

7 Agronomy

TRIMESTER WISE DISTRIBUTION OF COURSES

I TRIMESTER

		L	P
AGR 001	AGRONOMY OF RAINY SEASON CROPS	1	2
AG 503	PRINCIPLES AND PRACTICES OF WEED MANAGEMENT	3	1
AG 505	DRYLAND FARMING AND WATERSHED MANAGEMENT	3	1
AG 506	AGRONOMY OF CEREAL CROPS	3	1
AG 510/ SSAC 510 / WST 510	MANAGEMENT OF PROBLEM SOILS AND WATERS	3	1
AG 601	MODERN CONCEPTS IN AGRONOMY	3	1
AG 603	FARMING SYSTEMS	3	1
AG 691	SEMINAR	1	0

II TRIMESTER

AGR 002	AGRONOMY OF WINTER SEASON CROPS	1	2
AG 501	PRINCIPLES OF CROP PRODUCTION	3	1
AG 504/ WST 504	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	3	1
AG 507	AGRONOMY OF PULSE AND OILSEED CROPS	3	1
AG 508	AGRONOMY OF COMMERCIAL CROPS	3	1
AG 602	EXPERIMENTAL TECHNIQUES IN AGRONOMY	2	2
AG 604	PRINCIPLES AND PRACTICES OF ORGANIC FARMING	2	1
AG 691	SEMINAR	1	0

III TRIMESTER

AGR 003	AGRONOMY OF SUMMER SEASON CROPS	1	1
AG 502/ SSAC 502 /AP 502	SOIL FERTILITY AND NUTRIENT MANAGEMENT	3	1
AG 509	AGRONOMY OF FODDER AND PASTURE CROPS	3	1
AG 511/ AP 511	CROP ECOLOGY AND AGROMETEOROLOGY	3	1

AG 606	CROP PRODUCTION AND SIMULATION MODELING	2	1
AG 607/ PP 607	PHYSIOLOGY AND BIOCHEMISTRY OF HERBICIDE ACTION	3	1
AG 691	SEMINAR	1	0

Core courses

M.Sc.

Within the discipline: AG 501, AG 502, AG 503, AG 504 and AG 505

Outside the discipline: AS 501 and AS 502

Core courses for Ph.D.

Within the discipline: AG 601, AG 602 and AG 603

AGRONOMY

Major Field : Agronomy

Minor Fields : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

DESCRIPTION OF COURSES

AGR 001 AGRONOMY OF RAINY SEASON CROPS

(1L+2P) I

Objective

To provide basic knowledge to non-agricultural graduates about the rainy season crops and their cultivation practices

Theory

UNIT I

Tillage in crop production, soil fertility management, weeds and their control, concept of cropping and farming system.

UNIT II

Agronomic practices for cultivation of rainy season cereals – rice, maize, sorghum, pearl millet and minor millets.

UNIT III

Agronomic practices for cultivation of rainy season pulses – pigeonpea, greengram, blackgram and cowpea.

UNIT IV

Agronomic practices for cultivation of rainy season oilseeds – groundnut, soybean and sesamum.

UNIT V

Agronomic practices for cultivation of rainy season fibre crops – cotton and jute.

Practicals

Crop plants morphology, taxonomy, and nomenclature. Identification of rainy season crops and their seeds. Identification of rainy season weeds. Soil sampling and determination of bulk density and moisture content of soil. Field preparation and sowing methods of different crops. Calculation of seed and fertilizer requirement of rainy season crops. Herbicide requirement calculations. Cultivation practices including planting methods, nutrient and weed management, and irrigation scheduling for rainy season crops. Biometric studies and yield determination of rainy season crops. Plant herbarium preparation.

Suggested Readings

- Das, N.R. 2007. *Introduction to Crops in India*. Scientific Publishers.
- Das, T.K. 2008. *Weed Science – Basics and Applications*. Jain Brothers, New Delhi.
- Hunsigi, C. and Krishna, K.R. 1998. *Science of Field Crops Production*. Oxford & IBH.
- Kumar, Ashok, Dhar, Shiva, Rana, D.S. and Singh, R. 200. *Elementary Agronomy – A Practical Manual*. Division of Agronomy, IARI, New Delhi.
- Reddy, Y.T. and Reddi, S.G.H. 1992. *Principles of Agronomy*. Kalyani Publishers.
- Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Crops*. Oxford & IBH.
- Singh, S.S. 1983. *Crop Management Under Irrigated and Rainfed Conditions*. Kalyani Publishers.
- Singh, S.S. 1986. *Principles and Practices of Agronomy*. Kalyani Publishers.

AGR 002 AGRONOMY OF WINTER SEASON CROPS

(1L+2P) II

Objective

To provide basic knowledge to non-agricultural graduates about the winter season crops and their cultivation practices

Theory

UNIT I

Soil-water-plant relationship, irrigation scheduling, methods of irrigation and moisture conservation techniques.

UNIT II

Agronomic practices for cultivation of winter season cereals - wheat, barley, oats and winter maize.

UNIT III

Agronomic practices for cultivation of winter season pulses - chickpea, lentil and field peas.

UNIT IV

Agronomic practices for cultivation of winter season oilseeds - mustard, sunflower, safflower and linseed.

UNIT V

Agronomic practices for cultivation of sugarcane and potato.

Practicals

Crop plants morphology, taxonomy, and nomenclature. Identification of winter season crops and their seeds. Identification of winter season weeds. Soil sampling and determination of bulk density and moisture content of soil. Field preparation and sowing methods of different crops. Calculation of seed and fertilizer requirements of winter season crops. Herbicide requirement calculations. Cultivation practices including planting methods, nutrient and weed management, and irrigation scheduling for winter season crops. Biometric studies and yield determination of winter season crops. Plant herbarium preparation.

Suggested Readings

- Das, N.R. 2007. *Introduction to Crops in India*. Scientific Publishers.
- Das, T.K. 2008. *Weed Science – Basics and Applications*. Jain Brothers, New Delhi.
- Hunsigi, C. and Krishna, K.R. 1998. *Science of Field Crops Production*. Oxford & IBH.
- Kumar, Ashok, Dhar, Shiva, Rana, D.S. and Singh, R. 200. *Elementary Agronomy – A Practical Manual*. Division of Agronomy, IARI, New Delhi.
- Reddy, Y.T. and Reddi, S.G.H. 1992. *Principles of Agronomy*. Kalyani Publishers.
- Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Crops*. Oxford & IBH.
- Singh, S.S. 1983. *Crop Management Under Irrigated and Rainfed Conditions*. Kalyani Publishers.
- Singh, S.S. 1986. *Principles and Practices of Agronomy*. Kalyani Publishers.

AGR 003 AGRONOMY OF SUMMER SEASON CROPS

(1L+1P) III

Objective

To provide basic knowledge to non-agricultural graduates about the spring and summer season crops and their cultivation practices

Theory

UNIT I

Importance of summer ploughing, seed-bed and nursery management, green manuring, important pests and their control.

