



Deen Dayal Upadhyaya Gorakhpur University,  
Gorakhpur 273009

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COURSE CURRICULUM AND SYLLABUS

OF

M. Sc. (Ag.) Agronomy

**Nomenclature and Credit hour**

(On the recommendations of the members of National Core Group, 19 Broad Subject Matter Area (BSMA), ICAR)

Nomenclature	Credit hours
Major Courses	20
Minor Courses	08
Supporting Course	06
Common Courses	05
Credit Seminar	01
Research work or Research Methodology	30
Total	70

**Major courses:** From the discipline in which a student takes admission.

**Minor courses:** From the subjects closely related to a student's major subject. It is suggested that the student may choose minor courses as these are related to policy advocacy and aim to build larger understanding of the subject. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/HOD.

**Supporting courses:** The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

**Common Courses:** The following courses (one credit each) will be offered to all students undergoing

Master's degree programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its Management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

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

Academic eligibility for admission: - B.Sc. (Ag.)

### Curriculum and Syllabus

Course code	Course Title	Credit
<b>Major Courses</b>		<b>20</b>
AGRON-501	Modern Concepts in Crop Production	3(3+0)
AGRON-502	Principles and Practices of Soil Fertility and Nutrient Management	3(2+1)
AGRON-503	Principles and Practices of Weed Management	3(2+1)
AGRON-504	Principles and Practices of Water Management	3(2+1)
AGRON-505	Agronomy of Major Cereals, Pulses and oilseeds	3(2+1)
AGRON-506	Agronomy of Commercial crops, Fiber Crops and Forage crops	3(2+1)
AGRON-507	Cropping System and Sustainable Agriculture	2(2+0)
<b>Minor Courses</b>		<b>08</b>
AGRON-508	Dryland Farming and Watershed Management	3(2+1)
AGRON-509	Principles and Practices of Organic Farming	2(1+1)
*HORT-508	Production of Medicinal and Aromatic Crops	3(2+1)
<b>Supporting Courses</b>		<b>06</b>
STAT 502	Statistical Methods for Applied Sciences	3(2+1)
STAT 511	Experimental Designs	3(2+1)
<b>Common Courses</b>		<b>05</b>
PGS-501	Library and Information Services	1(0+1)
PGS-502	Technical Writing and Communications Skills	1(0+1)
PGS-503	Intellectual Property and its management in Agriculture	1(1+0)
PGS-504	Basic Concepts in Laboratory Techniques	1(0+1)
PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
<b>Seminar</b>		<b>01</b>
AGRON 591	Master's Seminar	1(0+1)
<b>Thesis Research/Special paper</b>		<b>30</b>
# AGRON 599	Master's Research (Thesis) or Special paper (Agronomical Research Methodology)	30
<b>Total Credit</b>		<b>70</b>

\*Minor course covered by Department of Horticulture

#Satisfactory/Non-satisfactory

### Semester Wise Course Distribution

Course code	Course Title	Credit
<b>Semester I</b>		
AGRON-501	Modern Concepts in Crop Production	3(3+0)
AGRON-503	Principles and Practices of Weed Management	3(2+1)
AGRON-505	Agronomy of Major Cereals, Pulses and oilseeds	3(2+1)
STAT 502	Statistical Methods for Applied Sciences	3(2+1)
PGS-501	Library and Information Services	1(0+1)
PGS-502	Technical Writing and Communications Skills	1(0+1)
		<b>14</b>
<b>Semester II</b>		
AGRON-502	Principles and Practices of Soil Fertility and Nutrient Management	3(2+1)
AGRON-504	Principles and Practices of Water Management	3(2+1)
HORT-508*	Production of Medicinal and Aromatic Crops	3(2+1)
STAT 511	Experimental Designs	3(2+1)
PGS-503	Intellectual Property and its management in Agriculture	1(1+0)
PGS-504	Basic Concepts in Laboratory Techniques	1(0+1)
		<b>14</b>
<b>Semester III</b>		
AGRON-506	Agronomy of Commercial crops, Fiber Crops and Forage crops	3(2+1)
AGRON-507	Cropping System and Sustainable Agriculture	2(2+0)
AGRON-508	Dryland Farming and Watershed Management	3(2+1)
AGRON-509	Principles and Practices of Organic Farming	2(1+1)
PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
		<b>5</b>
<b>Semester IV</b>		
AGRON 591	Master's Seminar	1(0+1)
#AGRON 599	Master's Research (Thesis) or Special paper (Agronomical Research Methodology)	30
		<b>31</b>

