RADHA GOVIND UNIVERSITY
RAMGARH, JHARKHAND

DEPARTMENT OF AGRICULTURAL SCIENCES

COURSE CURRICULUM FOR MASTER COURSES UNDER CHOICE BASED

CREDIT SYSTEM

[SYLLABUS]

M.Sc. (Ag) Agronomy (Two Year Master Degree Programme)

RADHA GOVIND UNIVERSITY
RAMGARH
RADHA GOVIND UNIVERSITY

REQUIREMENT OF CREDIT HOURS FOR AWARD OF THE DEGREE

Parameters	**Credits offered by the Department**	
Course Work	**52**	
a) Major Courses (including Seminar)	31	
b) Minor Courses	15	
c) Basic & Supporting Courses	06	
Research Work	30	
Total Credits	**82**	
Non-Credit Compulsory Courses	**05**	
Non-Credit Compulsory course to be Completed (Satisfactory/unsatisfactory)	PGS 501	Library And Information Service (0+1)
	PGS 502	Technical writing and communications skills (0+1)
	PGS 503	Intellectual Property and Its Management in Agriculture (1+0)
	PGS 504	Basic concept in laboratory techniques (0+1)
	PGS 505	Agricultural research and research ethics and rural development programme (1+0)

Name of Programme: M.Sc. (Ag.) Agronomy

Academic eligibility for admission: -B.Sc. Agriculture

Curriculum and Syllabus

Semester	Course Code & No.	Course Title	Credit Hrs.	Mid Exam.	Final Exam		Total
					Theory	Practical	
I st Sem.	AGRN 711	Modern Concepts in Crop Production	3 (3 + 0)	20	40	40	100
	AGRN 713	Principles & Practices of Weed Management	3 (2 + 1)	20	40	40	100
	AGRN 723	Agronomy of Major Cereals and Pulses	3 (2 + 1)	20	40	40	100
	SS 732	Principles & Practices of Soil Fertility & Nutrient Management	3 (2 + 1)	20	40	40	100
	AST-523	Statistical Methods	3 (2 + 1)	20	40	40	100
		Total credit hr.	**15**				
II nd Sem	AGRN 724	Agronomy of Oilseed, Fiber and Sugar Crops	3 (2 + 1)	20	40	40	100
	AGRN 725	Agronomy of Medicinal, Aromatic and Under-utilized Crops	3 (2 + 1)	20	40	40	100
	AGRN 899	Master's Research (Synopsis Presentation)	4	20	40	40	100
	SS 734	Soil Fertility and fertilizer use	3 (2 + 1)	20	40	40	100
	SWLE 704	Principles and Practices of Water Management	3 (2 + 1)	20	40	40	100
	AST 524	Experimental Statistics	3 (2 + 1)	20	40	40	100
		Total credit hr.	**19**				
III rd Sem	AGRN 731	Agronomy of Fodder & Forage Crops	3 (2 + 1)	20	40	40	100
	AGRN 733	Cropping Systems & Sustainable Agriculture	3 (2 + 1)	20	40	40	100
	AGRN 734	Dryland Farming & Watershed Management	3 (2 + 1)	20	40	40	100

	AGRN 735	Principles & Practices of Organic Farming	3 (2 + 1)	20	40	40	100
	AGFO 716	Agrostology and Agroforestry	3 (2 + 1)	20	40	40	100
	SSAC 717	Soil erosion and conservation	3 (2+1)	20	40	40	100
		Total credit hr.	**18**				

IVth	AGRN 899	Master's Research (Research Work & Thesis)	30(0+30)	40%Internal+60%External) Satisfactory /Unsatisfactory	100
		Total credit hr.	**30**		
		Grand Total	**82**		

Course Contents - M.Sc. Agriculture (Agronomy)

Major Courses

Course Title : Modern Concepts in Crop Production
Course Code : AGRN 711
Credit Hours : 3(3+0)

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 modelling 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.

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. Seventh 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.