UNIT II

Agronomic practices for cultivation of summer season fodder crops – maize, sorghum and pearl millet.

UNIT III

Agronomic practices for cultivation of summer/spring season crops - greengram, cowpea, blackgram, sunflower as well as green manures.

Practicals

Summer ploughing, seed-bed preparation and moisture conservation techniques. Crop plants morphology, taxonomy, and nomenclature. Field preparation and sowing methods of different spring / summer season crops. Identification of summer season crops, their seeds and weeds. Calculation of seed and fertilizer requirements of summer / spring season crops. Cultivation practices including planting methods, nutrient and weed management, and irrigation scheduling for summer season crops. Biometric studies and yield determination of summer season crops. Plant herbarium preparation.

Suggested Readings

- Das, N.R. 2007. *Introduction to Crops in India*. Scientific Publishers.
- Das, T.K. 2008. *Weed Science – Basics and Applications*. Jain Brothers, New Delhi.
- Hunsigi, C. and Krishna, K.R. 1998. *Science of Field Crops Production*. Oxford & IBH.

Kumar, Ashok, Dhar, Shiva, Rana, D.S. and Singh, R. 200. *Elementary Agronomy – A Practical Manual*. Division of Agronomy, IARI, New Delhi.

Reddy, Y.T. and Reddi, S.G.H. 1992. *Principles of Agronomy*. Kalyani Publishers.

Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Crops*. Oxford & IBH.

Singh, S.S. 1983. *Crop Management Under Irrigated and Rainfed Conditions*. Kalyani Publishers.

Singh, S.S. 1986. *Principles and Practices of Agronomy*. Kalyani Publishers.

AG 501 PRINCIPLES OF CROP PRODUCTION

(3L+1P) II

Objective

To teach the basic concepts of soil and crop management along with quantitative agro-biological principles and crop growth analysis

Theory

UNIT I

Historical aspects of crop production, genesis of scientific principles and modern concepts of crop production.

UNIT II

Quantitative agro-biological principles and their validity; Mitscherlich yield equation, its interpretation and validity; concept of inverse yield nitrogen law and Boule unit.

UNIT III

Conceptual development in tillage practices, resources conservation technologies, conservation agriculture, integrated farming systems, organic farming and precision agriculture.

UNIT IV

Theoretical concepts involved in growth analysis in relation to environment; validity and limitations in interpreting crop growth; different types of growth curves; root:shoot relationship; concept of plant ideotypes; physiological principles of dryland crop production; stress and strains - nature, injury, resistance and management.

UNIT V

Concepts of soil-plant relationships, yield potential of crops and cropping systems and their relationship to fertility status of soil; maximization of crop yields and the apparent limitations.

UNIT VI

Crop plants in relation to environment, competition between component crop plants in mixed crop and between crops and weeds; solar radiation, available moisture regime and crop production.

UNIT VII

Economics of crop production, law of diminishing returns in crop production, and crop response production functions.

Practicals

Plant sampling at different crop growth stages for dry matter and leaf area measurement. Calculation of growth indices using dry matter and leaf area, and interpretation of results in relation to treatments. Construction of crop growth curve based on growth analysis data. Measurement of

root:shoot relationship in crops at different growth stages. Computation of harvest index of different crops based on biomass and energy equivalent. Working out sustainability index of different cropping systems. Calculation of indices for assessment of cropping systems and input-use efficiency. Studying the effect of planting geometry on competition between crop plants, crop plants and weeds and input-use efficiency. Assessment of crop yield on the basis of yield attributing characters. Statistical analysis of fertilizer experiments to work out response equation, and optimum/economic dose of nutrients.

Suggested Readings

- Balasubramaniyan, P. and Palaniappan, SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
- Fageria, N.K. 1992. *Maximizing Crop Yields*. Marcel Dekker.
- Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, W.L. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Paroda, R.S. 2003. *Sustaining our Food Security*. Konark Publ.
- Reddy, S.R. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran, S. and Mudaliar, T.V.S. 1997. *Principles of Agronomy*. Bangalore Printing & Publ.
- Singh, S.S. 2006. *Principles and Practices of Agronomy*. Kalyani Publ.

AG 502 / SSAC 502 / AP 502 SOIL FERTILITY AND NUTRIENT MANAGEMENT (3L+1P) III

Objective

To teach basics of soil fertility, techniques of soil fertility evaluation, plant nutrients, integrated approach of plant nutrition, and environmental quality

Theory

UNIT I

Historical aspects of soil fertility, essential plant nutrients - criteria of essentiality, classification, functions, deficiency and toxicity symptoms, beneficial elements.

UNIT II

Carbon cycle in nature, carbon stocks, sequestration, greenhouse effects, different carbon pools in soil and their role in maintaining soil quality and productivity; soil organisms and their role in soil fertility.

UNIT III

Transformations and dynamics of major- and micro-nutrients in soils and their availability to plants.

UNIT IV

Nutrient interactions in soils and plants: concept, different types of interaction, interaction among essential plant nutrients, law of minimum and maximum.

UNIT V

Commercial fertilizers, new fertilizer materials and principles of their evaluation, crop response to fertilizer application and use efficiency, economics of fertilizer use, nutrient requirements of crops and cropping systems in sustainable agriculture and quality of the produce, foliar nutrition of crop plants.

UNIT VI

Soil fertility evaluation: different approaches, soil and plant tests, biological tests, hidden hunger. Critical nutrient concentration - concept and determination (graphical and statistical procedures), critical nutrient range, diagnosis recommendation and integrated system (DRIS).

UNIT VII

Integrated nutrient management - concept, objectives and components; organic farming: principles, practices and its impact on soil processes; precision farming - concept and practices. Organic manures including compost, farmyard manure, green manure and crop residues.

UNIT VIII

Fertilizer x water interactions, crop production under fertilizer / water constraints, site-specific nutrient management - concept and practices; summary of long-term fertilizer experiments.

Practicals

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 micronutrients). Analysis of plants for essential elements (major and micronutrients).

Suggested Readings

Brady, N.C. and Weil, R.R. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Epstein, E. and Bloom, A. 2005. *Mineral Nutrition of Plants: Principles and Perspectives*. Second edition. Sinauer Associates.

Fageria, N.K., Baligar, V.C. and Jones, C.A. 1991. *Growth and Mineral Nutrition of Field Crops*. Marcel Dekker.

Goswami, N.N., Rattan, R.K., Dev, G., Narayanasamy, G., Das, D.K., Sanyal, S.K., Pal, D.K. and Rao, D.L.N. 2009. *Fundamentals of Soil Science*. Second Edition. Indian Society of Soil Science, New Delhi.

Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson W. L. 2006. *Soil Fertility and Fertilizers*, 7th Edn. Prentice Hall, New Delhi.

Khasawneh, F.E., Sample, E.C. and Kamprath, E.J. (Eds.) 1980. *The Role of Phosphorus in Agriculture*. Soil Science Society of America, Madison, Wisconsin, USA.

Marschner, H. 1995. *Mineral Nutrition of Higher Plants*. Second Edition. Academic Press Ltd.

Mortvedt, J.J., Cox, F.R., Shuman, L.M. and Welch, R.M. (Eds.) 1991. *Micronutrients in Agriculture*, Second Edn. Soil Science Society of America, Madison, Wisconsin, USA.

Pierzynski, G.W., Sims, J.T. and Vance, G.F. 2002. *Soils and Environmental Quality*. Second Edn.

Prasad, R. and Power, J.F. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Srivastava, P.C. and Gupta, U.C. 1996. *Trace Elements in Crop Production*. Oxford and IBH, New Delhi.

Stevenson, F.J. (Ed.) 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison, Wisconsin, USA.

Stevenson, F.J. 1986. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulfur and Micronutrients*. John Wiley and Sons, New York.

Sumner, A.M.E. (Ed.) 2000. *Handbook of Soil Science*. CRC Press, Boca Raton, USA.

Swarup, A., Damodar Reddy, D. and Prasad, R.N. (Eds.) 1998. *Long-term Soil Fertility Management through Integrated Plant Nutrient Supply*. IISS, Bhopal.

Tandon, H.L.S. (Ed.) 1995. *Management of Nutrient Interactions in Agriculture*. FDCO, New Delhi.

Yawalkar, K.S., Agrawal, J.P. and Bokde, S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

AG 503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT

(3L+1P) I

Objective

To provide basic and applied knowledge of weed science to the students, and to make them acquainted with weeds, herbicides, and weed management and research methods

Theory

UNIT I

Weeds and their importance - harmful and beneficial aspects, weed characteristics and classification.

UNIT II

Weed multiplication/propagation – seed dormancy, viability, germination and dissemination of weeds; crop-weed competition/ interference, allelopathy.

UNIT III

Weed management principles and methods/options – preventive, physical, cultural, biological, chemical and integrated weed management approaches.

UNIT IV

History and properties of herbicides, differences with other pesticides, classification of herbicides based on miscellany, chemistry (organic and inorganic) and physiology, structure - activity and selectivity.

UNIT V

Herbicide injury symptoms, physiology/biochemistry of mode/mechanisms of action, herbicide transformations in plants and soil, herbicide formulations and applications; herbicide mixtures; herbicide resistance and management, herbicide residues in environment.

UNIT VI

Weed management in major crops and cropping systems, and non-cropped situations; perennial, aquatic, parasitic and invasive weeds management.

UNIT VII

Biotechnological applications in weed management; herbicide tolerant crops - risks and opportunities.

Practicals

Weeds and weed seeds identification. Determination of IVI (importance value index). Methodologies in studying crop-weed interference. Calibration of a sprayer, and volume, rate and swath width calculations. Herbicide application equipment and accessories, and application techniques. Herbicide formulations demonstration. Bioassay technique for the analysis of herbicide residues in soil. Determination of LD₅₀/GR₅₀ value of herbicides. Calculations of herbicide requirements for different crops, and non-crop terrestrial and aquatic situations. Weed control experiments – types, planning, conduct and recording of data. Data transformation and calculations of weed indices. Weed herbarium preparation.

Suggested Readings

- Aldrich, R.J. and Kramer, R.J. 1997. *Principles in Weed Management*. Panima Publ.
- Das, T.K. 2008. *Weed Science – Basics and Applications*. Jain Brothers, New Delhi, 901 p.
- Devine, M.D., Duke, S.O. and Fedtke, C. 1993. *Physiology of Herbicide Action*. PTR Prentice Hall, Englewood Cliffs, New Jersey, 441 p.
- Gupta, O.P. 1998. *Modern Weed Management*. AgroBotanica, Bikaner, 488 p.
- Gupta, O.P. 2007. *Weed Management – Principles and Practices*. Agrobios.
- Jayakumar, R. and Jagannathan, R. 2003. *Weed Science Principles*, Kalyani Publishers, Ludhiana.
- Mandal, R.C. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
- Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 555 p.
- Subramanian, S., Ali, A.M. and Kumar, R.J. 1997. *All About Weed Control*. Kalyani Publ.
- Walia, U.S. 2003. *Weed Management*. Kalyani Publishers, Ludhiana.

AG 504 / WST 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT (3L+1P) II

Objective

To teach the basic principles of water management and practices to enhance 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-plant-atmosphere continuum, 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; micro-irrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of crops and cropping systems, management of soil moisture stress and plant growth, strategies of using limited water supply, quality of irrigation water and management of saline water for irrigation, water-use efficiency.

UNIT V

Water stress – deficit and excess, its effect on growth and development, water stress injury and resistance, management of water stress through soil and crop manipulations, excess soil water and plant growth; water management in problem soils.

UNIT VI

Drainage - concept and classification. Field drainage systems with special emphasis on crop production and soil salinity. Inter-relationship of drainage with cropping patterns and types of farming. Drainage requirement of crops and methods of field drainage, their layout and spacing.

UNIT VII

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.

Practicals

Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus. Preparation of soil-moisture characteristic curves. Water flow measurements using different devices. Determination of irrigation requirement and irrigation efficiency. Determination of infiltration rate, saturated/unsaturated hydraulic conductivity. Estimation of drain spacing under surface and sub-surface method. Soil moisture constants and measurement. Measurement of evapotranspiration and water requirement of crops. Water management experiments – planning, conduct, recording of data and interpretation.

Suggested Readings

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

Michael, A.M. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Panda, S.C. 2003. *Principles and Practices of Water Management*. Agrobios.

Prihar, S.S. and Sandhu, B.S. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.

Reddy, S.R. 2000. *Principles of Crop Production*. Kalyani Publ.

Singh, Pratap and Maliwal, P.L. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AG 505 DRYLAND FARMING AND WATERSHED MANAGEMENT

(3L+1P) I

Objective

To teach the basic concepts and practices of dryland farming and soil moisture conservation, and watershed management

Theory

UNIT I

Definition, concept and characteristics of dryland farming, delineation of dryland areas, desertification, dryland versus rainfed farming, significance and dimensions of dryland farming in Indian agriculture, types of drought, constraints limiting crop production in dryland areas.

UNIT II

Drought resistance in crops, mechanism for drought tolerance and crop adaptability to drought situations, drought tolerant crops and their varieties, plant ideotypes for dryland areas, shoot and root growth characteristics, mid-season contingent crop planning under erratic and aberrant weather conditions, seed and fodder bank.

UNIT III

Soil moisture conservation and utilization, moisture retention and availability concepts, water adsorption by plants under stress conditions.

UNIT IV

Water loss through evaporation and transpiration and its management under stress conditions, mulches, anti-transpirants and light reflectance – their kinds, effectiveness and economics.

UNIT V

Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

UNIT VI

Concept of watershed management - constraints, approaches and components. Water harvesting - concept and techniques (indigenous and modern), improved agro-techniques, conservation tillage, seed hardening.

UNIT VII

Nutrient and weed management practices, cropping systems, integrated farming systems and alternative land use systems for dryland areas.

Practicals

Seed hardening treatment, seed germination and crop establishment in relation to moisture stress. Moisture stress effects and recovery behaviour of important crops. Estimation of moisture index, aridity index and water-use efficiency. Spray of anti-transpirants and their effect on crops. Plant root growth studies with reference to stress management. Collection and interpretation of data for water balance equations. Crop planning for different drought conditions. Visit to dryland research experiments /stations and watershed projects.

Suggested Readings

- Das, N.R. 2007. *Tillage and Crop Production*. Scientific Publishers.
- Dhopte, A.M. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.
- Dhruv Narayana V.V. 2002. *Soil and Water Conservation Research in India*. ICAR Publ.
- FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. Soils Bull., Paper 57.
- Frederick, R.T., Hobbs, J., Arthur, D. and Roy, L. 1999. *Soil and Water Conservation: Productivity and Environment Protection*. 3rd Ed. Prentice Hall.
- Gupta U.S. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.
- Katyal, J.C. and Farrington, J. 1995. *Research for Rainfed Farming*. CRIDA, Hyderabad.
- Rao, S.C and Ryan, J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.
- Singh, Gurmel, Venkataraman, C.G., Sastry, B. and Joshi, P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
- Singh, P. and Maliwal, P.L. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publishing Company.
- Singh, P., Ahlawat, I.P.S. and Yadav, R.L. 2000. *Fifty Years of Agronomic Research in India*. ISA Publication.

- Singh, R.P. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.
- Singh, S.D. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.
- Venkateshwarlu, J. 2004. *Rainfed Agriculture in India*. ICAR Publ.
- Venkateshwarlu, J. 2004. *Technical Manuals on Watershed Management*. I to V. MANAGE Publ.

AG 506 AGRONOMY OF CEREAL CROPS

(3L+1P) I

Objective

To teach the crop husbandry of cereal crops

Theory

UNIT I

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *kharif* cereals - rice, maize, sorghum and pearl millet.

UNIT II

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *rabi* cereals - wheat and barley.

UNIT III

Cereal-based cropping systems – their role in food security, productivity patterns. Physiological aspects of yield formation, approaches for breaking yield barrier and the role of agronomy.

UNIT V

Integrated nutrient, water and weed management in cereal-based cropping systems. Agronomic management in problematic soils. Recent advances in research on cereal crops.

Practicals

Phenological studies at growth stages of crops. Growth indices analysis: CGR, RGR, NAR, LAD, LAI, and root growth. Calculation of cropping and rotational intensity. Physiological maturity and crop yield estimation. Estimation of crop yield on the basis of yield attributes. Planning and layout of experiments. Nutrient, water and weed management practices. Study of seed production techniques in various crops. Determination of harvest index and economics of different crops. Nutrient-use efficiency and nutrient balance studies in cereal-based systems.

Suggested Readings

- Das, N.R. 2007. *Introduction to Crops of India*. Scientific Publ.
- Hunsigi, G. and Krishna, K.R. 1998. *Science of Field Crop Production*. Oxford & IBH.
- Khare, D. and Bhale, M.S. 2000. *Seed Technology*. Scientific Publ.
- Kumar, Ranjeet and Singh, N.P. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
- Pal, M., Deka, J. and Rai, R.K. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
- Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR Publ.

- Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
- Singh, S.S. 1998. *Crop Management*. Kalyani Publ.
- Smith, D.L and Hamel, C. 1999. *Crop Yield – Physiology and Processes*. Springer-Verlag, Berlin, Heidelberg.

AG 507 AGRONOMY OF PULSES AND OILSEED CROPS

(3L+1P) II

Objective

To teach the crop husbandry of major pulses and oilseed crops

Theory

UNIT I

Role of pulse and oilseed crops in Indian agriculture. Causes of low yields of pulse and oilseed crops, and strategies for improving productivity. Biofertilizers in pulses and leguminous oilseeds. Significance of BNF, mechanisms of residual effects, nutrient cycling and physical properties of soil.

UNIT II

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *kharif* pulses - pigeonpea, greengram, blackgram, cowpea, mothbean, field bean, horsegram and rice bean.

UNIT III

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *rabi* pulses – chickpea, lentil, peas, frenchbean, and grass pea.

UNIT IV

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *kharif* oilseeds - soybean, groundnut, sesamum, niger and castor.

UNIT V

Origin, history, production trends, adaptability, classification, varietal improvement, climate and soil requirements, cultural, nutritional, weed and water management, quality components for maximum production of *rabi* oilseeds – rape seed and mustard, sunflower, safflower, and linseed.

UNIT VI

Pulses and oilseeds in non-traditional areas and seasons. Physiological limitations for higher productivity in grain legumes; yield stability in pulses and oilseed crops. Non-monetary agro-techniques for augmenting productivity of pulses and oilseed crops.

Practicals

Sowing methods vis-à-vis germination pattern in pulses and oilseeds. Seed inoculation with *Rhizobium* and phosphate solubilizing bacteria. Cultural operations for higher productivity of pulses and oilseeds. Yield attributes of pulses and oilseeds, and estimation of yield. Estimation of biological nitrogen fixation by legume crops. Determination of oil content in oilseeds, and computation of

oil yield. Determination of protein content in pulses and computation of protein yield. Working out growth and intercropping indices. Estimation of quality parameters in pulses and oilseeds. Identification of major weeds, insect-pests and diseases of pulses and oilseed crops. Visit to oilseed and pulse processing industry, research and development institution.

Suggested Readings

- Ali, M., Singh, B.B., Shiv Kumar and Dhar, V. 2004. *Pulses in New Perspective*. Indian Society of Pulses Research and Development, Kanpur, India.
- Asthana, A.N. and Ali, M. 1997. *Recent Advances in Pulses Research*. Indian Society of Pulses Research and Development, Kanpur, India.
- Jeswani, L.M. and Baldev, B. 1997. *Advances in Pulse Production Technology*. ICAR, New Delhi.
- Prasad, R. 2002. *Text Book of Field Crops Production*. ICAR, New Delhi.
- Sengupta, K. and Das, P.K. 2003. *Cultivated Annual Oilseed Crops in India*. Calcutta.
- Singh, G., Sekhon, H.S. and Kolar, J.S. 2005. *Pulses*. Agrotech Publishing Academy, Udaipur, India.
- Weiss, E.A. 2000. *Oilseed Crops*. Blackwell Science Ltd., Oxford, UK

AG 508 AGRONOMY OF COMMERCIAL CROPS

(3L+1P) II

Objective

To teach production techniques of commercial crops, and some knowledge of medicinal, aromatic and spice crops

Theory

UNIT I

Importance, origin, history, adaptability, production, distribution, constraints, growth and development, varietal improvement, water and nutrient requirements, weed management, cropping systems, produce quality and value addition in respect of cotton, jute and sugarcane crops.

