UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 17-12-2022 has approved the recommendations of the Academic Council made at its meeting dated 24-11-2022 regarding approval for grant of permission to start Ph.D. Agronomy Program and its Curriculum at the Department of Agronomy with effect from the Academic Session, Fall, 2022.

The Curriculum of Ph.D. Program in Agronomy is attached, vide Annexure 'A'.

Sd/-
Shahid Javed
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 647 /Acad. **Dated: 25-01-2023.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. The Dean, Faculty of Agricultural Sciences
2. The Chairman, Department of Agronomy
3. Chairperson, DPCC
4. Controller of Examinations
5. Director (IT) for placement at website.
6. Admin Officer (Statutes)
7. Secretary to the Vice-Chancellor
8. Secretary to the Registrar
9. Assistant Syllabus (with file)

Assistant Registrar (Academic)
for Registrar

Curricula/Syllabi of PhD Agronomy

Program Title: PhD Agronomy

Department: Department of Agronomy

Faculty: Faculty of Agricultural Sciences

- **Department Mission**

Department of Agronomy, University of the Punjab, Lahore is focused on conducting applied research of high impact at multiple scales and is determined to ensure that our education and research addresses immediate problems and anticipates the challenges to be faced in the future. The department is providing progressive and pertinent undergraduate and postgraduate education programs to the underprivileged public of Pakistan in general and Punjab province in particular. The department always keeps itself actively engaged with the partners in the public and private sectors; and is trying its best to contribute to the national and international development agenda for research and education in the field of agronomy.

- **Introduction**

Department of Agronomy, University of the Punjab, Lahore has been established in 2021 after the upgradation of Institute of Agricultural Sciences (IAGS) to Faculty of Agricultural Sciences (FAS). The department is currently offering B. Sc. (Hons.) Agriculture (Agronomy) and M. Sc. (Hons.) Agriculture (Agronomy). Both the programs attract very highly qualified and high merit candidates as evident by the merit which is the highest among the institutions offering these programs throughout Pakistan. The department provides national and global leadership in the field of plant production, plant physiology, meteorology, conservation agriculture to boost the eminence of life through education and research in agronomy that results from innovation, learning and commitment.

OUR CORE VALUES

At Department of Agronomy, University of the Punjab we value:

- brilliance and ingenuity of research, teaching and outreach endeavors
- interdisciplinary looms for delivering our objectives
- unobstructed approach to our programs
- understanding and unravelling the requirements of our diversified clients
- having an affirmative existence among our community at regional and national level
- the success of our students, staff and public and private partners
- the farming community, the ultimate saviors of the country

▪ Program Introduction

PhD Agronomy is a 5 years postgraduate program which is offered to students having completed M.Sc. (Hons.) Agriculture (Agronomy). This program comprises of 10 semesters. In 1st and 2nd semester, 4 major courses comprising of at least 12 credit hours are offered along with 2 minor courses comprising of 6 credit hours. The 3rd to 10th semesters comprises of research work and thesis writing with 12 credit hours. For award of degree, candidates will need to complete 18 credit hours of course work along with 12 credit hours for research work/thesis.

▪ Program Objectives

This program is designed to:

- Produce the well skilled and equipped postgraduates with latest knowledge and modern practices of producing crops and contribute towards the economic growth of the Pakistan.
- Provide the best learning environment and practical knowledge to play a key role in agriculture sector of Pakistan by implementing their knowledge of crop production, crop protection, soil management and other related aspects like processing and marketing.
- Provide the students with the integrated knowledge of Plant biology, chemistry, ecology and genetics.
- Aware the students about the importance of modern Agronomic practices to meet the need of future food production.
- Develop the academia and industrial linkages to promote the collaboration in research and projects in agronomy.
- Develop the linkages with the regional, national and international Agricultural Research Institutes to promote research and development in agronomy.
- Develop a relation and means to aware the stake holders and share the latest knowledge of crop production.
- Train the postgraduates about the extension services and disseminate the latest knowledge of crop production and protection to the local farmers to enhance the production and yield.
- Improve the Human Resources department through improving regional and national agriculture sector.
- To train and prepare the students so that they can peruse their careers in the agricultural industries, Govt. Institutions and Academic Institutions.
- Develop and implement of appropriate cost-effective technology packages to produce a crop.

i.e., selection of quality seeds, crop nutrition, irrigation, crop protection, yield harvesting, storage and marketing of the farm produce to cope with the increasing needs of food, feed and fiber.

- Accelerate the development of farmer friendly technologies and policies to help the farmer to produce more effectively and efficiently.
- To train the students about thesis writing conducting research trials in agronomy.

▪ Market Need / Rationale of the Program

The proposal fornew program should include a market survey to address the need for introducing the program.

When it comes to the scope of the agronomy, no one can deny the fact that it has a wide scope and opportunities than any other major of the agriculture as it is known as the mother of the agriculture and covers almost every aspect related to crop production. More than 80% people of Pakistan are directly or indirectly connected to the field and crop production. Numerous industries like cotton and sugar industries are dependent upon the agronomist to produce the best raw material produced from the crops like cotton and sugarcane for the industries. Trained and skilled agronomist are greatly needed for such industries to produce the best raw material from the crops ultimately empowering the economy of the country. Agronomist are needed at the large Govt. and private farms to use their integrated knowledge of crop production and protection to meet the increasing need of food, feed and fiber. It is estimated that by 2050, the world population will be almost 9 billion and there will even more food demand so one can imagine the importance of the agronomist in producing the food to fees such a large population. A united nation sister organization i.e., Food and Agriculture Organization (FAO) is working on the research for the prosperity in the field of agriculture. The regional office of the organization offers openings for Pakistani agricultural scientists' time by time. PhD Agronomy degree holders are eligible for BPS 18 and above jobs in government organizations.

a) ***Potential Students for the program***. (Career needs, subject interest etc.)

Graduates of public/private sector universities / HEIs with M. Sc. (Hons.) / MS / MPhil (18 years of education) in the field of Agriculture with specialization / major in Agronomy or related field with at least 3.00 CGPA out of 4.00 CGPA.

After completed this program, the students are fully trained and skilled to:

- To get a job in Govt. Agriculture Department
- To be employed by Agriculture companies like fertilizers, pesticides, and seeds production companies.
- To work as an independent entrepreneur.
- To get a job in Agriculture Teaching Institutes.

- To be employed in R & D department.

  Program need assessment may include feedback from multiple sources such as:

  b) ***Potential Employers*** (Public, private, NGOs, required skill set, industry projections, employment opportunities/estimated market demand/Number of job openings, Current and future prospects)

Graduate of PhD Agronomy have opportunities to work in the following organizations:

- Agricultural Services
- Forest department
- WAPDA (Water and Power Development Authority)
- Seed Corporation
- Banking Sector (ZTBL, MCB, HBL, NBP, Khushhali Bank, BOP, Bank Alfalah Etc.)
- Research Organizations/Institutes (PAEC, PARC, AARI, PPI, PCSIR, CCRI, CRS Etc.)
- Government, Private and Military Farms
- Fertilizer, Seed and Pesticide Sector (FFC, Engro, NFC, Syngenta, Bayer, FMC, Dupont, Monsanto Etc.)
- Food Department/ Food Industry
- Department of Education

  c) ***Academic Projections*** (The national/ international universities that have launched the similar program)

  - University of Agriculture, Faisalabad
  - Bahauddin Zakariya University, Multan
  - Pir Mehar Ali Shah Arid Agriculture University, Rawalpindi
  - The Islamia University of Bahawalpur, Bahawalpur
  - Muhammad Nawaz Sharif University of Agriculture, Multan
  - University of Agriculture, Peshawar
  - University of Sargodha, Sargodha
  - Gomal University, D. I. Khan
  - Ghazi University, D. G. Khan
  - The University of Poonch, Rawlakot, AJK
  - University of Haripur, Haripur
  - Bacha Khan University, Charsada
  - Sindh Agriculture University Tandojam
  - Justus-Liebig University, Giessen, Germany
  - University of Hohenheim, Stuttgart, Germany
  - Czech University of Life Sciences, Prague, Czech Republic

- University of Florence, Florence, Italy
- University of Pretoria, Pretoria, South Africa
- Massey University, Palmerston North, New Zealand
- Northwest Agriculture and Forestry University, Shanghai, China
- The University of Melbourne, Melbourne, Australia
- Newcastle University, Newcastle upon Tyne, England
- University of Manitoba, Winnipeg, Canada
- Oklahoma State University, Stillwater, OK, USA
- University of Groningen, Groningen, The Netherlands

d) ***Faculty*** (Faculty credentials, capacity, resources sufficiency etc.)

Name	Designation	Qualification	University	Specialization	Experience (Years)
Dr. M. Bilal Chattha	Associate Professor/Chairman	PhD	UAF, Faisalabad, PK	Water Use Efficiency & Crop Production	15
Dr. Sajid Ali	Assistant Professor	PhD	JLU, Giessen, GER	Abiotic Stress & Neglected Plants	14
Dr. Adnan Zahid	Assistant Professor	PhD	PU, Lahore, PK	Conservation Agriculture & Crop Modelling	10

e) Physical Facilities (Lab and library facilities etc.)

- One undergraduate study laboratory is and one specified laboratory is in working under FAS
- As most of the research of agronomy/crop production is focused on field experiments the experimental research farm of FAS is used for conducting these experiments.
- One library is operating under FAS whereas students are entitled to use main library of the university.
- Additionally Electronic Library of the Department of Agronomy has also been created and a soft copy of it is available in the library of FAS and all the students and teachers of Department of Agronomy have a copy of it. This electronic library is in the form of a DVD (also available in soft form from Library of FAS or the office of Dr. Sajid Ali, coordinator of the department) and contains the copies of at least 2 recommended books for each under and postgraduate course.

Admission Eligibility Criteria

- Years of Study completed

  18 years of education from a HEC recognized institution
- Study Program/Subject

M. Sc. (Hons.) / MS / MPhil [After 16 years of B. Sc. (Hons.) / BS] in Agriculture with specialization / major in the field of Agronomy.

- Percentage/CGPA
  Minimum 3.00 CGPA out of 4.00 CGPA
- Entry Test (if applicable) with minimum requirement
  The candidates must have to qualify the written test (GRE based designed by the departmental HEC approved committees) with 70% marks.
- Any other (if applicable)
  - No third division throughout career
  - **Equivalence is required before admission:** From PU required (Qualification from Institutions other than the University of the Punjab will be equalized by the Equivalence Committee of the University of the Punjab). Candidates have to apply to equivalence cell.
  - Equivalence of Degrees Awarded by chartered foreign universities will be also required from HEC Pakistan. PU equivalence is also required.
  - A foreign candidate should apply through his/her Home Country's Embassy or Consulate and Pakistan Mission/s Abroad office (in case of Overseas Pakistani). NOC and equivalence of degrees from HEC required.

Details of the Admission Eligibility Criteria as per DPCC (Doctoral Programme Coordination Committee) is prescribed as under:

BS (Hons.) 4 years/ B. Sc (Hons.) 4 years Agriculture degree with specialization / major subject in Agronomy degree or equivalent from a HEC recognized University (At least 16 years of education; 130 credit hours) with minimum CGPA ≥ 3.0 out of 4.0 / first division as per HEC and PU rules.

1. MS / M.Phil. / M.Sc. (Hons.) Agriculture in Agronomy or equivalent degree with minimum CGPA ≥ 3.0 out of 4.0 / first division as per HEC and PU rules.
2. No 3rd division in the career.

Subject eligibility criteria of individual disciplines will be provided by the relevant DDPC / Board of studies of the Department / Institute / College / Centre / School before the admission.

- The candidates must have to qualify the written test (GRE based designed by the departmental HEC approved committees) with 70% marks.
- The admission regulations of PhD can also be obtained from the respective Department (Department of Agronomy).
- Candidates waiting for the result of 8th Semester BS / 4th Semester M.Sc. (Hons.) / MS / MPhil can apply and have to provide the result notified by the Controller of Examinations or concerned department before test date. Otherwise, they will not be considered for admission.

- Candidates without thesis in MS/MPhil/M.Sc. (Hons.) can be admitted but they have to complete deficiency of 06 credit hours research thesis.
- The PhD scholar shall complete coursework of at least 18 credit hours (as per new PhD policy guidelines) of which the majority shall be fulfilled through regular classes.
- If candidate admitted from other disciplines, then deficiency courses must be taken by the PhD scholar to meet the requirement/s as recommended by the respective DDPC /Board of studies of the Department.
- **Equivalence is required before admission:** From PU required (Qualification from Institutions other than the University of the Punjab will be equalized by the Equivalence Committee of the University of the Punjab). Candidates have to apply to equivalence cell.
- Equivalence of Degrees Awarded by chartered foreign universities will be also required from HEC Pakistan. PU equivalence is also required.
- A foreign candidate should apply through his/her Home Country's Embassy or Consulate and Pakistan Mission/s Abroad office (in case of Overseas Pakistani). NOC and equivalence of degrees from HEC required.

MERIT CALCULATION

Admission shall be made on the basis of the Basic Criteria given below:

S. No.	Description	Marks
1	Academic qualifications*	40
2	Publications in HEC approved journals/ Exhibitions/ Design Projects (One mark for each publication)	05
3	Professional experience in relevant field (one mark for each year for job in the relevant field/as per Departmental preference)	05
4	Subject written Entry Test**	40
5	Interview	10
Total		**100**
50% marks required to be obtained in academic merit & interview and 70 % in written test separately for PhD program.		

***Break up of 40 marks for academic qualifications:**

Course/Degree		%age Marks					
		45%	**50%**	**55%**	**60%**	**70%**	**≥80%**
Matric	Marks	2	4	5	6	7	8
F. Sc.	Marks	2	4	5	6	7	8
	CGPA						
		2.5	**2.7**	**3.0**	**3.4**	**≥3.8**	
BS (Hons.) 4 Years/ B. Sc. (Hons) 4 Years/ (16 years education)	Marks	08	10	12	14	16	
M.S / MPhil / M. Sc. (Hons.) (18 years education)		**3.0 CGPA / 1st Div.**		**3.0**	**3.6**	**≥3.8**	
	Marks	5		6	7	8	

**** A MCQs based test of total 100 marks will be conducted having both subject related and general knowledge related questions.**

- ## Duration of the Program

  Semesters/Years/ Credit hours

  10 semesters / 5 years / 32 Credit Hours

- ## Categorization of Courses as per HEC Recommendation and Difference

Semester	Courses	Category (Credit Hours)					
		Core Courses	Basic Courses	Major Electives	Minor Electives	Any Other	Semester Load
1	06	N/A	N/A	12	06	14	**09**
PU	06	N/A	N/A	12	06	14	**09**
HEC Guidelines	06	N/A	N/A	12	06	14	**09**
Difference (HEC &) PU	**00**			**00**	**00**	**00**	**00**

**Core: Compulsory, Basic: Foundation, Major Electives: Professional Minor Electives: Specialization*

Note: The course/column heads are customizable according to nature and level of the program.

- **Scheme of Studies / Semester-wise workload**

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
Semester I & II							
1.	Agr-701	Advanced Agronomy	Major	GDC	3 (2-1)		
2.	Agr-702	Applied Crop Ecology	Major	GDC	3 (3-0)		
3.	Agr-703	Advanced Irrigation Agronomy	Major	GDC	3 (2-1)		
4.	Agr-704	Agro-Environment Conservation	Major	GDC	3 (3-0)		
5	Agr-705	Agro-meteorology	Major	GDC	3 (3-0)		
6	Agr-706	Allelopathy in Crop Production	Major	GDC	3 (2-1)		
7	Agr-707	Applied Conservation Agronomy	Major	GDC	3 (3-0)		
8	Agr-708	Arid Zone Agronomy	Major	GDC	3 (3-0)		
9	Agr-709	Biological Crop Potential	Major	GDC	3 (3-0)		
10	Agr-710	Crop and Environment	Major	GDC	3 (3-0)		
11	Agr-711	Crop Management on Problem Soils	Major	GDC	3 (2-1)		
12	Agr-712	Advanced Crop Modeling	Major	GDC	3 (2-1)		
13	Agr-713	Crop Nutrition Management	Major	GDC	3 (2-1)		
14	Agr-714	Crop Production and Herbicides	Major	GDC	3 (2-1)		
15	Agr-715	Farming and Cropping Systems	Major	GDC	3 (3-0)		
16	Agr-716	Field Crop Experimentation	Major	GDC	3 (2-1)		
17	Agr-717	Herbicides in Plant and Soil Systems	Major	GDC	3 (2-1)		
18	Agr-718	Integrated Agriculture	Major	GDC	3 (3-0)		
19	Agr-719	Modern Concepts of Crop Production	Major	GDC	3 (2-1)		
20	Agr-720	Recent Advances in Agronomy	Major	GDC	3 (3-0)		
21	Agr-721	Seed Physiology	Major	GDC	3 (2-1)		
22	Agr-722	Seed Science and Technology	Major	GDC	3 (2-1)		
23	Agr-723	Stress Agronomy	Major	GDC	3 (2-1)		
24	Agr-724	Sustainable Agriculture	Major	GDC	3 (3-0)		
25	Agr-725	Water Relations of Plant	Major	GDC	3 (2-1)		
26	Agr-726	Weed Management	Major	GDC	3 (2-1)		
27	Agr-727	Climate Change and Agriculture	Major	GDC	3 (3-0)		
28	Agr-728	Postharvest Technology of Crops	Major	GDC	3 (2-1)		
Total Credit Hours							
Semester III to X							

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
1.	Agr-736	Special Problem			1 (1-0)		
2.	Agr-738	Seminar			1 (1-0)		
3.	Agr-742	Research & Thesis for PhD Agronomy			12 (0-12)		
Total Credit Hours							

1. Type of course may be core (compulsory), basic (foundation), major elective (professional), minor elective (specialization) etc.
2. **GDC:** Given in Detailed course outline for each course individually.

Major Courses for PhD Agronomy

*Four (4) Major courses comprised of at least 12 Credit Hours will be offered in 1st and 2nd semester of PhD Agriculture (Agronomy). Course studied during M. Sc. (Hons.) Agriculture (Agronomy) cannot be repeated in PhD Agriculture (Agronomy).

Minor Courses for PhD Agronomy

*Two (2) Minor courses comprised of 06 Credit Hours will be offered in in 1st and 2nd semester of PhD Agronomy. Course studied during M. Sc. (Hons.) Agriculture (Agronomy) cannot be repeated in PhD Agronomy.

Any other course approved as Major Course in the curriculum of PhD Plant Pathology, Horticulture, Entomology, Plant Breeding and Genetics, Food Science and Technology and Soil Science can be taken as Minor Course in PhD Agronomy.

Research Thesis / Project /Internship

Details (credit hours, semesters etc.)

Research and thesis will be conducted during 3rd to 10th semester which will comprise of 12 credit hours.

- ## Award of Degree

Degree awarding criteria stating:

CGPA / percentage required to Qualify

≥3.00 CGPA out of total 4.00 CGPA (≥70%).

Thesis /Project/Internship

A thesis (composite or classis) on the basis of the research conducted dully reviewed by two scientists / researchers from technologically advanced countries along with a scientific paper (out of the thesis/research) published in internationally reputed journal.

Any other requirement, e.g., Comprehensive examination (if applicable)

A comprehensive examination after the successful completion of course work and a seminar for defending synopsis of the research to be conducted for getting the degree.

- **NOC from Professional Councils (if applicable)**

  Provide the status of NOC from the concerned Professional Council(s), if applicable, depending on nature of the program being propose

  NOC for the start of PhD Agronomy form Higher Education Commission, Pakistan is in process.

- **Faculty Strength**

Degree	Area/Specialization	Total
PhD	1. Water Use Efficiency & Crop Production 2. Abiotic Stress & Neglected Plants 3. Conservation agriculture & Crop Modelling	03
MS/MPhil	NOT APPLICABLE	NIL
Total		**03**

- **Present Student Teacher Ratio in the Department**

Students				Teachers
B. Sc. (Hons.) 6th Sem.	**B. Sc. (Hons.) 8th Sem.**	**M. Sc. (Hons.) 2nd Sem.**	**Total**	
20	29	15	64	03

*29 students of 8th semester will pass out during first week of July, 2022

- **Course Outlines separately for each course**. The course outline has following elements:
  - Basic Information. Title and Code Number, Semester, and Credit Hours
  - Pre-requisites course requirements/ skills
  - Learning Outcomes
  - Contents

    Unit-I

    1.1 Headings

    1.1.1 Sub-headings

    Unit-II

    2.1 Headings

    2.1.1 Sub-headings

Agr-701 ADVANCED AGRONOMY 3 (2-1)

Pre-requisites course requirements/ skills

Basic knowledge of agronomy, crop production and its principles.

Objective

To deeply understand modern concepts of crop growth, phenology and development of plants under varying environments

Learning outcomes

After studying this course, the students will be able to:

- Understand phenological development of crop plants
- Know effects of photosynthesis and respiration on plant growth and development
- Analyze crop growth and its application in agronomy
- Measure radiation use efficiency

Theory

1. **Phenological Development of Crop Plants**
    1.1. Growth and development
    1.2. Determinants of crop growth
    1.3. Crop phenology
    1.4. Phenological stages of crops
    1.5. Crop canopy
    1.6. Factors affecting
2. **Photosynthesis and Respiration**
    2.1. Photosynthesis and factors affecting photosynthesis
    2.2. Respiration and factors affecting it
    2.3. Photosynthetic efficiency and respiration in relation to crop productivity
    2.4. Crop management for improving photosynthetic efficiency and harvest index
3. **Dry Matter Accumulation**
    3.1. Dry matter; definition and concept
    3.2. Potential for increasing dry matter accumulation in crop plants
    3.3. Dry matter partitioning
4. **Crop Growth Analysis**
    4.1. Concept and objectives
    4.2. Crop growth analysis and its agronomic uses

4.3. Growth analysis of individual crop plants

4.4. Classical and functional growth analysis

5. Crop Growth Functions

5.1. Introduction, concept and application

5.2. Biological relevance of different growth functions and curve fitting in crop growth studies

Practical

1. Phenological development stages of crop plants

1.1. Practical demonstration of phenological stages of crops

1.2. Group wise demonstration of phenological stages by growing different crops

2. Use of classical growth formulae for determining various crop growth indices

2.1. Crop growth formulae

2.2. Determination of crop growth indices using these formulae

3. Estimation of crop growth rates derived from different fitted growth functions

3.1. Crop growth functions

3.2. Estimation of crop growth rate by fitted growth functions

4. Demonstration and calculation of radiation interception and use efficiency

4.1. Radiation interception

4.2. Radiation Use Efficiency (RUE)

4.3. Calculation of RUE

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. Techniques in Bio productivity

and Photosynthesis, 2nd Ed. Pergamon Press, Oxford.

2. Hay, R.K.M. and J.R. Porter. 2006. The Physiology of Crop Yield. 2nd Ed. Wiley-Blackwell.
3. Hunt, R. 1978. Plant Growth Analysis. Edward Arnold, London.
4. Hunt, R. 1982. Plant Growth Curves: An Introduction to the Functional Approach to Plant Growth Analysis. Edward Arnold, London.
5. Gupta, U.S. 1992. Crop Improvement. Vol-I. Physiological Attributes. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

Agr-702 APPLIED CROP ECOLOGY 3 (3-0)

Pre-requisites course requirements/ skills

Basic theoretical knowledge of ecology, ecological environments, ecological pyramids and primary producers

Objective

To impart better understanding of ecological optima and its relevance to crop production.

To impart comprehension about ecological optima in relation to sustainable food and feed production

Learning outcomes

- Define and describe dynamics of agro-ecosystems.
- Explain ecological features of intensive agriculture.
- Adopt suitable approaches to reduce soil and water pollution under different farming systems.
- Perceive ecological optimization to sustain crop productivity.
- Integrate various farm operations to protect biodiversity

Theory

1. **Ecosystem Concepts**
   - 1.1. Definition and concept of ecosystem
   - 1.2. Components of ecosystem
   - 1.3. Types of ecosystem
2. **Dynamics of Agro-ecosystems**
   - 2.1. Agro-ecosystem
   - 2.2. Components of agro-ecosystem
   - 2.3. Factors affecting agro-ecosystem

2.4. Ecology of crop plant domestication

2.5. Ecological risk assessment

2.6. Ecological evaluation of different farming systems

3. Ecological Characteristics of Intensive Agriculture with Special Reference to;

3.1. Environmental pollution

3.2. Air pollution

3.3. Noise pollution

3.4. Insecticide pollution

3.5. Nuclear pollution

3.6. Pollution due to Socio Economic factors

3.7. Crop productivity and ecological optima

3.8. Biodiversity and its ecological role in agro-ecosystems

4. Ecology of Major Agronomic Crops

4.2. Economic crops

4.2. Oil seed crops

4.2. Pulses & miscellaneous crops

4.2. Sugar crops, etc.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
2. Fitter, A.H. and R.K.M. Hay. 2002. Environmental Physiology of Plants. 3rd Ed.

Academic Press, Inc., London.

3. Gurevitch, J. M.Schiner and A.F. Gordon. The Ecology of Plant. 2nd Ed. 2006. State University of New York.
4. Kapur, P. and R.G. Sudha. 2000, Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
5. Kumar, H.D. 1994. Modern Concepts of Ecology. 7th Ed. Vikas Pub. House New Delhi.
6. Larcher, W. 1995. Physiological Plant Ecology. Ecophysiology and Stress Physiology of Functional Groups. Springer Verlag, Berlin.
7. Schulze, E. B. and K. Muller-Hohenstein. 2005. Plant Ecology. State
8. University of New York.
9. Tivy, J. 1990. Agricultural Ecology. Longman Group U.K. Ltd. Essex
10. Environmental protection act of Pakistan.

AGR-703 ADVANCED IRRIGATION AGRONOMY 3 (2-1)

Pre-requisites course requirements/ skills

Basic knowledge of irrigation agronomy, different ways of irrigating crops.

Objective

To impart better understanding of estimation/measurement of environment variables used in irrigation scheduling

To educate about estimation/measurement of environment variables used in irrigation scheduling.

Learning Outcomes

After studying this course, the students will be able to:

- Describe the relationship between irrigation and crop yields
- Plan suitable irrigation schedules for field crops under different moisture regimes and prevailing weather conditions
- Modify irrigation use with respect to the prevailing weather conditions
- Use Make use of the drought stress indices for their research endeavors
- Compare and evaluate the crop growth and yield response under varying irrigation regimes to

total water received and drought

- Interpret the criteria for drought resistance

Theory

1. **Irrigation and Crop Yields**
   - 1.1. Irrigation, concept and types
   - 1.2. Effects of irrigation water quality on crop growth and development
2. **Irrigation Scheduling**
   - 2.1. Irrigation scheduling and its importance
   - 2.2. Irrigation water quality
   - 2.3. Effects of irrigation water quality on crop growth and development
   - 2.4. Impact of weather conditions on irrigation scheduling
   - 2.5. Methods of irrigation scheduling
   - 2.6. Moisture sensitive periods
3. **Drought Indices**
   - 3.1. Stress degree days
   - 3.2. Canopy temperature variability
   - 3.3. Crop water stress index
   - 3.4. Maximum allowable depletion, etc.
4. **Irrigation and Yield**
   - 4.1. Response of yield to irrigation
   - 4.2. Penman's irrigation-yield response analysis
   - 4.3. Concept of potential soil moisture deficit and limiting deficit
   - 4.4. Crop response to total water received and drought
   - 4.5. Criteria for drought resistance
   - 4.6. Concept of lost time for growth and crop yield
   - 4.7. Water use efficiency and factors affecting it.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Ali, M. H. 2010. Fundamentals of Irrigation and On-farm Water Management: Volume 1. Springer, New York.
2. Ali, M. H. 2011. Practices of Irrigation and On-farm Water Management: Volume 2. Springer, New York.
3. Choudhary, M. R. 2009. A Text book of Irrigation and Drainage Practices for Agriculture. University of Agric. Faisalabad, Pakistan.
4. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.
5. Michael, M.A. 2003. Irrigation Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi. India.
6. Sankara, R. G. H. and T. Y. Reddy. 2002. Efficient Use of Irrigation Water. Kalyani Publishers New Delhi, India.

AGR-704 AGRO-ENVIRONMENT CONSERVATION 3 (3-0)

Pre-requisites course requirements/ skills

Basic knowledge of environment, types of environment, ways to conserve environment.

Objective

To enhance the understanding of environmental degradation and conservation through integrated approaches.

Learning Outcomes:

After successful completion of the course, students will be able to:

- Describe impact of agricultural practices and industrial/municipal wastes on the environment

and ecosystem.

- Develop strategies to minimize degradation of environment and ecosystem resulting from agro-chemicals and industry.
- Understand the rules and regulations of environment conservation

Theory

1. **Agro-Chemicals**
   - 1.1. Uses and abuses
   - 1.2. Uptake and persistence
   - 1.3. Degradation and residual effect on ecosystem
2. **Management and Recycling of Agro-Industrial Wastes**
   - 2.1. Solid waste
   - 2.2. Farm waste
   - 2.3. Sewage sludge etc.
3. **Agriculture and Environment**
   - 3.1. Role of agriculture in environment conservation
   - 3.2. Integrated approaches to reduce use of agro-chemicals in agriculture
4. **Environment Conservation**
   - 4.2. Rules and regulations of environmental conservation
   - 4.2. Environment Protection Agency (EPA) rules

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
2. Hudson, N.W. 2004. Soil and water conservation in semi-arid areas. Scientific Publishers, India.
3. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa
4. Publishing House Pvt. Ltd. New Delhi, India.
5. Maloo, S.R. 2002. Sustainable Crop Production Under Stress Environments. Agro-tech Publishing Academy, Udaipur, India.
6. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York.

AGR-705 AGRO-METEOROLOGY 3 (3-0)

Pre-requisites course requirements/ skills

Basic know how of weather and climate, meteorology and its different components.

Objective

To important knowledge about meteorological optima and its relevance to crop production.

Learning Outcomes:

After successful completion of the course, students will be able to:

- Understand agricultural meteorology.
- Conceptualize the agroecological zones of Pakistan.
- Understand the crop water relationship.
- Know the affect of pollution on crop production.

Theory

1. **Agricultural Meteorology**
   - 1.1. Introduction and scope
   - 1.2. Agricultural zones of Pakistan
2. **Climate and Crop Productivity**
   - 2.1. Crop adaptation and distribution in relation to climate
   - 2.2. Diurnal and seasonal variation in photoperiod and light integral
   - 2.3. Atmospheric pollution and plant productivity
   - 2.4. Climate change and its potential effects on crop production

3. **Weather and Pests**
   - 3.1. Introduction, concept and importance
   - 3.2. Weather and pests of crops
4. **Crop Monitoring and Forecasting**
   - 3.1. Drought monitoring and planning for mitigation
   - 3.2. Remote sensing (RS)
   - 3.3. Geographical Information System (GIS)
   - 3.4. Global Positioning System (GPS)
   - 3.5. Application of RS, GIS and GPS in agricultural meteorology
   - 3.6. Use of climate information to improve agricultural productivity

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Ahrens, C. D. 2008. Meteorology Today Brooks/Cole Cengage Learning, Belmount, USA.
2. Brunt, D. 2007. Meteorology. Oxford University Press. UK.
3. Hall, A. E. 2001. Crop responses to environment. CRC Press. LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431. USA.
4. Mavi. H.S. and G.J. Tupper. 2005. Agro-meteorology; Principles and applications of climate studies in agriculture. International Book Distributing Co. Charbagh, Lucknow 226004 U.P. India.
5. Panda, B.C. 2009. Remote Sensing; Principles and Applications. Viva Books Pvt. Ltd.

4737/23, Ansari Road, New Delhi-110002. India.

6. Prasada, Rao, G.S.L.H. 2008. Agricultural Meteorology. Printice Hall of India, New Delhi.

AGR-706 ALLELOPATHY IN CROP PRODUCTION 3 (2-1)

Pre-requisites course requirements/ skills

Concept of allelopathy and allelochemicals. Positive and negative impacts of allelochemicals on crop and weed growth.

Objective

To educate students about allelopathic phenomena and its utilization in agro- ecosystem for sustaining productivity of crops.

Learning outcomes

After studying this course, the students will be able to:

- Describe allelopathy and types of allelochemicals.
- Comprehend the mechanism of allelochemicals production, translocation and mode of action.
- Understand the utilization of allelochemicals in enhancing crops production
- Acquire the skills of allelopathic extracts preparation and its application

Theory

1. **Allelopathy**
   - 1.1. Concept and history
   - 1.2. Allelopathic plants
2. **Allelochemicals**
   - 2.1. Types of allelochemicals
   - 2.2. Mechanism of allelochemicals' action
   - 2.3. Factors influencing production and effectiveness of allelochemicals
   - 2.4. Production, release, absorption and translocation of allelochemicals
3. **Allelopathy and Agro-Ecosystem**
   - 3.1. Role of allelopathy in agro-eco systems
   - 3.2. Interactions among cropping systems
   - 3.3. Utilization of allelopathy for pest management
   - 3.4. Enhancing crop productivity by utilizing allelopathy

3.5. Recent research trends in allelopathy

Practical

1. **Allelopathic Extract**
   1.1. Preparation of allelopathic plant water extracts
   1.2. Comparison of crop cultivars for their allelopathic effects
2. **Practical Demonstrations**
   2.1. Demonstration of allelopathic effects of crop extracts/residues on seed germination
   2.2. Demonstration of allelopathic effects of crop extracts/residues on seedling growth of crops
   2.3. Demonstration of allelopathic effects of crop extracts/residues on seedling growth of weeds
3. **Identification of Allelopathic Chemicals**
   3.1. Field visits and collection of samples
   3.2. Laboratory analyses of collected crops

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Gliessman, S. R. 2007. Field and Laboratory Investigations in Agroecology (2nd Ed.). Taylor and Francis, USA.
2. Kohli, K.R., H.P. Singh and D. R. Batish. 2004. Allelopathy in Agroecosystems. IDBC Lucknow, India.

3. Macias, F.A., C.G. Galindo and J.M. G. Molinillo. 2003. Allleopathy: Chemistry and Mode of Action of Allelochemicals. CRC Press, New York, USA.
4. Reigosa, M. J., N. Petdrol and L. Gonzalez. 2006. Allelopathy: A physiological process with ecological implications. Springer, Heidelberg, Germany.
5. Rice, E.L. 1997. Allelopathy. (4th Ed.). Academic Press, Inc. Orlando, Florida, USA.
6. Zeng, R.S, A.U. Mallik and S.M. Luo. 2008. Allelopathy in Sustainable Agriculture and Forestry. Springer, USA.

AGR-707 APPLIED CONSERVATION AGRONOMY 3 (3-0)

Pre-requisites course requirements/ skills

Basic knowledge of conservation agronomy, difference among conventional and conservation agriculture.

Objective

To develop understanding about resource conservation on economic basis with special emphasis on soil and water.

Learning outcomes

After studying this course, the students will be able to:

- Understand the objectives and principles of resources with their judicious use and conservation
- Explain advance methods of conservation in different farming system
- Use of conventional and modern techniques like biological conservation and farm machinery
- Apply the acquired knowledge to conserve resources with respect to climate change

Theory

1. **Water Resource Conservation**
   - 1.1. Principles, objective and types of Water resources
   - 1.2. Conservation and economic use of these resources in irrigated and non-irrigated regions
   - 1.3. Modern conservation practices in irrigated and non-irrigated areas
2. **Conservation and Farming Systems**
   - 2.1. Integrated resource conservation in different farming systems
   - 2.2. Conservation agronomy and climate change

3. Conservation and Agricultural Engineering

3.1. Use of farm machinery in conservation techniques

3.2. Conservation structures

3.3. Biological conservation

3.4. Recent developments in the field of conservation agronomy

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Arnon, I. 1992. Agriculture in drylands–principles and practices. Elsevier, Amsterdam.
2. Govindan, K. and V. Thirumurugan. 2003. Principles and Practices of Dryland Agriculture. Kalyani Publishers, New Delhi, India
3. Gurmel, S., C. Venkatarmanan, G. Sastry and B.P. Joshi. 1990. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Hudson, N.W. 2004. Soil and Water Conservation in Semi-arid Areas. Scientific Publishers, India.
5. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.
6. Maloo, S.R. 2002. Sustainable Crop Production under Stress Environments. Agro-tech Publishing Academy, Udaipur.

AGR-708 ARID ZONE AGRONOMY 3 (3-0)

Pre-requisites course requirements/ skills

Basic knowledge of agronomy in arid zone, crop production under scarce water conditions.

Objective

To broaden the understanding of problems, limitations and potentials of arid areas.

Learning Outcomes:

At the completion of the course, students will be able to:

- To understand the problem, limitation and their solution in the arid zone agriculture.
- To explore the potential of Arid area and its contribution in national crop production.
- Characterize the features of Arid Agriculture
- Apply the techniques to address the constraints and problems of Arid zone agriculture.
- Manage the dry spell period during the crop growth.
- Recommend practices for moisture conservation, water shed management and sustainable crop production in dry land Agriculture.

Theory

1. **Arid Agriculture**
   - 1.1. Constrains and techniques of arid agriculture
   - 1.2. Characteristics of dry land agriculture
   - 1.3. Problems, prospects and strategies of dry land agriculture
2. **Aridity Indices**
   - 2.1. Moisture availability index
   - 2.2. Aridity index
   - 2.3. Moisture deficit index
3. **Agronomic Approaches for Dry Land Agriculture**
   - 3.1. Tillage requirement
   - 3.2. Selection of most adaptive crops
   - 3.3. Sowing of crops; cropping pattern; pasture management
   - 3.4. Cropping plans to meet the weather conditions
   - 3.5. Weed control
   - 3.6. Plant protection measure

4. Dryland Farming

4.1. Managing dry spells during crop periods

4.2. Lay farming for non-arable lands

4.3. Recommendations for dry farming areas

4.4. Plant adaptation to water stress

4.5. Soil and rainfall characteristics in dry land farming

4.6. Soil and moisture conservation techniques

4.7. Water-shed management

4.8. Water harvesting

4.9. Sustainable dry land crop production

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Balasubramaniyan, P. and SP. Palaniappan. 2005. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
2. Govindan, K. and Thriumurugam. 2003. Principles and Practices of Dry Land Agriculture. Kalyani Publishers, New Delhi, India.
3. Panda, S.C. 2005. Agronomy. Agrobios, Jodhpur, India.
4. Reddy, S.R. 2004. Principles of Crop Production. Kalyani Publishers, New Delhi, India.
5. Arnon, I. 1992. Agriculture in drylands–principles and practices. Elsevier, Amsterdam.
6. Shaw, T. 2010. Dryland Farming. Nabu Press, USA.

7. Chandrasekaran, B. K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Pub., New Delhi, India.

AGR -709 BIOLOGICAL CROP POTENTIAL 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept of physiological functions of crop plants.

Objective

To elaborate the concept of biological potential and exploitation in crops.

Learning Outcomes

After studying this course, the students will be able to:

- Understand modern concepts of biological crop potential
- Describe the relationship between agro-physiological factors and potential yield of crop
- Collect and analyze the data of growth parameters of crop
- Examine the determinants of crop growth
- Analyze the relationship between crops and environment

Theory

1. **Biological Crop Potential**
   - 1.1. Concept & importance
   - 1.2. Agro-physiological factors limiting yield potential of crops
2. **BCP & Crop Productivity**
   - 2.1. Ecological optima in relation to crop productivity
   - 2.2. Blackman's principle of limiting factor
3. **Components of Crop Growth**
   - 4.1. Determinants of crop growth
   - 4.2. Components of plant leaf area expansion
   - 4.3. Crop canopy development
4. **Solar Radiation and Crop Productivity**
   - 4.1. Crop architecture and interception of solar radiation
   - 4.2. Potential for increasing photosynthetic efficiency
   - 4.3. Dry-matter partitioning

4.4. Modern agro-physiological techniques for harvesting maximum potential of field crops

4.5. Crop plants in relation to environment

Practical

1. **Actual and Potential Yield**
   1.1. Collection of data pertaining to actual and potential yields of various crops/varieties
   1.2. Determination of leaf area and dry weight of field crops
2. **Calculation of Crop Growth Indices**
   2.1. Crop Growth Rate (CGR)
   2.2. Net Assimilation Rate (NAR)
   2.3. Determination of Leaf Area Index (LAI) and Harvest Index (HI) of field crops
3. **Comparative Studies on Canopy Development**
   3.1. Comparative studies of crop canopy development in:
   3.2. Cereals
   3.3. Oilseeds
   3.4. Grain legumes

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. N. R. Das, 2008. Tillage and Crop Production. Sci. Pub., India.
2. Premjit Sharma, 2007. Precision Farming. Gene Tech Book, New Delhi, India
3. M. A. Khan, 2012. Water Resources Management and Sustainable

Agriculture.

4. John H. Martin, Richard P, Waldren and David L. Stamp. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.

AGR-710 CROP AND ENVIRONMENT 3 (3-0)

Pre-requisites course requirements/ skills

Concept of environments, different components of physical, chemical and biological environment.

Objective

To broaden the understanding of relationships between crop and environment.

Learning outcome

After studying this course, the students will be able to:

- Understand the environmental physiology and its impact on crop production.
- Explain global warming and greenhouse effects on plant growth & development.
- Elaborate environmental pollution and energy exchange by plants in ecosystem.
- Manage crop production under different environmental conditions.

Theory

1. **Crop Environment**
   - 1.1. Components, determinants and their role in crop productivity
   - 1.2. Microclimate in relation to crop management
2. **Greenhouse Effect**
   - 2.1. Global warming
   - 2.2. Greenhouse gases and greenhouse effect
3. **Environment and Crop Growth**
   - 3.1. Environmental pollution and plant growth
   - 3.2. Energy exchange by plants in ecosystem
4. **Evapotranspiration**
   - 4.1. Evapotranspiration and its reduction approaches
   - 4.2. Antitranspirants and reflectants
   - 4.3. Plant physiological aspects and plant architecture

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Loomis, R.S. 1992. Crop Ecology. Productivity and Management in Agricultural System. Cambridge University Press, U.K.
2. Nobel, P.S. 2005. Physiochemical and Environmental Plant Physiology. 5th Ed. Academic Press, New York.
3. Pritchart, S. G., J. S. Amthor. 2005. Crops and Environmental Changes: an introduction of global warming. CSSA, Madison, Wisconsin, USA.
4. Schultz, E.D. 2005. Plant Ecology. Springer Verlag, Berlin. Heidelberg.
5. Townsend, C.R., Harper, J.L. and Bego, M.E. 2000. Essentials of Ecology. Blackwell Scientific Publications, UK.

AGR-711 CROP MANAGEMENT ON PROBLEM SOILS 3 (3-0)

Pre-requisites course requirements/ skills

Basic concept and knowhow of problems soils and their management and amelioration.

Objective

To strengthen the knowledge for raising crops successfully on problem soils.

Learning outcome

Upon successful completion of the course, student will be able to:

- Understand the problem soils and their types.
- Manage different types of problem soils.

- Apply different crop management practices to reduce the intensity of problem soils.

Theory

1. **Crop Productivity in Problem Soils**
   - 1.1. Concept and perspective of crop productivity in eroded soils
   - 1.2. Concept and perspective of crop productivity in salt affected soils
   - 1.3. Concept and perspective of crop productivity in water deficient soils
   - 1.4. Concept and perspective of crop productivity in water-logged soils
2. **Improvement and Reclamation of Problem Soils**
   - 2.1. Site specific cultural practices
   - 2.2. Fertilizer and irrigation adjustments
   - 2.3. Specific cropping patterns and crop management practices for economic crop production in problem soils
   - 2.4. Demonstration of degraded soils

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Gupta, U.S. 2005. Physiology of Stressed Crops: nutrient relations. Science Pub., India.
2. IIMI. 1997. Salinization, Alkalinisation and Sodification on Irrigated Areas in Pakistan. Lahore.
3. Lauchli, A. and U. Luttge. 2002. Salinity: environment-plant-molecules. Lavoisir, France.

AGR-712 CROP MODELING 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept and knowhow of modeling.

Objective

To enhance the knowledge of crop modeling and its application in agriculture.

Learning Outcomes:

Upon successful completion of the course, the student will be able to:

- Understand components of crop modeling
- Use different models (DSSAT, APSIM and AQUACROP).
- Integrate crop models with remote sensing and GIS.
- Apply modelling for crop improvement and predictions.

Theory

1. **System Science**
   - 1.1. Philosophy and terminology of system science
   - 1.2. Scope of system analysis
2. **Crop Modeling**
   - 2.1. Concept and types of models
   - 2.2. Specification and use of models
   - 2.3. Statistical parameters in modeling
3. **Application of Crop Models**
   - 3.1. Parameterization and evaluation of crop models
   - 3.2. Model application in crops, soil, water and agrometeorology
   - 3.3. Modeling for crop improvement and risk assessment
   - 3.4. Crop models application in research, education and extension
4. **Integration of Crop Models**
   - 4.2. Integration of crop models with GIS
   - 4.2. Integration of crop models with remote sensing

Practical

1. **Working with Crop Models**
   - 1.1. DSSAT
   - 1.2. APSIM
   - 1.3. AQUACROP

2. **Setting Appropriate Coefficients**
   2.1. Setting of appropriate coefficients for cultivars, calibration, evaluation and validation
3. **Preparation of Input Files**
   3.1. Preparation of crop management files
   3.2. Preparation of experimental data files
   3.3. Preparation of weather and soil files
4. **Analysis**
   4.1. Working with sequence analysis
   4.2. Working with seasonal analysis
   4.3. Economic analysis
   4.4. Easy grapher

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
2. Floor M. B. and M. van Ittersum. 2010. Environmental and Agricultural Modeling: Integrated Approaches for Policy Impact Assessment, Springer, Heidelberg, Germany.
3. Singh, P. 2008. Modeling crop production systems: Principles and applications. Science publishers. Enfield, New Hampshire 03784.USA.
4. Vohnout, K. D. 2003. Mathematical modeling for system analysis in agricultural

research. Elsevier Sci., Amsterdam, The Netherlands.

5. Wallach, D., D. Makowski, J.W. Jones. 2006. Working with Dynamic Crop Models Evaluation, Analysis, Parameterization, and Applications. Elsevier Sci., Amsterdam, The Netherlands.

AGR-713 CROP NUTRIENT MANAGEMENT 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept and nutrients and their role in functioning of crops.

Objective

To equip students with latest developments in crop nutrition.

Learning Outcomes

At the end of the course, students will be able to:

- Understand the physiological role of macro and micro-nutrients.
- Learn modern strategies to improve crop nutrition.
- Compare the efficacy of different fertilizers in crop plants.
- Minimize the nutrient losses and apply judicious use of fertilizer.
- Analyze the nutrient content both in plant and growth media.

Theory

1. **Crop Nutrition**
   - 1.1. Crop nutrition in modern agriculture
   - 1.2. Rationale for use of fertilizers
   - 1.3. Biofortification
2. **Mineral Nutrients Uptake**
   - 2.1. Physiological classification of minerals
   - 2.2. Dynamics of plant nutrients in normal, flooded and salt affected soils
   - 2.3. Nutrient uptake and assimilation
   - 2.4. Nutrient losses and causes of low efficiency
3. **Nutrient Use Efficiency**
   - 3.1. Improving nutrient use efficiency
   - 3.2. Balanced nutrition and integrated plant nutrient management systems
   - 3.3. Concept of remote sensing in crop nutrition
   - 3.4. Nutrient indexing

Practical

1. **Nutrient Deficiency Symptoms**
   1.1. Demonstration of nutrient deficiency symptoms
2. **Preparation of Nutrients Solutions**
   2.1. Preparation of nutrient solution for field application
   2.2. Preparation and application of nutrients solutions in pots
   2.3. Preparation of nutrient solutions for hydroponic cultures.
3. **Nutrient Analysis**
   3.1. Nutrient analysis (macro and micro) of soil
   3.2. Nutrient analysis (macro and micro) of plants

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks

Final Exam: 40 marks

Recommended Books

1. Fageria. N.K. 2009. The Use of Nutrients in Crop Plants. CRC Press, London.
2. IFPRI. 2012. Reshaping Agriculture for Nutrition and Health. International Food Policy Research Institute, Washington DC, USA.
3. Krishna, K.R. 2002. Soil Fertility and Crop Production. Oxford and IBH publishing Co. New Delhi, India.
4. Marschner, H. 1995. Mineral Nutrition of Higher Plants. Elsevier, Amsterdam.
5. Singh, S.S. 2003. Soil Fertility and Nutrient Management. Kalyani Publishers, India.

AGR-714 CROP PRODUCTION AND HERBICIDES 3 (2-1)

Pre-requisites course requirements/ skills

Basic knowledge of herbs and herbicides and their impact on crops.

Objective

To enhance students' capability about herbicides and their use for crop maximization.

Learning Outcomes

At the end of the course, students will be able to:

- Understand the importance, nomenclature and registration of herbicides.
- Learn about the classification of herbicides.
- Compare the efficacy of different herbicide formulations.
- Minimize the environmental impacts due to herbicide application.
- Play their role in safe transportation, storage and disposal of herbicide packaging.

Theory

1. **Herbicides**
   - 1.1. Importance
   - 1.2. Nomenclature
   - 1.3. Registration
   - 1.4. Classification systems
   - 1.5. Chemical classification
   - 1.6. Bio-herbicides
2. **Herbicide Formulations**
   - 2.1. Concept and importance
   - 2.2. Surfactants
   - 2.3. Adjutants
3. **Herbicide Application**
   - 3.1. Application and incorporation techniques and equipment
   - 3.2. Spray drift management
4. **Herbicide Application**
   - 4.1. Herbicide selectivity
   - 4.2. Herbicide mixture and compatibility

5. **Herbicide Toxicity**
    5.1. Effect of herbicide residues on succeeding crops
    5.2. Herbicide hazards, toxicity, environmental pollution
    5.3. Storage, transportation and disposal of herbicides

Practical

1. **Herbicide Application**
    1.1. Calculation of herbicide dosage
    1.2. Determination of active ingredients in various herbicide formulations\
    1.3. Tank mixing of herbicides
2. **Herbicide Sprayers/Applicators**
    2.1. Types of sprayers
    2.2. Parts of sprayers
    2.3. Spray calibration
    2.4. Boom height adjustment
    2.5. Study of overlapping
3. **Herbicide Residue Effects**
    3.1. Study of residual effects on soil and succeeding crops

Recommended Books

1. Anderson, W.P. 2007. Weed Science Principles and Application. 4th Ed. West Publishing Co. St. Paul. New York.
2. Rao, V.S. 2002. Principles of Weed Science; Science Publishers, USA.
3. Ross. M. A. and C. A. Lembi, 2009. Applied Weed Science: including the Ecology and Management of Invasive plants. 3rd edition, Practice Hall, USA.
4. Walia, V. S. 2003. Weed Management. Kalyani Pub. New Delhi.
5. Zimdhal, T.L. 2007. Fundamentals of Weed Science. 3rd Ed. Academic Press, Ins. New York.

AGR-715 FARMING AND CROPPING SYSTEMS 3 (3-0)

Pre-requisites course requirements/ skills

Basic concept of cropping system and farming system and their types.

Objective

To identify the issues of farming/cropping systems and demonstrate research methods for

sustainable production.

Learning Outcomes:

Upon successful completion of the course, the student will be able to:

- Understand the concepts and significance of farming/cropping systems
- Assess input use efficiencies in various farming/cropping systems
- Use allied enterprises in agriculture-based systems
- Apply the acquired knowledge for sustainable production

Theory

1. **Cropping System**
   - 1.1. Concept and scope
   - 1.2. Classification and components of cropping system
   - 1.3. Agricultural resources, their utilization and management
   - 1.4. Major cropping systems of Pakistan
2. **Factors Affecting Cropping System**
   - 2.1. Role of tillage in cropping system
   - 2.2. Root dynamics and cropping system
   - 2.3. Impact of cover crops & crop residues in cropping system
   - 2.4. Assessing input use efficiencies in various cropping systems
3. **Farming System**
   - 3.1. Concept and scope
   - 3.2. Classification of farming system
   - 3.3. Components of farming systems
   - 3.4. Agricultural resources, their utilization and management
   - 3.5. Major farming systems of Pakistan
   - 3.6. Role of precision agriculture in farming system
   - 3.7. Study of allied enterprises (livestock, poultry, aquaculture, mushroom culture, tunnel farming)
4. **Future Perspectives**
   - 4.1. Emerging trends in farming/cropping system research
   - 4.2. Researchable issues and research methods in farming and cropping systems.

Recommended Books

1. Balasubramaniyan, P. and S.P. Palaniappan. 2009. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
2. Dixit, R.S. 2007. Cropping System Research. Kalyani Publishers, New Delhi, India.
3. Panda, S.C. 2006. Crop Management and Integrated Farming. Agrobios, Jodhpur, India.
4. Shrestha, A. 2003. Cropping Systems Trends and Advances. Food Products Press, Binghamton, NY, USA.

AGR-716 FIELD CROP EXPERIMENTATION 3 (2-1)

Pre-requisites course requirements/ skills

Basic knowledge of science, research, experimentation, layout etc.

Objective

To plan the experiments according to different design and layout therein the field and to collect the data, analysis it and interpretation.

Learning outcomes

Upon successful completion of the course, the student will be able to:

- Formulate null and alternate hypothesis.
- Select appropriate experimental design and execute its layout in the field.
- Analyze the data and interpret the results
- Determine possible relationships among variables
- Summarize the findings of the research and reporting

Theory

1. **Scientific Inquiry**
   - 1.1. Science and Research, Concept & importance
   - 1.2. Methods of scientific inquiry
2. **Experimentation**
   - 2.1. General types of experiments
   - 2.2. Principles of experimental design
   - 2.3. Planning, layout and conducting field experiments
   - 2.4. Recording research observations
3. **Data Arrangement**
   - 3.1. Arrangement of data

3.2. Tabulation and graphical presentation of data

3.3. Transformation of data

4. Data Analysis

4.1. Planned F test

4.2. Data processing

4.3. Data analyses

4.4. Statistical interpretation

4.5. Probability

4.6. F and t distribution

5. Separation of Means

5.1. Mean separation

5.2. LSD, DNMRT, HSD tests

6. Interaction Studies & Write up

6.1. Regression and Correlation

6.2. Research results reporting

Practical

1. Layout of Experiments

1.1. Layout of lab, greenhouse and field experiments on paper

1.2. Application of paper layout of lab, greenhouse and field experiments

2. Statistical Calculations

2.1. Statistical calculations based on sample data

2.2. Transformation of Experimental data

2.3. Preparation of analysis of variance table

3. Tests of Significance

3.1. Use of different tests of significance

3.2. Factorial experiments and their uses in scientific research

3.3. Use of statistical package for statistical tests

4. Interaction Studies

4.1. Calculation of linear regression

4.2. Calculation of correlation and correlation coefficients

5. Results Reporting

5.1. Reporting results of experiment

5.2. Factorial experiments and their uses in scientific research

Suggested Readings

1. Das, N.R. 2006. Agronomic Research Management. Agrotech Publishing Academy, Udaipur, India.
2. Gomez,K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. 2nd Ed. John Wiley and Sons, New York, USA.
3. Leclergy, E.L., W.H. Leonard and A.G. Clark. 1980. Field Plot Technique, 1st Ed. Reprinted by the National Book Foundation, Islamabad.
4. Steel, R.G.D., J.H. Torrie and D. Dickey. 1997. Principles and Procedures of Statistics: A Biometric Approach, 3rd Ed. McGraw-Hill Book Co. Inc., New York. USA.

AGR-717 HERBICIDES IN PLANT AND SOIL SYSTEMS 3 (2-1)

Pre-requisites course requirements/ skills

Background information of herbicides and their use in agronomic crops and possible fates in the soil.

Objective

To elucidate role of herbicides in plants and their dynamics in soil and environment.

Learning outcomes

After studying this course, the students will be able to:

- Know the mode of action of herbicides and their effect on photosynthesis, respiration, protein and nucleic acid metabolism etc.
- Understand the fate of herbicides, their lethal effect and interaction
- Demonstrate herbicide resistance, residual effect on germination and seedling growth of succeeding crops, use instrumental techniques for herbicide analysis

Theory

1. **Herbicides Uptake by Plants**
   1.1. Concept and importance
   1.2. Absorption and translocation of herbicides
2. **Herbicides and Metabolism**
   2.1. Effect of herbicides on photosynthesis
   2.2. Effect of herbicides on respiration

2.3. Effect of herbicides on protein metabolism

2.4. Effect of herbicides on nucleic acid metabolism

2.5. Effect of herbicides on enzymes

3. Herbicides in Plant and Soil

3.1. Metabolism of herbicides in plants

3.2. Sub lethal effects of herbicides

3.3. Herbicides and soil interaction

3.4. Fate of herbicides in soils

3.5. Herbicide residues in soil

4. Herbicide Resistance

4.1. Bioassay techniques in herbicide residue analysis

4.2. Instrumentation techniques for herbicide analysis

4.3. Herbicides resistance

4.4. Methods to combat herbicide resistance.

Practical

1. Herbicide Resistance Test

1.1. Definition, concept and importance

1.2. Demonstration of herbicide resistance through dose response test

2. Herbicide Residual Effects on Succeeding Crops

2.1. Demonstration of residual effect on germination and seedling growth of succeeding crops

2.2. Demonstration of herbicide movement in soils

Recommended Books

1. Kumar, R. J. and R. Jagannathan. 2007. Weed Science Principles. 2nd Ed. Kalyani Publisher, Ludhiana, India.
2. Powles, S. B. and J. A. M. Holtum. 1994. Herbicide Resistance in Plants: Biology and Biochemistry, Lewis Pub., Albany, USA.
3. Prado, R. De. J. Jossin and L. G. Torres. 1997. Weed and Crop Resistance to Herbicides. Kluwer Academic Publishers. Dordrecht/Boston/London.
4. Rao, V. S. 2002. Principles of Weed Science. Science Publishers. U.S.A.
5. Walia. U. S. 2010. Weed Management. Kalyani Publishers, Ludhiana, India.
6. Zimdhal, R. 2007. Fundamentals of Weed Science. 3rd Ed. Academic Press, New York.

AGR-718 INTEGRATED AGRICULTURE 3(3-0)

Pre-requisites course requirements/ skills

Basic concept of agriculture and its branches. Concept of different divisions of agriculture.

Objective

To equip students with the challenges and potential of Pakistan Agriculture.

Learning outcomes

After studying this course, the students will be able to:

- Define and describe the potential of agriculture for socio-economic uplift of country.
- Understand challenges faced by Pakistan's Agriculture and remedial strategies.
- Comprehend the role of natural resource management in rural development.
- Evaluate the working of agricultural institutions and agriculture related policies.

Theory

1. **Integrated Agriculture**
   - 1.1. Concept and importance
   - 1.2. Challenges in Pakistan's Agriculture
   - 1.3. Present scenario and future prospects
2. **Analytical Overview**
   - 2.1. Issues and strategies for improvement of crop management
   - 2.2. Issues and strategies for improvement of livestock management
   - 2.3. Issues and strategies for improvement of fisheries
3. **Institutions and Policies**
   - 3.1. Cottage industry
   - 3.2. National resource management and rural development
   - 3.3. Institutions and policies: issues and options.

Recommended Books

1. Ahmad, N. and A. Hamid. 1997. Plant Nutrients Management for Sustainable Agriculture Growth. Proc. Symposium held on December 8-10, 1997. Planning & Development Division, National Fertilizer Development Center, Islamabad.
2. Anonymous. 1999. Sustainable Agriculture Solutions. Novellow Press, Ltd. London.
3. ICIMOD. 1997. Appropriate Farm Technologies in Arid and Semi-Arid Mountainous

Areas of Pakistan. Katmandu, Nepal.

4. Virmani, S. M. J. C. Katyal, Eswaru, and I. P. Abarol. 1994. Stressed Ecosystems and Sustainable Agriculture. Oxford & IBH Pub. Co., New Delhi.

AGR -719 MODERN CONCEPTS OF CROP PRODUCTION 3 (2-1)

Pre-requisites course requirements/ skills

Basics of crop production and their use in traditional agriculture and farming.

Objectives

- To enable the students an insight understanding of Agro-physiological factors affecting crop potential.
- To harvest the maximum out of possessed genetic potential of a variety by integrating all the yield determinants.

Learning outcomes

Upon successful completion of the course, the student will be able to:

- Acquire in depth modern knowledge of crop productivity
- Analyze the issues of crop production with reference to modern concepts
- Apply modern techniques for maximizing crop harvest.

Theory

1. **Agricultural Productivity**
   - 1.1. Concept and indices of agricultural productivity
   - 1.2. Key issues limiting agricultural productivity in Pakistan
   - 1.3. Significance of crop management in determining crop productivity
2. **Dynamics of Stand Establishment**
   - 2.1. Multiple cropping;
   - 2.2. Manipulation of different tillage systems;
   - 2.3. Manipulation of crop development by the use of growth regulators
3. **Good Agricultural Practices**
   - 3.1. Concept and components
   - 3.2. Organic farming
   - 3.3. Precision agriculture and its tools
4. **Conservation Agriculture**
   - 4.1. Zero tillage: conditions, areas and crops

4.2. Alternate wetting and drying (AWD) techniques: conditions, areas and crops

5. Biofortification of Crops

5.1. Biofortification of staple food crops: concept, significance and crops

5.2. Biotechnology in improving crop production

Practical

1. Factors Influencing Stand Establishment

1.1. Study of different factors influencing stand establishment under field conditions

1.2. Demonstration of different factors influencing stand establishment under field conditions

2. Feasibility of Cropping Systems

2.1. Evaluation of some case histories for economic feasibility of different cropping systems

2.2. Field observation of different tillage systems

3. Good Agricultural Practices

3.1. Filed visits and observation on GAP

4. Global Warming, Conservation Agriculture & Agricultural Productivity

4.1. Demonstrations on the simulation of effects of global warming on agricultural productivity.

4.2. Visits to different agricultural research institutes and farmers field (where zero tillage, AWD are under practice).

5. Biofortification of Crops

5.1. Methods for biofortification of crops (Zn, Fe, Ca etc.)

Recommended Books

1. Byerlee, D. and T. Hussain. 1992. Farming Systems of Pakistan. Vanguard Books Pvt. Ltd. Lahore.
2. Chandrasskaran, B., K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age Int. (P) Ltd. Publishers, New Delhi, India.
3. Hester, R.E. and R.M. Harrison. 2005. Sustainability in Agriculture. Vol. 21. RSC Publishing, Thomas Graham House, Sci. Park, Milton Road, Cambridge, UK.
4. Singh, N.P. and R.A. Singh. 2002. Scientific Crop Production. Kalyani Publishers, Ludhiana, India.

AGR-720 RECENT ADVANCES IN AGRONOMY 3 (3-0)

Pre-requisites course requirements/ skills

Basic information of agronomy and its allied disciplines.

Objective

- To inculcate knowledge with respect to current developments in agronomic research.
- To adapt the current research and developments in agronomic research

Learning Outcomes

After studying this course, the students will be able to:

- Analyze the recent technologies for enhancing field crop productivity
- Compare traditional and new interventions
- Evaluate the new tools for agronomic research and development

Theory

1. **Latest Research in Agronomy**
   1.1. Selected topics on recent advances in agronomy
   1.2. Evaluation of the recent research of the entire field
2. **Lectures and Discussions**
   2.1. Lectures and discussions by the specialists in the areas of their research.

Recommended Books

1. Advances in Agronomy. All volumes from last three years. Academic Press Inc., New York.
2. Agronomy for Sustainable Development. All volumes of last three years.
3. INRA-CMSE-PME, Dijon, France and Springer, the Netherlands.
4. European Journal of Agronomy, Elsevier, Amsterdam, the Netherlands.
5. Critical Review in Plant Sciences. All volumes during last three years. Taylor and Francis, New York.
6. Sustainable Agriculture Reviews. All volumes of last three years. Springer, the Netherlands.

AGR-721 SEED PHYSIOLOGY 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept of seed and its structure.

Objective

To enhance students' understanding of physiological processes in seeds.

Learning outcomes

- Understand embryogenesis and flowers identification
- Comprehend seed formation and development
- Classify the chemical composition of seed
- Understand growth regulators and their role in seed development and dormancy
- Analyze moisture content, temperature and oxygen relations to germination process

Theory

1. **Seed**
   - 1.1. Seed and human beings
   - 1.2. Review of embryogenesis
   - 1.3. Physiological development of "seed"
   - 1.4. Implications of seed maturation
2. **Composition and Importance of Seed**
   - 2.1. Chemical composition of seed
   - 2.2. Phylogenetic implications
   - 2.3. Importance in storage
   - 2.4. Energy relationships
3. **Dormancy**
   - 3.1. Seed dormancy
   - 3.2. Seed survival value
   - 3.3. Occurrence and persistence of dormancy in cultivated, weedy and wild species
   - 3.4. Methods of overcoming dormancy
4. **Growth Regulators and Seed**
   - 4.1. Role of growth regulators in seed development and dormancy
   - 4.2. Seed sink strength and intensity

4.3. Seed food reserves, location and composition

5. Seed Aging, Maturity and Deterioration

5.1. Physiological and biochemical manifestation of seed aging

5.2. Seed deterioration-factors influencing rate of deterioration, theories of seed dying

5.3. Concept of seed vigor

5.4. Seed enhancement-production and yield

5.5. Requirements for germination-re-hydration and water relations, temperature and oxygen relations.

Practical

1. Seed Structure

1.1. Seeds germination

1.2. Monocot and dicot flower

1.3. Monocot and dicot seed structure

2. Seed Treatment

2.1. Seed priming techniques

2.2. Performance of primed seed under different moisture regimes

3. Seed Germination Analyses

3.1. Changes in protein and carbohydrate contents of seeds during germination.

3.2. Determination of enzyme activities (amylase, glutamine synthetase) in germinating seeds

Recommended Books

1. Bewley, J.D. and M. Black. 1994. Seeds: Physiology of Development and Germination. 2nd Ed. Plenum Press, New York
2. Copeland L.O. and M.F. McDonald. 2001. Principles of Seed Science and Technology – 4th Ed. Burgess Pub. Co., USA
3. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press / Ames, USA.
4. Stanwood, P.C. and M.B. McDonald. 1989. Seed Moisture. ASA, Madison, Wisconsin.

AGR-722 SEED SCIENCE AND TECHNOLOGY 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept of seed, its development and sciences involved in production of seed.

Objective

Augmenting students' capacity regarding principles of seed production and innovations in seed technology.

Learning outcomes

Upon successful completion of the course, the student will be able to:

- Understand functional concept of seed production
- Evaluate Seed vigor, quality management and maintenance
- Understand the role of seed industry, concept and future need for seed demand
- Examine Seed health, fortification and invigoration and ageing

Theory

1. **Seed Technology and Seed Production**
   - 1.1. Functional concept of seed production
   - 1.2. Recent trends in seed technology and management
   - 1.3. Hybrid and synthetic seed production
   - 1.4. Seed vigor and quality
   - 1.5. Ecological aspects of seed production
2. **Seed Certification**
   - 2.1. Seed certification standards
   - 2.2. Seed storage, structures and related problems
3. **Seed Industry**
   - 3.1. Seed industry. Import/export of seed
   - 3.2. Seed legislation and quarantine laws
   - 3.3. Genetically modified seeds (GMOs)
   - 3.4. Transgenetics for crop improvement
4. **Seed Quality**
   - 4.1. Seed quality, control and management
   - 4.2. Seed fortification and invigoration

4.3. Seed health

4.4. Organic seed production

Practical

1. **Analysis for Quality Tests**
   1.1. Physical purity test
   1.2. Seed viability test
   1.3. Germination test
   1.4. Seed vigor test
2. **Seed Treatment**
   2.1. Seed cleaning
   2.2. Seed grading
   2.3. Seed treatment
   2.4. Seed priming
3. **Sampling and Testing**
   3.1. Seed samples
   3.2. Sampling techniques involved in seed testing
4. **Field Visits**
   4.1. Visit to seed farms
   4.2. Visit to storage houses
   4.3. Visit to processing plants

Recommended Books

1. Advances in seed sciences and technology 2006 Agro Bios, India.
2. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
3. Copeland L.O. and M.F. McDonald. 2001. Principles of Seed Science and Technology – 4th Ed. Burgess Pub. Co., USA
4. ISTA. 1996. International rules for seed testing, Vol. 26, 31, 35, and 37. Proceedings of International Seed Testing Association, Zurich, Switzerland.
5. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press / Ames, USA.

AGR-723 STRESS AGRONOMY 3 (2-1)

Pre-requisites course requirements/ skills

Basic concept of stress and its impact on crop production.

Objective

To broaden the knowledge regarding various stresses influencing crop production and stress management

Learning Outcomes:

At the end of the course, students will be able to:

- Understand types of stresses and their impact on morphological, physiological and biochemical processes
- Describe the natural tolerance ability of various crop plants and manage crops through agro-management practices
- Induce the different stress in different growth media in field, pots and hydroponic experiments

Theory

1. **Stress Agronomy**
   - 1.1. Concepts and importance
   - 1.2. Plant stress factors and their impact on productivity of cropping systems
2. **Types of Stresses**
   - 2.1. Water/moisture stress
   - 2.2. Nutrient stress
   - 2.3. Salt stress
   - 2.4. Temperature Stress
   - 2.5. CO_2 stress
   - 2.6. Light stress
   - 2.7. Inter and intra plant competition
3. **Crop Responses and Management**
   - 3.1. Crop responses and adaptation to different stresses and their individual and interactive impact on plant growth and development
   - 3.2. Agro-management practices for successful crop husbandry under stress environments

Practical

1. **Demonstration**
   1.1. Experiments will be designed to invoke understanding among the students about plant behavior to various types of stresses
2. **Field Visits**
   2.1. Field visits to demonstrate types of stresses and their impact on crop productivity

Recommended Books

1. Arnon, I. 1992. Agriculture in drylands–principles and practices. Elsevier, Amsterdam.
2. Fitter, A.H. and R.K.M. Hay. 2002. Environmental Physiology of Plants. 3rd Ed. Academic Press, Inc., London.
3. Guar, R.K. and P. Sharma, 2014 Approaches to Plant Stress and their Management. Springer, India
4. Nösberger, J., H.H. Geiger and P.C Struik. 2001. Crop Science: Progress and Prospects. CABI, Pub., Oxon, UK.
5. Pessarakli, M. (Ed.). 1994. Handbook of Plant and Crop Stress. 2nd Edition. Marcel and Dekker Inc., New York.

AGR-724 SUSTAINABLE AGRICULTURE 3(3-0)

Pre-requisites course requirements/ skills

Basic concept and knowhow of subsistence agriculture.

Objective

To extend students' knowledge about management of agricultural resources on sustainable basis.

Learning Outcomes

After successful completion of this course, students will be able to:

- learn the concept, components and significance of Sustainable Agriculture.
- plan efficient utilization of soil, and water resources.
- Acquire the understanding and skill of Integrated nutrients management.
- Examine the effect of crop production practices on environmental pollution.

Theory

1. **Sustainable Agriculture**
   - 1.1. Definition, concept and significance
   - 1.2. Evolution of sustainable agriculture
   - 1.3. Management practices for sustainable agriculture
2. **Sustainable Use of Resources**
   - 2.1. Sustainable utilization of land and water resources and agro-biodiversity
   - 2.2. Integrated nutrient management
   - 2.3. Sustainable weed management
3. **Farming Systems**
   - 3.1. Integrated farming systems to sustain farm productivity
   - 3.2. Alternate land uses
4. **Climate Change and Latest Research**
   - 4.1. Agriculture, climate change and carbon sequestration
   - 4.2. Latest research methodologies related to the above topics ----------

Recommended Books

1. Beth, Lanfalvaj, C.J. and R.C. Linduman. 1992. Mycorhizae in Sustainable Agriculture, Pub. No. 54. ASA. Madison, USA.
2. Das, P.C. 2000. Crops and their production technology under different conditions. First Edition. Kalyani Publishers. New Delhi.
3. Lichtfouse, E. M. Nanarrete, B. Debacke, and V. Souchere. 2009. Sustainable Agriculture. Springer, The Netherland.
4. Maloo, S. R. 2002. Sustainable Crop Production under Stress Environments. Geeta Soman; Agrotech Publishing Academy, Udaipur, India.
5. Reddy, T.Y. and G.H.S. Reddy. 2002. Principles of Agronomy. Third Edition, Kalyani Publishers, New Delhi.
6. Singh, S.S. 1998. Crop management under irrigated and rain fed conditions, 3rd Edition. Kalyani Publishers, New Delhi.
7. Trivedi, P. C. 2011. Organic farming for sustainable Agriculture. Aavishkar Publishers, Distributors. Jaipur (Raj) India.

AGR-725 WATER RELATIONS OF PLANTS 3(2-1)

Pre-requisites course requirements/ skills

Basic concept of water and its importance and role in maintaining life.

Objective

To enhance the understanding of relationship between plants and water.

Learning Outcomes:

At the end of the course, students will be able to:

- Define the terminology and describe theories related to soil plant relationship
- know the physico-biochemical role of water in crop plants
- Understand mechanisms involved in water mobility from soil through the plant into the atmosphere.
- Analyze the plant water status and irrigate the crop as per requirement to ensure the judicious use of water
- Learn practically induce the water stress in different growth media in field, pots and hydroponic experiments

Theory

1. **Water**
   - 1.1. Importance of water in plants
   - 1.2. Physical and chemical properties of water
2. **Water Movement in Plants**
   - 2.1. The ascent of sap
   - 2.2. The cohesion mechanism, anatomy of pathway
   - 2.3. Water potential gradient, capillary rise in xylem
   - 2.4. Free energy and chemical potential
3. **Water Potential and Chemical Potential**
   - 3.1. Water potential and its components
   - 3.2. Analysis of chemical potential
   - 3.3. Standard state
   - 3.4. Hydrostatic pressure
4. **Water Activity**

4.1. Water activity and osmotic potential

4.2. Van't Hoff equation, matric potential

4.3. Ohm's law to study the movement of water in the soil-pant atmosphere system

Practical

1. Techniques and Experiments

1.1. Techniques and experimental approaches for measurement of plant water status

2. Measurements

2.1. Water content

2.2. Water potential

2.3. Pressure chamber technique

2.4. Psychrometric techniques

3. Water Stress Induction

3.1. Methods of inducing water stress in plants

Recommended Books

1. Kirkham, M.B. 2004. Principles of Soil and Water Relations, Academic Press, London.
2. Kramer, P.J. and J.S. Boyer. 1995 Water Relations of Plants and Soils. San Diego, CA: Academic Press, New York.
3. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology. San Diego, CA: Academic Press, New York.

AGR-726 WEED MANAGEMENT 3(2-1)

Pre-requisites course requirements/ skills

Definition of weed, its positive and negative impacts in agriculture and agronomy.

Objective

To acquaint students with comprehensive knowledge of weed management in field crops.

Learning Outcomes

After studying this course, the students will be able to:

- Comprehend importance of weed management.
- Compare weed crop competition and weed crop interference.
- Analyze weeds on the basis of host crops.

- Use natural products as herbicides.
- Test herbicide resistance.

Theory

1. **Weed Management**
   - 1.1. Concept and significance
   - 1.2. Weed management using principles of competition
   - 1.3. Integrated weed management
2. **Weed Management in Different Crops**
   - 2.1. Weed management for field crops
   - 2.2. Weed Management for Horticultural crops
   - 2.3. Weed management in lawn, turf grass, pastures, forestry and range lands
3. **Non-Cropped Area**
   - 3.1. Management of problematic, parasitic and non-cropped area
   - 3.2. Invasive weeds and their management
4. **Herbicides**
   - 4.1. Herbicide tolerant crops
   - 4.2. Herbicide resistant weeds and their management
   - 4.3. Natural products as lead for new herbicides.

Practical:

1. **Weeds Identification**
   - 1.1. Identification of weeds
   - 1.2. Collection of weeds
2. **Weed-Crop Competition**
   - 2.1. Demonstration of competitive effect of weeds on crop growth
   - 2.2. Determination of critical period of weed interference in crops
3. **Weed Control Approaches**
   - 3.1. Use of tillage implements for effective and economical weed control
   - 3.2. Testing of herbicide resistance in weeds

Recommended Books

1. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4th Ed. Waveland Pub.

Inc.

2. Andrew H. Cobb and John P.H. Reade. 2010 Herbicide and plant physiology Physiology-2nd Edition. Willey Blackwell, UK.
3. Cobb, A.H. and J.P.H. Reade. 2010. Herbicides and Plant Physiology. 2nd Ed. Wiley Blackwell, UK.
4. M.K. Upadhyaya and R.E. Black Shaw. 2007. Non-chemical weed management. Principle concepts and technology. Biddle Ltd. Kings Lynh UK.
5. Monaco T.J. 2002. Weed Science Principles and practices-4th Edition. John Wiley & Sons Inc. USA.
6. Tanveer, A., A. Khaliq, A. Ali and M.A. Khan. 2005. Weed Science Research in Pakistan – A Compendium. Agriculture Department, Government of Punjab.
7. Zimdahl R.L. 2013. Fundamentals of Weed Science. 4th Ed. Academic press.
8. Zimdahl, R.L. 2004. Weed-Crop Competition- a review. 2nd Ed. Wiley Blackwell, UK.

AGR -727 CLIMATE CHANGE AND AGRICULTURE 3(3-0)

Pre-requisites course requirements/ skills

Basic concept and knowhow of climate and different components of climate.

Objective

To develop ink-link about crop production under changing climate.

Learning Outcomes

After studying this course, the students will be able to:

- Comprehend importance of climate in agriculture
- Compare climate variability and change: past, present and future scenario
- Analyze impact of climate change in different regions
- Interpret influence of climate change on productivity of major and minor crops
- Examine implications of changing climatic scenario for pests, livestock and natural resources
- Design strategies for managing climate change and vulnerability

Theory:

1. **Climate and Agriculture**
   1.1. Concept and significance

1.2. Climate variability and change-past, present and future scenario

2. Climate Change Impact

2.1. Impact of climate change in different regions

2.2. Influence of climate change on productivity of major and minor crops

2.3. Implications of changing climatic scenario for pests, livestock and natural resources

3. Strategies to Combat Climate Change

3.1. Strategies for managing climate change and vulnerability

3.2. Capacity building and action plan for policy makers and planners

Recommended Books

1. Hillel, D. and C. Rosenzweig. 2013. Handbook of Climate Change and Agroecosystems: Global and Regional Aspects and Implications. Imperial College Press, London, UK.
2. Anboumozhi, V., M. Breiling, S. