and feed safety

CO4 : Students will understand about risk assessment and gene flow

CO5 : Students will understand about ethics in biotechnology and GM food labelling

MBB 555 Introduction to Bioinformatics

CO1 : Students will understand about biological database

CO2 : Student will understand protein coding, blast and phylogenetic analysis

CO3 : Students will understand about sequence analysis and alignments

CO4 : Students will understand about primer designing and software for genomics

CO5 : Students will understand about drug designing and docking

MBB 513 Nano Biotechnology

CO1 : Students will understand about Nanoparticles and nanotechnology

CO2 : Students will understand about Membrane channels and nanomotors

CO3 : Students will understand about Structure and properties of natural materials

CO4 : Students will understand about Aerosol properties biomineralization and biosynthesis

CO5 : Students will understand about Nanoparticle carrier system and gene therapy

Minor Subjects

GP 501 Principles of Genetics

CO1 : Fundamental Concepts and Principles of Genetics

CO2 : Analyse Molecular Mechanisms and Genetic Processes

CO3 : Explore Advanced Topics in Genetic Engineering and Molecular Techniques

CO4 : Evaluate Genetic Variation and Genomics in Biological Systems

CO5 : Discuss Ethical and Societal Implications of Genetic Discoveries

GP 502 Principles of Plant Breeding

CO1 : Understand the Historical Evolution and Objectives of Plant Breeding

CO2 : Analyse Genetic Basis and Breeding Strategies in Self- and Cross-Pollinated Crops

CO3 : Evaluate Breeding Methods Across Different Crop Types

CO4 : Explore Advanced Techniques and Technologies in Plant Breeding

CO5 : Understand Regulatory and Ethical Considerations in Cultivar Development

GP 509 Bio Technology for Crop Improvements

CO1 : Students will learn techniques for genetic modification to enhance crop traits.

CO2 : Students will understand the application of molecular markers in crop breeding programs.

CO3 : Students will gain skills in plant tissue culture methods for crop improvement.

CO4 : Students will explore biotechnological approaches to develop crops resistant to pests, diseases, and environmental stresses.

CO5 : Students will understand the regulatory frameworks and ethical considerations in the use of biotechnology for crop improvement.

GP 515 Maintenance Breeding and Concept of Variety Release and Seed Production

CO1 : Students will learn methods to maintain genetic purity in crop varieties.

CO2 : Students will acquire skills in producing high-quality seeds for breeding programs.

CO3 : Students will understand strategies to manage diseases and pests in breeding populations.

CO4 : Students will gain proficiency in the multiplication and maintenance of breeder seeds.

CO5 : Students will learn to monitor and evaluate the performance of breeding lines for consistent quality.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Environmental Science –Old Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : The learners will become knowledgeable in the subject of Environmental Science. Students will demonstrate an understand major concepts of Environment in association with multidisciplinary subjects such as physics, chemistry and mathematics etc. Understood the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena

and their relevance in the day-to-day life.

PSO2 : The learners will be able to become effective scientific communicators/collaborators in multidisciplinary teams providing technical leadership to engage with the challenging environmental problems of local, national and global nature.

PSO3 : Identify environmental problems, evaluate problem solving strategies and develop science-based solutions; understand the need to integrate relevant social sciences (e.g.: environmental planning, law, economics) in environmental problem solving; Understand essential mathematical and statistical approaches, acquired knowledge, skills and ingenuity used to analyse environmental data to solve complex problems.

PSO4 : To make the students to apply their knowledge for efficient environmental decision-making, preparation, planning and implementation of environmental projects and for successful career in environmental departments, research institutes, industries, consultancy and NGOs, etc.

Course Outcomes (COs)

Major Subjects

EVS-501 (Fundamentals of Environmental Science)

CO1 : To study basic concepts of environment, ecosystem and their components

CO2 : Knowledge and skills to realize and combine the complexity of the relations and interactions between the ecosystem structures and functions

CO3 : Become familiar with the cyclic flow of energy, water and nutrient through ecosystems

CO4 : To study environmental pollution, legislation and policies and practices.

CO5 : To study the National and Global environmental issues

EVS-502 (Instrumental Methods of Environment Analysis)

CO1 : Student gain insight into the basic principles of instrumental analysis , relevant technologies, and methods used in environmental analysis.

CO2 : Students can describe the Spectroscopic techniques used in environmental analysis.

CO3 : Students can describe the Chromatographic techniques used in environmental analysis.

CO4 : Students can describe the Advanced molecular techniques used in

environmental analysis.

CO5 : Students can demonstrate the most common methods of chemical analysis that are used in environmental analysis and extensive knowledge of the area, relevant technologies, methods and theories

EVS-503 (Environmental Chemistry & Ecotoxicology)

CO1 : The students will learn about the thermo-chemical and photochemical reactions taking place in the atmosphere

CO2 : The students will be able to evaluate the Ozone chemistry, Acid Rain, Photochemical smog, Aerosols and contribution of Green Houses Gases in Global warming

CO3 : Develop in depth knowledge about the types of reactions in various water bodies and estimation of various Water Quality Parameters

CO4 : Develop in depth knowledge about soil properties and green environmental issues like Carbon foot print, Carbon Credits, Carbon Sequestration etc.

CO5 : Students will learn about the various toxicants present in the environment and their effect on various organisms.

EVS-504 (Solid Waste Management)

CO1 : The students will learn about the overall characteristics and types of solid waste

CO2 : Deep knowledge of disposal of solid waste.

CO3 : Knowledge for the protection of environment through effective waste management techniques.

CO4 : To impart knowledge to reduce and reuse of solid waste and understanding of green techniques for solid waste disposal

CO5 : Legislation and policies in solid waste management

EVS-507 (Biodiversity and Conservation)

CO1 : In-depth knowledge about the biodiversity at national and global level

CO2 : In-depth knowledge and critical understanding of the theory and principles of biodiversity

CO3 : In-depth knowledge about the agricultural development and biodiversity i.e., Agro-biodiversity

CO4 : To know about the threats to biological diversity and Approaches for conservation of biodiversity at all levels.

CO5 : The students will learn about the National and international

conventions, policies, acts and laws to conservation biodiversity

EVS-508 (Global climate Change and Agriculture)

CO1 : Students will be able to Evaluate the role of Remedial Measures in Combating Global Warming and Climate Change

CO2 : . Students will be able to Evaluate contribution of Green Houses Gases in Global warming and thereby bringing Change in Climate.

CO3 : Students will Analyse the impact of Global Warming and Climate Change on growth, productivity and quality of different crops (on Agriculture)

CO4 : Students will Analyse the impact of Global Dimming on growth, productivity and quality of different crops (on Agriculture)

CO5 : Students will be able to Evaluate Various Policies related to Climate Change mitigation Strategies and Create a knowledge base for Global and National Action

EVS-511 (Environmental Monitoring Systems and Impact Assessment)

CO1 : Students will be able to learn about the various types of environmental Impacts due to developmental activities.

CO2 : Students will be able to know the various methods of Environmental Impacts Assessment(EIA)

CO3 : Students will be able to learn about the Environmental Impacts Assessment(EIA) in developed countries

CO4 : Students will learn about the Criteria for evaluating environment related projects and status of EIA in India.

CO5 : Students will Analyse the role of World trade on EIA (case study)

EVS-513 (Agroforestry)

CO1 : To impart knowledge to the students about a broad outline of Agroforestry

CO2 : To Know about the models for various land use systems in Agroforestry.

CO3 : To understand the principle of Agroecology and Agroforestry systems in relation to environment.

CO4 : To learn the about the conversion of organic movements for crop rotation, crop diversity and to enhance soil health, a scope of global and national needs for Agroforestry with its practices

CO5 : To understand the economics of Agroforestry systems

EVS-591 (Master's Seminar Outcomes)

CO1	:	To test the communication skills. The communication skill test includes both written and oral communication.
CO2	:	To test the technical skills.
CO3	:	The research skill is tested by the student's ability to study the given topic and arrive at potential research topics.
CO4	:	Help to identify own strengths and develop areas for growth
CO5	:	Seminars provide a chance to interact with experts from the specific field.

EVS-599 (Master's Research Outcomes)

CO1	:	Through Dissertation, student can identify a particular environmental problem
CO2	:	Students will review the literature for finding the gaps.
CO3	:	Students will develop a research methodology, collect data and carry out data analysis and interpretation for finding a suitable solution.
CO4	:	They will acquire the ability to write the research findings in the form of structured thesis
CO5	:	They will be able to communicate the research results through oral or poster presentations.

Supporting and Non-Gradial (PGS) subjects

STAT 511 Statistical Methods for Applied Sciences.

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom

CO4 : Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data

CO5 : Learning about the bioassays- direct and indirect

STAT 512 Sampling Techniques

CO1 : Conceptual understanding of sampling techniques such as simple random sampling, stratified sampling, cluster sampling, and multi-stage sampling

CO2 : Proficiency in determining sample sizes for different sampling methods, considering factors such as population size and variability

CO3 : Application of sampling methods such as sampling for proportions, inverse sampling, systematic sampling, and PPS sampling

CO4 : Use of auxiliary information at estimation, ratio product and regression estimators.

CO5 : Identify and evaluate sampling errors, including both sampling and non-sampling errors

PGS501 Library and Information Services

CO1 : Study the history of Library and information science

CO2 : Study and understand management of Libraries and information centres

CO3 : Study information sources and services

CO4 : Study and understand the basics of Information technology and Library Automation

CO5 : Study the ICT applications in Libraries and information centres

PGS502 Technical Writing and Communications Skills

CO1 : Development of the skills to write dissertations, research papers, etc.

CO2 : Induce the capacity and skills to write technical papers, reviews, manuals, etc.

CO3	:	Train the learners to write the abstracts, summaries, précis, citations, etc.
CO4	:	Learners shall gain the knowledge about communication skills
CO5	:	Enable the students to participate in group discussion, facing interview and presentation of scientific papers

PGS503 Intellectual Property and its Management in Agriculture

CO1	:	Understanding the basic concepts of Intellectual Property Rights
CO2	:	Understand the necessity of patents, copyright, trademark, GI
CO3	:	Development of design or some innovation for patent application
CO4	:	Acquire the knowledge about the rights related to Intellectual Property Rights
CO5	:	Learners shall know about the Protection of Plant Variety and Farmers Rights Act

PGS504 Basic Concepts in Laboratory Techniques

CO1	:	To acquaint the students about the basics of commonly used techniques in laboratory
CO2	:	Gained knowledge on Safety measures, use and handling of laboratory equipment and chemical reagents while working in laboratory
CO3	:	Gained insights on soil, water and plant analysis for various parameters and biomolecule contents.
CO4	:	Development of capability to interpret the data and generate recommendations
CO5	:	Acquire knowledge on botanical terms in relation to taxonomy

PGS505 Agriculture Research, Research Ethics and Rural Development Programmes

CO1	:	Learn about the Indian Agriculture Research system and Global agriculture research system
CO2	:	Understand the rural development status and programmes in India
CO3	:	Learn about knowledge of agriculture research ethics
CO4	:	Extend their knowledge of history of agriculture, historical stages of development of agriculture
CO5	:	Understand about Panchayati raj institutions, voluntary agencies/non-government organizations

PGS 506 Disaster Management

CO1	:	To collect knowledge about different types of Natural Disasters and its solutions
CO2	:	To collect knowledge about Man Made Disasters and its solutions
CO3	:	Analysis of Disaster and its management on the global level
CO4	:	Development of International Strategy for Disaster reduction
CO5	:	Analysis of role or govt and non govt organizations in the management of disaster

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Agronomy Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
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PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

AGRON 501 (Modern Concepts in Crop Production)

CO1 : Analysis the crop growth agro-ecological zones of India.

CO2 : Study of different quantitative approaches and laws of crop production

CO3 : optimizing different plant patterns and resources for effective environment and sustainability

CO4 : To understand the principles of crop production

CO5 : Application of balanced approach of nutrient management

AGRON 502 (Principles and practices of Soil fertility & Nutrient Management)

CO1 : To identify the factor this will be responsible for positive and negative impact on soil fertility and productivity

CO2 : To understand essential plant nutrient and their function for crop production

CO3 : Application or preparation of different type of compost and its impact on crop production

CO4 : Analysis of different parameters related to the nutrient management of fertilizer

CO5 : Adaptation or functional knowledge about different method of fertilizer application

AGRON 503 (Principles and practices of weed management)

CO1 : To identify weed and their management.

CO2 : Functional knowledge about herbicide for effective weed management.

CO3 : To increase the knowledge about the trait of herbicide

CO4 : Analysis of different approaches of weed control for crop production

CO5 : To increase the awareness about resent advances of weed management for long life learning

AGRON 504 (Principles and Practices of Water Management)

CO1 : To analyses the quality of irrigation water and resources

CO2 : To acquire the knowledge of different recommended plant relationship

CO3 : To the adaptation of different irrigation scheduling and methods

CO4 : Calculation or analytical approach of water use efficiency under quality parameters.

CO5 : To construct ideologies pertaining to water management in problem soils

AGRON 511 (Cropping System & Sustainable Agriculture)

CO1 : To gain knowledge as well as develop eco-friendly farming system models.

CO2 : Analysis the mechanism of different cropping systems

CO3 : Application of low cost technologies for sustainability

CO4 : Role of elements to maintain the ecosystems under Crop diversification

CO5 : Plant ideotypes for effective cropping.

AGRON 512 (Dry land farming and watershed management)

CO1 : To know about the dryland farming and rainfed agriculture.

CO2 : To increase the knowledge about drought and its impact on crop production.

CO3 : To increase the knowledge about contingent plan/ farming under rainfed agriculture

CO4 : Analysis of the impact tillage and cultural practices on crop production under rainfed areas

CO5 : To know about watershed management and its usefulness under rainfed condition.

AGRON 513 (Principles and practices of organic Farming)

CO1 : To clear the concept and thinking about organic farming

CO2 : To increase the awareness of organic elements to increase soil fertility

CO3 : Adaptation of different farming system along with soil productivity

CO4 : Functional knowledge of different approaches of weed control

CO5 : Impact of social and economical aspects of organic farming

Minor Subjects

SOILS 505 (Soil erosion & conservation)

CO1 : Forms of soil erosion, its effects and different factors affecting

CO2 : Wind erosion its types, mechanism, factors affecting and extent of problem in the country

CO3 : To learn about agronomical and engineering aspects of erosion control structures

CO4 : Soil conservation planning and land capability classification in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands

CO5 : Water harvesting and recycling; flood control in watershed management and its socioeconomic aspects

SOILS 506 (Soil Biology and Biochemistry)

CO1 : To understand the soil biota, soil microbial-ecology and types of organisms in different soils of India

CO2 : Course gives the knowledge of microbiology and biochemistry of root-soil interface

CO3	:	Soil enzymes, origin, activities and importance and their effect on growth and activity of microflora
CO4	:	The students will acquire good knowledge of preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost and their chemical composition
CO5	:	Biological indicators of soil quality, bioremediation of contaminated soils and microbial transformations of heavy metals in cultivated soil

SOILS 513 (Soil Survey & Land Use Planning)

CO1	:	Understanding Soil survey its types and techniques
CO2	:	To gain knowledge about RS and GIS in soil survey and mapping of major soil group of India
CO3	:	Land Resources Information System
CO4	:	To learn about land capability classification and constraints in its application
CO5	:	Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production

STAT502 (Statistical Methods for Applied Sciences)

CO1	:	Exposure of students to the classification, tabulation, graphical representation of data and theory of probability
CO2	:	Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory
CO3	:	Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients
CO4	:	Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks
CO5	:	Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1	:	Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments
CO2	:	Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD
CO3	:	Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom
CO4	:	Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data
CO5	:	Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. M.Sc. (Hort.) Vegetable Science Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

VSC 501 (Production Technology of cool season Vegetable Crops)

CO1 : Appreciate the scope and scenario of cool season vegetable crops in India

CO2 : Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops

CO3 : Calculate the economics of vegetable production in India

CO4 : Production technology for vegetable legume crops with post-harvest handling and Hi-tech cultivation practices

CO5 : Gain in techniques of the management of leafy vegetables that further enhance productivity and skill development

VSC 502 (Production of warm season Vegetable Crops)

CO1 : Understand scope, scenario and production technology for solanaceous (fruit vegetable) crops with PHM and Hi- Tech Cultivation practices

CO2 : Insight of Production technology for vegetable legume crops with PHM and Hi- Tech Cultivation practices

CO3 : Acquire knowledge about the package and practices for cucurbitaceous crops with post-harvest handling and processing

CO4 : Understanding the production technology for Tuber Crops with PHM and Hi- Tech Cultivation practices with its economics

CO5 : Gain in technique of the management of leafy vegetables that further enhance productivity and skill development

VSC 504 (Principles of vegetable breeding)

CO1 : Understanding the fundamental concepts of vegetable breeding and learning approaches of evolving new varieties that contributing to food security and nutrition crops in India

CO2 : Understanding of yield improvement techniques along with genetic and nutria diversity learning contribute to more sustainable and resilient food system

CO3 : To understand the basic knowledge and its application of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development

CO4 : Better understanding of new varieties, crop productivity , quality and resilience to meet the demands of farmers and consumer ensuring sustainable practices

CO5 : Sensitize the learners about the basic knowledge and principles of biotech approaches and molecular techniques in vegetable improvement to make profitable agricultural system

VSC 503 (Growth and Development of Vegetable crops)

CO1 : Acquire knowledge of growth analysis and physiology of Phyto-hormones

CO2 : Better understanding of Physiology of dormancy and germination in vegetable crop production

CO3 : Understanding the integrated practical knowledge for affect of abiotic factors on flowering and sex expression in vegetable crops

CO4 : Analytical approaches for understanding the physiology of growth and development in vegetable crops

CO5 : Morphogenesis and tissue culture techniques in vegetable crops for skill development and employment generation

VSC 507 (Protected cultivation of vegetable crops)

CO1 : Understanding the principles and sustainable practices in protected cultivation and efficient soilless plant cultivation

CO2 : Students master techniques for managing the environmental factors and develop skill in nursery management within protected structures

CO3 : Gaining practical skills of cultivation of crops tailored for protected structures to maximize yield and quality

CO4 : Developing knowledge and proficiency in INM to minimize pesticide use and surveillance techniques specific to protected cultivation systems

CO5 : Acquiring proficiency of greenhouse operations and agricultural business and resource allocation to maximize profitability

VSC 509 (Production of underutilized vegetable crops)

CO1 : Better understanding of improved technology and understanding of stem and bulb crops that contribute to food security, income generation and overall agricultural sustainability

CO2 : Better understanding of improved technology and understanding of Cole and salad crops that contribute to food security, income generation and overall agricultural sustainability

CO3 : Better understanding of improved technology and understanding of leafy vegetables that contribute to food security, income generation and overall agricultural sustainability

CO4 : Better understanding of improved technology and understanding of cucurbitaceous crops that contribute to food security, income generation and overall agricultural sustainability

CO5 : Better understanding of improved technology and understanding of yam and bean crops that contribute to food security, income generation and overall agricultural sustainability

VSC 514 (Post-harvest management of vegetable crops)

CO1 : To equip students with the skills and knowledge necessary for effective handling and management of vegetables after harvest

CO2 : To understand the implementation of strategies to minimize losses during

harvesting and transportation of post-harvest losses in vegetable production

CO3 : Encompass understanding of quality grading and sorting techniques to develop skills in managing packing house operations efficiently

CO4 : Understanding the skills to implement integrated disease management strategies to minimize post harvest losses and ensure food safety and quality

CO5 : Acquiring skills in selecting the most appropriate storage method and mastering techniques to maintain optimal storage condition to extend the shelf life and preserve quality

Minor Subjects

FSC 501 (Tropical Fruit Production)

CO1 : Understanding of more resilient and productive cultivation with better economic return practices

CO2 : Better conservation of different traits by adopting the hi-tech propagation techniques that contribute to future generation of plants

CO3 : Expansion of lifespan of fruit plants, improve quality traits leading to orchard health and profitability

CO4 : To gain knowledge of pre harvest management value chain optimizing the fruit yield, quality, market value and ultimately good services reached to consumer level

CO5 : Aware about the management practices for quality improvement and market linkages of tropical fruit crops for skill development and employment generation

FSC 503 (Propagation and Nursery management for fruit crops)

CO1 : To ensure the successful propagation and quality of fruit crops ultimately impacting fruit yield and crop success

CO2 : To maintain the desired traits along with rapid propagation and provide specific skills and resources that increase the plant protection measures

CO3 : By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability

CO4 : Micro propagation and micro grafting offers practical benefits in pomology by providing a reliable and efficient means of producing high quality planting material with desirable traits

CO5 : Learning about nursery management practices and regulations for skill development and employment generation

FSC 506 (Canopy Management in Fruit Crops)

CO1 : By the approach of canopy management techniques improve the fruit quality that ensure the marketability and profitability

CO2	:	Better management techniques of fruit crops reduces the infestation of insect pest and diseases
CO3	:	Leveraging geometry and LUT in canopy management result in improved quality, enhanced efficiency and potentially increase profitability
CO4	:	By the application of precise plant growth regulators in fruit crops optimize the performance of fruit crop and profitability
CO5	:	Analytical approach to understand canopy development and management for entrepreneurship skill development

STAT502 (Statistical Methods for Applied Sciences)

CO1	:	Exposure of students to the classification, tabulation, graphical representation of data and theory of probability
CO2	:	Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory
CO3	:	Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients
CO4	:	Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks
CO5	:	Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1	:	Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments
CO2	:	Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD
CO3	:	Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom
CO4	:	Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data
CO5	:	Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Fruit Science Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Comprehensive understanding of scientific principles of Fruit Science and allied systems

PSO2 : Development of the ability to identify problems of fruit crops and ensure empowerment for techno-economic solutions.