UNIT II

Importance, origin, history, adaptability, production, distribution, constraints, growth and development, varietal improvement, water and nutrient requirements, weed management, cropping systems, produce quality and value addition in respect of potato, chilli and tobacco crops.

UNIT III

Importance of medicinal and aromatic plants in human health and national economy, classification according to botanical characteristics and uses, adaptability, climate, seed, water and nutrient requirements, cultural practices, plant protection, yield and important constituents, produce quality, processing and value addition in respect of mentha, lemon grass, aloe vera, celery etc.

UNIT IV

Importance, origin, history, adaptability, production trend, distribution, plant growth and development, varietal improvement, soil, water and nutrient requirements, weed management and crop protection, factors affecting produce quality, processing and value addition in respect of tea and coffee.

Practicals

Seed / seedling treatment in different crops. Delinting in cotton and visit to cotton gin. Estimation of seed rate in cotton and jute based on different parameters. Estimation of crop yield on the basis of yield attributes. Quality characteristics in medicinal and aromatic plants. Working out cost of cultivation of different crops. Raising of herbarium of medicinal, aromatic and under-utilized plants. Visit to the processing plant (medicinal and aromatic, sugarcane, potato etc.). Preparation of project report for commercial cultivation of crops. Field visits to acquaint the students about the plant growth and important cultural practices in the crops under study.

Suggested Readings

- Chadha, K.L. and Gupta, R. 1995. *Advances in Horticulture*. Vol. II. Medicinal and Aromatic Plants. Malhotra Publ.
- Das, N.R. 2007. *Introduction to Crops of India*. Scientific Publ.
- Handa, S.S. 1984. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.
- Hussain, A. 1984. *Essential Oil Plants and their Cultivation*. CIMAP, Lucknow.
- Hussain, A. 1993. *Medicinal Plants and their Cultivation*. CIMAP, Lucknow.
- ICAR. 2006. *Hand Book of Agriculture*. ICAR, New Delhi.
- Kumar, N., Khader, Md. Abdul, Rangaswami, J.B.M. and Irulappan. 1997. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.
- Prajapati, N.D., Purohit, S.S., Sharma, A.K. and Kumar, T. 2003. *A Hand Book of Medicinal Plants: A Complete Source Book*. Agrobios.
- Prasad, R. 2002. *Text Book of Field Crops Production*. ICAR Publ.
- Sharma, R. 2004. *Agro-techniques of Medicinal Plants*. Daya Publ. House, New Delhi.

AG 509 AGRONOMY OF FODDER AND PASTURE CROPS

(3L+1P) III

Objective

To teach the crop husbandry, conservation and utilization of different fodder crops, pastures and tree-forage crop-based systems

Theory

UNIT I

Introduction, origin, history, distribution, adaptation, classification, climate, soil, varieties, water, weed management and nutrient requirement of important cultivated fodder crops like maize, pearl millet, teosinte, cluster bean, cowpea, oats, barley, berseem, senji, lucerne etc.

UNIT II

Introduction, origin, history, distribution, adaptation, classification, climate, soil, varieties, water, weed management and nutrient requirement of important forage crops/grasses/ legumes, like, napier and hybrid napier grass, guinea grass, *Lasiurus*, buffel grass, stylo etc.

UNIT III

Anti-quality factors of important fodder crops, forage grasses and legumes. Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting

quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder.

UNIT IV

Seed production of important fodder, forage and pasture crops/ grasses/ legumes.

UNIT V

Natural grasslands of India. Establishment of pastures and their management with special reference to weed control and fertilization including micronutrients important to animals, defoliation and its effects, regeneration of infested pastures.

UNIT VI

Agrostology and agroforestry systems – definition, classification and importance. Crop production technology in agroforestry and agrostology system; silvipastoral system. Wasteland development - selection of species, planting methods and problems of seed germination in agro-forestry systems. Lopping and coppicing in agroforestry systems.

Practicals

Practical training of farm operations in raising fodder crops and canopy measurement. Yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops. Anti-quality components like HCN in sorghum and such factors in other crops. Hay and silage making, and economics of their preparation. Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry. Methods of propagation/planting of grasses, trees in silvipastoral system. Fertilizer application in strip and silvi-pastoral systems. Economics of agroforestry systems. Visit to IGFRI / NRCAF, Jhansi.

Suggested Readings

- Das, N.R. 2007. *Introduction to Crops of India*. Scientific Publ.
- George, Thomas, C. 2003. *Forage Crop Production in the Tropics*. Kalyani Publishers.
- IGFRI. 1999. *Forage Production Technology - A Bulletin* by P.S. Tomar, N.P. Shukla and S.N. Tripathi
- Sen, N.L., Dadheech, R.C., Dashora, L.K. and Rawat, T.S. 2004. *Manual of Agroforestry and Social Forestry*. Agrotech Publ.
- Singh, Panjab, Pathak, P.S. and Roy, M.M.1994. *Agroforestry System for Sustainable Use*. Oxford & IBH.
- Singh, S.P. 1994. *Handbook of Agroforestry*. Agrotech Publ.
- Solanki, K.R. 2000. *Multipurpose Tree Species: Research, Retrospect and Prospects*. Agrobios.
- Tejwani, K.G. 1994. *Agroforestry in India*, Oxford and IBH Publ.
- Young, A. 1997. *Agroforestry for Soil Management*, 2nd edition. CAB International.

AG 510 / SSAC 510 / WST 510 MANAGEMENT OF PROBLEM SOILS AND WATERS

(3L+1P) I

Objective

To educate students about basic concepts of problem soils and waters, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically-degraded soils; origin and basic concept of problematic soils, and factors responsible.

UNIT II

Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH, physical, chemical and microbiological properties.

UNIT III

Acid soils - nature of soil acidity, sources of soil acidity, effect on plant growth, lime requirement. Management of acid soils, biological sickness of soils and its management.

UNIT IV

Management of saline and sodic soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dryland soils.

UNIT V

Agronomic practices in relation to problematic soils; cropping patterns for utilizing poor quality ground waters.

UNIT VI

Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters.