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Course Title : Principles and Practices of Weed Management
Course Code : AGRN 713
Credit Hours : 3 (2+1)

Theory

Unit I

Weed biology, and ecology and classification, crop-weed competition including allelopathy; principles and methods of weed control and classification management; weed indices, weed shift in different eco-systems

Unit II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

Unit III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures, sequential application of herbicides, rotation; weed control through use of nano-herbicides and bio-herbicides, myco-herbicides bio-agents, and allelochemicals; movement of herbicides in soil and plant, Degradation of herbicides in soil and plants; herbicide resistance, residue, persistence, and management; development of herbicide resistance in weeds and crops and their management, herbicide combination and rotation.

Unit IV

Weed management in major crops and cropping systems; alien, invasive and parasitic weeds and their management; weed shifts in cropping systems; aquatic and perennial weed control; weed control in non-crop area.

Unit V

Integrated weed management; recent development in weed management- robotics, use of drones and aeroplanes, organic etc., cost: benefit analysis of weed management.

Practical

Identification of important weeds of different crops; Preparation of a weed herbarium; Weed survey in crops and cropping systems; Crop-weed competition studies; Weed indices calculation and interpretation with data; Preparation of spray solutions of herbicides for high and low-volume sprayers; Use of various types of spray pumps and nozzles and calculation of swath width; Economics of weed control; Herbicide resistance analysis in plant and soil; Bioassay of herbicide resistance residues;

Calculation of herbicidal herbicide requirement

Suggested Reading

Böger, Peter, Wakabayashi, Ko, Hirai, Kenji (Eds.). 2002. Herbicide Classes in Development. Mode of Action, Targets, Genetic Engineering, Chemistry. *Springer.*

Chauhan B and Mahajan G. 2014. Recent Advances in Weed Management. *Springer.*

Das TK. 2008. Weed Science: Basics and Applications, Jain Brothers (New Delhi).

Fennimore, Steven A and Bell, Carl. 2014. Principles of Weed Control, 4th Ed, *California Weed Sci. Soc.*

Gupta OP. 2007. Weed Management: Principles and Practices, 2nd Ed.

Jugulan, Mithila (ed). 2017. Biology, Physiology and Molecular Biology of Weeds. *CRC Press.*

Monaco TJ, Weller SC and Ashton FM. 2014. Weed Science Principles and Practices,*Wiley.*

Powles SB and Shaner DL. 2001. Herbicide Resistance and World Grains, *CRC Press.*

Walia US. 2006. Weed Management, *Kalyani.*

Zimdahl RL. (*ed*). 2018. Integrated Weed Management for Sustainable Agriculture, *B. D. Sci. Pub.*

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Course Title : Conservation Agriculture

Course Code : AGRN 722
Credit Hours : 2(1+1)

Theory

Unit I

Conventional and conservation agriculture systems, sustainability concerns, conservation agriculture: Historical background and present concept, global experiences, present status in India.

Unit II

Nutrient management in CA, water management, weed management, energy use, insect-pest and disease management, farm machinery, crop residue management, cover crop management.

Unit III

Climate change mitigation and CA, C-sequestration, soil health management, soil microbes and CA.

Unit IV

CA in agroforestry systems, rainfed / dryland regions.

Unit V

Economic considerations in CA, adoption and constraints, CA: The future of agriculture.

Practical

Study of long-term experiments on CA; Evaluation of soil health parameters; Estimation of C-sequestration; Machinery calibration for sowing different crops, weed seedbank estimation under CA, energy requirements, economic analysis of CA.

Suggested Reading

Arakeri HR and Roy D. 1984. Principles of Soil Conservation and Water Management. *Oxford & IBH.*

Bisht JK, Meena VS, Mishra PK and Pattanayak A. 2016. Conservation Agriculture – An approach to combat climate.

change in Indian Himalaya. Publisher: *Springer Nature.* Doi: 10/1007/978-981-10-2558-7.

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.

Gracia-Torres L, Benites J, Martinez-Vilela A and Holgado-Cabera A. 2003. Conservation AgricultureEnvironment Farmers experiences, innovations Socio-economic policy.

Muhammad F and Kamdambot HMS. 2014. Conservation Agriculture. Publisher:*Springer.*Cham Heidelberg, New Yaork.

Dordrecht London. Doi: 10.1007/978-3-319-11620-4.

