

# VIDYASAGAR UNIVERSITY



**Syllabus  
for  
M. Sc (Agriculture) in Agronomy**

[w.e.f.: 2022-2023]

## **MISSION**

The **M.Sc. in Agronomy** course is to train students in the field of Crop Science. Theoretical as well as practical training is imparted to the candidates in the subspecialties viz. Crop production, Irrigation, Weed Managements and Nutrient Management so that they can participate in good crop production as well as farmers in grass root level. They are introduced to basic research methodology so that they can conduct fundamental and applied research. They are also imparted farmers training methods in the subject which may enable them to take up in research in Agricultural Colleges/Institutes.

## **OBJECTIVES OF THE COURSE**

As a nation we have gone ahead in many respects. But there are still areas, which demand attention, care and concern. The area identified by our think-tanks is “Indian Council of Agricultural Research”. This course will provide trained, qualified, technical personnel in the field of Crop Science to support the farmers and their profession. At the end of the course the students should be able to: Establish good number of services in various fields in agro based companies and different sectors related to agriculture. They will be able to plan, execute and evaluate teaching assignments and research work in Agronomy.

## **ELIGIBILITY FOR ADMISSION**

The students who have passed Bachelor’s degree in Agricultural / Botany / Horticulture or Forestry with 50% marks for General and 45% marks for SC/ST category.

## **JOB PROSPECTS**

The M.Sc. in Agronomy may be assigned to a specialized area of work in a large field. In fields they may refer variety of trails. They can also work as laboratory manager/ Agriculture officer/ Agricultural administrative officer, agricultural technology manager, Agricultural zonal manager, Agricultural consultant, educational director, food safety officer etc.

## **MINIMUM ELIGIBILITY FOR APPEARANCE IN EXAMINATION**

A Regular student i.e. a student who has undergone a regular course of study in a college for the period specified for that course of study by having been on the rolls of the college immediately preceding the examination and has his/her name submitted to the Controller of Examinations by the college Principal where he/she has pursued the course for the examination and has fulfilled the following conditions to be certified by the college Principal concerned:

- He/she has been a student of good conduct.
- He/she has attended not less than 75% of the lecture delivered including seminars, tutorials etc. in each course opted by him/her in that semester.
- He/she has passed in previous semester.
- In the case of laboratory course/practical, he/she has attended not less than 75% of the practical classes conducted (practical include field studies, workshop practice, surveying etc.).
- He/she has paid the prescribed fee.

## SCHEME OF EXAMINATION

The evaluation of M.Sc. in Agronomy course contains two parts: Internal Assessment (IA) and End-Semester Assessment (EA). The internal grade awarded to the students in the course in a semester shall be published on the notice board at least one week before the commencement of end semester examination. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course. There will be University Examinations at the end of each semester for both Theory and Practical. Semester End Examinations for all theory papers shall be set/prepared by the Controller of Examinations as per existing norms and evaluation of all theory papers courses shall be done by eligible faculty members set in the Board of Studies meeting held before the examination and under the supervision and coordination of the Controller of Examination. When there is a single college in a subject it has the liberty either to join the nearest cluster or form a new cluster with a similarly placed college.

The students will learn 14 theory papers (Full Marks 50) and 14 practical papers (Full Marks 30) with Research paper (Full Marks 100) in total semester (it may be changed as per the recommendation of Board of Studies members and approved by the Hon'ble Vice Chancellor). The details of the syllabus should be approved by the Board of Studies members and or syllabus committee made for the course. The evaluation of a candidate shall be awarded and record thereof maintained in accordance with the Regulations prescribed:

Paper	Internal Assessment	End Semester	Total Marks
Theory	20	50	100
Practical	00	30	

### Internal Assessment:

Categories	Class Assignment	Class Attendance	Internal exam*(IA)	Total
Number Distribution	05	05	10	20

\*IA should be held two times. Best of the two should be awarded

The questions pattern of theory will be as follows:

<b>Questions Pattern</b>	<b>Marks</b>
05 Short Answer type Questions out of 08 Questions. Each carries 02 marks.	<b>05×02=10</b>
05 Medium Answer type Questions out of 08 Questions. Each carries 04 marks.	<b>05×04=20</b>
02 Long Answer type Questions out of 04 Questions. Each carries 10 marks.	<b>02×10=20</b>

The questions pattern of practical will be as follows:

<b>Questions Pattern</b>	<b>Marks</b>
2 experimental questions with full marks of 15	<b>15</b>
Laboratory Note Book	<b>05</b>
Viva-voce	<b>10</b>

#### **PROMOTION TO NEXT SEMESTER**

- The students should secure 40% marks in each paper for qualifying the semester.
- If a student fails in 1 or 2 papers in an end semester examination, he/she get chance (two times) to clear those supplementary papers in the next year.
- If a student fails in more than 3 papers in an end semester examination, he/ she has to repeat the semester.
- The internal marks of a paper secured by a student will not be changed if he/ she fail in the respective paper in the end semester examination.

**Syllabus for M. Sc (Agriculture) in Agronomy**

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK			TOTAL CREDIT	MARKS DISTRIBUTION					
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total	
AGRON-501*	Modern Concepts in Crop Production	3		0	3	3	20	80	-	100	
AGRON-502*	Principles and Practices of Soil Fertility and Nutrient Management	2		1	3	3	20	50	30	100	
AGRON-503*	Principles and Practices of Weed Management	2		1	3	3	20	50	30	100	
AGRON-504*	Principles and Practices of Water Management	2		1	3	3	20	50	30	100	
AGRON-505@	Conservation Agriculture	1		1	2	2	20	50	30	100	
AGRON-506*	Agronomy of Major Cereals and Pulses	2		0	2	2	20	80	-	100	
AGRON-507@	Agronomy of Oilseed, Fibre and Sugar Crops	2		1	3	3	20	50	30	100	
AGRON-508@	Agronomy of Medicinal, Aromatic and Under-Utilized Crops	2		1	3	3	20	50	30	100	
AGRON-512*	Dryland Farming and Watershed Management	2		1	3	3	20	50	30	100	
AGRON-513*	Principles and Practices of Organic Farming	2		1	3	3	20	50	30	100	
AGRON-550	Master's Seminar	0		1	1	1	-	-	100	100	
AGRON-560	Master's Research	0		30	30	30	-	-	100	100	
STAT-502#	Statistical methods for applied sciences	3		1	4	4	20	50	30	100	
BIOCHEM-505#	Techniques in Biochemistry	2		2	4	4	20	50	30	100	
PGS-501+	Library and Information Services	0		1	1	1	-	-	100	100	
PGS-502+	Technical Writing and Communications Skills	0		1	1	1	-	-	100	100	
PGS-503+	Intellectual Property and its management in Agriculture	1		0	1	1	20	80	-	100	
PGS-504+	Basic Concepts in Laboratory Techniques	0		1	1	1	-	-	100	100	
PGS-505+	Agricultural Research, Research Ethics and Rural Development Programmes	1		0	1	1	20	80	-	100	
<b>TOTAL THEORY</b>					27	27	<b>1900</b>				
<b>TOTAL PRACTICAL</b>					15	15					
<b>RESEARCH</b>					30	30					
<b>TOTAL</b>					72	72					

\*: Major courses, @: Minor courses, #: Supporting subject, +: Common subject

### FIRST SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
AGRON-501	Modern Concepts in Crop Production	3		0	3	3	20	80	-	100
AGRON-502	Principles and Practices of Soil Fertility and Nutrient Management	2		1	3	3	20	50	30	100
AGRON-503	Principles and Practices of Weed Management	2		1	3	3	20	50	30	100
AGRON-504	Principles and Practices of Water Management	2		1	3	3	20	50	30	100
AGRON-505	Conservation Agriculture	1		1	2	2	20	50	30	100
AGRON-506	Agronomy of Major Cereals and Pulses	2		0	2	2	20	80	-	100
<b>TOTAL THEORY</b>		<b>12</b>				<b>12</b>	<b>600</b>			
<b>TOTAL PRACTICAL</b>		<b>4</b>				<b>4</b>				
<b>TOTAL</b>		<b>16</b>				<b>16</b>				