UNIT VII

Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

Practicals

Characterization of acid, acid-sulfate, salt-affected and calcareous soils. Determination of cations (Na^+ , K^+ , Ca^{++} and Mg^{++}) in ground water and soil samples. Determination of anions (Cl^- , SO_4^{--} , CO_3^{--} and HCO_3^-) in ground waters and soil samples. Determination of electrical conductivity and gypsum requirement of salt-affected soils. Determination of soil pH and lime requirements of acid soils. Demonstration of salt stress / injury on plants under laboratory conditions. Visit to salt-affected / acid soil areas (CSSRI / CPRI).

Suggested Readings

- Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. 1982. *Saline and Alkali Soils of India*. ICAR, New Delhi.
- Bolt, G.H. and Bruggenwert, M.G.M. 1978. *Soil Chemistry*. Elsevier, Amsterdam, The Netherlands.
- Goswami, N.N., Rattan, R.K., Dev, G., Narayanasamy, G., Das, D.K., Sanyal, S.K., Pal, D.K. and Rao, D.L.N. 2009. *Fundamentals of Soil Science*. Second Edition. Indian Society of Soil Science, New Delhi.
- Havlin, J. L., Beaton, J. D., Tisdale, S. L. and Nelson W. L. 2006. *Soil Fertility and Fertilizers* (7th Edn.) Prentice Hall, New Delhi. .
- Jurinak, J.J. 1978. *Salt-affected Soils*. Department of Soil Science and Biometeorology, Utah State Univ, Ames, USA.
- Mahapatra, I.C., Mandal, S.C., Mishra, C., Mitra, G.N. and Panda, N. (Eds). *Acid Soils of India*. ICAR, New Delhi.

Objective

To impart knowledge about crop ecology and agrometeorology

Theory

UNIT I

Concept of crop ecology, ecosystem characteristics, energy flow in ecosystem, succession and climax concept, adaptation of crops, agro-ecological regions.

UNIT II

Agrometeorology – aims, scope and development in relation to environment. Historical aspects of meteorology / climatology.

UNIT III

Physiological response of crop plants to weather variables (light, temperature, CO₂, moisture and solar radiation). Atmospheric pollution and its effect on climate. Global climate change and its impact on agriculture.

UNIT IV

Competition in crop plants, environmental manipulation through agronomic practices, agro-climatic indices. Improvement of unproductive lands through crop selection and management.

UNIT V

Stress and strain terminology; nature of stress injury and resistance, causes of stress. Low temperature stress - freezing injury and resistance in plants, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress. High temperature or heat stress - meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT VI

Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

UNIT VII

Monsoons – their origin and characteristics. Weather hazards and their mitigation. Artificial rain making. Weather forecasting in India – short, medium and long range. Remote sensing – aerospace science and weather forecasting. Benefits of weather services to agriculture.

Practicals

Visit to agro-meteorological observatory to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure. Measurement of solar radiation outside and within plant canopy, soil and canopy temperature. Measurement/estimation of evapo-transpiration by various methods. Measurement/estimation of soil water balance. Rainfall variability analysis. Agro-climatic indices - determination of heat-unit / photo-thermal units requirement. Remote sensing and familiarization with agro-advisory service bulletins. Study of weather reports, working principle of automatic weather station.

Suggested Readings

Chadha, K.L. and Swaminathan, M.S. 2006. *Environment and Agriculture*. Malhotra Publ. House.
Critchfield, H.J. 1995. *General Climatology*. Prentice Hall of India.

- Hemantarajan, A. 2007. *Environmental Physiology*. Scientific Publ.
- Kumar, H.D. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ.
- Lal, D.S. 1998. *Climatology*. Sharda Pustak Bhawan.
- Lenka, D. 1998. *Climate, Weather and Crops in India*. Kalyani Publ.
- Menon, P.A.1991. *Our Weather*. National Book Trust Publ.
- Sahu, D.D. *Agrometeorology and Remote Sensing: Principles and Practices*.
- Sharma, P.D. 1998. *Ecology and Environment*. Rastogi Publ.
- Varshneya, M.C. and Balakrishana Pillai, P. 2003. *Textbook of Agricultural Meteorology*. ICAR Publ.

AG 601 MODERN CONCEPTS IN AGRONOMY

(3L+1P) I

Objective

To acquaint the students about the recent developments in agronomy and resource management.

Theory

UNIT I

Environmental concerns related to intensive use of agricultural inputs. Sustainable agriculture - need, scope, practices and economic evaluation, holistic approach of farming systems. Agro-physiological basis of variation in yield, role of agro-biodiversity in sustainable food production, GM crops, crop diversification for improved food and nutritional security.

UNIT II

Conservation agriculture, modern approaches for improving resource-use efficiency, crop residue management in multiple cropping systems. Principles and practices of conservation tillage and watershed management, carbon sequestration.

UNIT III

Precision farming - current status and opportunities for adoption in India. GIS, GPS and remote sensing for crop management, global warming.

UNIT IV

Contract farming - concept, scope, partnerships, types, characteristics, management and administration, problems and advantages for farmers/ sponsors, WTO issues in agriculture.

UNIT V

Crop modeling, systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams information technology, elementary models for crop growth based on basic methods of classical growth analysis.

UNIT VI

Protected agriculture - concept, characteristics, types, scope and limitations in India. Plant nutrition - challenges and tasks ahead. Organic farming - importance, history, scope, principles and practices, limitations, export potential of organic products, certification, labeling and accreditation procedures.

UNIT VII

Climate change and crop adaptation. Stress crop production. Potential evapo-transpiration, water balance of the soil, and production with nutrient and moisture limitations.

Practicals

Sustainability indicators in agriculture. Agro-ecological zones and biodiversity in India. Estimation of nutrient and water-use efficiency in Indian agriculture. Practical considerations in conservation tillage and carbon sequestration. Instrumentation for precision farming. Contract farming models in peri-urban areas of metropolitan cities. Simulation of elementary models for crop growth. Simulation of potential production. Practical considerations in protected agriculture. Certification and accreditation procedures in organic farming. Crop phenology studies in major crops.

Suggested Readings

- Ernst, van Heum and Kees, van der Post. 2004. Protected Cultivation: Construction, requirements and use of greenhouse in various climates. Agromisa Foundation, Wageningen, Netherlands.
- Gordan, G. 1992. *System Simulation*. 2nd Ed. Prentice Hall. Delhi.
- Govardhan, V. 2000. *Remote Sensing and Water Management in Command Areas: Agroecological Perspectives*. IBDC.
- Jana, B.L. 2008. *Precision Farming*. Agrotech Publishing Academy, Udaipur.
- Murty, J.V.S. 1998. *Watershed Management*. New Age International, New Delhi.
- NAAS, 2009. *State of Indian Agriculture*. National Academy of Agricultural Sciences, New Delhi.
- Narasaiah, M.L. 2004. *World Trade Organization and Agriculture*. Sonali Publ.
- Negi, S.S. 2008. *Biodiversity and its Conservation in India*. Indus Publishing Company.
- Palaniappan, SP. and Annadurai, K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.
- Penning de Vries, F.W.T. and Van Laar, H.H. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.
- Ritchie, J.T. and Hanks, J. 1991. *Modeling Plant and Soil Systems*. American Society of Agronomy, Madison.
- Sharma, Premjit. 2007. *Contract Farming*. Daya Publishing House, New Delhi.
- Sharma, A.R. and Behera, U.K. 2010. *Resource Conserving Techniques in Crop Production*. Scientific Publ.

AG 602 EXPERIMENTAL TECHNIQUES IN AGRONOMY

(2L+2P) II

Objective

To teach methodology of planning, layout, data recording, analysis, interpretation and report writing of agronomic experiments

Theory

UNIT I

Historical aspects, principles and practices of field experimentation

UNIT II

Identification of research problem and preparation of research project proposal. Presentation of data and report writing.

UNIT III

Planning of experiments, recording of data - before layout of experiment, during crop growth and after harvest. Selection of experimental design, layout of experiment, number of treatments / replications, plot size, border effect etc. Techniques for increasing the precision for an experiment.

UNIT IV

Interpretation of data from weed control, irrigation, fertilizer and cropping system experiments. Interactions in factorial experiments.

UNIT V

Contrast analysis, pooled analysis and data transformation. Evaluation of direct, residual and cumulative effects of treatments.

UNIT VI

Correlation and regression analysis, and their application. Energetics and economic analysis.

UNIT VII

Analysis of data of typical agronomic experiments. Nutrient and water balance sheets. Statistical softwares and their application.

Practicals

Practical considerations in field experimentation. Practical use of softwares in agricultural research and analysis of data. Analysis of data of field experiments. Use of excel in data analysis. Statistical analysis of data using MSTATC. Calculation and interpretation of interaction of factorial experiments. Calculation of direct, residual and cumulative effects of treatments in cropping systems. Exercise on confounding designs. Exercise on contrast analysis. Exercise on data transformation. Exercise on missing plot analysis. Exercise on pooled analysis of data over years/locations. Exercise on linear regression equation. Exercise on quadratic regression equation. Exercise on computation of energy requirement in agricultural production. Economic analysis of field crop production. Exercise on determination of optimum economic dose of fertilizers. Exercises on interpretation of data from different types of experiments.

Suggested Readings

- Clewer, A.G. and Scarisbrick, D.H. 2001. *Practical Statistics and Experimental Design for Plant and Crop Science*. John Wiley and Sons Ltd. West Sussex, England
- Cochran, W.G. and Cox, G.M. 1992. *Experimental Designs*. John Wiley and Sons, Inc. Toronto, New York, USA.
- Darmaraju Raghavarao. 1983. *Statistical Techniques in Agricultural and Biological Research*. Oxford and IBH Publishing Co. New Delhi.
- Das, N.R. 2008. *Agronomic Research Management*. Agrotech Publishing Academy, Udaipur.
- Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Wiley and Sons, Singapore.
- Rangaswamy, R.A. 2006. *Text Book of Agricultural Statistics*. New Age International (P) Limited, New Delhi.

Objective

To appraise about cropping and farming systems, types of integrated farming systems under different agro-ecosystems, farming systems research and optimization methodologies.

Theory

UNIT I

Cropping systems – definition, indices, production potential, resource management in cropping systems, production potential under monoculture, multiple cropping, alley cropping, intercropping, multi-storied cropping. Yield advantages in intercropping systems.

UNIT II

Farming systems - definition and importance; classification of farming systems, characteristics, objectives and principles. Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

UNIT III

Production potential of different components of farming systems. Cropping systems as an important component of farming systems, remunerative cropping systems, crop diversification.

UNIT IV

Integrated farming systems for different agro-ecosystems, interactions and resource recycling among different enterprises.

UNIT V

Farming system research methodologies: on-farm research, on-station research and system modeling. Preparation of different farming system models; evaluation of different farming systems. case studies on different farming systems.

UNIT VI

Multi-criteria decision making and optimization methodologies for designing integrated farming systems.

Practicals

Indices for assessing cropping system efficiency. Measurement of competition effects in intercropping systems. Farming system analysis: Participatory Rural Appraisal, Rapid Rural Appraisal, diagnostic survey. Farming system analysis: Interaction with farmers, problem identification, prioritization and development projects/interventions for solutions to the identified problems. Use of optimization software for developing models, formation of matrix and drawing of different scenarios. Handling single objective LP model, Handling multi-objective LP model and analysis of data for risk analysis, resource allocation and enterprise selection decisions. Visit to apiary, vermicompost, mushroom production and biogas production unit, integrated farming systems.

Suggested Readings

- Behera, U.K., Das, T.K. and Sharma A.R. 2009. *Manual on Multicriteria Decision Making and Optimization Methodology for Sustainable Farming*. Division of Agronomy, IARI, New Delhi.
- Mahapatra, I.C., Mahapatra, P.K. and Batra, P.K. 2002. *Field Manual for On-farm Adaptive Research. Agroecosystem Directorate (Rainfed farming)*. National Agricultural Technology Project. Central Research Institute for Dryland Agriculture, Hyderabad.

- Malcolm, Hall. 2001. *Farming Systems and Poverty: Improving Farmers Livelihood in Changing World*.
FAO and World Bank, Rome and Washington, D.C.
- Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping Systems in the Tropics: Principles and Management*.
New Age Publ.
- Panda, S.C. 2004. *Cropping Systems and Farming Systems*. Agribios.
- Raman, K.V. and Balguru, T. 1992. Farming Systems Research in India: Strategies for
Implementation. Proceedings of the National Workshop, November 25-28, 1991, NAARM,
Hyderabad, India
- Rangaswamy, A., Annadurai, K., Subbain, P. and Jayanti, C. 2002. *Farming Systems in the Tropics*,
Kalyani Publishers.
- Sankaran, S. and Mudaliar, T.V.S. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
Co.
- Singh, A.K., Sharma, S.K., Batra, P.K. and Sharma, N.K. 2003. *Instruction Manual for On-farm
Research (Cropping Systems)*. Project Directorate for Cropping Systems Research, Modipuram, Meerut.

AG 604 PRINCIPLES AND PRACTICES OF ORGANIC FARMING

(2L+1P) II

Objective

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

Theory

UNIT I

Definition, concepts, history and importance of organic farming; organic production scenario in the world, relevance and scope in India, principles, myths and constraints. Limitations of organic farming.

UNIT II

Relevance of organic farming with reference to international trade, climate change, carbon trading and carbon sequestration, and human health. Biodynamic farming.

UNIT III

Package of practices for organic crop production – farm designing, crop planning, site selection, conversion period, selection of seed / seedlings, availability and use of organic inputs, viz. vermicompost, biofertilizers, compost, green manures for crop nutrition, water and weed management, crop protection, harvesting and post-harvesting processing / care.

UNIT IV

Production technology and availability of different organic inputs, viz. vermicompost, biofertilizers, improved compost, green manure, bio-pesticides and plant products, crop-specific package of practices for organic production of different food, vegetable and flower crops.

UNIT V

Changes in physical, microbiological and chemical properties of soil. Evaluation of soil and produce quality.

UNIT VI

Certification of organic produce and process, certification agencies, group certification, marketing, success stories, potential organic production areas/ crops of India.

Practicals

Technique of biofertilizers application and their response in crops. Technique of biopesticide and pheromones application and their response in crops. Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms. Techniques of growing green manure crops. Visit to National Centre for Organic Farming (NCOF). Visit to blue-green algae centre of IARI, vermicompost and biofertilizers production unit. Visit to biopesticide production units, Centre for Protected Crop Production, organic crop production farm.

Suggested Readings

- Cooper, J., Niggli, U. and Leifert, C. 2007. *Handbook of Organic Food Safety and Quality*. Woodhead Publishing Limited, Cambridge.
- FAO. 2002. *Organic Agriculture, Environment and Food Security*. FAO Publ.
- Lampkin, N. 1990. *Organic Farming*. Press Books, Ipswich, UK.
- Palaniappan, SP. and Anandurai, K. 1999. *Organic Farming – Theory and Practice*. Scientific Publ.
- Rao, B.V. Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective:Publ.3, Parisaraprajna Parishatana, Bangalore.
- Reddy, M.V. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
- Sharma, A. 2002. *Hand Book of Organic Farming*. Agrobios.
- Singh, S.P. (Ed.) 1994. *Technology for Production of Natural Enemies*. PDDBC, Bangalore.
- Veeresh, G.K., Shivashankar, K. and Suiglachar, M.A. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.
- WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*. WHO Publ.

AG 606 CROP PRODUCTION AND SIMULATION MODELING

(2L+1P) III

Objective

To familiarize the students about systems approach and to simulate yields and growth of crops under varied soil and weather conditions with different management practices, and their optimization

Theory

UNIT I

Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.

UNIT II

Elementary models for crop growth based on basic methods of classical growth analysis.

UNIT III

Crop modeling methods for crop-weather interaction, climate change and variability components, DSSAT, APSIM, INFOCROP and Century models

UNIT IV

Potential production: leaf and canopy CO₂ assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops. Estimation of generic coefficients.

Practicals

Creation of management files for simulation. Simulation of elementary models for crop growth. Simulation of potential production. Simulation with limitations of water and nutrient management options. Sensitivity analysis using different climatic years and crop management practices.

Suggested Readings

Gordan, G. 1992. *System Simulation*. 2nd Ed. Prentice Hall.

Kropff, M.J. and Vann Laar, H.H. (Ed.). 1993. *Modelling Crop Weed Interactions*. ISBN.

Mathews, R.B., Kropff, M.J., Bachelet, D. and Vaan Laar, H.H. (Eds.). 1993. *Modelling the Impact of Climate Change on Rice Production in Asia*. CABI.

Penning de Vries, F.W.T. and Van Laar, H.H. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.

Ritchie, J.T. and Hanks, J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.

AG 607 / PP 607 PHYSIOLOGY AND BIOCHEMISTRY OF HERBICIDE ACTION

(3L + 1P) III

Objective

To provide the students up-to-date knowledge on herbicide physiology and biochemistry, and recent approaches in weed management including biotechnological methods

Theory

UNIT I

Weed biology and ecology; allelopathy and allelochemicals; management options; weed economic thresholds; use of models for improved competition studies.

UNIT II

Recent concepts on entry, uptake, translocation and metabolism of soil and foliar-applied herbicides, and impact of environmental and plant factors.

UNIT III

Physiological, biochemical and molecular mechanism of action of different groups of herbicides. Metabolic pathway of herbicide degradation in plants and soil.

UNIT IV

Selectivity of herbicides - physiological and molecular mechanism; herbicide non-target toxicity. Herbicide residue and its management in cropping systems.

UNIT V

Herbicide resistance in weeds. Site-specific weed management. Advances in herbicide formulations; adjuvants and their classification. Herbicide mixtures and interactions. Remote sensing and GIS applications in weed science.

UNIT VI

Herbicide resistant crops - prospects, biotechnological and tissue culture approaches for development of herbicide resistant crops.

Practicals

Adjuvants and their effect on spray droplets, chemical entry and transport in the plants. Determination of effect of herbicides on physiological and biochemical processes like photosynthesis, respiration, membrane permeability. Quantification of pigment levels in leaves as affected by herbicides. Estimation of specific enzyme activities affected by herbicides. Demonstration of herbicides translocation by radio-labeling techniques. Bio-assay technique for analysis of herbicide residues. Allelopathic effects of plants. Evaluation of bio-efficacy and selectivity of herbicides.

Suggested Readings

- Akobundu, I.O. 1987. *Weed Science in the Tropics: Principles and Practices*. John Wiley and Sons, Chichester, 522 p.
- Cobb, Andrew and Kirkwood, R.C. 2001. *Herbicides and Their Mechanisms of Action*. Blackwell.
- Cobb, Andrew. 1991. *Herbicides and Plant Physiology*. Chapman and Hall Publishers.
- Ashton, F.M. and Crafts, A.S. 1981. *Mode of Action of Herbicides*. 2nd Edn. Wiley-Interscience, 524 p.
- Das, T.K. 2008. *Weed Science – Basics and Applications*. Jain Brothers, New Delhi, 901 p.
- Devine, M.D., Duke, S.O. and Fedtke, C. 1993. *Physiology of Herbicide Action*. PTR Prentice Hall, Englewood Cliffs, New Jersey, 441 p.
- Gupta, O.P. 1998. *Modern Weed Management*. AgroBotanica, Bikaner, 488 p.
- Jayakumar, R. and Jagannathan, R. 2003. *Weed Science Principles*. Kalyani Publishers, Ludhiana.
- Klingman, G. C. 1981. *Weed Science: Principles and Practices*. John Wiley and Sons Inc., New York, 449 p.
- Monaco T.J., Weller, S.C. and Ashton, F.M. 2002. *Weed Science - Principles and Practices*. Wiley.com Publ.
- Rao, V.S. 2000. *Principles of Weed Science*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 555 p.
- Stephen, B. Powles and Qin, Yu. 2010. *Evolution inaction: Plant resistant to herbicides*. Ann. Review Plant Bio. 61, 317-347.
- Swarbrick, J.T. and Mercado, B.L. 1987. *Weed Science and Weed Control in South-east Asia*. FAO Plant Production and Protection Paper 81, Rome, Italy, 203 p.
- Walia, U.S. 2003. *Weed Management*. Kalyani Publishers, Ludhiana.
- Zimdahl, R.L. 1999. *Fundamentals of Weed Science*. 2nd Edn., Academic Press, 556 p.