Yellamanda Reddy T and Sankara Reddy GH. 1992. Principles of Agronomy. *Kalyani.*

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Course Title : Agronomy of Major Cereals and Pulses
Course Code : AGRN 723
Credit Hours : 3 (2+1)

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling, and processing of the produce for maximum production of:

Unit I: *Rabi* cereals.

Unit II: *Kharif* cereals.

Unit III: *Rabi* pulses.

Unit IV: *Kharif* pulses.

Practical

Phenological studies at different growth stages of crop; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW *etc.,*); Assessment of land use and yield advantage (Rotational intensity, Cropping intensity, Diversity Index, Sustainable Yield Index Crop Equivalent Yield, Land Equivalent ration, Aggressiveness, Relative Crowding Coefficient, Competition Ratio and ATER etc.); Estimation of protein content in pulses; Planning and layout of field experiments; Judging of physiological maturity in different crops; Intercultural operations in different crops; Determination of cost of cultivation of different crops; Working out harvest index of various crops; Study of seed production techniques in selected crops; Visit of field experiments on cultural, fertilizer, weed control and water management aspects; Visit to nearby villages for identification of constraints in crop production.

Suggested Reading

Das NR. 2007. Introduction to Crops of India. *Scientific Publ.*

Hunsigi G and Krishna KR. 1998. Science of Field Crop Production. *Oxford & IBH.*

Jeswani LM and Baldev B. 1997. Advances in Pulse Production Technology. *ICAR.*

Khare D and Bhale MS. 2000. Seed Technology. *Scientific Publ.*

Kumar Ranjeet and Singh NP. 2003. Maize Production in India: Golden Grain in Transition. IARI, New Delhi.

Pal M, Deka J and Rai RK. 1996. Fundamentals of Cereal Crop Production.Tata McGraw Hill.

Prasad Rajendra. 2002. Text Book of Field Crop Production. *ICAR.*

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

Singh SS. 1998. Crop Management. *Kalyani.*

Yadav DS. 1992. Pulse Crops. *Kalyani.*

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Course Title : Agronomy of Oilseed, Fiber and Sugar Crops
Course Code : AGRN 724
Credit Hours : 3(2+1)
Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling & processing of the produce for maximum production of:

Unit I

Rabi oilseeds – Rapeseed and mustard, Linseed and Niger

Unit II

Kharif oilseeds - Groundnut, Sesame, Castor, Sunflower, Soybean and Safflower

Unit III

Fiber crops - Cotton, Jute, Ramie, and Mesta.

Unit IV

Sugar crops – Sugar-beet and Sugarcane.

Practical

Planning and layout of field experiments; Cutting of sugarcane setts, its treatment, and methods of sowing, tying, and propping of sugarcane; Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop; Intercultural operations in different crops; Cotton seed treatment; Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW etc.);Assessment of land use and yield advantage (Rotational intensity, Cropping intensity, Diversity Index, Sustainable Yield Index Crop Equivalent Yield, Land Equivalent ration, Aggressiveness, Relative Crowding Coefficient, Competition Ratio and ATER etc); Judging of physiological maturity in different crops and working out harvest index; Working out cost of cultivation of different crops; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes forvarious farm sizes and calculation of cropping and rotational intensities; Determination of oil content in oilseeds and computation of oil yield; Estimation of quality of fibre of different fibre crops; Study of seed production techniques in various crops; Visit of field experiments on cultural, fertilizer, weed control and water management aspects; Visit to nearby villages for identification of constraints in crop production.

Suggested Reading

Das NR. 2007. Introduction to Crops of India. *Scientific Publ.*

Das PC. 1997. Oilseed Crops of India. *Kalyani.*

Lakshmikantam N. 1983. Technology in Sugarcane Growing. 2nd Ed. *Oxford & IBH.*

Prasad Rajendra. 2002. Text Book of Field Crop Production. *ICAR.*

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

Singh SS. 1998. Crop Management. *Kalyani.*

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Course Title : Agronomy of Medicinal, Aromatic and Under Utilized Crops
Course Code : AGRN 725
Credit Hours : 3(2+1)

Theory

Unit I

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge.

Unit II

Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Mulhati, Isabgol, Rauwolfia, Poppy, Aloe vera, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, Nuxvomica, Rosadle, *etc.,*).

Unit III

Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium)

Unit IV

Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco).

Unit V

Post-harvest handling – drawing, processing, grading, packing and storage, value addition and quality standards in herbalproducts.

Practical

Identification of crops based on morphological and seed characteristics; Raising of herbarium of medicinal, aromatic and under-utilized plants; Quality characters in medicinal and aromatic plants; Methods of analysis of essential oil and otherchemicals of importance in medicinal and aromatic plants.

Suggested Reading

Chadha KL and Gupta R. 1995. Advances in Horticulture. Vol. II. Medicinal and Aromatic Plants. *Malhotra Publ.*

Das NR. 2007. Introduction to Crops of India. *Scientific Publ.*

Handa SS. 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 JBM & Irulappan 1997. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. *Oxford & IBH.*

Prajapati ND, Purohit SS, Sharma AK and Kumar T. 2003. A Hand Book of Medicinal Plants: A Complete SourceBook. *Agrobios.*

Sharma R. 2004. Agro-Techniques of Medicinal Plants. *Daya Publ.* House.

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Course Title : Agronomy of Fodder and Forage Crops
Course Code : AGRN 731
Credit Hours : 3(2+1)

Theory

Unit I

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like sorghum, maize, bajra, guar, cowpea, oats, barley, berseem, senji, lucerne, *etc.*

Unit II

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses lime, Napier grass, Panicum, Lasiuras, Cenchrus, *etc*.

Unit III

Year-round fodder production and management, preservation and utilization of forage and pasture crops.

Unit IV

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. Fodder production through hydroponics. Azolla cultivation.

Unit V

Economics of forage cultivation uses and seed production techniques of important fodder crops.

Practical

Practical training of farm operations in raising fodder crops; Canopy measurement, yield, Leaf: Stem ratio and quality estimation, *viz.* crude protein, NDF, ADF, lignin, silica, cellulose and IVDMD, *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.

Suggested Reading

Chatterjee BN. 1989. Forage Crop Production - Principles and Practices. *Oxford & IBH.*

Das NR. 2007. Introduction to Crops of India. *Scientific Publ.*

Narayanan TR and Dabadghao PM. 1972. Forage Crops of India. *ICAR.*

Singh P and Srivastava AK. 1990. Forage Production Technology. *IGFRI*, Jhansi.

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

Tejwani KG. 1994. Agroforestry in India. *Oxford & IBH.*

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Course Title : Cropping Systems and Sustainable Agriculture
Course Code : AGRN 733
Credit Hours : 2(2+0)

Theory

Unit I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

Unit II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

Unit III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

Unit IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Advanced nutritional tools for big data analysis and interpretation.

Unit V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Unit VI

Artificial Intelligence- Concept and application.

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,NelsonWL,Beaton JDandHavlin JL. 1997.Soil Fertility and Fertilizers.*Prentice Hall.*

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Course Title : Dryland Farming and Watershed Management
Course Code : AGRN 734
Credit Hours : 3(2+1)

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); anti-transpirants; 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 Thornth waite method; Estimation of Reference ET by Penman Monteith Method Classification of climate by Thornth waite method (based on moisture index, humidity index and aridity index); Classification of climate by Koppen Method; Estimation of water balance by Thornth waite 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.

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 for Drylands. *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 &Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. *Agrotech Publ. Co.*

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,* New Delhi

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Course Title : Principles and Practices of Organic Farming
Course Code : AGRN 735
Credit Hours : 3(2+1)

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 and 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, 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 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 a biogas plant; Visit to an organic farm; Quality standards, inspection, certification and labelling and accreditation procedures for farm produce from organic farms.

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., 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.*

Minor Courses

Course Title: Principles & Practices of Soil Fertility & Nutrient Management

Course Code: SS 732

Credit Hours: 3 (2 + 1)

Theory

Unit I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of
nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

Unit II

Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation
and dynamics of major plant nutrients

Unit III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic
concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.
Soil less cultivation.

Unit IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects
and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades;

methods of increasing
fertilizer use efficiency; nutrient interactions.