### SECOND SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
AGRON-507	Agronomy of Oilseed, Fibre and Sugar Crops	2		1	3	3	20	50	30	100
AGRON-512	Dryland Farming and Watershed Management	2		1	3	3	20	50	30	100
AGRON-513	Principles and Practices of Organic Farming	2		1	3	3	20	50	30	100
STAT-502	Statistical methods for applied sciences	3		1	4	4	20	50	30	100
BIOCHEM-505	Techniques of Biochemistry	2		2	4	4	20	50	30	100
AGRON-550	Master's Seminar	0		1	1	1	-	-	100	100
<b>TOTAL THEORY</b>		<b>11</b>				<b>11</b>	<b>600</b>			
<b>TOTAL PRACTICAL</b>		<b>7</b>				<b>7</b>				
<b>TOTAL</b>		<b>18</b>				<b>18</b>				

### THIRD SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
AGRON-508	Agronomy of Medicinal, Aromatic and UnderUtilizedCrops	2		1	3	3	20	50	30	100
PGS-502	Technical Writing and Communications Skills	0		1	1	1	-	-	100	100
PGS-504	Basic Concepts in Laboratory Techniques	0		1	1	1	-	-	100	100
PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1		0	1	1	20	80	-	100
<b>TOTAL THEORY</b>		<b>3</b>				<b>3</b>	<b>400</b>			
<b>TOTAL PRACTICAL</b>		<b>3</b>				<b>3</b>				
<b>TOTAL</b>		<b>6</b>				<b>6</b>				

### FOURTH SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
PGS-501	Library and Information Services	0		1	1	1	-	-	100	100
PGS-503	Intellectual Property and its management in Agriculture	1		0	1	1	20	80	-	100
AGRON-560	Master's Research	0		30	30	30	-	-	100	100
<b>TOTAL THEORY</b>		<b>1</b>				<b>1</b>	<b>300</b>			
<b>TOTAL PRACTICAL</b>		<b>1</b>				<b>1</b>				
<b>RESEARCH</b>		<b>30</b>				<b>30</b>				
<b>TOTAL</b>		<b>32</b>				<b>32</b>				

Research work for master's dissertation: 30

Major course:20

Minor course:8

Supporting course: 8

Common courses: 5

**Course Contents**  
**M.Sc. in AGRONOMY**  
**FIRST SEMESTER**  
**Modern Concepts in Crop Production**

**Code: AGRON-501**

**Full Marks - 100**

**Credit hours: 3L+0P**

**Credit-3**

**Objective**

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

**Theory**

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil- plant relations; yield and environmental stress, 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: soilless cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.

**Suggested Readings**

1. Balasubramanian P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
2. Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.
3. Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
4. Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
5. Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
6. Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
7. Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

**Principles and Practices of Soil Fertility and Nutrient Management**



**Code: AGRON-502**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

**Objective**

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.

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 manures; economics of fertilizer use; integrated nutrient management; use of vermicompost and residuewastes in crops.

**Practical**

1. Determination of soil pH and soil EC
2. Determination of soil organic C
3. Determination of available N, P, K and S of soil
4. Determination of total N, P, K and S of soil
5. Determination of total N, P, K, S in plant
6. Computation of optimum and economic yield

**Suggested Readings**

1. Brady, N. C and Weil, R.R 2002. *The Nature and Properties of Soils* (13th Ed.). Pearson Education.
2. Fageria, N.K., Baligar, V.C. and Jones, C.A. 1991. *Growth and Mineral Nutrition of Field Crops*, MarcelDekker, New York.
3. Havlin, J.L, Beaton, J.D., Tisdale, S.L. and Nelson, W.L. 2006. *Soil Fertility and Fertilizers* (7th Ed.)Prentice Hall of India, New Delhi.

4. Prasad, R. and Power, J. F. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC-Lewis, Boca Raton, Florida.
5. Yawalkar, K.S., Agrawal, J.P. and Bokde, S. 2000. *Manures and Fertilizers*. Agri-HortiPubl.

### **Principles and Practices of Weed Management**

**Code: AGRON -503**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

#### **Objective**

To familiarize the students about the weeds, herbicides and methods of weed control

#### **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, 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

#### **Suggested Readings**

1. Aldrich, R.J., Kramer, R.J. 1997. *Principles in Weed Management*. Panima publ.
2. Ashton, F.M and Crafts, A.S. 1981. *Mode of Action of Herbicides* (2nd Ed). Wiley inter Science.
3. Gupta, O.P. 2007. *Weed management – Principles and Practices*. Agrobios
4. Mandal, R. C, 1990. *Weed, weedicides and weed control – Principles and Practices*. Agro – Botanical Publ.
5. Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH
6. Subramanian, S. Ali, A.M and Kumar, R.J. 1997. *All About Weed Control*. Kalyani
7. Thomas, C.G. and Abraham, C.T. 2007. *Methods in Weed Science*. Kerala Agricultural University, Vellanikkara
8. Zimdahl RL. 1999. *Fundamentals of Weed Science* (2nd Ed). Academic Press

### **Principles and Practices of Water Management**

**Code: AGRON-504**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

**Objective**

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 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; rainwater management and its utilization for crop production.

## UNIT VI

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

## UNIT VII

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

## UNIT VIII

Hydroponics,

## UNIT IX

Water management of crops under climate change scenario

### **Practical**

1. Determination of Field capacity by field method
2. Determination of Permanent Wilting Point by sunflower pot culture technique
3. Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus
4. Determination of Hygroscopic Coefficient
5. Determination of maximum water holding capacity of soil
6. Measurement of matric potential using gauge and mercury type tensiometer
7. Determination of soil-moisture characteristics curves
8. Determination of saturated hydraulic conductivity by constant and falling head method
9. Determination of hydraulic conductivity of saturated soil below the water table by auger hole method
10. Measurement of soil water diffusivity
11. Estimation of unsaturated hydraulic conductivity Study of micro irrigation systems and their layout in field crops
12. Estimation of upward flux of water using tensiometer and from depth ground watertable
13. Determination of irrigation requirement of crops (calculations)
14. Determination of effective rainfall (calculations)
15. Determination of ET of crops by soil moisture depletion method
16. Determinationof water requirements of crops
17. Measurement of irrigation water by volume and velocity-area method
18. Measurement of irrigation water by measuring devices and calculation of irrigationefficiency
19. Determination of infiltration rate by double ring infiltrometer

### **Suggested Readings**

1. Majumdar DK. 2014. Irrigation Water Management: Principles and Practice. PHL Learning private publishers
2. Mukund Joshi. 2013. A Text Book of Irrigation and Water Management Hardcover, Kalyani publishers
3. Lenka D. 1999. Irrigation and Drainage. Kalyani.
4. Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
5. Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi.

6. Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
7. Prihar SS and Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
8. Reddy SR. 2000. Principles of Crop Production. Kalyani.
9. Singh Pratap and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. AgrotechPubl

### **Conservation Agriculture**

**Code: AGRON-505**

**Full Marks - 100**

**Credit hours: 1L+1P=2**

**Credit-2**

**Objective**

To impart knowledge of conservation of agriculture for economic development

**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

**Practicals:**

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

**Suggested Readings**

- 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 Agriculture-Environment Farmers experiences, innovations Socio-economic policy.

Muhammad F and Kamdambot HMS. 2014. Conservation Agriculture. Publisher: Springer Cham Heidelberg, New York Dordrecht London. Doi: 10.1007/978-3-319-11620-4.

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

## **Agronomy of Major Cereals and Pulses**

**Code: AGRON-506**

**Full Marks - 100**

**Credit hours: 2L+0P**

**Credit-2**

**Objective**

To impart knowledge of crop husbandry of cereals and pulse 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

**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 ratio, 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 Readings**

1. Das, N. R. 2007. *Introduction to Crops of India*. Scientific Publ.
2. Hunsigi, G. and Krishna, K. R. 1998. *Science of Field Crop Production*. Oxford & IBH.
3. Jeswani, L.M. and Baldev, B. 1997. *Advances in Pulse Production Technology*. ICAR.
4. Khare, D. and Bhale, M. S. 2000. *Seed Technology*. Scientific Publ.
5. Kumar Ranjeet and Singh, N. P. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
6. Pal, M., Deka, J. and Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
7. Prasad, R. 2002 (ed.). *Text Book of Field Crop Production*. ICAR.
8. Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
9. Singh, S.S. 1998. *Crop Management*. Kalyani
10. Yadav DS. 1992. *Pulse Crops*. Kalyani.