\*Minor course covered by Department of Horticulture

#Satisfactory/Non-satisfactory

## **AGRONOMY**

### **Syllabus**

**Course Title : Modern Concepts in Crop Production**

**Course Code : AGRON 501**

**Credit Hours : 3(3+0)**

**Aim of the course** - To teach the basic concepts of soil management and crop production.

**Theory:**

**Unit I:**

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

**Unit II:**

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

**Unit III:**

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

**Unit IV:**

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition.

**Unit V:**

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture. Modern crop production concepts: soil less cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment and class discussion

**Learning outcome -**

Basic knowledge on soil management and crop production.

**Suggested Reading:-**

- Balasubramaniyan P and Palaniappan SP. 2001. Principles and Practices of Agronomy. Agrobios.
- Fageria NK. 1992. Maximizing Crop Yields. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. Soil Fertility and Fertilizers. 7thEd. 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 TV. 1997. Principles of Agronomy. The Bangalore Printing & Publ.
- Singh SS. 2006. Principles and Practices of Agronomy. Kalyani.
- Alvin PT and kozlowski TT (ed.). 1976. Ecophysiology of Tropical Crops. Academia Pul., New York.
- Gardner PP, Pearce GR and Mitchell RL. 1985. Physiology of Crop Plants. Scientific Pub. Jodhpur.
- Lal R. 1989. Conservation tillage for sustainable agriculture: Tropics versus Temperate Environments. Advances in Agronomy 42: 85-197.
- Wilsie CP. 1961. Crop Adaptation and Distribution. Euresia Pub., New Delhi.

**Course Title : Principal and Practices of Soil Fertility and Nutrient Management**

**Course Code : AGRON 502**

**Credit Hours : 3( 2+1)**

**Aim of the course -** To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

**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 vermincompost 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

### **Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome -

Basic knowledge on soil fertility and management

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.

### **Course Title : Principles and Practices of Weed Management**

**Course Code : AGRON 503**

**Credit Hours : 3 ( 2+1 )**

**Aim of the course** - To familiarize the students about the weeds, herbicides and methods of weed control.

#### **Theory**

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 herbicide requirement

### **Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, field visit to identify weeds.

### **Learning outcome -**

Basic knowledge on weed identification and control for crop production

### **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.

**Course Title : Principles and Practices of Water Management**

**Course Code : AGRON 504**

**Credit Hours : 3 ( 2+1 )**

**Aim of the course -**

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

**Theory**

**Unit I:**

Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in of India and the concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states.

**Unit II:**

Field water cycle, water movement in soil and plants; transpiration; soil-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 losses.

**Unit III:**

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

Irrigation efficiency and water use efficiency.

**Unit IV:**

Water management of crop and cropping system, Quality of irrigation water and management of saline water for irrigation, water use efficiency, Crop water requirement- estimation of ET and effective rainfall; Water management of the major crops and cropping systems. Automated irrigation system.

**Unit V:**

Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage, their layout and spacing; rain water management and its utilization for crop production.

**Unit VI:**

Quality of irrigation water and management of saline water for irrigation, water management in problem soils

**Unit VII:**

Soil moisture conservation, water harvesting, rain water management and its utilization for crop production.