PSO3 : Demonstration of proficiency in utilizing modern horticultural technologies and tools to enhance efficiency in utilizing resources and increasing productivity with sustainability in horticulture system particularly fruit crops as well as taking care of environmental and global nutritional security

PSO4 : Infusion of entrepreneurial skills with adherence to ethical standards and professionalism for job opportunities in various sectors

Course Outcomes (COs)

Major Subjects

FSC 501 (Tropical and Dry Land Fruit Production)

CO1 : Students will be able to develop the skills on different practices involved in cultivation and management of different tropical and dry land fruits crops.

CO2 : Students will be able to identify the suitable commercial varieties of regional, national and international importance including export potential varieties.

CO3 : Students will be able to identify the biotic and abiotic factors limiting fruit production in tropical and dryland regions.

CO4 : Students gain knowledge about various management practices to improve fruit quality including maturity index, harvesting, grading, packing, storage and ripening techniques.

CO5 : Acquaint the students with plan for mega food parks and development of instructional fruit orchard with hi-tech interventions.

FSC 502 (Subtropical and Temperate Fruit Production)

CO1 : To impart basic Knowledge about the importance and management of Subtropical and Temperate fruits grown in India

CO2 : Understanding export potential, Agri Export Zones and industrial support, problems and prospects in Sub Tropical and Temperate fruit crops.

CO3 : Students able for plant multiplication including in vitro techniques and nursery management

CO4 : Students understand the basic knowledge of recent trends in Planting System, Crop management and Canopy management, physiological disorders and biotic and abiotic factors limiting fruit production

CO5 : Comprehensive understanding of Post harvest handling including primary processing, precooling, grading, packaging, storage and transportation techniques.

FSC 503 (Biodiversity and Conservation of Fruit Crops)

CO1 : Students will be acquainted with understanding of biodiversity, center of origin of cultivated fruit crops including maintenance of PGR diversity.

CO2 : Students will learn about biodiversity, conservation issues and exploitation of the biological diversity through crop management in in-situ and exist.

CO3 : Students will be acquainted with the Intellectual property rights,

regulatory horticulture and PPFVR in fruit crops

CO4 : Students will learn the importance of biodiversity of fruit crops in the breeding program and conservation of crops in in-situ and ex-situ.

CO5 : Students will learn the importance of GIS and documentation of local biodiversity, Geographical Indication, GI Tag.

FSC 505 (Propagation and Nursery management of fruit crops)

CO1 : Students understand the principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

CO2 : Students develop skills in germination test, viability test, vigor test ,moist. test, genetic and physical purity test, I.D. test and health.

CO3 : Students develop skills in multiplication of plants through sexual and asexual means with rapid propagation techniques to produce genuine and true-to-type planting material.

CO4 : Students develop skills in multiplication of plants through micro propagation and micro grafting

CO5 : Students learn about the nursery management practices and regulations for skill development and employment generation.

FSC 504 (Canopy Management in Fruit Crops)

CO1 : Students learn importance and advantages; factors affecting canopy development.

CO2 : Students gain knowledge about the different structures of canopy and importance of light interceptions (PAR) in canopies of fruit crops.

CO3 : Students will be acquainted with the knowledge of Spacing and utilization of land area through management of canopy.

CO4 : Students will learn Canopy management through PGR, training & pruning and management root and shoot system.

CO5 : Canopy development and management of quality fruit in temperate fruit crops.

FSC 506 (Breeding of Fruit Crops)

CO1 : Students understand the origin, distribution and taxonomical status of species and cultivars of fruit crops.

CO2 : Students able to acquainted with floral biology and breeding objectives of fruit crops.

CO3 : Students gain knowledge about crop improvement through conventional and modern methods and improvement of quality traits.

CO4 : Students gain knowledge about resistance breeding for biotic and abiotic stresses including biotechnological interventions.

CO5 : Students gain knowledge about achievements and future thrust.

FSC 508 (Growth and Development of Horticultural Crops)

CO1	:	Understanding the parameters of growth and development, growth dynamics and morphogenesis.
CO2	:	Knowledge about environmental impact on growth and development of horticultural crops, photosynthesis and photoperiodism, vernalization and hermaphrodism.
CO3	:	Learning about the influence of water and mineral nutrition on growth and development and biosynthesis of plant growth regulators.
CO4	:	Knowledge about developmental physiology and biochemistry during growth and development phases of horticultural crops
CO5	:	Acquaint the students with growth and developmental process during stress including manipulation of growth and development and their impact.

FSC 505 (Propagation and Nursery management of fruit crops)

CO1	:	Students understand the principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.
CO2	:	Students develop skills in germination test, viability test, vigour test ,moist test, genetic and physical purity test, I.D. test and health.
CO3	:	Students develop skills in multiplication of plants through sexual and asexual means with rapid propagation techniques to produce genuine and true-to-type planting material.
CO4	:	Students develop skills in multiplication of plants through micro propagation and micro grafting
CO5	:	Students learn about the nursery management practices and regulations for skill development and employment generation.

STAT502 (Statistical Methods for Applied Sciences)

CO1	:	Exposure of students to the classification, tabulation, graphical representation of data and theory of probability
CO2	:	Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory
CO3	:	Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients
CO4	:	Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks
CO5	:	Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1	:	Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2	:	Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD
CO3	:	Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom
CO4	:	Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data
CO5	:	Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Plantation, Spices, Medicinal and Aromatic Plants Science Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

PSMA 501 (Production of Plantation Crops)

CO1	:	To impart the basic and applied knowledge on various aspects of production technology.
CO2	:	To impart basic knowledge of role of plantation crops in national economy and clean development mechanism as well as carbon sequestration potential.
CO3	:	Understanding of export potential, problems and prospects and IPR issues in plantation crops
CO4	:	To know the role of commodity boards and directorates in the development programmes.
CO5	:	Entrepreneurship skill development in plantation crop industry for plant multiplication including in vitro and nursery techniques of plantation crops

PSMA 502 (Production of Spice Crops)

CO1	:	To impart theoretical as well as hands-on experience to the learner on scientific production technology of various spice crops
CO2	:	Understand the role of spices in employment generation, Value addition and Marketing of value added products.
CO3	:	Be able to post harvest management including primary processing, grading, packaging and storage, GMP in major spice crops.
CO4	:	To know about the quality control, pharmaceutical significance and protected cultivation of spices.
CO5	:	To impart comprehensive knowledge of propagation and nursery management of major spices.

PSMA 503 (Production of Medicinal and Aromatic Crops)

CO1	:	To impart comprehensive knowledge about theoretical as well as hands-on experience on commercial cultivation of MAPs in Indian perspectives
CO2	:	To develop the technical skill to start medicinal and aromatic crop-based enterprises.
CO3	:	Understand the enriched herbal formulations for the healthcare system, quality seeds and planting materials and co products of MAP waste to boost economy.
CO4	:	To get exposure on botany, classification, harvesting and post-harvest management in MAPs.
CO5	:	Understands the role of institutions, Medicinal Plant Board and NGOs in research and development of MAPs.

PSMA 504 (Breeding of Plantation Crops and Spices)

CO1	:	To impart comprehensive knowledge on the theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods and breeding achievements in various plantation and spice crops.
CO2	:	Understanding the fundamental concepts of molecular breeding and biotechnological approaches for climate resilience Crops.
CO3	:	Thoughtful of yield improvement techniques along with biotic and abiotic factors in plantation and spices.
CO4	:	To understand the basic knowledge and its application of hybrid seed production techniques for improving yield and quality traits that contribute in entrepreneurship skill development.
CO5	:	Be able to start plantation and spice crop-based seed production/ nursery centres

PSMA 505 (Breeding of Medicinal and Aromatic Crops)

CO1	:	To impart comprehensive knowledge on the technical skill in breeding of medicinal and aromatic plants.
CO2	:	Better understanding of plant bio-diversity, conservation of germplasm and IPR issues.
CO3	:	Be able to start medicinal and aromatic crop-based seed production/ nursery centres to make profitable horticultural system.
CO4	:	To impart the current approaches for improvement of quality traits, resistance breeding for biotic and abiotic stresses with the help of biotechnological tools.
CO5	:	To know about the breeding achievements in terms of released varieties, parentage and salient features.

PSMA 509 (Growth and Development of Plantation, Spice, Medicinal and Aromatic Crops)

CO1	:	To impart comprehensive knowledge on the growth, developmental stages and crop regulation to increase the productivity in PSMAs
CO2	:	To facilitate deeper understanding on growth, development, assimilate partitioning and plant bio regulators in PSMAs.
CO3	:	To know about the canopy management for conventional and high density planting pruning and training in PSMAs.
CO4	:	Understanding the developmental physiology and biochemistry during dormancy, bud break and juvenility in PSMAs.
CO5	:	Understanding the physiology of flowering and stress hormones in PSMAs.

PSMA 511 (Biodiversity and Conservation of Plantation, Spices Medicinal and Aromatic Crops)

CO1	:	Understanding on biodiversity and conservation with molecular levels

also GIS in biodiversity mapping of PSMAs.

CO2 : Impart comprehensive knowledge of exploration and germplasm collection, conservation and evaluation in PSMAs.

CO3 : To know about proper documentation and cataloguing of collections, conservation and evaluation of germplasms in PSMAs

CO4 : To be well aware about concepts of rarity, threat, endangerment and extinction in major PSMAs.

CO5 : To impart comprehensive knowledge of genetic resources management and bio diversity concerns at National and international levels.

FSC 506 (Canopy Management in Fruit Crops)

CO1 : To impart basic knowledge about the principle and practices in canopy management of fruit crops

CO2 : Special emphasis on geometry of planting, canopy manipulation for optimum utilization of light

CO3 : To provide basic knowledge of about canopy management through plant growth inhibitors, training and pruning and management practices

CO4 : To facilitate understanding about spacing and utilization of land area, canopy classification, management through rootstock and scion

CO5 : Comprehensive understanding of canopy development and management in relation to growth, flowering, fruiting and fruit quality of fruit crops

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and

partitioning of degrees of freedom

CO4 : Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data

CO5 : Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Hort.) Floriculture and Landscape Architecture Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity- centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

FLS 501 (Systematic of Ornamental Plants)

CO1 : To impart comprehensive knowledge on history, origin, hotspots, classification and nomenclature systems

CO2 : The student will be able to understand the fundamental concepts International code, identification features, descriptors, red book, registration with NBPGR, PPVFRA

CO3 : To impart comprehensive knowledge on the theoretical as well as hands-on experience to the learner on reproductive biology in ornamental plants

CO4 : Thoughtful of constraints and achievements made in systematics of ornamental plants

CO5 : The student will be able to understand the basic knowledge of biotechnology and use of molecular techniques in systematics of ornamental crops in entrepreneurship skill development

FLS 502 (Breeding of Ornamental crops)

CO1 : To impart comprehensive knowledge on the evolution of varieties, origin, distribution, genetic resources of ornamental crops. Understanding the fundamental concept of IPR and plant breeder right

CO2 : The student will be able to understand the fundamental concepts of genetic inheritance of different traits of ornamental crops

CO3 : To impart comprehensive knowledge on the theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods in ornamental crops

CO4 : Thoughtful of breeding constraints and achievements made in ornamental crops

CO5 : The student will be able to understand the basic knowledge of biotechnology and its role for improving yield and quality traits of ornamental crops that contribute in entrepreneurship skill development

FLS 503 (COMMERCIAL PRODUCTION OF CUT FLOWERS)

CO1 : The students will be able to understand the national and international scenario of cut flower production, varietal wealth and nursery management practices

CO2 : The student will have knowledge on advanced production technologies in growing cut flower crops.

CO3 : The students will be able to diagnose production problems in cut flowers.

CO4 : The students will become capable of managing a floriculture unit for year round flowering

CO5 : The students will have knowledge on harvest indices, harvesting techniques, post-harvest handling, marketing and export potential cut flowers

FLS 504 (Commercial Production of loose flowers)

CO1	:	To understand the national and international scenario of loose flower production, varietal wealth and nursery management practices
CO2	:	The student will have knowledge on advanced production technologies in growing loose flower crops
CO3	:	The students will be able to diagnose production problems in loose flowers.
CO4	:	The students will become capable of managing a floriculture unit for year round flowering.
CO5	:	The students will have knowledge on harvest indices, harvesting techniques, post-harvest handling, marketing and export potential of loose flowers

FLS 505 (Ornamental gardening and landscaping)

CO1	:	The students will be able to understand the different style and types of garden
CO2	:	The students will be able to understand the different components, bio-aesthetic planning, eco-tourism, theme parks, indoor gardening and therapeutic gardening
CO3	:	Students will gain skill in preparation, establishment and maintenance of special types of gardens
CO4	:	The student will have knowledge on fundamental principles of garden, drawing skill and steps in preparation of garden design
CO5	:	The students will become capable of designing and execution of landscape project for different specific situations and prepare the cost economics

FLS 506 (Indoor Plants and Interior scaping)

CO1	:	The student will be able to understand the role of indoor plants in national and global scenario and know how women empowerment possible through interior scaping.
CO2	:	The students must be able to understand the classification indoor plants.
CO3	:	Students will gain skill in interior scaping
CO4	:	Will gain skill and proficiency in production of indoor plants.
CO5	:	Students will gain skill in making of special garden, vertical gardens and their marketing

FLS 509 (Value addition in floriculture)

CO1	:	The student will be able to understand the role of value addition in flowers in national and global scenario and know how women empowerment possible through value added products making.
CO2	:	The students must be able to demonstrate important value addition processes in flower crops.
CO3	:	Students will gain skill in production of floral crafts, dry flower making and

proficiency in floral arrangements

CO4 : Students will gain skill in extraction of pigments and nutraceuticals, and also understand with significance of natural pigments as nutraceuticals

CO5 : Students will gain skill in extraction of concrete and essential oils, and also understand with aromatherapy, synthetic and natural dyes.

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom

CO4 : Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data

CO5 : Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Soil Science Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-cantered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

SOIL 501 (Soil Physics)

CO1	:	Fundamental of physical Characterization of different soils
CO2	:	Physical properties of soil and alleviation of soil physical constraints for crop production
CO3	:	Soil water dynamics: Retention, Flow regimes and plant availability
CO4	:	Soil atmosphere interactions: Composition, Gas exchange and plant health management
CO5	:	To learn about soil thermal properties and their influence on plant growth and development

SOIL 502 (Soil Fertility and Fertilizer use)

CO1	:	To identify the deficiency and functions of essential plant nutrients, dynamics and their management
CO2	:	To understand about macro and micro nutrient availability their role in soil plant system
CO3	:	STCR method for fertilizer recommendations and improving fertilizer use efficiency
CO4	:	Soil fertility evaluation methods in relation to sustainable agriculture
CO5	:	To understand and improve soil health and soil quality

SOIL 503 (Soil chemistry)

CO1	:	Introduction about composition of the earth's crust and thermodynamics equilibrium
CO2	:	Classification and properties of soil colloids
CO3	:	To understand the ion exchange processes in soil
CO4	:	Potassium, phosphate and ammonium fixation in soils and their management aspects
CO5	:	Chemistry of Problematic soil and their management

SOIL 504 (Soil Mineralogy, Genesis, Classification)

CO1	:	Introduction of crystallography including isomorphism and polymorphism
CO2	:	To know about classification and chemical composition of clay minerals and its impact in plant nutrition
CO3	:	Pedogenic processes of soil formation special reference to Indian soils
CO4	:	To acquire the knowledge of modern systems of soil classification with special emphasis on soil taxonomy
CO5	:	To increase the knowledge about soil mineralogy and soil maps through latest software – usefulness

SOIL 505 (Soil erosion & conservation)

CO1	:	Forms of soil erosion, its effects and different factors affecting
CO2	:	Wind erosion its types, mechanism, factors affecting and extent of problem in the country
CO3	:	To learn about agronomical and engineering aspects of erosion control structures
CO4	:	Soil conservation planning and land capability classification in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands
CO5	:	Water harvesting and recycling; flood control in watershed management and its socioeconomic aspects

SOIL 506 (Soil Biology and Biochemistry)

CO1	:	To understand the soil biota, soil microbial-ecology and types of organisms in different soils of India
CO2	:	Course gives the knowledge of microbiology and biochemistry of root-soil interface
CO3	:	Soil enzymes, origin, activities and importance and their effect on growth and activity of microflora
CO4	:	The students will acquire good knowledge of preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost and their chemical composition
CO5	:	Biological indicators of soil quality, bioremediation of contaminated soils and microbial transformations of heavy metals in cultivated soil

SOIL 513 (Soil Survey & Land Use Planning)

CO1	:	Understanding Soil survey its types and techniques
CO2	:	To gain knowledge about RS and GIS in soil survey and mapping of major soil group of India
CO3	:	Land Resources Information System
CO4	:	To learn about land capability classification and constraints in its application
CO5	:	Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production

Minor Subjects

AGRON 502 (Principles and practices of Soil fertility & Nutrient Management)

CO1	:	To identify the factor this will be responsible for positive and negative impact on soil fertility and productivity
CO2	:	To understand essential plant nutrient and their function for crop production

CO3	:	Application or preparation of different type of compost and its impact on crop production
CO4	:	Analysis of different parameters related to the nutrient management of fertilizer
CO5	:	Adaptation or functional knowledge about different method of fertilizer application

AGRON 504 (Principles and Practices of Water Management)

CO1	:	To analyses the quality of irrigation water and resources
CO2	:	To acquire the knowledge of different recommended plant relationship
CO3	:	To the adaptation of different irrigation scheduling and methods
CO4	:	Calculation or analytical approach of water use efficiency under quality parameters.
CO5	:	To construct ideologies pertaining to water management in problem soils

AGRON 512 (Dry land farming and watershed management)

CO1	:	To know about the dryland farming and rainfed agriculture.
CO2	:	To increase the knowledge about drought and its impact on crop production.
CO3	:	To increase the knowledge about contingent plan/ farming under rainfed agriculture
CO4	:	Analysis of the impact tillage and cultural practices on crop production under rainfed areas
CO5	:	To know about watershed management and its usefulness under rainfed condition.

AGRON 513 (Principles and practices of organic Farming)

CO1	:	To clear the concept and thinking about organic farming
CO2	:	To increase the awareness of organic elements to increase soil fertility
CO3	:	Adaptation of different farming system along with soil productivity
CO4	:	Functional knowledge of different approaches of weed control
CO5	:	Impact of social and economical aspects of organic farming

STAT502 (Statistical Methods for Applied Sciences)

CO1	:	Exposure of students to the classification, tabulation, graphical representation of data and theory of probability
CO2	:	Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory
CO3	:	Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients
CO4	:	Learning about the non-parametric tests – sign, Wilcoxon, Mann-

Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom

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CO5 : Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Genetics and Plant Breeding Programme – Restructured Syllabus

Programme Outcomes (POs)

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Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

GPB 501 (Principles of Genetics)

CO1 : Mendelian genetics and its extensions.

CO2 : Population genetics.

CO3 : Genetics at DNA and molecular level.

CO4 : Gene: Isolation, cloning, sequencing and its modification.

CO5 : Study of omics and transgenics.

GPB 502 (Principles of Plant Breeding)

CO1 : Pre & Post Mendelian era; Plant Introduction & Role of PGR in PB

CO2 : Genetic basis of Self-pollinated and Cross-pollinated crops.

CO3 : SI and Male sterility and their commercial exploitation

CO4 : Special breeding techniques.

CO5 : Varietal development with plant breeders' rights & plant variety protection and farmers rights.

GPB 503 (Fundamentals of Quantitative of Genetics)

CO1 : Study of quantitative inheritance, analysis and variability parameters.

CO2 : Designs, Principles and application of plant breeding experiments.

CO3 : Assessment of polygenic variation and determination of yield components.

CO4 : Study of gene action assessment of varietal adaptation.

CO5 : QTL mapping and MAS.

GPB 504 (Varietal Development and Maintenance Breeding)

CO1 : Definition, variety testing, release and notification system in India and abroad.

CO2 : DUS testing, factor responsible for genetic deterioration of varieties during seed production.

CO3 : Maintenance of varieties and generation system of seed multiplication.

CO4 : Quality seed production technology of self and cross-pollinated crop varieties.

CO5 : Seed certification, laws and PPV & FR act in India and abroad.

GPB 505 (Principles of Cytogenetics)

CO1 : Structure variation of chromosomes, types and its evolutionary significance.

CO2 : Numerical variations of chromosomes,& its evolutionary significance

CO3 : Fertilization barriers in crop plants, role of polyploids

CO4 : Interspecific hybridization and synthesis of new crops.

CO5 : Chromosome manipulation; & its production

GPB 506 (Molecular Breeding and Bioinformatics)

CO1 : Study of genotyping of markers, mapping population and its statistical analysis.

CO2 : Study of allele mining, MAS, gene pyramiding and QTLs analysis in crop plant

CO3 : Comparative genomics, proteomics and nanotechnology application in crop improvement.

CO4 : Recombinant-DNA technology, production of transgenic plants and application of tissue culture in molecular breeding.

CO5 : GMOs, IPR and bioinformatics in crop improvements.

GPB 510 (Seed Production and Certification)

CO1 : Principles of seed production and factor responsible for genetic deteriorations.

CO2 : Seed production and hybrid seed production of nucleus, breeder, foundation, certified and its maintenance.

CO3 : Floral structure, pollination mechanism and seed production techniques in self-pollinated crops.

CO4 : Floral structure, pollination mechanism and seed production techniques in cross-pollinated crops.

CO5 : Procedure, standards and programs of seed certification.

GPB 516 (Breeding for stress Resistance and Climate Change)

CO1 : Climate change; Importance of plant breeding with special reference to biotic and biotic stress resistance.

CO2 : Concepts of resistance to insect, pathogen, signal transduction and host-defence mechanism against viruses and bacteria.

CO3 : Genetic mechanisms for biotic and abiotic stress resistance and its classification

CO4 : Genetics and breeding of abiotic stress resistance and utilizing MAS procedures for identifying resistance types in crops.

CO5 : Source of resistance to biotic abiotic factor through wild relatives of crops and transgenic management of biotic abiotic stresses.

Minor Subjects

PL PATH 506 (Techniques in Detection and Diagnosis of Plant Diseases)

CO1 : Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases.

CO2 : Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms .

CO3 : Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens.

CO4 : Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis.

CO5 : Interpret diagnostic test results and make informed decisions regarding disease management strategy.

PL PATH 515 (Diseases of Field and Medicinal Crops)

CO1 : Understanding of the pathogens, etiology, symptomatology, epidemiology and life cycle of disease of cereals and pulses

CO2 : Evaluate and analyze the factors contributing to yield losses quality reduction and marketable issue associated with diseased crops

CO3 : Regulating framework and biosecurity measure aimed at preventing the introduction and spread of diseases in field and medicinal crops

CO4 : Innovation approaches for disease management such as precision agriculture, remote sensing, predictive modeling and genome assisted breeding for disease resistance

CO5 : Knowledge and skills necessary to diagnosis, manage and prevention of diseases to start plant health clinic

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

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CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

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CO4 : Introduction to split plot and strip plot designs, analysis of covariance,

missing plot techniques, transformation of data

CO5 **:** Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Agricultural Extension Education Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
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PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

EXT 501 (Extension Landscape)

CO1 : To introduce the new challenges before extension and how extension is evolving globally

CO2 : To get insight about the communication and innovation studies that are influencing the practice of extension globally

CO3 : Help students to appreciate the process and the impact of extension reforms implemented in India and other countries

CO4 : To aware students about new approaches that are evolving globally in different regions and the policy challenges in managing a pluralistic extension system.

CO5 : To presents the new capacities that are needed by EAS providers to provide a much wider support to farmers

EXT 502 (Applied Behavior Change)

CO1 : To build capacities of students to understand the fundamental psychological processes which guide human behavior

CO2 : To get insight about various psychological or cognitive bases of human behavior that affect it

CO3 : To make aware students about how people learn, make decisions and choices that affect their behavior

CO4 : To develop understanding about attitude and its impact on human behavior

CO5 : To make aware students about Social Judgment, Social Identity and Inter-Group Relations

EXT 503 (Organizational Behavior and Development)

CO1 : To understand the theory and practice relating to the processes of organizational behavior, development and change

CO2 : To develop insight and competence in diagnostic and intervention processes and skills for initiating and facilitating change in organizations.

CO3 : To gain necessary self-insight, skills in facilitation, organizational development (OD) skills, group process and techniques, to become an effective change agents and OD consultants.

CO4 : To understand the behavior of individuals and small groups in organization with special focus on beliefs, attitudes and values, human inference - attribution, self-concept, motivation, active listening, interpersonal communication, conflicts management

CO5 : To make aware students about various simulation used to understand the individual or group in an organization

EXT 504 (Research Methodology in Extension)

CO1 : Get better understanding, knowledge and skills in methods of behavioural

science research.

CO2 : Learn about various statistical packages for social sciences.

CO3 : Selection and formulation of research problem and research articles

CO4 : Learn about presentation of reports, report writing, thesis writing and scientific article writing

CO5 : To provide knowledge and skills in methods of behavioural sciences research and learn the appropriate statistics for data analysis.

EXT 505 (Capacity Development)

CO1 : To understand the concepts of training, capacity building, capacity development .

CO2 : To aware students about human resource development in the context of roles and responsibilities of extension professionals

CO3 : To discuss capacity development- approaches, strategies, needs assessment and methods / tolls

CO4 : To help you devise, organize, implement and evaluate capacity development programmes

CO5 : To understand contemporary realities of HRD and its interface with technology.

EXT 506 (ICTs for Agricultural Extension and Advisory Services)

CO1 : To discuss different ICT initiatives, knowledge management process and application aspects in agriculture

CO2 : To provides knowledge about handling of ICT Tools

CO3 : To orient students on advances in smart/disruptive technologies and data analysis in the field of agricultural extension

CO4 : Hands on experience in navigating ICTs

CO5 : To learn about creating and designing web portals, blogs, and social media pages

EXT 507 (Evaluation and Impact Assessment)

CO1 : To orient students on the importance of evaluation and impact assessment

CO2 : To develop capacities of students regarding evaluation and impact assessment in agricultural extension

CO3 : Students get insight about how to conducting evaluations and impact assessment in social sciences

CO4 : Learn about Environment Impact Assessment (EIA)

CO5 : To upgrade the skill of students about the assessment of impact of various technology in agriculture

Minor Subjects

AEC 502 (Agricultural Production Economics)

CO1 : Concepts of decision making, quantitative tools, and linear programming

CO2 : Formulation of farms and non-farm problems as linear programming models and solutions.

CO3 : Concept of simplex Method, solving profit maximization and cost minimizations problems.

CO4 : Extension of Linear Programming Models.

CO5 : Concepts of game theory

AEC 503 (Agricultural Marketing and Price Analysis)

CO1 : Basics of dynamics of agricultural marketing.

CO2 : Problems in agricultural marketing, market intermediaries and their role, need for regulation

CO3 : Market structure, conduct and performance analysis and integration in market.

CO4 : Introduction to Commodities markets and future trading.

CO5 : Role of Information Technology and Market Intelligence in marketing of agricultural commodities

AEC 507 (Agricultural Finance and Project Management)

CO1 : Knowledge about the principles, procedures, problems and policies relating to financing agricultural firms.

CO2 : Financial Institutions and credit flow to rural/priority sector.

CO3 : Financial decisions, Preparation of financial statements, and assessing the performance of farm/ firm.

CO4 : Identification, preparation, appraisal, financing and implementation of projects.

CO5 : Risks in financing agriculture, and its management strategies and coping mechanism.

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster

analysis, Principal component analysis

STAT512 (Basis Sampling Techniques)

CO1	:	Conceptual understanding of sampling techniques such as simple random sampling, stratified sampling, cluster sampling, and multi-stage sampling
CO2	:	Proficiency in determining sample sizes for different sampling methods, considering factors such as population size and variability
CO3	:	Application of sampling methods such as sampling for proportions, inverse sampling, systematic sampling, and PPS sampling
CO4	:	Use of auxiliary information at estimation, ratio product and regression estimators
CO5	:	Identify and evaluate sampling errors, including both sampling and non-sampling errors

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc.(Ag.) Agricultural Economics Programme – Restructured Syllabus

Programme Outcomes (POs)

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Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

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Course Outcomes (COs)

Major Subjects

AEC 501 (Micro Economic Theory and Applications)

CO1 : Basics of micro economics i.e. Demand & Supply

CO2 : Various types of economic approaches according to consumer choice

CO3 : Consumer behavior in different economic situations and price and demand correlation.

CO4 : Overview of Market: Firms behavior and different market types

CO5 : Concepts of Factor Market i.e. Market structures, components and resource interaction

AEC 502 (Agricultural Production Economics)

CO1 : Concepts of decision making, quantitative tools, and linear programming

CO2 : Formulation of farms and non-farm problems as linear programming models and solutions.

CO3 : Concept of simplex Method, solving profit maximization and cost minimizations problems.

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CO3 : Market structure, conduct and performance analysis and integration in market.

CO4 : Introduction to Commodities markets and future trading.

CO5 : Role of Information Technology and Market Intelligence in marketing of agricultural commodities

AEC 504 (Macro Economics and Policy)

CO1 : Concepts, scopes and principles of macroeconomics from classical to Keynesian theories.

CO2 : Laws and theories about supply, demand, money, labour, wages and prices

CO3 : Model of income determination, Keynesian Multiplier- aggregate spending, and concepts of taxation, transfer payments, foreign spending, balanced budget.

CO4 : Theories of Aggregate Consumption and Investment.

CO5 : Concepts, nature and effect of Inflation and Unemployment

AEC 507 (Agricultural Finance and Project Management)

CO1	:	Knowledge about the principles, procedures, problems and policies relating to financing agricultural firms.
CO2	:	Financial Institutions and credit flow to rural/priority sector.
CO3	:	Financial decisions, Preparation of financial statements, and assessing the performance of farm/ firm.
CO4	:	Identification, preparation, appraisal, financing and implementation of projects.
CO5	:	Risks in financing agriculture, and its management strategies and coping mechanism.

AEC 508 (Linear Programming)

CO1	:	Concepts of decision making, quantitative tools, and linear programming
CO2	:	Formulation of farms and non-farm problems as linear programming models and solutions.
CO3	:	Concept of simplex Method, solving profit maximization and cost minimizations problems.
CO4	:	Extension of Linear Programming Models.
CO5	:	Concepts of game theory

AEC 509 (Research Methodology for Social Sciences)

CO1	:	Importance and scope of research in agricultural economics.
CO2	:	Hypothesis: Framing and Testing
CO3	:	Sampling theory and sampling design
CO4	:	Data collection – assessment of data needs – sources of data collection – discussion of different situations.
CO5	:	Data coding, tabulation, cleaning, Universal procedures for preparation of bibliography – writing of research articles.

Minor Subjects

EXT 501 (Extension Landscape)

CO1	:	To introduce the new challenges before extension and how extension is evolving globally
CO2	:	To get insight about the communication and innovation studies that are influencing the practice of extension globally
CO3	:	Help students to appreciate the process and the impact of extension reforms implemented in India and other countries
CO4	:	To aware students about new approaches that are evolving globally in different regions and the policy challenges in managing a pluralistic extension system.
CO5	:	To presents the new capacities that are needed by EAS providers to provide a much wider support to farmers

EXT 505 (Capacity Development)

CO1	:	To understand the concepts of training, capacity building, capacity development .
CO2	:	To aware students about human resource development in the context of roles and responsibilities of extension professionals
CO3	:	To discuss capacity development- approaches, strategies, needs assessment and methods / tolls
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CO4	:	Use of auxiliary information at estimation, ratio product and regression estimators
CO5	:	Identify and evaluate sampling errors, including both sampling and non-sampling errors

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc.(Ag.) Plant Pathology Programme – Restructured Syllabus

Programme Outcomes (POs)

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Course Outcomes (COs)

Major Subjects

PL PATH 501 (Mycology)

CO1 : Basic understanding about the plant disease causing fungi.

CO2 : Ultra Morphological identification and detection of different orders of fungi.

CO3 : Economic importance of plant pathogenic fungi and its role in various ecosystem.

CO4 : Etiological understanding about the soil, air and seed inhabitant fungi.

CO5 : Integration of conceptual understanding of fungi for the better management.

PL PATH 502 (Plant Virology)

CO1 : Conceptual understanding about the diversity transmission and detection.

CO2 : Symptomatological, Molecular, Serological diagnosis of plant viruses.

CO3 : Understanding about the virus-vector relationship, biology and spread of plant viruses.

CO4 : Economic importance of viral diseases and its role in various ecosystem.

CO5 : Integrating the conceptual understanding about the plant viruses for formulating management option.

PL PATH 503 (Plant Pathogenic Prokaryotes)

CO1 : Basic understanding about the Bacterial diversity, host pathogen interaction and role in various ecosystem.

CO2 : Etiological understanding the Bacterial survival mode of infection and Economic importance.

CO3 : Explore the role of bacteria as Nitrogen fixing, PGPR and bio control.

CO4 : Ethical understanding in the use of genetically modifies bacteria and their application in Agriculture.

CO5 : Integrating the conceptual understanding about the bacteria for formulating management option.

PL PATH 504 (Plant Nematology)

CO1 : Understanding of the biology, morphology, anatomy and life cycle of plant parasitic nematode.

CO2 : Gain knowledge of the taxonomy, diversity, ecological and soil ecosystem.

CO3 : Develop skill in sampling, extraction, symptomatology of plant pathogenic nematode.

CO4 : To understand the principles of Integrated nematode management .

CO5 : Develop skills in experimental design, data analysis and interpretation of research funding.

PL PATH 505 (Principles of Plant Pathology)

CO1	:	Understanding of the fundamental principles of plant diseases.
CO2	:	Gain proficiency in identifying and classifying plant pathogens including fungi, Bacteria, Viruses, Nematode and Parasitic Plants.
CO3	:	Learn the mechanism for plant disease development, spread epidemiology, host susceptibility and pathogen biology.
CO4	:	Explore various strategies for integrated management of plant disease.
CO5	:	Appreciate the economic, environmental, social impact, surveillance, forecasting and biosecurity of plant disease.

PL PATH 506 (Techniques in Detection and Diagnosis of Plant Diseases)

CO1	:	Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases
CO2	:	Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms
CO3	:	Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens
CO4	:	Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis
CO5	:	Interpret diagnostic test results and make informed decisions regarding disease management strategy

PL PATH 515 (Diseases of Field and Medicinal Crops)

CO1	:	Understanding of the pathogens, etiology, symptomatology, epidemiology and life cycle of disease of cereals and pulses
CO2	:	Evaluate and analyze the factors contributing to yield losses quality reduction and marketable issue associated with diseased crops
CO3	:	Regulating framework and biosecurity measure aimed at preventing the introduction and spread of diseases in field and medicinal crops
CO4	:	Innovation approaches for disease management such as precision agriculture, remote sensing, predictive modeling and genome assisted breeding for disease resistance
CO5	:	Knowledge and skills necessary to diagnosis, manage and prevention of diseases to start plant health clinic

Minor Subjects

ENT 505 (Biological Control of Insect Pests and Weeds)

CO1	:	Understanding the theory and practice of biological control
CO2	:	Knowledge on techniques for mass production of quality bio-agents and their usage
CO3	:	Impart knowledge on role of natural enemies in pest management and

their field evaluation

CO4 : To understand role of insect pathogenic microorganisms

CO5 : knowledge of semiochemicals in biological control

ENT 506 (Toxicology of Insecticides)

CO1 : Knowledge on structure and mode of action of important insecticides belonging to different groups

CO2 : Understand the concept of toxicity, bioefficacy, insecticide formulations, etc.

CO3 : Attaining knowledge on insecticide residues, their significance and environmental implications, and insecticide residue analysis

CO4 : Understand insecticide resistance development, resistance management and pest resurgence

CO5 : Knowledge of Insecticide Act, insecticide registration procedures, safe use of insecticides, diagnosis and treatment of insecticide poisoning

ENT 508 (Concepts of Integrated Pest Management)

CO1 : To understand the principles of insect pest management, including concept and philosophy of IPM

CO2 : Knowledge on computation of ETL, EIL, and implementation of IPM programmes

CO3 : Estimation of losses due to insect pests

CO4 : Acquaintance with ITKs for Integrated pest management.

CO5 : Knowledge of the Pest survey, surveillance and forecasting.

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and

LSD

CO3	**:**	Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom
CO4	**:**	Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data
CO5	**:**	Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Ag.) Entomology Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 : Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 : Effective Communication	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 : Social Interaction	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 : Effective Citizenship	Demonstrate empathetic social concern and equity-cantered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 : Ethics	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 : Environment and Sustainability	Understand the issues of environmental contexts and sustainable development.
PO7 : Self-directed and Long-Life Learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

ENT 501 (Insect Morphology)

CO1	:	To acquaint the students with external morphology of the insect's body
CO2	:	Understanding the functions of various body parts of the insects
CO3	:	Knowledge about the insect's sense organs and other morphological traits which will be used in applied entomology
CO4	:	To familiarize students with various developmental stages of insects
CO5	:	To increase analytical thinking among students by taking cues from modification of insect morphology with changing environment

ENT 502 (Insect Anatomy and Physiology)

CO1	:	Understanding on the insect growth and physiology of integument, moulting and chemistry of cuticle
CO2	:	Knowledge on physiology and mechanism of various organ systems of insects
CO3	:	Understanding nutritional physiology in insects and knowledge about artificial diets
CO4	:	Knowledge on exocrine and endocrine glands of insects
CO5	:	Extra and intra-cellular microorganisms and their role in physiology

ENT 503 (Insect Taxonomy)

CO1	:	Understanding the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification
CO2	:	Understanding the ICZN rules governing the animal naming and its application in taxonomy
CO3	:	Attainment of skills on collecting, mounting, and preserving insects
CO4	:	Concepts of taxonomic hierarchy, identification, taxonomic characters, variations, taxonomic keys and preparation of taxonomic papers
CO5	:	Identification of insects of economic importance

ENT 505 (Biological Control of Insect Pests and Weeds)

CO1	:	Understanding the theory and practice of biological control
CO2	:	Knowledge on techniques for mass production of quality bio-agents and their usage
CO3	:	Impart knowledge on role of natural enemies in pest management and their field evaluation
CO4	:	To understand role of insect pathogenic microorganisms
CO5	:	knowledge of semi chemicals in biological control

ENT 506 (Toxicology of Insecticides)

CO1 : Knowledge on structure and mode of action of important insecticides belonging to different groups

CO2 : Understand the concept of toxicity, bio-efficacy, insecticide formulations, etc.

CO3 : Attaining knowledge on insecticide residues, their significance and environmental implications, and insecticide residue analysis

CO4 : Understand insecticide resistance development, resistance management and pest resurgence

CO5 : Knowledge of Insecticide Act, insecticide registration procedures, safe use of insecticides, diagnosis and treatment of insecticide poisoning

ENT 508 (Concepts of Integrated Pest Management)

CO1 : To understand the principles of insect pest management, including concept and philosophy of IPM

CO2 : Knowledge on computation of ETL, EIL and implementation of IPM programmes

CO3 : Estimation of losses due to insect pests

CO4 : Acquaintance with ITKs for Integrated pest management.

CO5 : Knowledge of the Pest survey, surveillance and forecasting.

ENT 509 (Pests of Field Crops)

CO1 : Understanding the Insect pest scenario in relation to climate change.

CO2 : Gain knowledge on nature of damage and seasonal incidence of pestiferous insects

CO3 : Knowledge on insect pests of field crops, their life history traits and effective management

CO4 : Acquaint with collection methods and identification of important pests and their natural enemies

CO5 : Detection and estimation of infestation and losses in different crops

ENT 515 (Techniques in Plant Protection)

CO1 : Skills of appropriate use of plant protection equipments and its related techniques

CO2 : Imparting knowledge of concepts of different plant protection equipments.

CO3 : Concept of tissue culture techniques in plant protection

CO4 : Understand calibration and formulation of pesticides.

CO5 : Knowledge on application of drones in plant protection

Minor Subjects

PL PATH 503 (Plant Bacteriology)

CO1	:	Basic understanding about the Bacterial diversity, host pathogen interaction and role in various ecosystem.
CO2	:	Etiological understanding the Bacterial survival mode of infection and Economic importance.
CO3	:	Explore the role of bacteria as Nitrogen fixing, PGPR and bio control.
CO4	:	Ethical understanding in the use of genetically modifies bacteria and their application in Agriculture.
CO5	:	Integrating the conceptual understanding about the bacteria for formulating management option.

PL PATH 504 (Plant Nematology)

CO1	:	Understanding of the biology, morphology, anatomy and life cycle of plant parasitic nematode.
CO2	:	Gain knowledge of the taxonomy, diversity, ecological and soil ecosystem.
CO3	:	Develop skill in sampling, extraction, symptomatology of plant pathogenic nematode.
CO4	:	To understand the principles of Integrated nematode management .
CO5	:	Develop skills in experimental design, data analysis and interpretation of research funding.

PL PATH 505 (Techniques in Detection and Diagnosis of Plant Diseases)

CO1	:	Understanding of the principles, advantages, limitations and usage of detection and diagnosis of plant diseases.
CO2	:	Develop practical skills in performing diagnostiv test including sample collection, preparation and analysis of causal organisms .
CO3	:	Learn for accuracy of phenotypic and genotypic test for identification of plant pathogens.
CO4	:	Understanding the test sensitivity, specificity and reliability in the context of disease diagnosis.
CO5	:	Interpret diagnostic test results and make informed decisions regarding disease management strategy.

STAT502 (Statistical Methods for Applied Sciences)

CO1	:	Exposure of students to the classification, tabulation, graphical representation of data and theory of probability
CO2	:	Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory
CO3	:	Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients
CO4	:	Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom

CO4 : Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data

CO5 : Learning about the bioassays- direct and indirect

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of M.Sc. (Agri.) Molecular Biology and Biotechnology Programme – Restructured Syllabus

Programme Outcomes (POs)

PO1 :	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2 :	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3 :	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4 :	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5 :	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6 :	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7 :	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

PSO1 : Functional knowledge of crop production and soil management

PSO2 : Specific knowledge of scientific and modern agronomical practices of different cropping and farming system

PSO3 : Student will exercise in modern agronomical practices along with natural resource management system

PSO4 : Opportunity as researcher, teacher, entrepreneurship and helps in modern agriculture grower

Course Outcomes (COs)

Major Subjects

MBB 501 (Principles of Biotechnology)

CO1 : Understand the Foundations and Scope of Biotechnology

CO2 : Master Specializations in Agricultural Biotechnology

CO3 : Comprehend Basic Concepts in Biotechnology

CO4 : Explore Advanced Techniques in Biotechnology

CO5 : Engage with Modern Applications and Emerging Topics in Biotechnology

MBB 502 (Fundamentals of Molecular Biology)

CO1 : Historical Developments and Fundamental Concepts in Molecular Biology

CO2 : Comprehend DNA Structure, Replication, and Repair Mechanisms

CO3 : Explore Transcription and Post-Transcriptional Processing

CO4 : Understand Translation and Protein Modification

CO5 : Evaluate Gene Regulation Mechanisms in Prokaryotes and Eukaryotes

MBB 503 (Molecular Cell Biology)

CO1 : Understanding the Insect pest scenario in relation to climate change.

CO2 : Gain knowledge on nature of damage and seasonal incidence of pestiferous insects

CO3 : Knowledge on insect pests of field crops, their life history traits and effective management

CO4 : Acquaint with collection methods and identification of important pests and their natural enemies

CO5 : Detection and estimation of infestation and losses in different crops

MBB 509 (Plant Tissue Culture)

CO1 : Understand the Principles and Techniques of Micropropagation and Virus Elimination

CO2 : Protoplast and Cell Culture Techniques for Biotechnological Applications

CO3 : Explore the Diversity and Applications of Somatic Embryogenesis and Androgenesis/Gynogenesis

CO4 : Analyse Commercial Applications and Economic Viability of Plant Tissue Culture

CO5 : Understand Quality Management and Genetic Fidelity Testing in Tissue Culture Plants

MBB 504 (Techniques in Molecular Biology)

CO1 : Fundamental Laboratory Techniques in Molecular Biology

CO2 : Perform DNA Isolation, Quantification, and Manipulation

CO3 : Apply Advanced Molecular Biology Techniques

CO4 : Utilize Chromatographic Techniques for Biomolecular Separation

CO5 : Master Immunological Techniques for Biomolecular Analysis

MBB 505 (Omics and Systems Biology)

CO1 : Advanced Genomics and Genome Analysis Techniques:

CO2 : Analyse Proteins and Protein Interactions Using Advanced Techniques

CO3 : Explore Metabolomics and Ionomics for Biomarker Identification

CO4 : Understand the Principles and Applications of Systems Biology

CO5 : Apply Integrated Omics Approaches to Biological Systems

MBB 514 (Nano Biotechnology)

CO1 : Nanomaterials Synthesis and Characterization Techniques

CO2 : Understand Bio-Nanostructures and Cellular Nanomachines:

CO3 : Analyse Chemical, Physical, and Biological Properties of Biomaterials

CO4 : Explore Advanced Applications of Nanotechnology in Biomedical Engineering

CO5 : Apply Statistical Mechanics in Biological Systems and Nanotechnology

Minor Subjects

GP 501 (Principles of Genetics)

CO1 : Fundamental Concepts and Principles of Genetics

CO2 : Analyse Molecular Mechanisms and Genetic Processes

CO3 : Explore Advanced Topics in Genetic Engineering and Molecular Techniques

CO4 : Evaluate Genetic Variation and Genomics in Biological Systems

CO5 : Discuss Ethical and Societal Implications of Genetic Discoveries

GP 502 (Principles of Plant Breeding)

CO1 : Understand the Historical Evolution and Objectives of Plant Breeding

CO2 : Analyse Genetic Basis and Breeding Strategies in Self- and Cross-Pollinated Crops

CO3 : Evaluate Breeding Methods Across Different Crop Types

CO4 : Explore Advanced Techniques and Technologies in Plant Breeding

CO5 : Understand Regulatory and Ethical Considerations in Cultivar Development

GP 506 (Molecular Breeding and Bioinformatics)

CO1 : Develop a deep understanding of the principles and methodologies involved in molecular breeding, including marker-assisted selection, gene editing techniques, and genomic selection.

CO2 : Acquire advanced skills in bioinformatics tools and databases, enabling efficient analysis of genomic and transcriptomic data for breeding purposes.

CO3 : Gain the ability to integrate genomic information into breeding programs

effectively, enhancing the efficiency and precision of breeding strategies.

CO4 : Evaluate and compare different molecular breeding strategies in terms of their applicability, effectiveness, and ethical implications in agricultural and biotechnological contexts.

CO5 : Demonstrate effective communication skills for collaborating with interdisciplinary teams, stakeholders, and industry partners to translate molecular breeding innovations into practical applications.

GP 504 (Varietal Development & Maintenance Breeding)

CO1 : Definition, variety testing, release and notification system in India and abroad.

CO2 : DUS testing, factor responsible for genetic deterioration of varieties during seed production.

CO3 : Maintenance of varieties and generation system of seed multiplication.

CO4 : Quality seed production technology of self and cross-pollinated crop varieties.

CO5 : Seed certification, laws and PPV & FR act in India and abroad.

STAT502 (Statistical Methods for Applied Sciences)

CO1 : Exposure of students to the classification, tabulation, graphical representation of data and theory of probability

CO2 : Understanding the concept sampling distribution, normal distribution, binomial, Poisson, chi-square, large sample theory

CO3 : Introduction to theory of estimation, correlation and regression, test of significance of correlation and regression coefficients

CO4 : Learning about the non-parametric tests – sign, Wilcoxon, Mann-Whitney U- test etc., Friedman two-way ANOVA by ranks

CO5 : Knowledge of multivariate analytical techniques, D2-static, cluster analysis, Principal component analysis

STAT511 (Experimental Designs)

CO1 : Understanding the basic principles of Designs, characteristics of a good design, need for designing of experiments

CO2 : Learn about the uniformity trials, analysis of variance, CRD, RBD and LSD

CO3 : Exposure to Factorial experiments, confounding, orthogonality and partitioning of degrees of freedom

CO4 : Introduction to split plot and strip plot designs, analysis of covariance, missing plot techniques, transformation of data

CO5 : Learning about the bioassays- direct and indirect

Non-Gradial (PGS) Courses

PGS 501 Library and Information Services

CO1	:	Study the history of Library and information science
CO2	:	Study and understand management of Libraries and information centres
CO3	:	Study information sources and services
CO4	:	Study and understand the basics of Information technology and Library Automation
CO5	:	Study the ICT applications in Libraries and information centres

PGS 502 Technical Writing and Communications Skills

CO1	:	Development of the skills to write dissertations, research papers, etc.
CO2	:	Induce the capacity and skills to write technical papers, reviews, manuals, etc
CO3	:	Train the learners to write the abstracts, summaries, précis, citations, etc.
CO4	:	Learners shall gain the knowledge about communication skills
CO5	:	Enable the students to participate in group discussion, facing interview and presentation of scientific papers

PGS 503 Intellectual Property and its Management in Agriculture

CO1	:	Understanding the basic concepts of Intellectual Property Rights
CO2	:	Understand the necessity of patents, copyright, trademark, GI
CO3	:	Development of design or some innovation for patent application
CO4	:	Acquire the knowledge about the rights related to Intellectual Property Rights
CO5	:	Learners shall know about the Protection of Plant Variety and Farmers Rights Act

PGS 504 Basic Concepts in Laboratory Techniques

CO1	:	To acquaint the students about the basics of commonly used techniques in laboratory
CO2	:	Gained knowledge on Safety measures, use and handling of laboratory equipment and chemical reagents while working in laboratory
CO3	:	Gained insights on soil, water and plant analysis for various parameters and biomolecule contents.
CO4	:	Development of capability to interpret the data and generate recommendations
CO5	:	Acquire knowledge on botanical terms in relation to taxonomy

PGS 505 Agriculture Research, Research Ethics and Rural Development Programmes

CO1	:	Learn about the Indian Agriculture Research system and Global agriculture research system
CO2	:	Understand the rural development status and programmes in India
CO3	:	Learn about knowledge of agriculture research ethics
CO4	:	Extend their knowledge of history of agriculture, historical stages of development of agriculture
CO5	:	Understand about Panchayati raj institutions, voluntary agencies/non-government organizations

PROGRAMME-16

Ph.D.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agronomy – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agronomy)

PSO1	:	Learned to manage Agronomic problems, develop practical skills, analyze data scientifically, and draw logical conclusions.
PSO2	:	Specific knowledge of scientific and Advance agronomical practices of different cropping and farming system
PSO3	:	Student will exercise in modern agronomical practices along with natural resource management system
PSO4	:	Prepare students to understand major agronomical concepts, while also

providing opportunities for research, teaching, entrepreneurship, and leadership development across all disciplines of soil science.

Course Outcomes (COs)

Department – Ph. D. (Agronomy)

Agron-601 (Current trend in Agronomy)

CO1 : "By exploring recent advances in the soil-plant-water relationship, we can gain a deeper understanding of the agro-physiological basis of yield variation and potentially improve crop productivity."

CO2 : To study about the recent development in precision agriculture and organic farming related to global market & ITK in organic farming

CO3 : To study about the technology related to cropping system and their management, GIS, GPS, remote sensing and IoT in agriculture

CO4 : Concept of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

CO5 : Conservation agriculture, robotics, drones & aeroplanes etc. in agriculture

Agron-604 (Recent Trends in Crop Growth and Productivity)

CO1 : To study the harvesting of the solar energy for crop productivity

CO2 : To acquire the knowledge of crop growth analysis and development, inter and mixed cropping and their criteria in assessing the yield advantages.

CO3 : To study the competitive relationship and completion functions, in intercropping; dryland crop production; heat unit concept in crop maturity

CO4 : Concept of plant ideotypes of different crop, Exposure visit to hydroponic/aeroponic/aquaponic unit

CO5 : Growth hormones and their role in crop production, controlled environment agriculture, regenerative agriculture

Agron-605 (Irrigation Management)

CO1 : Water resources and irrigation projects in India, irrigation needs & methods, water deficits and crop growth

CO2 : Soil-plant-water relationships and crop productivity

CO3 : Water movement in soil, WUE and Application of irrigation water, water management under climate change scenario.

CO4	:	Strategies of using limited water supply; management of ET, crop water stress
CO5	:	Classification of land on the basis of suitability and irrigability; visit and water management in command area, Crop water production function, Hydroponics

Agron-606 (Advances in Weed Management)

CO1	:	Crop weed competition; changes in weed flora, various causes and affects
CO2	:	To know the physiological and biological aspect of herbicides; their mode of action and selectivity
CO3	:	Phytotoxicity of herbicides; fate of herbicide in soil, their residue management, adjuvants
CO4	:	Advance knowledge in herbicide application techniques; compatibility of herbicide
CO5	:	Transgenic herbicide resistant crop; relationship of herbicide with other agronomic practices, use of nano herbicide, robotics, drones and aeroplanes, organic etc. in weed management

Agron 607 Integrated farming system for sustainable agriculture

CO1	:	Advance knowledge of different farming system
CO2	:	Knowledge of natural resources management in farming system for sustainability
CO3	:	Knowledge of production potential, mechanism, and interaction of component of farming system
CO4	:	Models of different farming system; simulation model for intercropping
CO5	:	New concept and approaches of farming system, cropping system and organic farming

Agron 608 Soil conservation and watershed management

CO1	:	Nutrient availability; clay minerals and fertility status of major soils group of India
CO2	:	Imparted the knowledge about nutrient movement and their transformation in soil
CO3	:	To study the Modern concepts of fertilizer evaluation, application and nutrient budgeting.

CO4	:	Monitoring physico-chemical and biological changes in soils; fertilizer use for sustainability.
CO5	:	Experience on the knowledge of soil fertility and fertilizers in relation to plant growth, development and productivity

SOILS 602 Advances in Soil Fertility

CO1	:	To study the harvesting of the solar energy for crop productivity
CO2	:	To acquire the knowledge of crop growth analysis and development, inter and mixed cropping and their criteria in assessing the yield advantages.
CO3	:	To study the competitive relationship and competitive functions, in intercropping; dryland crop production; heat unit concept in crop maturity
CO4	:	Concept of plant ideotypes of different crop
CO5	:	Growth hormones and their role in crop production

SOILS 605 Biochemistry of Soil Organic Matter

CO1	:	Impart knowledge about biochemistry of organic substances and their significance in soils and methods of organic matter analysis.
CO2	:	Current thinking of organic matter maintenance, Biochemistry of the humus formation; Carbon retention and sequestration.
CO3	:	To provide knowledge about Nutrient transformation; trace metal interaction with humic substances
CO4	:	Clay organic matter complexes. Humus-pesticide interactions and mechanisms in soil environment.
CO5	:	Experience the knowledge of soil biochemistry on research for solving field problems.

Soils-606 (Soil Erosion & conservation)

CO1	:	To study identification and description soil erosion of India
CO2	:	Soil and water erosion, estimation, method of erosion measurement and soil loss valuation.
CO3	:	Erosion control measures, agronomical and engineering erosion control structures
CO4	:	Soil conservation planning for different regions and land of India

CO5 : Water harvesting, recycling case studies to monitoring watersheds, use of remote sensing in planning of watershed.

SOILS 606 (Land Use Planning & Watershed Management)

CO1 : Concept technique and principles of land use planning

CO2 : To study land evaluation methods and suitability, capability classification for crop production

CO3 : Study of agroecological region/ sub regions of India in relation to crop production

CO4 : Use of water harvesting in Agriculture to increase water productivity

CO5 : Watersheds development, execution, community participation, rehabilitation of watersheds. Developing economically and ecologically sustainable agroforestry system for case studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Vegetable science – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Vegetable science)

PSO1 : The scholar will acquire knowledge on crop improvement, production technologies and crop improvement through biotechnologies pertaining to vegetable crops with special reference to advancement in research.

PSO2 : The scholar will gain skills in approaching research problems and define research methodology for problems solving research in the field of vegetable

crops.

PSO3 : The scholar will be able to conduct individual research works and become eligible to work in research programmes offered by national and international organizations in vegetable science.

PSO4 : The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

Course Outcomes (COs)

Department – Ph. D. (Vegetable science)

VSC 601 (Advances in Vegetable Production)

CO1 : To know about the recent advances in vegetable production (solanaceous crops) tomato, brinjal, chilli, sweet paper and potato.

CO2 : To know about the recent advances in vegetable production (Cole crops) cabbage, cauliflower and knol-khol.

CO3 : To know about the recent advances in vegetable bhindi, onion, peas, beans, Amaranthus and drumsticks.

CO4 : To know about the recent advances in vegetable production carrot, beetroot and radish and cucurbits

CO5 : To know about the recent advances in vegetable production (tuber crops) sweet potato, tapioca, elephant foot yam and taro.

VSC 602 (Advances in Breeding of Vegetable Crops)

CO1 : To know about the breeding objectives and recent advances for crop improvement in solanaceous vegetables; Tomato, brinjal, chili, sweet pepper and potato.

CO2 : To know about the breeding objectives and recent advances for crop improvement in cucurbits and cole vegetables; cucurbits, cabbage, cauliflower, and knol-khol.

CO3 : To know about the breeding objectives and recent advances for crop improvement in legumes and leafy vegetables; Bhindi, pea, beans, Amaranthus and drumstick.

CO4 : To know about the breeding objectives and recent advances for crop improvement in root and bulb vegetables; carrot, beet root, radish, onion and tuber vegetables; sweet potato, tapioca, elephant foot yam, Colocasia and dioscorea.

CO5 : To acquire the knowledge of recent advances for vegetable crops through breeding methods

VSC 603 Protected Cultivation of Vegetable Crops

CO1	:	To know about importance and scope of protected cultivation of vegetable crops and its principles
CO2	:	To know about types of protected structures and environmental factors affecting in vegetable crops.
CO3	:	Nursery raising in protected structure like- poly tunnel, types of benches and containers, different media for growing nursery under cover.
CO4	:	Regulation of flowering and fruiting, training and stacking in protected crops, varieties and hybrids for growing vegetables under protected structures.
CO5	:	To know about problems of growing vegetables in protected structures and their remedies, insect and disease management in protected structure, soil less culture, use of protected structure for seed production.

VSC 604 Bio-Technologies in Vegetable Crops

CO1	:	Importance and scope of biotechnology- for crop improvement in vegetable
CO2	:	Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, in vitro conservation.
CO3	:	DNA finger printing; In vitro mutation for biotic and abiotic stresses and recombinant DNA methodology.
CO4	:	Quality advancement; improvement for biotic and abiotic stresses, transgenic plants.
CO5	:	Importance and use of molecular marker - Achievements, problems and future thrusts in horticultural biotechnology.

FSC 602 Advances in Production of Fruit Crops

CO1	:	To keep the students abreast with latest developments and trends in production technology of fruit crops
CO2	:	To analyse the influence of rootstocks and planting systems for fruit production
CO3	:	To understand the essentialities and importance of crop modeling, precision farming in scientific fruit production
CO4	:	To understand and apply decision support systems for advances in fruit

production

CO5 : CO5: Able to apply integrated and moderns approaches in water and nutrients management and total quality management (TQM) in fruit production

FSC 603 Advances in Growth Regulation of Fruit Crops

CO1 : To update knowledge on Eco physiological influences on growth and development of fruit crops

CO2 : To study about the role of Plant growth regulators in fruit crops

CO3 : To impart knowledge on Absorption, translocation and degradation of phytoharmones; Internal and external factors influencing harmonal sysnthesis

CO4 : To know about growth regulation aspects of propagation in fruit crops

CO5 : To update knowledge on flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity, ripening and storage

VSC 605 Seed Certification, Processing and Storage of Vegetable Crops

CO1 : To gain knowledge about seed certification, seed agencies, seed certification standards and seed certification procedure.

CO2 : To gain knowledge about seed processing equipments, processing methods and seed packaging and handling.

CO3 : To know about seed treatment, storage, quality control of seed and methods of seed storage.

CO4 : To acquire knowledge about different test like- purity, vigour, sampling, germination seed viability, seed health and dormancy of seed

CO5 : To develop ability of marketing and seed production and more gain knowledge about seed act and laws.

VSC 606 Abiotic Stress Management in Vegetable Crops

CO1 : To update knowledge on environment stress and its classification of vegetable crops.

CO2 : To impart knowledge about mechanism and measurements of tolerance; drought, water logging, soil salinity, frost and heat stress in vegetable crops.

CO3 : To know about the soil-plant-water relations under different stress

conditions in vegetable crops production and their management practices.

CO4 : To acquire knowledge on techniques of vegetable growing under water deficit, water logging, salinity and sodicity, high and low temperature stress conditions.

CO5 : To develop proficiency on use of chemicals in alleviation of stress conditions, identification of susceptibility and tolerance systems to various types of stresses.

FSC 607 Post Harvest Technology for Fruit Crops

CO1 : To analysing maturity stages, maturity indices, harvesting and pre-harvest practices for specific market requirements

CO2 : To understanding the physiology and biochemistry of fruit ripening, ethylene release and ethylene evaluation and management. Factor leading to the post-harvest losses of fruits.

CO3 : To know treatments prior to shipment; pre-cooling, chlorination, waxing, chemicals, bio-control agents and natural plant products use in post-harvest technology of fruits. Packaging and transportation; improved packing techniques of important fruit commodities.

CO4 : To impart the knowledge on methods of storage, physical injury, disorder and estimation of quality characteristics of stored fruit.

CO5 : To facilitates deeper understanding on principles and methods of processing and preservation, preparation nutritionally enriched products, processing waste management and food safety standards of post-harvest fruits.

FSC 605 Biotic and Abiotic Stress Management in Horticultural Crops

CO1 : To update Knowledge about abiotic stresses and its classifications

CO2 : To acquire knowledge on pollution and physiological and biochemical factors associated with stress

CO3 : To update Knowledge on the crop modeling for stress situations

CO4 : To acquire knowledge about greenhouse effect, PGRs in stress management, HSP inducer and stress management techniques

CO5 : To update knowledge on the rain water Harvesting, skimming technology and contingency planning to mitigate different stress situations

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Fruit Science– (Old)

Programme Outcomes (POs)

PO1	:	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	:	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	:	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	:	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	:	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	:	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	:	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Fruit Science)

PSO1 : The scholar will acquire knowledge on crop improvement, production technologies, biotechnology and postharvest technologies pertaining to Fruit crops with special reference to advancement in research.

PSO2 : The scholar will develop skills in approaching research problems and define research methodology for problems solving research in the field of Fruit crops.

PSO3 : The scholar will be able to conduct individual research works and become

eligible to work in research programmes offered by national and international organizations in Fruit science.

PSO4 : The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

Course Outcomes (COs)
Department – Ph. D. (Fruit Science)
FSC 601 (Advances in Breeding of Fruit Crops)

CO1 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of mango and banana.

CO2 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of papaya, grape s and citrus.

CO3 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of guava, sapota, pomegranate, kiwi fruit, strawberry and litchi.

CO4 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of apple, pear plums, peaches, apricot, cherries and nut crops.

CO5 : To update theoretical knowledge and developed practical skills on transgenics, markers and bio-informatics tools and database for genomics research in fruit crops.

FSC 602 Advances in Production of Fruit Crops

CO1 : To keep the students abreast with latest developments and trends in production technology of fruit crops

CO2 : To analyse the influence of rootstocks and planting systems for fruit production

CO3 : To understand the essentialities and importance of crop modeling, precision farming in scientific fruit production

CO4 : To understand and apply decision support systems for advances in fruit production

CO5 : Able to apply integrated and moderns approaches in water and nutrients

management and total quality management (TQM) in fruit production

FSC 603 Advances in Growth Regulation of Fruit Crops

CO1	:	To update knowledge on ecophysiological influences on growth and development of fruit crops
CO2	:	To study about the role of Plant growth regulators in fruit crops
CO3	:	To impart knowledge on Absorption, translocation and degradation of phytoharmones; Internal and external factors influencing harmonal sysnthesis
CO4	:	To know about growth regulation aspects of propagation in fruit crops
CO5	:	To update knowledge on flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity, ripening and storage

VSC 601 (Advances in Vegetable Production)

CO1	:	To know about the recent advances in vegetable production (solaneceious crops) tomato, brinjal, chilli, sweet paper and potato.
CO2	:	To know about the recent advances in vegetable production (Cole crops) cabbage, cauliflower and knol-khol.
CO3	:	To know about the recent advances in vegetable bhindi, onion, peas, beans, Amaranthus and drumsticks.
CO4	:	To know about the recent advances in vegetable production carrot, beetroot and radish and cucurbits
CO5	:	To know about the recent advances in vegetable production (tuber crops) sweet potato, tapioca, elephant foot yam and taro.

VSC 603 Protected Cultivation of Vegetable Crops)

CO1	:	To know about the recent advances in vegetable production (solanaceous crops) tomato, brinjal, chilli, sweet paper and potato.
CO2	:	To know about the recent advances in vegetable production cucurbits, cabbage, cauliflower and knol-khol.
CO3	:	To know about the recent advances in vegetable bhendi, onion, peas, beans, Amaranthus and drumsticks.
CO4	:	To know about the recent advances in vegetable production carrot,

beetroot and radish.

CO5 : To know about the recent advances in vegetable production sweet potato, tapioca, elephant foot yam and taro.

FSC 605 (Biotic and Abiotic stress management in Horticulture crops)

CO1 : To update Knowledge about abiotic stresses and its classifications

CO2 : To acquire knowledge on pollution and physiological and biochemical factors associated with stress

CO3 : To update Knowledge on the crop modeling for stress situations

CO4 : To acquire knowledge about greenhouse effect, PGRs in stress management, HSP inducer and stress management techniques

CO5 : To update knowledge on the rain water Harvesting, skimming technology and contingency planning to mitigate different stress situations

FSC 606 Abiotic Stress Management in Vegetable Crops

CO1 : To update knowledge on environment stress and its classification of vegetable crops.

CO2 : To impart knowledge about mechanism and measurements of tolerance; drought, water logging, soil salinity, frost and heat stress in vegetable crops.

CO3 : To know about the soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

CO4 : To acquire knowledge on techniques of vegetable growing under water deficit, water logging, salinity and sodicity, high and low temperature stress conditions.

CO5 : To develop proficiency on use of chemicals in alleviation of stress conditions, identification of susceptibility and tolerance systems to various types of stresses.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Soil Science– (Old)

Programme Outcomes (POs)

PO1	**: Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**: Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**: Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**: Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**: Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**: Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**: Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Soil Science)

PSO1 : Acquired knowledge and skills to manage problems associated with Soil Science. Developing practical skills, handling equipment, analysing and interpreting data in a scientific manner and coming to a logical conclusion.

PSO2 : Demonstrate the capability to analyse and evaluate, formulate coherent arguments, policies and theories with scientific approach to knowledge

development in soil science.

PSO3 : Apply innovative solutions, independently and cooperatively, at local and global level. Analyse and evaluate different soil conservation strategies based on specific environmental condition and land use patterns.

PSO4 : To prepare students demonstrating, solving, and understanding major concepts. Opportunity as researcher, teacher, entrepreneurship and helps in modern soil science and agriculture. Developing flexibility and leadership skills in all disciplines of soil science.

Course Outcomes (COs)

Department – Ph. D. (Soil Science)

SOIL 602 (Advances in Soil Fertility)

CO1 : Nutrient availability; fertility status of major soils group of India

CO2 : Imparted the knowledge about nutrient movement and their transformation in soil

CO3 : To study the Modern concepts of fertilizer evaluation, application and nutrient budgeting.

CO4 : Monitoring physico-chemical and biological changes in soils; fertilizer use for sustainability.

CO5 : Experience on the knowledge of soil fertility and fertilizers in relation to plant growth, development and productivity

SOIL 603 (Physical Chemistry of Soil)

CO1 : Student will get knowledge about modern concepts of physical chemistry, processes involved with practical significance.

CO2 : Understand colloidal chemistry; thermodynamics, empirical structure and properties.

CO3 : To know ions adsorption/desorption and utility in agricultural system

CO4 : Solubility equilibria, electrochemical properties of clays for agricultural use.

CO5 : Student will acquaint the knowledge of soil chemical behaviour and research for solving field problems.

SOIL 605 (Biochemistry of Soil Organic Matter)

CO1 : Impart knowledge about biochemistry of organic substances and their

significance in soils.

CO2 : Current thinking of organic matter maintenance, Biochemistry of the humus formation; Carbon retention and sequestration.

CO3 : To provide knowledge about Nutrient transformation; trace metal interaction with humic substances

CO4 : Clay organic matter complexes. Humus-pesticide interactions and mechanisms.

CO5 : Experience the knowledge of soil biochemistry on research for solving field problems.

AGRON 604 (Advances in Crop Growth and Productivity)

CO1 : To study the harvesting of the solar energy for crop productivity

CO2 : To acquire the knowledge of crop growth analysis and development, inter and mixed cropping and their criteria in assessing the yield advantages.

CO3 : To study the competitive relationship and completion functions, in intercropping; dryland crop production; heat unit concept in crop maturity

CO4 : Concept of plant ideotypes of different crop

CO5 : Growth hormones and their role in crop production

AGRON 604 (Irrigation Management)

CO1 : Water resources of India, irrigation needs and water deficits and crop growth

CO2 : Soil-plant-water relationships and crop productivity

CO3 : Water movement in soil, WUE and Application of irrigation water, losses and their management

CO4 : Strategies of using limited water supply; management of ET

CO5 : Classification of land on the basis of suitability and irrigability; water management in command area

SOIL 601 (Advances in Soil Physics)

CO1 : Understanding the basic principles and practices of soil physics.

CO2 : Understanding soil-plant-atmospheric continuum (SPAC); Study theories of infiltration

CO3	:	It suitable and closely related to soil and water conservation, agriculture, and engineering, etc.
CO4	:	It directly provided knowledge of movement of salts in soils, Soil air, moisture, solar radiation in relation to plant growth.
CO5	:	Skill development in identification of soil physical properties in relation to food insecurity caused by climate change

SOIL 604 (Soil Genesis and Micro pedology)

CO1	:	It imparts knowledge about the paedogenic processes and micro-pedological study in soils.
CO2	:	Understand paedogenic evolution; composition and characterization of soils; weathering and soil formation
CO3	:	Assessment of soil profile development by mineralogical and chemical analysis
CO4	:	To study micro-pedological features of soils and role in genesis and classification.
CO5	:	To gain knowledge of soil genesis, taxonomy and micromorphology and related research for solving field problems

SOIL 505 Soil Erosion and Conservation

CO1	:	To study identification and description soil erosion of India
CO2	:	Soil and water erosion, estimation, method of erosion measurement and soil loss valuation.
CO3	:	Erosion control measures, agronomical and engineering erosion control structures
CO4	:	Soil conservation planning for different regions and land of India
CO5	:	Water harvesting, recycling case studies to monitoring watersheds, use of remote sensing in planning of watershed.

SOIL 606 Land Use Planning and Watershed Management

CO1	:	Concept technique and principles of land use planning
CO2	:	To study land evaluation methods and suitability, capability classification for crop production
CO3	:	Study of agro ecological region/ sub regions of India in relation to crop production

CO4 : Use of water harvesting in Agriculture to increase water productivity

CO5 : Watersheds development, execution, community participation, rehabilitation of watersheds. Developing economically and ecologically sustainable agroforestry system for case studies

AGRON 607 Integrated Farming System

CO1 : Advance knowledge of different farming system

CO2 : Knowledge of natural resources management in farming system for sustainability

CO3 : Knowledge of production potential, mechanism, and interaction of component of farming system

CO4 : Models of different farming system; simulation model for intercropping

CO5 : New concept and approaches of farming system, cropping system and organic farming

AGRON 608 Soil Conservation and Watershed Management.

CO1 : Knowledge of soil erosion: definition, nature, extent, types and factor affecting it

CO2 : Definition and method of soil conservation

CO3 : Advance knowledge of watershed management

CO4 : Land use capability classification and alternate land use system

CO5 : Drainage considerations and agronomic management

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Genetics and Plant Breeding – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Genetics and Plant Breeding)

PSO1	:	To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.
PSO2	:	This course focuses on the advanced techniques in analysing chromosome structure and manipulations for genome analysis in crop species.

PSO3 : To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in plant breeding.

PSO4 : To provide insight into recent advances in improvement of cereals, millets and non-cereal crops using conventional and modern biotechnological approaches.

Course Outcomes (COs)

Department – Ph. D. (Genetics and Plant Breeding)

GP 601 (Plant Genetics Resources and Pre-Breeding)

CO1 : To learn History, Importance and principles of plant genetic resources
CO2 : Germplasm conservation and different categories of PGR management
CO3 : To learn about Genetic enhancement in pre and post Mendelian era
CO4 : To understand Distant Hybridization and crop improvement
CO5 : Application of biotechnology for Genetic enhancement

GP 603 (Molecular and Chromosomal Manipulation for Crop Breeding)

CO1 : To understand genome organization, expression and C value paradox
CO2 : Chromosome karyotyping and distant hybridization
CO3 : Different cytological methods and B/A chromosome translocations and gene location
CO4 : To learn Trisomics and intervarital substitutions
CO5 : Different pathways of in vitro morphogenesis organogenesis and somatic embryogenesis; in vitro mutant/somaclone selection for biotic and abiotic stresses

GP 605 (Advances in plant Breeding Systems)

CO1 : Basics and facts of plant breeding and study abiut Self- incompatibility and male sterility system
CO2 : To study about Principles and procedures in the formation of a complex population.
CO3 : To learn about Creation of genetic variability selection methods for self- and cross-pollinated crops
CO4 : To understand general and specific combining ability for crop improvement
CO5 : Environmental influence on sterility and Apomixis and its use in heterosis breeding

ENT 606 (Recent Trends in Biological Control)

CO1 : Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of

entomophagous insects and their hosts

CO2 : Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices

CO3 : Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis

CO4 : To learn about ecological manipulations, largescale production of biocontrol agents, bankable project preparation.

CO5 : Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections

ENT 608 Advance Host Plant Resistances

CO1 : Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance

CO2 : Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance

CO3 : Biotechnological approaches in host plant resistance- genetic marker-aided selection in resistance breeding manipulation of secondary plant substances

CO4 : Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses

CO5 : biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways

GP 603 (Genomics in Plant Breeding)

CO1 : To understand genome complexity and chromosomal & mitochondrial genome

CO2 : To learning about Regulation of Plant gene expression, Functional genomics and gene Expression Analysis using Microarrays

CO3 : To study Genome sequencing in plants and their Principles and Techniques, Applications of sequence information in plant genome analyses

CO4 : Learning about Importance of understanding the phenotypes for exploiting the outcome of genomic technologies, TILLING and Eco- TILLING

CO5 : Learn to Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools

GP 602 Advanced Biometrical & Quantitative Genetics

CO1 : To learn about Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis

CO2	**:**	Models in stability analysis, Multiplicative Interaction (AMMI) analysis and Principal Component Analysis.
CO3	**:**	Analysis and selection of genotypes; Methods and steps to select the best model -Biplots and mapping genotypes
CO4	**:**	Encourage students to learn Genetic architecture of quantitative traits; Conventional analyses to detect gene actions
CO5	**:**	QTL mapping- Strategies for QTL mapping - desired populations, Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding

GP 608 (Advances in Breeding of Major Field Crops)

CO1	**:**	Learn about History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, pulses, millets and oil seeds
CO2	**:**	Breeding objectives in major cereals, pulses, millets and oil seeds, Genetic resources and their utilization.
CO3	**:**	Breeding for value addition and resistance to abiotic and biotic stresses.
CO4	**:**	Conventional and other approaches for Development of New cultivars and transgenic.
CO5	**:**	National and International accomplishments in genetic improvement of major field crops and their seed production.

ENT 611 Molecular Approaches in Entomological Research

CO1	**:**	Introduction to molecular biology; techniques used in molecular biology
CO2	**:**	DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest
CO3	**:**	Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases
CO4	**:**	Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression, DNA finger printing for taxonomy and phylogeny
CO5	**:**	DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications

ENT 612 Advanced Integrated Pest Management

CO1	**:**	Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

CO2	:	Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.
CO3	:	Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management
CO4	:	Scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real time situations.
CO5	:	Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agriculture Extension – (Old)

Programme Outcomes (POs)

PO1	:	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	:	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	:	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	:	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	:	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	:	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	:	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agriculture Extension)

PSO1 : To carry out extension and outreach research on the basis of clientele needs

PSO2 : To carry out exploratory and ex-post facto research for agricultural innovations and interventions

PSO3 : To suggest research outcomes to promote the convergence and collaboration of

stakeholders for sustainable agriculture

PSO4 : To link extension with teaching and research system through research feedback for enabling the end-users to adopt the innovations in agriculture and allied sectors

Course Outcomes (COs)
Department – Ph. D. (Agriculture Extension)
EXT- 601 (Policy Engagement in Extension)

CO1 : Understanding of the policy frameworks at local, regional, and national levels that influence and govern extension services.

CO2 : Learn to analyse policies from a critical perspective to understand their implications on extension work

CO3 : Equip with the strategies to effectively engage with stakeholders involved in the policy process, including government officials, community leaders, non-governmental organizations, and the beneficiaries of extension services

CO4 : Learn how to advocate for and lobby for policy changes that align with the goals of extension services

CO5 : Learn how to design, implement, and evaluate extension programs that are informed by current policies and potentially influence future policy-making.

EXT 602 (Methodology for Social and Behavioral Science)

CO1 : Develop critical skills in conducting systematic and objective research by using robust methods while minimizing biases and errors

CO2 : Intellectually choose and apply advanced methods and tools at every stage of research and execute them by managing the actors and processes effectively

CO3 : Develop expertise in designing tests, scales and index along with other tools to measure to measure the socio-psychological processes

CO4 : Developing research proposals and application of theoretical frameworks to guide the methodology of research projects

CO5 : Develop competencies in thinking about methodologies across disciplines and multidiscipline to enhance the robustness of research

EXT 603 (Technology Commercialization and Incubation)

CO1 : Understand the entire lifecycle of technology commercialization, from concept through development to market launch.

CO2 : Acquire knowledge to effectively manage intellectual property (IP) rights to protect innovations and maximize their commercial value.

CO3	:	Learn about the incubation and acceleration strategies
CO4	:	Develop skills in pitching their technology ventures to various stakeholders, including investors, partners, and customers.
CO5	:	Learn how to develop robust business models for technology ventures.

EXT 604 (Educational Technology and Instructional Design)

CO1	:	Develop the critical understanding of concept of leering and education within the concept of agricultural development
CO2	:	Learn to apply learning theories and models to the development, design and evaluation of courses utilizing education technology and instructional design
CO3	:	Impart the skills in taking up the research work in analysing and evaluating different learning systems, teaching- learning environments, competencies and learning outcomes
CO4	:	Encourage students to conduct research on current issues and trends in educational technology and instructional design.
CO5	:	Able to utilize the competencies in the industry for job-profile such as e-learning specialists, training officers, curriculum developer, instructional designers, education consultants

AG ECON 606 (Advanced Agricultural Marketing and Price Analysis)

CO1	:	Concepts of Agricultural Marketing, quantitative estimation of agricultural prices and analysis of software used in agriculture.
CO2	:	Marketing Institutions, functions and their efficiency.
CO3	:	Multi market estimation, GAP analysis. Current trend in information in the changing agri-food system.
CO4	:	Agricultural commodity marketing, price discovery, risk management and regulatory mechanism of future trading.
CO5	:	Estimation of lag operators, Heteroscedasticity models, methods of forecasting and price indices.

AG ECON 604 (Advanced Production Economics)

CO1	:	Understand Production Process and relationship between farm planning and production economics.
CO2	:	Analysis of Production Functions, its characteristics and interpretation.
CO3	:	Application of Decision making with multiple inputs and output.

CO4	:	Analysis of Technology, Efficiency and measurement of Risk and Uncertainty in agriculture.
CO5	:	Explain Simulation and programming techniques in agricultural production.

STAT 521 (Applied Regression Analysis)

CO1	:	Gain advanced Understanding of Regression Models and proficiency in model building
CO2	:	Proficient Handling complex data Structures using diagnostic and validation techniques
CO3	:	Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis
CO4	:	Application of regression analysis to real-world data relevant to the students' research interests
CO5	:	Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 522 (Data Analysis Using Statistical Packages)

CO1	:	To gain expertise and upgrade the competency in statistical softwares
CO2	:	To understand the statistical analytic tools with relevance to agriculture
CO3	:	To get the first-hand experience in data-cleaning, processing and data analysis tools
CO4	:	To understand and comprehend the data visualization tools and techniques application in agriculture
CO5	:	To apply the statistical softwares in experimental as well as ex-post facto studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agricultural Economics – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agricultural Economics)

PSO1 : To enhance the ability to understand the Advanced skills such as data analysis and management.

PSO2 : To provide researchers and students with a practical understanding of how agricultural economics applies in real-world scenarios.

PSO3 : To instil both qualitative and quantitative skills related to agricultural economics in students.

PSO4 : To assist students in cultivating entrepreneurial skills, enhancing decision-making abilities and recognizing and seizing economic opportunities.

Course Outcomes (COs)

Department – Ph. D. (Agricultural Economics)

AGECON 601 (Advanced Micro Economic Analysis)

CO1 : Explain advanced concepts and theories related to consumer behaviour, Indifference curves risk and uncertainty.

CO2 : Analyse advanced concepts and theories of production and **cost** and distinguish between different production functions.

CO3 : Explain different collusive and non-collusive market models.

CO4 : Analyse decision making and Game theory.

CO5 : Analyse various concepts and theories of equilibrium, welfare Economics and Social welfare function.

AEC 603 (Advanced Econometrics)

CO1 : Understand Advanced Econometrics Techniques.

CO2 : Applications of Least square methods and Linear Regression Models and their properties**.**

CO3 : Explain Dummy Variables, Probit and Logit model and their multinomial extensions.

CO4 : Critical Evaluation of Models and their extensions.

CO5 : Identification and estimation of Simultaneous equation methods.

AEC 602 (Advanced Macro Economic Analysis)

CO1 : Compare and contrast different macroeconomics models, consumption theories and explain their significance.

CO2 : Explain various theories of investment and interrelation between interest and investment and Multiplier and Accelerator.

CO3 : Analyse different post-Keynesian approaches to demand for money and supply of money.

CO4 : Critically examine the Neo classical Synthesis, IS-LM model, Inflation and Philips curve analysis.

CO5 : Evaluate the Macroeconomics Crises and related Policy Issues, Monetary and Fiscal Policy.

AG ECON 604 (Advanced Production Economics)

CO1 : Understand Production Process and relationship between farm planning and production economics.

CO2 : Analysis of Production Functions, its characteristics and interpretation.

CO3 : Analysis of resource use efficiency, frontier production function, total factor productivity, decision making under risk and uncertainty.

CO4 : Analysis of Technology, Efficiency and measurement of Risk and Uncertainty in agriculture.

CO5 : Explain Simulation and programming techniques in agricultural production.

AG ECON 605 (Quantitative Development Policy Analysis)

CO1 : Concepts of Policy framework, failure of policy and role of Quantitative policy analysis.

CO2 : Estimation of demand-supply analysis, supply response models and policy implications.

CO3 : Household behavior and Policy analysis, Policy options for sustainable agriculture development, measurement of poverty and poverty alleviation programmes.

CO4 : Analysis of partial equilibrium analysis, price distortions, Transaction cost and multi market approach to policy.

CO5 : Computation of Social Account Matrices and Multipliers

AEC ECON 606 (Advanced Agricultural Marketing and Price Analysis)

CO1 : Concepts of Agricultural Marketing, quantitative estimation of agricultural prices and analysis of software used in agriculture.

CO2 : Marketing Institutions, functions and their efficiency.

CO3 : Multi market estimation, GAP analysis. Current trend in information in the changing agri-food system.

CO4 : Agricultural commodity marketing, price discovery, risk management and

regulatory mechanism of future trading.

CO5 : Estimation of lag operators, Heteroscedasticity models, methods of forecasting and price indices.

EXT 601 (Advances in Agriculture Extension)

CO1 : Understand Production Process and relationship between farm planning and production economics.

CO2 : Analysis of Production Functions, its characteristics and interpretation.

CO3 : Application of Decision making with multiple inputs and output.

CO4 : Analysis of Technology, Efficiency and measurement of Risk and Uncertainty in agriculture.

CO5 : Explain Simulation and programming techniques in agricultural production.

EXT 602 (Advance Design and Techniques in Social Science Research)

CO1 : Students will acquire advanced skills in designing robust social science research studies.

CO2 : Enhance expertise in applying sophisticated quantitative analysis methods.

CO3 : Develop a deep understanding of advanced qualitative research techniques.

CO4 : Students will learn to implement ethical principles and practices in complex social science research.

CO5 : Students will gain skills in utilizing innovative data collection tools and methodologies.

EXT 603 (Advance in Training Technology)

CO1 : Understand the entire lifecycle of technology commercialization, from concept through development to market launch.

CO2 : Acquire knowledge to effectively manage intellectual property (IP) rights to protect innovations and maximize their commercial value.

CO3 : Learn about the incubation and acceleration strategies

CO4 : Develop skills in pitching their technology ventures to various stakeholders, including investors, partners, and customers.

CO5 : Learn how to develop robust business models for technology ventures.

EXT 604 (Organizational Development)

CO1	:	Develop the critical understanding of concept of learning and education within the concept of agricultural development
CO2	:	Learn to apply learning theories and models to the development, design and evaluation of courses utilizing education technology and instructional design
CO3	:	Impart the skills in taking up the research work in analysing and evaluating different learning systems, teaching- learning environments, competencies and learning outcomes
CO4	:	Encourage students to conduct research on current issues and trends in educational technology and instructional design.
CO5	:	Able to utilize the competencies in the industry for job-profile such as e-learning specialists, training officers, curriculum developer, instructional designers, education consultants

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Plant Pathology – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Plant Pathology)

PSO1 : To develop comprehensive understanding of plant diseases, laboratory techniques and experimental methodologies commonly used in plant pathology teaching & research

PSO2 : To fulfil the knowledge and skills necessary to develop integrated pest/Disease management strategies and to mitigate the impact of plant diseases on agricultural productivity sustainably.

PSO3 : To develop critical thinking and problem-solving abilities, allowing them to assess disease outbreaks, analyse data, and recommend appropriate control

measures tailored to specific crop systems and environmental conditions.

PSO4 : To demonstrate effective communication skills, both written and verbal, enabling to disseminate research findings, educate stakeholders, and collaborate with interdisciplinary teams to address complex challenges in plant health and food security.

Course Outcomes (COs)

Department – Ph. D. (Plant Pathology)

PL. PATH 601 (Advances in Mycology)

CO1 : Acquaint with importance of fungi in natural ecological system, development and economics of human civilization

CO2 : To interpret the role of various fungi as bioindicator

CO3 : To understand the biotechnological processes in different industries and applications in reference to fungi

CO4 : Study will also allow the development of various applied discipline, especially biomedical, pharmaceutical, agricultural and forestry sciences

CO5 : Obtained the global vision of fungi from the perspective of its " destructive role as from its creator role"

PL. PATH 602 (Advances Virology)

CO1 : Student acquaintance with Origin and Evolution of virus their properties.

CO2 : Acquaintance with the genome organization, replication and movement of viruses

CO3 : To gain the knowledge of Isolation, purification along with protein and nucleic acid based diagnostic methods

CO4 : To know the different symptoms and Mechanism of plant Virus Resistance.

CO5 : Acquaintance with the management practices of plant virus

PL. PATH 603 (Advanced Bacteriology)

CO1 : To acquaint with the bacteria, other prokaryotic cells

CO2 : To know the classification and nomenclature current scenario

CO3 : To learn the different mechanism and management practices of phytobacteria

CO4 : To acquire the knowledge of Infection, survival, dissemination and reproduction Plant prokaryotes

CO5	:	To gain the knowledge of variability, epidemiology and beneficial prospects of prokaryotes

PL. PATH 604 (Molecular basis of Host Pathogen Interaction)

CO1	:	To acquaint with compatible, non-compatible and basic reaction of host pathogen interaction.
CO2	:	To understand the physiological and pathological mechanism of diseases and their management
CO3	:	To extract the key issues and research specific areas of host pathogen interaction
CO4	:	To acquaint with biotechnological tools and genetic engineering approaches.
CO5	:	To acquaint with practical approaches of molecular Plant Pathology

PL. PATH 605 (Principles and Procedure of Certification)

CO1	:	To understand the certification principles
CO2	:	To know the regulatory requirement
CO3	:	To learn the documentation and record keeping
CO4	:	To understand the quality assurance, risk management, ethical consideration and communication skills
CO5	:	To develop problem solving abilities, improvement, evaluation and assessment of certification procedures

PL. PATH 606 (Plant Biosecurity and Biosafety)

CO1	:	To understand the plant biosecurity concept
CO2	:	To acquire the knowledge of plant pathogens and pest
CO3	:	To acquaint the risk assessment and management of potential threats to plant health and ecosystem
CO4	:	To aware with the importance of quarantine, procedures, regulations and protocols
CO5	:	To know the biosecurity measures

ENT 606 (Recent Trends in Biological Control)

CO1	:	To learn about scope importance of Insecticide Toxicology and Residues.
CO2	:	To acquaint with the latest advancements in the field of insecticide toxicology.
CO3	:	To study biochemical and physiological target sites of insecticides.

CO4	:	To know the latest technologies of bioassays, insecticide/ pesticide residue analysis.
CO5	:	To acquaint with the latest advancements in the field of insecticide pesticides resistance mechanisms in insects.

ENT 607 (Advances in Insecticide Toxicology)

CO1	:	To study the scope and importance of plant resistance to insects.
CO2	:	To know the recent advances in resistance of plants to insects.
CO3	:	To study the biotechnical approaches in host plant resistance.
CO4	:	To know Physical and chemical environment conferring resistance in plants, role trypsin inhibitors and protease inhibitors in plant resistance.
CO5	:	To acquaint with the biotechnical approaches in host plant resistance-genetic manipulation of secondary plant substances.

ENT 608 (Advanced Host Plant Resistance)

CO1	:	Typically include a combination of academic, research and practical competencies to learn the research methodology and interpretation of data
CO2	:	Practical implementation of theatrical knowledge, experimental design, data analysis to complete original research project that contributes new knowledge in the field of plant pathology
CO3	:	Ability to critically review scientific literatures, synthesizing of the current research findings.
CO4	:	Mastery in handling of the independent research projects, writing a comprehensive scholarly manner thesis and ability to defend research finding during viva voce
CO5	:	Well-prepared for careers in research, academia, industry, or governmental and non-governmental organizations focusing on plant health and disease management.

ENT 612 (Advanced Integrated Pest Management)

CO1	:	Understanding the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification
CO2	:	Understanding distinguishing characters, general biology, habits and habitats of insect orders including economically important families
CO3	:	Attainment of skills on collecting, mounting, and preserving insects
CO4	:	Knowledge on taxonomic keys and its importance in taxonomy
CO5	:	Identification of insects of major orders

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Entomology – (Old)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Entomology)

PSO1	:	To make the students very clear about the fundamental concepts about insect morphology, systematics, anatomy, physiology and ecology.
PSO2	:	To enriched the knowledge on recent developments in crop management, commercial entomology and, integrated pest management.
PSO3	:	To make the students familiar towards Nobel concepts like species distribution modeling, habit mapping, pest management
PSO4	:	To make the students understand about the basic research ethics, concepts and methodologies helpful to farming communities.

Course Outcomes (COs)

Department – Ph. D. (Entomology)

ENT 601 (Advanced Insect Physiology)

CO1	:	To know the importance and scope of insect's physiology.
CO2	:	To impart knowledge to the students on detailed physiology of various secretory and excretory systems.
CO3	:	To learned the detailed physiology of moulting process and chintin synthesis .
CO4	:	To understand on details of physiology of digestion and transmission of nerve impulses.
CO5	:	To gain the knowledge of nutrition of insects and pheromones.

ENT 605 Insect Behaviour

CO1	:	To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects.
CO2	:	To know the evolution of ecological characteristics.
CO3	:	Study of insect-plant interactions.
CO4	:	To know the definition of ecology branches of ecology and its importance.
CO5	:	To get acquainted with biodiversity and conservation.

ENT 606 (Recent Trends in Biological Control)

CO1	:	To learn about scope importance of Insecticide Toxicology and Residues.
CO2	:	To acquaint with the latest advancements in the field of insecticide toxicology.
CO3	:	To study biochemical and physiological target sites of insecticides.
CO4	:	To know the latest technologies of bioassays, insecticide/ pesticide residue analysis.
CO5	:	To acquaint with the latest advancements in the field of insecticide pesticides resistance mechanisms in insects.

ENT 607 (Advances in Insecticide Toxicology)

CO1	:	To study the scope and importance of plant resistance to insects.
CO2	:	To know the recent advances in resistance of plants to insects.
CO3	:	To study the biotechnical approaches in host plant resistance.
CO4	:	To know Physical and chemical environment conferring resistance in

plants, role trypsin inhibitors and protease inhibitors in plant resistance.

CO5 : To acquaint with the biotechnical approaches in host plant resistance-genetic manipulation of secondary plant substances.

PL. PATH 603 (Advanced Bacteriology)

CO1 : To acquaint with the bacteria, other prokaryotic cells

CO2 : To know the classification and nomenclature current scenario

CO3 : To learn the different mechanism and management practices of phytobacteria

CO4 : To acquire the knowledge of Infection, survival, dissemination and reproduction Plant prokaryotes

CO5 : To gain the knowledge of variability, epidemiology and beneficial prospects of prokaryotes

PL. PATH 604 (Molecular basis of Host Pathogen Interaction)

CO1 : To acquaint with compatible, non-compatible and basic reaction of host pathogen interaction

CO2 : To understand the physiological and pathological mechanism of diseases and their management

CO3 : To extract the key issues and research specific areas of host pathogen interaction

CO4 : To acquaint with biotechnological tools and genetic engineering approaches.

CO5 : To acquaint with practical approaches of molecular Plant Pathology

ENT 608 (Advanced Host Plant Resistance)

CO1 : Typically include a combination of academic, research and practical competencies to learn the research methodology and interpretation of data

CO2 : Practical implementation of theatrical knowledge, experimental design, data analysis to complete original research project that contributes new knowledge in the field of plant pathology

CO3 : Ability to critically review scientific literatures, synthesizing of the current research findings.

CO4 : Mastery in handling of the independent research projects, writing a comprehensive scholarly manner thesis and ability to defend research finding during viva voce

CO5 : Well-prepared for careers in research, academia, industry, or governmental and non-governmental organizations focusing on plant health and disease

management.

ENT 611 Molecular Approaches in Entomological Research

CO1	:	To understand the plant biosecurity concept
CO2	:	To understand the physiological and pathological mechanism of diseases and their management
CO3	:	To extract the key issues and research specific areas of host pathogen interaction
CO4	:	To acquaint with biotechnological tools and genetic engineering approaches.
CO5	:	To acquaint with practical approaches of molecular Plant Pathology

ENT 612 (Advanced Integrated Pest Management)

CO1	:	Understanding the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification
CO2	:	Understanding distinguishing characters, general biology, habits and habitats of insect orders including economically important families
CO3	:	Attainment of skills on collecting, mounting, and preserving insects
CO4	:	Knowledge on taxonomic keys and its importance in taxonomy
CO5	:	Identification of insects of major orders

PL. PATH 602 (Advances Virology)

CO1	:	Student acquaintance with Origin and Evolution of virus their properties.
CO2	:	Acquaintance with the genome organization, replication and movement of viruses
CO3	:	To gain the knowledge of Isolation, purification along with protein and nucleic acid based diagnostic methods
CO4	:	To know the different symptoms and Mechanism of plant Virus Resistance.
CO5	:	Acquaintance with the management practices of plant virus

PL. PATH 605 (Principles and Procedure of Certification)

CO1	:	To understand the certification principles
CO2	:	To know the regulatory requirement
CO3	:	To learn the documentation and record keeping
CO4	:	To understand the quality assurance, risk management, ethical

consideration and communication skills

CO5 : To develop problem solving abilities, improvement, evaluation and assessment of certification procedures

Supporting and Non-Gradial (PGS) subjects

STAT 521 Applied Regression Analysis

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 522 Data Analysis Using Statistical Packages

CO1 : Demonstrate proficiency in using statistical software package

CO2 : Learn to clean and prepare raw data for analysis, including handling missing values, outliers, and inconsistencies.

CO3 : Learn to calculate and interpret descriptive statistics, as well as conduct inferential analyses.

CO4 : Able to perform advanced data analysis techniques such as multivariate analysis, time series analysis, cluster analysis, factor analysis

CO5 : Enable the students to apply advanced production economics concepts and methods to analyse agricultural and industrial production systems.

PGS 501 Library and Information Services

CO1 : Study the history of Library and information science

CO2 : Study and understand management of Libraries and information centres

CO3 : Study information sources and services

CO4 : Study and understand the basics of Information technology and Library Automation

CO5 : Study the ICT applications in Libraries and information centres

PGS 502 Technical Writing and Communications Skills

CO1 : Development of the skills to write dissertations, research papers, etc.

CO2 : Induce the capacity and skills to write technical papers, reviews,

manuals, etc.

CO3	:	Train the learners to write the abstracts, summaries, précis, citations, etc.
CO4	:	Learners shall gain the knowledge about communication skills
CO5	:	Enable the students to participate in group discussion, facing interview and presentation of scientific papers

PGS 503 Intellectual Property and its Management in Agriculture

CO1	:	Understanding the basic concepts of Intellectual Property Rights
CO2	:	Understand the necessity of patents, copyright, trademark, GI
CO3	:	Development of design or some innovation for patent application
CO4	:	Acquire the knowledge about the rights related to Intellectual Property Rights
CO5	:	Learners shall know about the Protection of Plant Variety and Farmers Rights Act

PGS 504 Basic Concepts in Laboratory Techniques

CO1	:	To acquaint the students about the basics of commonly used techniques in laboratory
CO2	:	Gained knowledge on Safety measures, use and handling of laboratory equipment and chemical reagents while working in laboratory
CO3	:	Gained insights on soil, water and plant analysis for various parameters and biomolecule contents.
CO4	:	Development of capability to interpret the data and generate recommendations
CO5	:	Acquire knowledge on botanical terms in relation to taxonomy

PGS 505 Agriculture Research, Research Ethics and Rural Development Programmes

CO1	:	Learn about the Indian Agriculture Research system and Global agriculture research system
CO2	:	Understand the rural development status and programmes in India
CO3	:	Learn about knowledge of agriculture research ethics
CO4	:	Extend their knowledge of history of agriculture, historical stages of development of agriculture
CO5	:	Understand about Panchayati raj institutions, voluntary agencies/non-government organizations

PGS 506 Disaster Management

CO1	:	To collect knowledge about different types of Natural Disasters and its solutions
CO2	:	To collect knowledge about Man Made Disasters and its solutions
CO3	:	Analysis of Disaster and its management on the global level
CO4	:	Development of International Strategy for Disaster reduction
CO5	:	Analysis of role or govt and non govt organizations in the management of disaster

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agronomy – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agronomy)

PSO1	:	Learned to manage Agronomic problems, develop practical skills, analyze data scientifically, and draw logical conclusions.
PSO2	:	Specific knowledge of scientific and Advance agronomical practices of different cropping and farming system
PSO3	:	Student will exercise in modern agronomical practices along with natural resource management system
PSO4	:	Prepare students to understand major agronomical concepts, while also

providing opportunities for research, teaching, entrepreneurship, and leadership development across all disciplines of soil science.

Course Outcomes (COs)

Department – Ph. D. (Agronomy)

Agron-601 (Current trend in Agronomy)

CO1 : By exploring recent advances in the soil-plant-water relationship, we can gain a deeper understanding of the agro-physiological basis of yield variation and potentially improve crop productivity."

CO2 : To study about the recent development in precision agriculture and organic farming related to global market & ITK in organic farming

CO3 : To study about the technology related to cropping system and their management, GIS, GPS, remote sensing and IoT in agriculture

CO4 : Concept of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

CO5 : Conservation agriculture, robotics, drones & aeroplanes etc. in agriculture

Agron-602 (Recent Trends in Crop Growth and Productivity)

CO1 : To study the harvesting of the solar energy for crop productivity

CO2 : To acquire the knowledge of crop growth analysis and development, inter and mixed cropping and their criteria in assessing the yield advantages.

CO3 : To study the competitive relationship and competitive functions, in intercropping; dryland crop production; heat unit concept in crop maturity

CO4 : Concept of plant ideotypes of different crop, Exposure visit to hydroponic/aeroponic/aquaponic unit

CO5 : Growth hormones and their role in crop production, controlled environment agriculture, regenerative agriculture

Agron-603 (Irrigation Management)

CO1 : Water resources and irrigation projects in India, irrigation needs & methods, water deficits and crop growth

CO2 : Soil-plant-water relationships and crop productivity

CO3 : Water movement in soil, WUE and Application of irrigation water, water management under climate change scenario.

CO4 : Strategies of using limited water supply; management of ET, crop water stress

CO5 : Classification of land on the basis of suitability and irrigability; visit and water management in command area, Crop water production function, Hydroponics

Agron-604 (Recent trends in weed management)

CO1 : Crop weed competition; changes in weed flora, various causes and affects

CO2 : To know the physiological and biological aspect of herbicides; their mode of action and selectivity

CO3 : Phytotoxicity of herbicides; fate of herbicide in soil, their residue management, adjuvants

CO4 : Advance knowledge in herbicide application techniques; compatibility of herbicide

CO5 : Transgenic herbicide resistant crop; relationship of herbicide with other agronomic practices, use of nano herbicide, robotics, drones and aeroplanes, organic etc. in weed management

Agron 608 (Research and Public ethics)

CO1 : To study the introductory background of philosophy and ethics

CO2 : To acquire the Knowledge about ethics in respect to scientific research and publication

CO3 : To study open access publication and initiatives

CO4 : To acquaint the Knowledge of different software tools for publication misconduct

CO5 : To study the database and research metrics for quality research

Soils-602 (Modern concept in soil fertility)

CO1 : Nutrient availability; clay minerals and fertility status of major soils group of India

CO2 : Imparted the knowledge about nutrient movement and their transformation in soil

CO3 : To study the Modern concepts of fertilizer evaluation, application and nutrient budgeting.

CO4 : Monitoring physico-chemical and biological changes in soils; fertilizer use for sustainability.

CO5 : Experience on the knowledge of soil fertility and fertilizers in relation to plant growth, development and productivity

Soils – 605 (Biochemistry of Soil organic matter)

CO1 : Impart knowledge about biochemistry of organic substances and their significance in soils and methods of organic matter analysis.

CO2 : Current thinking of organic matter maintenance, Biochemistry of the humus formation; Carbon retention and sequestration.

CO3 : To provide knowledge about Nutrient transformation; trace metal interaction with humic substances

CO4 : Clay organic matter complexes. Humus-pesticide interactions and mechanisms in soil environment.

CO5 : Experience the knowledge of soil biochemistry on research for solving field problems.

Soils-606 (Soil Erosion & conservation)

CO1 : To study identification and description soil erosion of India

CO2 : Soil and water erosion, estimation, method of erosion measurement and soil loss valuation.

CO3 : Erosion control measures, agronomical and engineering erosion control structures

CO4 : Soil conservation planning for different regions and land of India

CO5 : Water harvesting, recycling case studies to monitoring watersheds, use of remote sensing in planning of watershed.

STAT-521 (Statistics applied regression on analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT-522 (Data Analysis Using Statistical package)

CO1	:	Demonstrate proficiency in using statistical software package
CO2	:	Learn to clean and prepare raw data for analysis, including handling missing values, outliers, and inconsistencies.
CO3	:	Learn to calculate and interpret descriptive statistics, as well as conduct inferential analyses.
CO4	:	Able to perform advanced data analysis techniques such as multivariate analysis, time series analysis, cluster analysis, factor analysis
CO5	:	Enable the students to apply advanced production economics concepts and methods to analyse agricultural and industrial production systems.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Vegetable science – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Vegetable science)

PSO1 : The scholar will acquire knowledge on crop improvement, production technologies and crop improvement through biotechnologies pertaining to vegetable crops with special reference to advancement in research.

PSO2 : The scholar will gain skills in approaching research problems and define research methodology for problems solving research in the field of vegetable crops.

PSO3 : The scholar will be able to conduct individual research works and become eligible to work in research programmes offered by national and international organizations in vegetable science.

PSO4 : The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

Course Outcomes (COs)

Department – Ph. D. (Vegetable science)

VSC 601 (Recent Trends in Vegetable Production)

CO1 : To know about the recent advances in vegetable production (solanaceous crops) tomato, brinjal, chilli, sweet paper and potato.

CO2 : To know about the recent advances in vegetable production (Cole crops) cabbage, cauliflower and knol-khol.

CO3 : To know about the recent advances in vegetable bhindi, onion, peas, beans, Amaranthus and drumsticks.

CO4 : To know about the recent advances in vegetable production carrot, beetroot and radish and cucurbits

CO5 : To know about the recent advances in vegetable production (tuber crops) sweet potato, tapioca, elephant foot yam and taro.

VSC 602 (Advances in Breeding of Vegetable Crops)

CO1 : To know about the breeding objectives and recent advances for crop improvement in solanaceous vegetables; Tomato, brinjal, chili, sweet pepper and potato.

CO2 : To know about the breeding objectives and recent advances for crop improvement in cucurbits and Cole vegetables; cucurbits, cabbage, cauliflower, and knol-khol.

CO3 : To know about the breeding objectives and recent advances for crop improvement in legumes and leafy vegetables; Bhindi, pea, beans, Amaranthus and drumstick.

CO4 : To know about the breeding objectives and recent advances for crop improvement in root and bulb vegetables; carrot, beet root, radish, onion and tuber vegetables; sweet potato, tapioca, elephant foot yam, colocasia and dioscorea.

CO5 : To acquire the knowledge of recent advances for vegetable crops through breeding methods

FSC 602 (Modern trends in fruit production)

CO1 : To keep the students abreast with latest developments and trends in

production technology of fruit crops

CO2 : To analyse the influence of rootstocks and planting systems for fruit production, and apply decision support systems for advances in fruit production

CO3 : To understand the essentialities and importance of crop modeling, precision farming in scientific fruit production

CO4 : Able to apply integrated and moderns approaches in water and nutrients management and total quality management (TQM) in fruit production

CO5 : To understand the climate change impact assessment and mitigation strategies for fruit production

STAT-521 (Statistics applied regression on analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT-522 (Data Analysis Using Statistical package)

CO1 : Demonstrate proficiency in using statistical software package

CO2 : Learn to clean and prepare raw data for analysis, including handling missing values, outliers, and inconsistencies.

CO3 : Learn to calculate and interpret descriptive statistics, as well as conduct inferential analyses.

CO4 : Able to perform advanced data analysis techniques such as multivariate analysis, time series analysis, cluster analysis, factor analysis

CO5 : Enable the students to apply advanced production economics concepts and methods to analyse agricultural and industrial production systems.

VSC 603 (Abiotic Stress Management in Vegetable Crops)

CO1 : To update knowledge on environment stress and its classification of

vegetable crops.

CO2 : To impart knowledge about mechanism and measurements of tolerance; drought, water logging, soil salinity, frost and heat stress in vegetable crops.

CO3 : To know about the soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

CO4 : To develop proficiency on use of chemicals in alleviation of stress conditions, identification of susceptibility and tolerance systems to various types of stresses.

CO5 : To acquire knowledge about the recent development through abiotic stress tolerance in diverse vegetable crops

VSC 604 (Seed Certification, Processing and Storage of Vegetable Crops)

CO1 : To gain knowledge about seed certification, seed agencies, seed certification standards and seed certification procedure.

CO2 : To gain knowledge about seed processing equipments, processing methods and seed packaging and handling.

CO3 : To know about seed treatment, storage, quality control of seed and methods of seed storage.

CO4 : To acquire knowledge about different test like- purity, vigour, sampling, germination seed viability, seed health and dormancy of seed

CO5 : To develop ability of marketing of seeds and their transportation. Advancement of seed treatment methods, seed priming and seed pelleting.

FSC 603 (Recent Development in Growth Regulations)

CO1 : To update knowledge on ecophysiological influences on growth and development of fruit crops

CO2 : To study about the role of New Generation Plant growth regulators and its application in fruit production

CO3 : To impart knowledge on Absorption, translocation and degradation of phytoharmones; Internal and external factors influencing hormonal synthesis

CO4 : To know about growth regulation aspects of propagation in fruit crops

CO5 : To update knowledge on flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity, ripening and storage

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Fruit Science– (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
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PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Fruit Science)

PSO1 : The scholar will acquire knowledge on crop improvement, production technologies, biotechnology and postharvest technologies pertaining to Fruit crops with special reference to advancement in research.

PSO2 : The scholar will develop skills in approaching research problems and define research methodology for problems solving research in the field of Fruit crops.

PSO3 : The scholar will be able to conduct individual research works and become eligible to work in research programmes offered by national and international

organizations in Fruit science.

PSO4 : The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

Course Outcomes (COs)

Department – Ph. D. (Fruit Science)

FSC 601 (Innovative Approaches in Fruit Breeding)

CO1 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of mango and banana.

CO2 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of papaya, grape s and citrus.

CO3 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of guava, sapota, pomegranate, kiwi fruit, strawberry and litchi.

CO4 : To update theoretical knowledge and developed practical skills on the recent research trends in the field of breeding of fruit crops with special emphasis on improvement of apple, pear plums, peaches, apricot, cherries and nut crops.

CO5 : To update theoretical knowledge and developed practical skills on transgenics, markers and bio-informatics tools and database for genomics research in fruit crops.

FSC 602 (Modern trends in fruit production)

CO1 : To keep the students abreast with latest developments and trends in production technology of fruit crops

CO2 : To analyse the influence of rootstocks and planting systems for fruit production, and apply decision support systems for advances in fruit production

CO3 : To understand the essentialities and importance of crop modeling, precision farming in scientific fruit production

CO4 : Able to apply integrated and moderns approaches in water and nutrients management and total quality management (TQM) in fruit production

CO5 : To understand the climate change impact assessment and mitigation strategies for fruit production

VSC 601 (Recent Trends in Vegetable Production)

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FSC 603 (Recent Development in Growth Regulations)

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CO2 : To study about the role of New Generation Plant growth regulators and its application in fruit production

CO3 : To impart knowledge on Absorption, translocation and degradation of phytoharmones; Internal and external factors influencing harmonal sysnthesis

CO4 : To know about growth regulation aspects of propagation in fruit crops

CO5 : To update knowledge on flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity, ripening and storage

FSC 606 (Abiotic stress management in fruit crops)

CO1 : To update Knowledge about abiotic stresses and its classifications

CO2 : To acquire knowledge on pollution and physiological and biochemical factors associated with stress

CO3 : To update Knowledge on the crop modeling for stress situations

CO4 : To acquire knowledge about greenhouse effect, PGRs in stress management, HSP inducer and stress management techniques

CO5 : To update knowledge on the rain water Harvesting, skimming technology and contingency planning to mitigate different stress situations

VSC 604 (Seed Certification, Processing and Storage of Vegetable Crops)

CO1 : To gain knowledge about seed certification, seed agencies, seed certification standards and seed certification procedure.

CO2 : To gain knowledge about seed processing equipments, processing methods and seed packaging and handling.

CO3 : To know about seed treatment, storage, quality control of seed and methods of seed storage.

CO4 : To acquire knowledge about different test like- purity, vigour, sampling, germination seed viability, seed health and dormancy of seed

CO5 : To develop ability of marketing of seeds and their transportation. Advancement of seed treatment methods, seed priming and seed pelleting.

STAT-521 (Statistics applied regression on analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT-522 (Data Analysis Using Statistical package)

CO1 : Demonstrate proficiency in using statistical software package

CO2 : Learn to clean and prepare raw data for analysis, including handling missing values, outliers, and inconsistencies.

CO3 : Learn to calculate and interpret descriptive statistics, as well as conduct inferential analyses.

CO4 : Able to perform advanced data analysis techniques such as multivariate analysis, time series analysis, cluster analysis, factor analysis

CO5 : Enable the students to apply advanced production economics concepts and methods to analyse agricultural and industrial production systems.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Soil Science– (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
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PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Soil Science)

PSO1 : Acquired knowledge and skills to manage problems associated with Soil Science. Developing practical skills, handling equipment, analysing and interpreting data in a scientific manner and coming to a logical conclusion.

PSO2 : Demonstrate the capability to analyse and evaluate, formulate coherent arguments, policies and theories with scientific approach to knowledge development in soil science.

PSO3 : Apply innovative solutions, independently and cooperatively, at local and global

level. Analyse and evaluate different soil conservation strategies based on specific environmental condition and land use patterns.

PSO4 : To prepare students demonstrating, solving, and understanding major concepts. Opportunity as researcher, teacher, entrepreneurship and helps in modern soil science and agriculture. Developing flexibility and leadership skills in all disciplines of soil science.

Course Outcomes (COs)

Department – Ph. D. (Soil Science)

SOIL 602 (Modern concept in Soil Fertility)

CO1 : Nutrient availability; fertility status of major soils group of India

CO2 : Imparted the knowledge about nutrient movement and their transformation in soil and submerged soil.

CO3 : To study the Modern concepts of fertilizer evaluation, application and nutrient budgeting.

CO4 : Monitoring physico-chemical and biological changes in soils; fertilizer use for sustainability.

CO5 : Experience on the knowledge of soil fertility and fertilizers in relation to plant growth, development and productivity

SOIL 603 (Physical Chemistry of Soil)

CO1 : Student will get knowledge about modern concepts of physical chemistry, processes involved with practical significance.

CO2 : Understand colloidal chemistry; thermodynamics, empirical structure and properties.

CO3 : To know ions adsorption/desorption and utility in agricultural system

CO4 : Solubility equilibria, electrochemical properties of clays for agricultural use.

CO5 : Student will acquaint the knowledge of soil chemical behaviour and research for solving field problems.

SOIL 605 (Biochemistry of Soil Organic Matter)

CO1 : Impart knowledge about biochemistry of organic substances and their significance in soils.

CO2 : Current thinking of organic matter maintenance, Biochemistry of the humus formation; Carbon retention and sequestration.

CO3 : To provide knowledge about Nutrient transformation; trace metal

interaction with humic substances

CO4 : Clay organic matter complexes. Humus-pesticide interactions and mechanisms.

CO5 : Experience the knowledge of soil biochemistry on research for solving field problems.

SOIL 601 (Recent trends in Soil Physics)

CO1 : Understanding the basic principles and practices of soil physics.

CO2 : Understanding soil-plant-atmospheric continuum (SPAC); Study theories of infiltration

CO3 : It suitable and closely related to soil and water conservation, agriculture, and engineering, etc.

CO4 : It directly provided knowledge of movement of salts in soils, Soil air, moisture, solar radiation in relation to plant growth.

CO5 : Skill development in identification of soil physical properties in relation to food insecurity caused by climate change

SOIL 606 (Soil Resource Management)

CO1 : To impart the knowledge about soil as resource, source and sink of greenhouse gases and its sustainable use.

CO2 : Sustainable land management through soil conservation practices and its relationship with soil quality

CO3 : To study land degradation; application of GIS and remote sensing; erosion control and conservation

CO4 : Watershed management; Agro-ecological regions of India for national and international soil policy considerations

CO5 : Experience on the knowledge of soil resources and research for solving field problems

SOIL 606 (Soil Genesis and Micro morphology)

CO1 : It imparts knowledge about the pedogenic processes and micro-pedological study in soils.

CO2 : Understand pedogenic evolution; composition and characterization of soils; weathering and soil formation

CO3 : Assessment of soil profile development by mineralogical and chemical analysis

CO4 : To study micro-pedological features of soils and role in genesis and

classification.

CO5 : To gain knowledge of soil genesis, taxonomy and micromorphology and related research for solving field problems

AGRON 602 (Recent Trends in Crop Growth and Productivity)

CO1 : To study the harvesting of the solar energy for crop productivity

CO2 : To acquire the knowledge of crop growth analysis and development, inter and mixed cropping and their criteria in assessing the yield advantages.

CO3 : To study the competitive relationship and competitive functions, in intercropping; dryland crop production; heat unit concept in crop maturity

CO4 : Concept of plant ideotypes of different crop

CO5 : Growth hormones and their role in crop production

AGRON 603 (Irrigation Management)

CO1 : Water resources of India, irrigation needs and water deficits and crop growth

CO2 : Soil-plant-water relationships and crop productivity

CO3 : Water movement in soil, WUE and Application of irrigation water, losses and their management

CO4 : Strategies of using limited water supply; management of ET

CO5 : Classification of land on the basis of suitability and irrigability; water management in command area

AGRON 604 (Recent trends in weed management)

CO1 : Advance knowledge of different weed management.

CO2 : Knowledge of herbicides their absorption, translocation metabolism.

CO3 : Knowledge of climate factors phytotoxicity of herbicides, residue management of herbicides

CO4 : Different application technique herbicide resistance, pesticides, herbicide rotation and herbicide mixtures.

CO5 : Development of transgenic herbicide resistant crops.

AGRON-601 (Current trends in Agronomy)

CO1 : Study Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship

CO2 : Globalization ,WTO, contract farming, organic farming, marketing and export potential of organic products,

CO3 : Crop residue management in multiple cropping, modern agriculture, weed management cropping systems, agro-forestry

CO4 : GIS,GPS and remote sensing, global warming

CO5 : Holistic approach farming system, dryland farming, research methodology

STAT 521 (Applied Regression Analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 522 (Data Analysis Using Statistical Packages)

CO1 : To gain expertise and upgrade the competency in statistical softwares

CO2 : To understand the statistical analytic tools with relevance to agriculture

CO3 : To get the first-hand experience in data-cleaning, processing and data analysis tools

CO4 : To understand and comprehend the data visualization tools and techniques application in agriculture

CO5 : To apply the statistical softwares in experimental as well as ex-post facto studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Genetics and Plant Breeding – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
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PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Genetics and Plant Breeding)

PSO1 : To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

PSO2 : This course focuses on the advanced techniques in analysing chromosome structure and manipulations for genome analysis in crop species.

PSO3 : To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in

plant breeding.

PSO4 : To provide insight into recent advances in improvement of cereals, millets and non-cereal crops using conventional and modern biotechnological approaches.

Course Outcomes (COs)

Department – Ph. D. (Genetics and Plant Breeding)

GP 601 (Advances in Plant Breeding Systems)

CO1 : Basics and facts of plant breeding and study about Self- incompatibility and male sterility system

CO2 : To study about Principles and procedures in the formation of a complex population.

CO3 : To learn about Creation of genetic variability selection methods for self and cross pollinated crops

CO4 : To understand general and specific combining ability for crop improvement

CO5 : Environmental influence on sterility and Apomixis and its use in heterosis breeding

GP 603 (Molecular Cytogenetics for Crop Improvement)

CO1 : Understand Genome Organization and Variation

CO2 : Master Cytogenetic Techniques and Gene Mapping

CO3 : Different cytological methods and B/A chromosome translocations and gene location

CO4 : Apply Chromosome Aberrations in Crop Improvement

CO5 : Integrate Cytogenetics and Polyploidy in Breeding Programs

GP 604 (Plant Genetics Resources, Conservation and Utilization)

CO1 : To learn History, Importance and principles of plant genetic resources

CO2 : Germplasm conservation and different categories of PGR management

CO3 : To learn about Genetic enhancement in pre and post Mendelian era

CO4 : To understand Distant Hybridization and crop improvement

CO5 : Application of biotechnology for Genetic enhancement

ENT 605 (Bio-inputs for Pest Management)

CO1 : To appraise the students about various Bio-Inputs for pest management.

CO2 : To acquainted with advantages and disadvantages of various bio-inputs.

CO3 : To know modern methods of biological control.

CO4 : To learned future scope of bio-inputs for pest management.

CO5 : Acquaintance with the use of bio-inputs their scope in cropping system-based pest management in agro-ecosystems.

GP 605 (Genomics in Plant Breeding)

CO1 : To understand genome complexity and chromosomal & mitochondrial genome

CO2 : To learning about Regulation of Plant gene expression, Functional genomics and gene Expression Analysis using Microarrays

CO3 : To study Genome sequencing in plants and their Principles and Techniques, Applications of sequence information in plant genome analyses

CO4 : Learning about Importance of understanding the phenotypes for exploiting the outcome of genomic technologies, TILLING and Eco- TILLING

CO5 : Learn to Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools

GP 602 (Advances in Biometrical Genetics)

CO1 : To learn about Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis

CO2 : Models in stability analysis, Multiplicative Interaction (AMMI) analysis and Principal Component Analysis.

CO3 : Analysis and selection of genotypes; Methods and steps to select the best model -Biplots and mapping genotypes

CO4 : Encourage students to learn Genetic architecture of quantitative traits; Conventional analyses to detect gene actions

CO5 : QTL mapping- Strategies for QTL mapping - desired populations, Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding

GP 609 (IPR and Regulatory Mechanism (e-course)]

CO1 : Understand the Foundations and Framework of Intellectual Property Rights (IPR)

CO2 : Explain TRIPs and Various Provisions in TRIPs Agreement:

CO3 : Recognize the Benefits of Securing Intellectual Property Rights (IPRs)

CO4 : Evaluate Indian Legislations for the Protection of Various Types of Intellectual Properties

CO5 : Discuss Fundamentals of Patents, Copyrights, Geographical Indications, Trade Secrets, Trademarks etc.

PL. PATH 604 (Molecular Basis of Host-pathogen Interaction)

CO1 : To acquaint with compatible, non-compatible and basic reaction of host pathogen interaction

CO2 : To understand the physiological and pathological mechanism of diseases and their management

CO3 : To extract the key issues and research specific areas of host pathogen interaction

CO4 : To acquaint with biotechnological tools and genetic engineering approaches.

CO5 : To acquaint with practical approaches of molecular Plant Pathology

STAT 521 (Applied Regression Analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

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CO3 : To get the first-hand experience in data-cleaning, processing and data

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CO4 : To understand and comprehend the data visualization tools and techniques application in agriculture

CO5 : To apply the statistical softwares in experimental as well as ex-post facto studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agriculture Extension – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
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PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
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Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agriculture Extension)

PSO1 : To carry out extension and outreach research on the basis of clientele needs

PSO2 : To carry out exploratory and ex-post facto research for agricultural innovations and interventions

PSO3 : To suggest research outcomes to promote the convergence and collaboration of stakeholders for sustainable agriculture

PSO4 : To link extension with teaching and research system through research

feedback for enabling the end-users to adopt the innovations in agriculture and allied sectors

Course Outcomes (COs)

Department – Ph. D. (Agriculture Extension)

EXT- 601 (Policy Engagement in Extension)

CO1 : Understanding of the policy frameworks at local, regional, and national levels that influence and govern extension services.

CO2 : Learn to analyse policies from a critical perspective to understand their implications on extension work

CO3 : Equip with the strategies to effectively engage with stakeholders involved in the policy process, including government officials, community leaders, non-governmental organizations, and the beneficiaries of extension services

CO4 : Learn how to advocate for and lobby for policy changes that align with the goals of extension services

CO5 : Learn how to design, implement, and evaluate extension programs that are informed by current policies and potentially influence future policy-making.

EXT 602 (Methodology for Social and Behavioral Science)

CO1 : Develop critical skills in conducting systematic and objective research by using robust methods while minimizing biases and errors

CO2 : Intellectually choose and apply advanced methods and tools at every stage of research and execute them by managing the actors and processes effectively

CO3 : Develop expertise in designing tests, scales and index along with other tools to measure to measure the socio-psychological processes

CO4 : Developing research proposals and application of theoretical frameworks to guide the methodology of research projects

CO5 : Develop competencies in thinking about methodologies across disciplines and multidiscipline to enhance the robustness of research

EXT 603 (Technology Commercialization and Incubation)

CO1 : Understand the entire lifecycle of technology commercialization, from concept through development to market launch.

CO2 : Acquire knowledge to effectively manage intellectual property (IP) rights to

protect innovations and maximize their commercial value.

CO3 : Learn about the incubation and acceleration strategies

CO4 : Develop skills in pitching their technology ventures to various stakeholders, including investors, partners, and customers.

CO5 : Learn how to develop robust business models for technology ventures.

EXT 604 (Educational Technology and Instructional Design)

CO1 : Develop the critical understanding of concept of learning and education within the concept of agricultural development

CO2 : Learn to apply learning theories and models to the development, design and evaluation of courses utilizing education technology and instructional design

CO3 : Impart the skills in taking up the research work in analysing and evaluating different learning systems, teaching- learning environments, competencies and learning outcomes

CO4 : Encourage students to conduct research on current issues and trends in educational technology and instructional design.

CO5 : Able to utilize the competencies in the industry for job-profile such as e-learning specialists, training officers, curriculum developer, instructional designers, education consultants

AG ECON 606 (Advanced Agricultural Marketing and Price Analysis)

CO1 : Concepts of Agricultural Marketing, quantitative estimation of agricultural prices and analysis of software used in agriculture.

CO2 : Marketing Institutions, functions and their efficiency.

CO3 : Multi market estimation, GAP analysis. Current trend in information in the changing agri-food system.

CO4 : Agricultural commodity marketing, price discovery, risk management and regulatory mechanism of future trading.

CO5 : Estimation of lag operations, Heteroscedasticity models, methods of forecasting and price indices.

AG ECON 604 (Advanced Production Economics)

CO1 : Understand Production Process and relationship between farm planning and production economics.

CO2 : Analysis of Production Functions, its characteristics and interpretation.

CO3 : Application of Decision making with multiple inputs and output.

CO4 : Analysis of Technology, Efficiency and measurement of Risk and Uncertainty in agriculture.

CO5 : Explain Simulation and programming techniques in agricultural production.

STAT 521 (Applied Regression Analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 522 (Data Analysis Using Statistical Packages)

CO1 : To gain expertise and upgrade the competency in statistical softwares

CO2 : To understand the statistical analytic tools with relevance to agriculture

CO3 : To get the first-hand experience in data-cleaning, processing and data analysis tools

CO4 : To understand and comprehend the data visualization tools and techniques application in agriculture

CO5 : To apply the statistical softwares in experimental as well as ex-post facto studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Agricultural Economics – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Agricultural Economics)

PSO1 : To enhance the ability to understand the Advanced skills such as data analysis and management.

PSO2 : To provide researchers and students with a practical understanding of how agricultural economics applies in real-world scenarios.

PSO3 : To instil both qualitative and quantitative skills related to agricultural economics in students.

PSO4 : To assist students in cultivating entrepreneurial skills, enhancing decision-making abilities and recognizing and seizing economic opportunities.

Course Outcomes (COs)

Department – Ph. D. (Agricultural Economics)

AEC 601 (Advanced Micro Economic Analysis)

CO1 : Explain advanced concepts and theories related to consumer behaviour, Indifference curves risk and uncertainty.

CO2 : Analyse advanced concepts and theories of production and **cost** and distinguish between different production functions.

CO3 : Explain different collusive and non-collusive market models.

CO4 : Analyse decision making and Game theory.

CO5 : Analyse various concepts and theories of equilibrium, welfare Economics and Social welfare function.

AEC 603 (Advanced Econometrics)

CO1 : Understand Advanced Econometrics Techniques.

CO2 : Applications of Least square methods and Linear Regression Models and their properties.

CO3 : Explain Dummy Variables, Probit and Logit model and their multinomial extensions.

CO4 : Critical Evaluation of Models and their extensions.

CO5 : Identification and estimation of Simultaneous equation methods.

AEC 602 (Advanced Macro Economic Analysis)

CO1 : Compare and contrast different macroeconomics models, consumption theories and explain their significance.

CO2 : Explain various theories of investment and interrelation between interest and investment and Multiplier and Accelerator.

CO3 : Analyse different post-Keynesian approaches to demand for money and supply of money.

CO4 : Critically examine the Neo classical Synthesis, IS-LM model, Inflation and Philips curve analysis.

CO5 : Evaluate the Macroeconomics Crises and related Policy Issues, Monetary and Fiscal Policy.

AG ECON 604 (Advanced Production Economics)

CO1	:	Understand Production Process and relationship between farm planning and production economics.
CO2	:	Analysis of Production Functions, its characteristics and interpretation.
CO3	:	Analysis of resource use efficiency, frontier production function, total factor productivity, decision making under risk and uncertainty.
CO4	:	Analysis of Technology, Efficiency and measurement of Risk and Uncertainty in agriculture.
CO5	:	Explain Simulation and programming techniques in agricultural production.

AG ECON 607 (Quantitative Development Policy Analysis)

CO1	:	Concepts of Policy framework, failure of policy and role of Quantitative policy analysis.
CO2	:	Estimation of demand-supply analysis, supply response models and policy implications.
CO3	:	Household behavior and Policy analysis, Policy options for sustainable agriculture development, measurement of poverty and poverty alleviation programmes.
CO4	:	Analysis of partial equilibrium analysis, price distortions, Transaction cost and multi market approach to policy.
CO5	:	Computation of Social Account Matrices and Multipliers

AEC 606 (Advanced Agricultural Marketing and Price Analysis)

CO1	:	Concepts of Agricultural Marketing, quantitative estimation of agricultural prices and analysis of software used in agriculture.
CO2	:	Marketing Institutions, functions and their efficiency.
CO3	:	Multi market estimation, GAP analysis. Current trend in information in the changing agri-food system.
CO4	:	Agricultural commodity marketing, price discovery, risk management and regulatory mechanism of future trading.
CO5	:	Estimation of lag operators, Heteroscedasticity models, methods of forecasting and price indices.

EXT 603 (Technology Commercialization and Incubation)

CO1 : Understand the entire lifecycle of technology commercialization, from concept through development to market launch.

CO2 : Acquire knowledge to effectively manage intellectual property (IP) rights to protect innovations and maximize their commercial value.

CO3 : Learn about the incubation and acceleration strategies

CO4 : Develop skills in pitching their technology ventures to various stakeholders, including investors, partners, and customers.

CO5 : Learn how to develop robust business models for technology ventures.

STAT 522 (Data Analysis Using Statistical Packages)

CO1 : To gain expertise and upgrade the competency in statistical softwares

CO2 : To understand the statistical analytic tools with relevance to agriculture

CO3 : To get the first-hand experience in data-cleaning, processing and data analysis tools

CO4 : To understand and comprehend the data visualization tools and techniques application in agriculture

CO5 : To apply the statistical softwares in experimental as well as ex-post facto studies

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Plant Pathology – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Plant Pathology)

PSO1 : To develop comprehensive understanding of plant diseases, laboratory techniques and experimental methodologies commonly used in plant pathology teaching & research

PSO2 : To fulfil the knowledge and skills necessary to develop integrated pest/Disease management strategies and to mitigate the impact of plant diseases on agricultural productivity sustainably.

PSO3 : To develop critical thinking and problem-solving abilities, allowing them to

assess disease outbreaks, analyse data, and recommend appropriate control measures tailored to specific crop systems and environmental conditions.

PSO4 : To demonstrate effective communication skills, both written and verbal, enabling to disseminate research findings, educate stakeholders, and collaborate with interdisciplinary teams to address complex challenges in plant health and food security.

Course Outcomes (COs)

Department – Ph. D. (Plant Pathology)

PL. PATH 601 (Advances in Mycology)

CO1 : Acquaint with importance of fungi in natural ecological system, development and economics of human civilization

CO2 : To interpret the role of various fungi as bioindicator

CO3 : To understand the biotechnological processes in different industries and applications in reference to fungi

CO4 : Study will also allow the development of various applied discipline, especially biomedical, pharmaceutical, agricultural and forestry sciences

CO5 : Obtained the global vision of fungi from the perspective of its " destructive role as from its creator role"

PL. PATH 602 (Advances in Plant Virology)

CO1 : Student acquaintance with Origin and Evolution of virus their properties.

CO2 : Acquaintance with the genome organization, replication and movement of viruses

CO3 : To gain the knowledge of Isolation, purification along with protein and nucleic acid based diagnostic methods

CO4 : To know the different symptoms and Mechanism of plant Virus Resistance.

CO5 : Acquaintance with the management practices of plant virus

PL. PATH 603 (Advances in Plant Pathogenic Prokaryotes)

CO1 : To acquaint with the bacteria, other prokaryotic cells

CO2 : To know the classification and nomenclature current scenario

CO3 : To learn the different mechanism and management practices of phytobacteria

CO4 : To acquire the knowledge of Infection, survival, dissemination and

reproduction Plant prokaryotes

CO5 : To gain the knowledge of variability, epidemiology and beneficial prospects of prokaryotes

PL. PATH 604 (Subject Name: Molecular basis of Host Pathogen Interaction)

CO1 : To acquaint with compatible, non-compatible and basic reaction of host pathogen interaction

CO2 : To understand the physiological and pathological mechanism of diseases and their management

CO3 : To extract the key issues and research specific areas of host pathogen interaction

CO4 : To acquaint with biotechnological tools and genetic engineering approaches.

CO5 : To acquaint with practical approaches of molecular Plant Pathology

PL. PATH 605 (Principles and Procedure of Certification)

CO1 : To understand the certification principles

CO2 : To know the regulatory requirement

CO3 : To learn the documentation and record keeping

CO4 : To understand the quality assurance, risk management, ethical consideration and communication skills

CO5 : To develop problem solving abilities, improvement, evaluation and assessment of certification procedures

PL. PATH 606 (Plant Biosecurity and Biosafety)

CO1 : To understand the plant biosecurity concept

CO2 : To acquire the knowledge of plant pathogens and pest

CO3 : To acquaint the risk assessment and management of potential threats to plant health and ecosystem

CO4 : To aware with the importance of quarantine, procedures, regulations and protocols

CO5 : To know the biosecurity measures

ENT 605 (Bio-inputs for Pest Management)

CO1 : To appraise the students about various Bio-Inputs for pest management.

CO2 : To acquainted with advantages and disadvantages of various bio-inputs.

CO3 : To know modern methods of biological control.

CO4 : To learned future scope of bio-inputs for pest management.

CO5 : Acquaintance with the use of bio-inputs their scope in cropping system-based pest management in agro-ecosystems.

ENT 606 (Insecticide Toxicology and Residues)

CO1 : To learn about scope importance of Insecticide Toxicology and Residues.

CO2 : To acquaint with the latest advancements in the field of insecticide toxicology.

CO3 : To study biochemical and physiological target sites of insecticides.

CO4 : To know the latest technologies of bioassays, insecticide/ pesticide residue analysis.

CO5 : To acquaint with the latest advancements in the field of insecticide pesticides resistance mechanisms in insects.

ENT 608 (Advanced Host Plant Resistance)

CO1 : Typically include a combination of academic, research and practical competencies to learn the research methodology and interpretation of data

CO2 : Practical implementation of theatrical knowledge, experimental design, data analysis to complete original research project that contributes new knowledge in the field of plant pathology

CO3 : Ability to critically review scientific literatures, synthesizing of the current research findings.

CO4 : Mastery in handling of the independent research projects, writing a comprehensive scholarly manner thesis and ability to defend research finding during viva voce

CO5 : Well-prepared for careers in research, academia, industry, or governmental and non-governmental organizations focusing on plant health and disease management.

ENT 612 (Advanced Integrated Pest Management)

CO1 : Understanding the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification

CO2 : Understanding distinguishing characters, general biology, habits and habitats of insect orders including economically important families

CO3 : Attainment of skills on collecting, mounting, and preserving insects

CO4 : Knowledge on taxonomic keys and its importance in taxonomy

CO5 : Identification of insects of major orders

STAT 521 (Applied Regression Analysis)

CO1 : Gain advanced Understanding of Regression Models and proficiency in model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 531 (Data Analysis using Statistical packages)

CO1 : Demonstrate proficiency in using statistical software package

CO2 : Learn to clean and prepare raw data for analysis, including handling missing values, outliers, and inconsistencies.

CO3 : Learn to calculate and interpret descriptive statistics, as well as conduct inferential analyses.

CO4 : Able to perform advanced data analysis techniques such as multivariate analysis, time series analysis, cluster analysis, factor analysis

CO5 : Enable the students to apply advanced production economics concepts and methods to analyse agricultural and industrial production systems.

Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes of Ph. D. Entomology – (Restructured)

Programme Outcomes (POs)

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Long-Life Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes (PSOs)

Department – Ph. D. (Entomology)

PSO1 : To make the students very clear about the fundamental concepts about insect morphology, systematics, anatomy, physiology and ecology.

PSO2 : To enriched the knowledge on recent developments in crop management, commercial entomology and, integrated pest management.

PSO3 : To make the students familiar towards Nobel concepts like species distribution modeling, habit mapping, pest management

PSO4 : To make the students understand about the basic research ethics, concepts and methodologies helpful to farming communities.

Course Outcomes (COs)

Department – Ph. D. (Entomology)

ENT 601 (Insect Phylogeny and Systematics)

CO1 : To familiarize the students with different schools of classification.

CO2 : Acquaint with importance of phylogenetics.

CO3 : To understand the classical and molecular methods of classification.

CO4 : Detailed study about the international code of Zoological Nomenclature.

CO5 : To study evolution of different groups of insects, ethics and procedure for taxonomic publications.

ENT 603 (Insect Ecology and Diversity)

CO1 : To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects.

CO2 : To know the evolution of ecological characteristics.

CO3 : Study of insect-plant interactions.

CO4 : To know the definition of ecology branches of ecology and its importance.

CO5 : To get acquainted with biodiversity and conservation.

ENT 605 (Bio-inputs for Pest Management)

CO1 : To appraise the students about various Bio-Inputs for pest management.

CO2 : To acquainted with advantages and disadvantages of various bio-inputs.

CO3 : To know modern methods of biological control.

CO4 : To learned future scope of bio-inputs for pest management.

CO5 : Acquaintance with the use of bio-inputs their scope in cropping system-based pest management in agro-ecosystems.

ENT 602 (Insect Physiology and Nutrition)

CO1 : To know the importance and scope of insect's physiology.

CO2 : To impart knowledge to the students on detailed physiology of various secretory and excretory systems.

CO3 : To learned the detailed physiology of moulting process and chintin

synthesis .

CO4 : To understand on details of physiology of digestion and transmission of nerve impulses.

CO5 : To gain the knowledge of nutrition of insects and pheromones.

ENT 606 (Insecticide Toxicology and Residues)

CO1 : To learn about scope importance of Insecticide Toxicology and Residues.

CO2 : To acquaint with the latest advancements in the field of insecticide toxicology.

CO3 : To study biochemical and physiological target sites of insecticides.

CO4 : To know the latest technologies of bioassays, insecticide/ pesticide residue analysis.

CO5 : To acquaint with the latest advancements in the field of insecticide pesticides resistance mechanisms in insects.

ENT 607 (Plant Resistance to Insects)

CO1 : To study the scope and importance of plant resistance to insects.

CO2 : To know the recent advances in resistance of plants to insects.

CO3 : To study the biotechnical approaches in host plant resistance.

CO4 : To know Physical and chemical environment conferring resistance in plants, role trypsin inhibitors and protease inhibitors in plant resistance.

CO5 : To acquaint with the biotechnical approaches in host plant resistance-genetic manipulation of secondary plant substances.

PL. PATH 603 (Advances in Plant Pathogenic Prokaryotes)

CO1 : To acquaint with the bacteria, other prokaryotic cells

CO2 : To know the classification and nomenclature current scenario

CO3 : To learn the different mechanism and management practices of phytobacteria

CO4 : To acquire the knowledge of Infection, survival, dissemination and reproduction Plant prokaryotes

CO5 : To gain the knowledge of variability, epidemiology and beneficial prospects of prokaryotes

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CO1 : Gain advanced Understanding of Regression Models and proficiency in

model building

CO2 : Proficiency in Handling complex data Structures using diagnostic and validation techniques

CO3 : Gain proficiency in using advanced statistical software tools (e.g., R, SAS, Stata) for conducting regression analysis

CO4 : Application of regression analysis to real-world data relevant to the students' research interests

CO5 : Learn to integrate regression analysis into the broader design of empirical research studies, including planning data collection and analysis strategies that align with their research questions and hypotheses

STAT 522 (Data Analysis Using Statistical Packages)

CO1 : To gain expertise and upgrade the competency in statistical softwares

CO2 : To understand the statistical analytic tools with relevance to agriculture

CO3 : To get the first-hand experience in data-cleaning, processing and data analysis tools

CO4 : To understand and comprehend the data visualization tools and techniques application in agriculture

CO5 : To apply the statistical softwares in experimental as well as ex-post facto studies

Non-Gradial (PGS) Courses

PGS 501 Library and Information Services

CO1	:	Study the history of Library and information science
CO2	:	Study and understand management of Libraries and information centres
CO3	:	Study information sources and services
CO4	:	Study and understand the basics of Information technology and Library Automation
CO5	:	Study the ICT applications in Libraries and information centres

PGS 502 Technical Writing and Communications Skills

CO1	:	Development of the skills to write dissertations, research papers, etc.
CO2	:	Induce the capacity and skills to write technical papers, reviews, manuals, etc
CO3	:	Train the learners to write the abstracts, summaries, précis, citations, etc.
CO4	:	Learners shall gain the knowledge about communication skills
CO5	:	Enable the students to participate in group discussion, facing interview and presentation of scientific papers

PGS 503 Intellectual Property and its Management in Agriculture

CO1	:	Understanding the basic concepts of Intellectual Property Rights
CO2	:	Understand the necessity of patents, copyright, trademark, GI
CO3	:	Development of design or some innovation for patent application
CO4	:	Acquire the knowledge about the rights related to Intellectual Property Rights
CO5	:	Learners shall know about the Protection of Plant Variety and Farmers Rights Act

PGS 504 Basic Concepts in Laboratory Techniques

CO1	:	To acquaint the students about the basics of commonly used techniques in laboratory
CO2	:	Gained knowledge on Safety measures, use and handling of laboratory equipment and chemical reagents while working in laboratory
CO3	:	Gained insights on soil, water and plant analysis for various parameters and biomolecule contents.
CO4	:	Development of capability to interpret the data and generate recommendations
CO5	:	Acquire knowledge on botanical terms in relation to taxonomy

PGS 505 Agriculture Research, Research Ethics and Rural Development Programmes

CO1	:	Learn about the Indian Agriculture Research system and Global agriculture research system
CO2	:	Understand the rural development status and programmes in India
CO3	:	Learn about knowledge of agriculture research ethics
CO4	:	Extend their knowledge of history of agriculture, historical stages of development of agriculture
CO5	:	Understand about Panchayati raj institutions, voluntary agencies/non-government organizations