### **SECOND SEMESTER**

#### **Agronomy of Oilseed, Fibre and Sugar Crops**

**Code: AGRON-507**

**Credit hours: 2L+1P**

**Credit-3**

**Full Marks - 100**

## **Objective**

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

*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**

1. Planning and layout of field experiments
2. Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane
3. Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice
4. Phenological studies at different growth stages of crop, visit to a sugarcane research station
5. Intercultural operations in different crops
6. Cotton seed treatment
7. Working out growth indices (CGR, RGR, NAR, LAD), LER, aggressiveness, relative crowding coefficient, monetary yield advantage and ATER (Area Time Equivalent Ratio) of prominent intercropping systems of different crops
8. 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)
9. Judging of physiological maturity in different crops and working out harvest index
10. Working out cost of cultivation of different crops
11. Estimation of crop yield on the basis of yield attributes
12. Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
13. Determination of oil content in oilseeds and computation of oil yield
14. Estimation of quality of fibre of different fibre crops
15. Study of seed production techniques in various crops
16. Visit of field experiments on cultural, fertilizer, weed control and water management aspects
17. Visit to nearby villages for identification of constraints in crop production

## **Suggested Readings**

1. Das, N.R. 2007. *Introduction to Crops of India*. Scientific Publ.



2. Das, P.C. 1997. *Oilseed Crops of India*.Kalyani.
3. Lakshmikantam, N. 1983. *Technology in Sugarcane Growing* (2<sup>nd</sup> Ed.) Oxford &IBH.
4. Prasad, R. 2002 (ed.). *Text Book of Field Crop Production*.ICAR.
5. Singh, C, Singh, P. and Singh R. 2003. *Modern Techniques of Raising Field Crops*.Oxford& IBH.
6. Singh, S. S. 1998. *Crop Management*.Kalyani.

### **Dryland Farming and Watershed Management**

**Code: AGRON-512**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

#### **Objective**

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

#### **Theory**

##### **UNIT I**

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

##### **UNIT II**

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

##### **UNIT III**

Stress physiology and crop 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, tillth, 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**

1. Method of Seed Priming
2. Determination of moisture content of germination of important dryland crops
3. Determination of Relative Water Content and Saturation Deficit of Leaf
4. Moisture stress effects and recovery behaviour of important crops
5. Estimation of Potential ET by Thornthwaite method
6. Estimation of Reference ET by Penman Monteith Method
7. Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index)

8. Classification of climate by Koppen Method
9. Estimation of water balance by Thornthwaite method
10. Estimation of water balance by FAO method
11. Assessment of drought
12. Estimation of length of growing period
13. Estimation of probability of rain and crop planning for different drought condition
14. Spray of anti-transpirants and their effect on crops
15. Water use efficiency
16. Visit to dryland research stations and watershed projects

### **Suggested Readings**

1. Reddy TY. 2018. *Dryland Agriculture Principles and Practices*, Kalyani publishers
2. Das, N.R. 2007. *Tillage and Crop Production*. Scientific Publishers.
3. Dhopte. A.M. 2002. *Agro technology for Dry land Farming*. Scientific Publ.
4. DhruvNarayana, V.V. 2002. *Soil and Water Conservation Research in India*. ICAR.
5. Gupta, U.S. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.
6. Katyal, J.C. and Farrington, J. 1995. *Research for Rainfed Farming*. CRIDA.
7. Rao, S.C. and Ryan, J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.
8. Singh, P. and Maliwal, P.L. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publishing Company.
9. Singh, R.P. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.
10. Singh, R.P. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.
11. Singh, S.D. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.
12. Venkateshwarlu, J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR

### **Principles and Practices of Organic Farming**

**Code: AGRON -513**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

#### **Objective**

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

#### **Theory**

##### **UNIT I**

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; 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 biogastechnology.