**Unit VIII:**

Hydroponics,

**Practical**

- Determination of Field capacity by field method
- Determination of Permanent Wilting Point by sunflower pot culture technique
- Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus
- Determination of Hygroscopic Coefficient
- Determination of maximum water holding capacity of soil
- Measurement of matric potential using gauge and mercury type tensiometer
- Determination of soil-moisture characteristics curves
- Determination of saturated hydraulic conductivity by constant and falling head method
- Determination of hydraulic conductivity of saturated soil below the water table by auger hole method
- Measurement of soil water diffusivity

- Estimation of unsaturated hydraulic conductivity
- Estimation of upward flux of water using tensiometer and from depth ground water table
- Determination of irrigation requirement of crops (calculations)
- Determination of effective rainfall (calculations)
- Determination of ET of crops by soil moisture depletion method
- Determination of water requirements of crops
- Measurement of irrigation water by volume and velocity-area method
- Measurement of irrigation water by measuring devices and calculation of irrigation efficiency
- Determination of infiltration rate by double ring infiltrometer

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment and field visit

**Learning outcome -**

Basic knowledge on water management for optimization of crop yield

**Suggested Reading**

- Majumdar DK. 2014. Irrigation Water Management: Principles and Practice. PHL Learning private publishers
- Mukund Joshi. 2013. A Text Book of Irrigation and Water Management Hardcover, Kalyani publishers
- Lenka D. 1999. Irrigation and Drainage. Kalyani.
- Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
- Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi.
- Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
- Prihar SS and Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
- Reddy SR. 2000. Principles of Crop Production. Kalyani.
- Singh Pratap and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ.

**Course Title : Agronomy of Major Cereals, Pulses and Oilseeds**

**Course Code : AGRON -505**

**Credit Hours : 3 ( 2+1 )**

**Aim of the course -**

To impart knowledge of crop husbandry of cereals, pulses and Oilseeds crops.

**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.

**Unit V :** Rabi oilseeds

**Unit VI :** Kharif oilseeds

**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

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment and class discussion

**Learning outcome -**

Basic knowledge on cereals and pulse growing in the country .

**Resources -**

- 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 Field Crops. Oxford & IBH.
- Singh SS. 1998. Crop Management. Kalyani.
- Yadav DS. 1992. Pulse Crops. Kalyani.

**Course Title : Agronomy of Commercial crops, Fibre and Forage Crops**

**Course Code : AGRON 506**

**Credit Hours : 3 ( 2+1 )**

**Aim of the course -**

To teach the crop husbandry of oilseed, fiber and sugar crops

**Theory:**

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality

component, handling and processing of the produce for maximum production of:

**Unit I:**

Commercial Crops - Sugarcane

**Unit II:**

Fiber crops - Cotton, Jute, Ramie and Mesta.

**Unit III:**

Forage crops –

Berseem, Lucerne, Paragrass, Napier grass, Sudan grass, Rhodes Grass, Guinea grass, Oats, Maize

**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 for various 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

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment and class discussion

**Learning outcome -**

Basic knowledge on production of oil seed, sugar and fibre crops.

**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.

**Course Title : Cropping Systems and Sustainable Agriculture**

**Course Code : AGRON- 507**

**Credit Hours : 2 ( 2+0 )**

**Aim of the course -**

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

**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.

**Teaching methods/ activities -**

Classroom teaching with AV aids, group discussion, assignment.

**Learning outcome -**

Basic knowledge on cropping system for sustainable agriculture.

**Suggested Reading**

- Panda SC. 2017. Cropping Systems and Sustainable Agriculture. Agrobios (India)
- Panda SC. 2018. Cropping and Farming Systems. Agrobios.
- Palaniappan SP and Sivaraman K. 1996. Cropping Systems in the Tropics; Principles and Management. New Age.
- Panda SC. 2003. Cropping and Farming Systems. Agrobios.
- Reddy SR. 2000. Principles of Crop Production. Kalyani.
- Sankaran S and Mudaliar TVS. 1997. Principles of Agronomy. The Bangalore Printing & Publ. Co.
- Singh SS. 2006. Principles and Practices of Agronomy. Kalyani.
- Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1997. Soil Fertility and Fertilizers. Prentice Hall.

**Course Title : Dryland Farming and Watershed Management**

**Course Code. : AGRON - 508**

**Credit Hours : 3 ( 2+1 )**

**Aim of the course -**

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

**Theory****Unit I:**

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



**Unit II:**

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

**Unit III:**

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

**Unit IV:**

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

**Unit V:**

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

**Practical**

- Method of Seed Priming
- Determination of moisture content of germination of important dryland crops
- Determination of Relative Water Content and Saturation Deficit of Leaf
- Moisture stress effects and recovery behaviour of important crops
- Estimation of Potential ET by Thornthwaite method
- Estimation of Reference ET by Penman Monteith Method
- Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index)
- Classification of climate by Koppen Method
- Estimation of water balance by Thornthwaite method
- Estimation of water balance by FAO method
- Assessment of drought
- Estimation of length of growing period
- Estimation of probability of rain and crop planning for different drought condition

- Spray of anti-transpirants and their effect on crops
- Water use efficiency
- Visit to dryland research stations and watershed projects

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment.

**Learning outcome -**

Basic knowledge on dry land farming and soil moisture conservation.

**Suggested Reading -**

- Reddy TY. 2018. Dryland Agriculture Principles and Practices, Kalyani publishers
- Das NR. 2007. Tillage and Crop Production. Scientific Publ.
- Dhopte AM. 2002. Agrotechnology for Dryland Farming. Scientific Publ.
- Dhruv Narayan VV. 2002. Soil and Water Conservation Research in India. ICAR.
- Gupta US. (Ed.). 1995. Production and Improvements of Crops 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 and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ. Company.
- Singh RP. 1988. Improved Agronomic Practices for Dryland Crops. CRIDA.
- Singh RP. 2005. Sustainable Development of Dryland Agriculture in India. Scientific Publ.
- Singh SD. 1998. Arid Land Irrigation and Ecological Management. Scientific Publ.
- Venkateshwarlu J. 2004. Rainfed Agriculture in India. Research and Development Scenario.

**Course Title : Principles and Practices of Organic Farming**

**Course Code : AGRON - 509**

**Credit Hours : 2 ( 1+1 )**

**Aim of the course -**

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

**Theory**

**Unit I:**

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; principles of organic agriculture; organics and farming standards; organic farming and sustainable agriculture; selection and conversion of land, soil and water management - land use, conservation tillage; shelter zones,

hedges, pasture management, agro-forestry.

**Unit II:**

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, bio-fertilizers and biogas technology.

**Unit III:**

Farming systems, selection of crops 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 trees and trees for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field
- Visit to a biogas plant
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

**Teaching methods/activities -**

Classroom teaching with AV aids, group discussion, assignment, exposure visit

**Learning outcome -**

Basic knowledge on organic farming for sustainable agriculture and development of entrepreneurship on organic inputs.

### **Suggested Reading**

- Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.
- Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO.
- Joshi M. 2016. New Vistas of Organic Farming. Scientific Publishers
- Lampin N. 1990. Organic Farming. Press Books, Ipswich, UK.
- Palaniappan SP and Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.
- Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, ParisaraprajnaParishtana, Bangalore.
- Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
- Sharma A. 2002. Hand Book of Organic Farming. Agrobios.
- Singh SP. (Ed.). 1994. Technology for Production of Natural Enemies. PDDB, 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.

### **AGRON 591 Seminar**

**1 (0+1)**

The seminar paper will be related to the area of research of the candidate and the candidate should have to give a seminar presentation of it.

### **STAT 502 Statistical Methods for Applied Sciences**

**3(2+1)**

#### **Aim of the course**

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to

presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

## **Theory**

### **Unit I**

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

### **Unit II**

Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chisquare,  $t$  and  $F$  distributions. Tests of significance based on Normal, chi-square,  $t$  and  $F$  distributions.

### **Unit III**

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

### **Unit IV**

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

### **Unit V**

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data. **Practical**

- Exploratory data analysis, fitting of distributions  $\sim$  Binomial, Poisson, Negative Binomial, Normal.
- Large sample tests, testing of hypothesis based on exact sampling distributions  $\sim$  chi square,  $t$  and  $F$ .
- Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.
- Non-parametric tests. ANOVA: One way, Two Way, SRS.

## **Suggested Reading**

Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.  
Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.  
Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.  
Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.  
Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.  
Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.  
Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley.  
<http://freestatistics.altervista.org/en/learning.php>. • <http://www.statsoft.com/textbook/stathome.html>.

## **STAT 511 Experimental Designs**

**3(2+1)**

### **Aim of the course**

This course is meant for students of agricultural and animal sciences other than Agricultural Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

### **Theory**

#### **Unit I**

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.

#### **Unit II**

Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

#### **Unit III**

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

#### **Unit IV**

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

### **Practical**

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

### **Suggested Reading**

Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.

[www.drs.icar.gov.in](http://www.drs.icar.gov.in).

## **PGS 501 LIBRARY AND INFORMATION SERVICES**

**(0+1)**

### **Objective**

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

### **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.

## **PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS**

**(0+1)**

### **Objective**

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

### **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.

## **PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE**

**(1+0)**

### **Objective**

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

### **Theory**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, 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

## **PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES**

**(0+1)**

### **Objective**

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

### **Practical**

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

### **Suggested Readings**

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

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

**PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)**

**Objective**

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

**Theory**

**UNIT I**

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

**UNIT II**

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

**UNIT III**

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**Suggested Readings**

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

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

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

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

**Course Title: Production of Medicinal and Aromatic Crops**

**Course Code: HOR 508**

**Credit Hours: 3(2+1)**

**Theory**

**Block 1: Importance of Medicinal and Aromatic Crops**

**Unit 1:**

Classification of medicinal and aromatic crops: Importance of medicinal plants, Importance of aromatic plants, Role in national economy, utility sectors of medicinal and aromatic crops, classification of medicinal and aromatic crops, role of institutions, Medicinal Plant Board and NGO's in research and development of medicinal and aromatic crops.

**Unit 2:**

Medicinal and plant based industry: Indian system of medicine, traditional systems of medicine, tribal medicine, medicinal industry, source of medicinal plants, area, production, export and import of major crops, problems, prospects and challenges, IPR issues.

**Unit 3:**

Aromatic plant based industry: Essential oils, classification, physical and chemical properties and storage of essential oils. Indian perfumery industry, area, production, export and import status of major aromatic crops, history and advancements, problems, prospects and challenges, IPR issues.

**Block 2: Production technology of medicinal and aromatic crops**

**Unit 1:**

Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in medicinal and aromatic crops.

**Unit 2:**

Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices.

**Unit 3:**

Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection.

**Block 3: Harvest and Post harvest management**

**Unit 1:**

Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons in medicinal and aromatic crops.

### **Unit 2:**

Post harvest management: Post harvest management including primary processing, extraction, grading, packaging and storage, GMP in medicinal and aromatic crops.

### **Crops**

**A. Medicinal crops:** Senna, aswagandha, sarpagandha, *Aloe vera*, isabgol, opium poppy, safedmusli, *Stevia rebaudiana*, *Piper longum*, *Plumbago zeylanica*

**B. Aromatic crops:** Palmarosa, lemongrass, citronella, mentha, jasmine, geranium, *Ocimum* sp., eucalyptus, sandal

### **Practical**

- Description of botanical and varietal features;
- Nursery techniques;
- Lay out and planting;
- Manuring practices;
- Maturity standards;
- Harvesting;
- Primary processing;
- Extraction of oils;
- Herbarium preparation;
- Project preparation for establishing herbal gardens;
- GAP in medicinal and aromatic crops;
- GMP in medicinal and aromatic crops;
- Exposure visits to institutes, herbal gardens and industries.

### **Suggested Reading**

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

Barche S. 2016. *Production technology of spices, aromatic, medicinal and plantation crops*. New India Publishing Agency, New Delhi.

Das K. 2013. *Essential oils and their applications*. New India Publishing Agency, New Delhi

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

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

Gupta RK. 2010. *Medicinal and Aromatic plants*. CBS publications.