Unit V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of
organic and inorganic nutrients; economics of fertilizer use; integrated nutrient management; use of vermin-compost and
residue wastes in crops.

Practical

Determination of soil pH and soil EC: Determination of soil organic C; Determination of available N, P, K and S of soil;
Determination of total N, P, K and S of soil; Determination of total N, P, K, S in plant; Computation of optimum and economic yield

Suggested Reading

Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.

Fageria NK, Baligar VC and Jones CA. 1991.Growth and Mineral Nutrition of Field Crops. Marcel Dekker.

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

Prasad R and Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.

Yawalkar KS, Agrawal JP and Bokde S. 2000. Manures and Fertilizers. Agri-Horti Publ.

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Course Title : Principles and Practices of Water Management
Course Code : IDE 704
Credit Hours : 3(2+1)

Theory

Unit I

Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in of India andconcerned 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-water- plant 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 loses.

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.

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 &Maliwal PL. 2005. Technologies for Food Security & Sustainable Agriculture. *Agrotech Pub.*

Course Title : Agrostology and Agro-forestry

Course Code : SAF 716
Credit Hours : 3(2+1)

Theory

Unit I

Agrostology: definition and importance; principles of grassland ecology: grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

Unit II

Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.

Unit III

Agroforestry: definition and importance; agroforestry systems, Agri silviculture, Silvi pasture, agrisilvipasture, Agri horticulture, aqua silviculture, alley cropping and energy plantation.

Unit IV

Crop production technology in agro-forestry and agrostology system; Silvi pastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practical

Preparation of charts and maps of India showing different types of pastures and agro-forestry systems; Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry; Seed treatment for better germination of farm vegetation; Methods of propagation/ planting of grasses and trees in Silvi pastoral system; Fertilizer application in strip and silvipastroal systems; After-care of plantation; Estimation of protein content in loppings of important fodder trees; Estimation of calorie value of wood of important fuel trees; Estimation of total biomass and fuel wood; Economics of agro-forestry; Visit to important agro-forestry research stations

Suggested Reading

Chatterjee BN and Das PK. 1989. Forage Crop Production. Principles and Practices. *Oxford & IBH.*

Dabadghao PM and Shankaranarayan KA. 1973. The Grass Cover in India. *ICAR.*

Dwivedi AP. 1992. Agroforestry- Principles and Practices. *Oxford & IBH.*

Indian Society of Agronomy. 1989. Agroforestry System in India. Research and Development,New Delhi.

Narayan TR and Dabadghao PM. 1972. Forage Crop of India. *ICAR,* New Delhi.

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Course Title : SOIL FERTILITY AND FERTILIZERS USE

Course Code: SAC-734

Credit Hours: 3(2+1)

Theory

UNIT I

Soil fertility and soil productivity; nutrient sources - fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.

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 and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT IV

Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V

Sulphur - source, forms, fertilizers and their behavior in soils; 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; blanket fertilizer recommendations - usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. UNIT IX

Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical

- Principles of colorimetry
- Flame-photometry, and atomic absorption spectroscopy.
- Chemical analysis of soil for total and available nutrients.
- Analysis of plants for essential elements.

Suggested Readings

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13 Ed. Pearson Edu.

Kabata-Pendias A & Pendias H. 1992. Trace Elements in Soils and Plants. CRC Press.

Kannaiyan S, Kumar K & Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.

Leigh JG. 2002. Nitrogen Fixation at the Millennium. Elsevier.

Mengel K & Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. Micronutrients in nd Agriculture. 2 Ed. SSSA, Madison.

Pierzinsky GM, Sims TJ & Vance JF. 2002. Soils and Environmental nd Quality. 2nd Ed. CRC Press.

Stevenson FJ & Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. Soil Fertility and th Fertilizers. 5th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. Soils and Soil Fertility. Blackwell.

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ss**Course Title : PRINCIPLES AND PRACTICES OF WATER MANAGEMENT**

Course Code: SWLE 704

Credit Hours: 3(2+1)

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; micro irrigation 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. 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.

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.

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Course Title: Soil erosion and conservation

Course Code: SSAC

Credit Hours: 3 (2+1)

Theory

UNIT-I

History, distribution, identification and description of soil erosion problems in India. 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 EI30 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-II

Wind erosion- types, mechanism and factors affecting wind erosion, extent of problem in the country. Principles of erosion control, erosion control measures – agronomical and engineering, erosion control structures - their design and layout.

UNIT-III

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-IV

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

1. Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio and raindrop erodibility index.
2. Computation of kinetic energy of falling rain drop.
3. Computation of rainfall erosivity index using rain gauge data.
4. Visits to a watershed.

Supporting Course

Course Title: STATISTICAL METHOD

Course Code: AST-523

(Credit Hours: 2+1=3)

Frequency distribution, classification and tabulation of data, graphical and diagrammatic representation of data, measures of central tendency, measures of dispersion, coefficient of variance, standard error, skewness & kurtosis. Consus & sample survey, population and sample, probability, concept of random sampling, simple random sample, statified sample systematic & cluster sampling parameter & sample value. Testing of hypothesis, test of signification based on Z , t and F test X2-test for goodness of fit and independence of attributes. Scatttered diagram. Linear regression & correlation, regression and correlation coefficient.

Course Title: Experimental Designs

Course Code: AST 524

Credit Hour:3 (2 + 1)

Theory

UNIT-I

Need for designing of experiments, characteristics of a good design, basic principles of designs - randomization, replication and local control. Uniformity trials, analysis of variance and interpretation of data, transformations, orthogonality and partitioning of degrees of freedom.

UNIT-II

Completely randomized design, randomized block design and Latin square design, repeated Latin square design, analysis of covariance and missing plot techniques in randomized block and Latin square designs.

UNIT-III

Factorial experiments (symmetrical as well as asymmetrical), confounding in symmetrical factorial experiments, factorial experiments with control treatment.

UNIT-IV

Split plot and strip plot designs, crossover designs, balanced incomplete block design, lattice design-concepts, randomization procedure, analysis and interpretation of results, experiments with mixtures.

Practical

1. Analysis of data obtained from CRD, RBD, LSD.
2. Analysis of factorial experiments with and without confounding.
3. Analysis with missing data; balanced incomplete block design; split plot and strip plot designs.
4. Transformation of data.
5. Analysis of lattice design.

Non-Credit Courses

Course Title : Library and Information Services

Course Code : PGS 501

Credit Hours : 1(0+1)

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e- resources access methods.

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Course Title : Technical Writing and communications Skills

Course Code : PGS 502

Credit Hours : 1(0+1)

Practical (Technical Writing)

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications; Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article; Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech; Participation in group discussion; Facing an interview; Presentation of scientific papers.

Suggested Readings

Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. *Collins' Cobuild English Dictionary.* 1995.

Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. *3rd Ed.*

Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. *Oxford University Press*.

James HS. 1994. Handbook for Technical Writing. *NTC Business Books.*

Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. *Affiliated East-West Press.*

Mohan K. 2005. Speaking English Effectively. *MacMillan India.*

Richard WS. 1969. *Technical Writing.*

Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. *Prentice Hall of India*

Wren PC and Martin H. 2006. High School English Grammar and Composition. *S. Chand & Co.*

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Course Title : Intellectual Property and its Management in Agriculture

Course Code : PGS - 503

Credit Hours : 1(1+0)

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.

Suggested Readings

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 and Aesthetic Technologies.*

Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. *Academic Foundation.*

Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. *CABI.*

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. *Daya Publ.* House. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

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Course Title : Basic Concepts in Laboratory Techniques

Course Code : PGS 504

Credit Hours : 1(0+1)

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, and micropipettes; 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; Neutralization 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, sand bath, water bath, oil bath; 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 and Latchem WE. 1968. A Handbook of Laboratory Solutions. *Chemical Publ. Co.*

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Course Title : Agricultural Research, Research Ethics and Rural Development Programme

Course Code : PGS 505

Credit Hours : 1(0+1)

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.

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 and Singh G. 2001. Indian Agriculture - Four Decades of Development. *Sage Publ*.

Punia MS. Manual on International Research &Research Ethics.CCS Haryana Agricultural University, Hisar.

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

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

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