#### 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, biopesticides.

#### UNIT V

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

#### Practical

1. Method of making compost by aerobic method
2. Method of making compost by anaerobic method
3. Method of making vermicompost
4. Identification and nursery raising of important agro-forestry trees and tree shelter belts
5. Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and *PSB* cultures in field
6. Visit to a biogas plant
7. Visit to an organic farm
8. Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

#### Suggested Readings

1. Ananthakrishnan, T. N. (ed.). 1992. *Emerging Trends in Biological Control of Phytophagous insects*. Oxford & IBH.
2. Gaur, A.C. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.
3. Lampkin, N. 1990. *Organic Farming*. Press Books, Ipswich, UK.
4. Palaniappan, S.P and Anandurai, K. 1999. *Organic Farming – Theory and Practice*. Scientific Publ.
5. Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting
6. Rao, B.V.V. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishtana, Bangalore.
7. Reddy M.V. (ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
8. Sharma, A. 2002. *Hand Book of Organic Farming*. Agrobios.
9. Singh, S. P. (ed.) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.
10. SubbaRao, N.S. 2002. *Soil Microbiology*. Oxford & IBH.
11. Trivedi, R. N. 1993. *A Text Book of Environmental Sciences*, Anmol Publ.
12. Veeresh, G. K, Shivashankar, K. and Singlachar, M. A. 1997. *Organic Farming and*
13. *Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

14. WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*.WHO.  
 15. Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

### **Statistical methods for applied sciences**

**Code: STAT-502**

**Full Marks - 100**

**Credit hours: 3L+1P**

**Credit-4**

#### **Objective**

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: chi-square, 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**

1. Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal.
2. Large sample tests, testing of hypothesis based on exact sampling distributions ~ 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 Readings

- Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. TheWorld Press.
- Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. TheWorldPress.
- 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. JohnWiley.
- Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley

## Techniques in Biochemistry

**Code: BIOCHEM-505**

**Full Marks - 100**

**Credit hours: 2L+2P**

**Credit-4**

### Objective

To provide hands-on experience to different biochemical techniques commonly used in research along with the knowledge on principles and the instrumentation.

### Theory

**Block 1: Separation Techniques:** Principles and applications of separation techniques.

#### Unit 1: Chromatography techniques (4 Lectures)

Principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, column & HPTLC, GC, HPLC and FPLC.

#### Unit 2: Electrophoretic technique (2 Lectures)

General principles, paper and gel electrophoresis, native and SDS-PAGE, 2D-PAGE, capillary electrophoresis.

#### Unit 3: Hydrodynamic methods (2 Lectures)

Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation velocity, - their principles.

#### Unit 4: Centrifugation (2 Lectures)

Basic principles of sedimentation, type, care and safety aspects of centrifuge preparative and analytical centrifugation.

### Block 2: Spectroscopic Techniques

#### Unit 1: Spectrophotometry (3 Lectures)

Principles and applications of UV-visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy.

**Unit 2: Mass spectroscopy (3 Lectures)**

MS/MS, LC-MS, GC-MS, MALDI-TOF, applications of mass spectrometry in biochemistry.

**Unit 3: Atomic absorption spectrophotometry (2 Lectures)**

Principle, function and instrumentation of atomic absorption spectrophotometry.

**Block 3. Microscopy**

**Unit 1: Microscopic techniques (2 Lectures)**

Principles and applications, light, UV, phase contrast, fluorescence and electron microscopy, flow cytometry.

**Block 4: Tracer, Imaging, Immunochemical and Other Techniques**

**Unit 1: Tracer technique (2 Lectures)**

Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of  $\alpha$ ,  $\beta$  and  $\gamma$  emitters, scintillation counters,  $\gamma$ -rays spectrometers, autoradiography, applications of radioactive tracers in biology.

**Unit 2: Imaging techniques (2 Lectures)**

Principles and applications of phosphor imager, MRI and CT scan.

**Unit 3: Immunochemical technique (2 Lectures)**

Production of antibodies, immunoprecipitation, immunoblotting, immunoassays, RIA and ELISA.

**Unit 4: Other techniques (2 Lectures)**

Cryopreservation, polymerase chain reaction (PCR), FACS.

**Practicals**

1. Expression of concentration in terms of dilution, molarity, normality, percent expression
2. pH measurement and buffer preparation
3. Determination of absorption maxima of biomolecules
4. Estimation of biomolecules through spectrophotometry and other methods
5. Separation of carbohydrates and amino acids by paper chromatography
6. Separation and analysis of fatty acids/lipids by GC
7. Separation/estimation of biomolecules through HPLC and FPLC
8. Separation of proteins using ion exchange, gel filtration and affinity chromatography
9. Electrophoretic separation of proteins and nucleic acids
10. Centrifugation- differential and density gradient
11.  $(\text{NH}_4)_2\text{SO}_4$  precipitation and dialysis
12. Use of radioisotopes in metabolic studies
13. PCR
14. ELISA
15. Western blotting/ Dot blotting

**Suggested Reading**

Boyer R. 2011. Biochemistry Laboratory: Modern Theory and Techniques 2nd Edition. Pearson  
Hofmann A and Clokie S. 2010. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

Sawhney SK and Singh R. 2000. Introductory Practical Biochemistry. 2nd Ed. Narosa  
Katoch R. 2011. Analytical Techniques in Biochemistry and Molecular Biology. Springer  
Boyer R. 2009. Modern Experimental Biochemistry. Fifth impression. Pearson  
Lottspeich F and Engels JW. (Eds). 2018. Bioanalytics: Analytical Methods and Concepts  
in Biochemistry and Molecular Biology. Wiley-VCH  
Wilson K and Walker J. 2010. Principles and Techniques of Biochemistry and Molecular Biology, 7th  
Edition. Cambridge University Press

### **Master's Seminar**

**Code: AGRON-550**

**Full Marks - 100**

**Credit hours: 0L+ 1P**

**Credit:1**

The seminar paper will be evaluated only by the internal.

### **THIRD SEMESTER**

#### **Agronomy of Medicinal, Aromatic and Under Utilized Crops**

**Code: AGRON-508**

**Full Marks - 100**

**Credit hours: 2L+1P**

**Credit-3**

**Objective**

To acquaint students about different medicinal, aromatic and underutilized fieldcrops, their package of practices and processing

## **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, *Aloevera*, 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 –drying, processing, grading, packing and storage, value addition and quality standards in herbal products.

## **Practical**

1. Identification of crops based on morphological and seed characteristics
2. Raising of herbarium of medicinal, aromatic and under-utilized plants
3. Quality characters in medicinal and aromatic plants
4. Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

## **Suggested Readings**

- 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 Source Book. Agrobios.
- Sharma R. 2004. Agro-Techniques of Medicinal Plants. Daya Publ. House.



## TECHNICAL WRITING AND COMMUNICATIONS SKILLS

**Code: PGS-502**

**Full Marks – 100**

**Credit hours: 0L+1P**

**Credit-1**

**Aim:**

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):**

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

### **Suggested Readings**

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
9. Richard WS. 1969. Technical Writing.
10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

## BASIC CONCEPTS OF LABORATORY TECHNIQUES

**Code: PGS-504**

**Full Marks – 100**

**Credit hours: 0L+1P**

### **Credit-1**

#### **Aim:**

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

#### **Practical:**

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

#### **Suggested Readings**

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

### **Agricultural Research, Research Ethics and Rural Development Programmes**

**Code:PGS-505 Full Marks – 100**

**Credit hour: 1L+0P=1**

#### **Credit-2**

#### **Aim:**

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

#### **UNIT I**

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC),

partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

#### UNIT II

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

#### UNIT III

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

#### **Suggested Readings**

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ

### **FOURTH SEMESTER LIBRARY AND INFORMATION SERVICES**

**Code: PGS-501**

**Full Marks – 100**

**Credit hours: 0L+1P**

**Credit-1**

**AIM:**

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.

### **Intellectual Property and Its Management In Agriculture**

**Code: PGS-503**

**Full Marks – 100**

**Credit hour: 1L+0P**

**Credit-1**

**Aim:**

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**

1. Erbis FH and Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol.V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. 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.

### **Master's Research**

**Code: AGRON-560**

**Full Marks - 100**

**Credit- 30**

#### **Objective**

This course is meant for students who want to undertake research work in future and get training through this course. During their M.Sc. dissertation/project work students will be able to know the different aspects of a research work in nutshell. Besides experimental works, learners will learn how to write a M.Sc. thesis starting from introduction (including literature review), objectives of the work through material & methods, results, discussion, conclusion and lastly references.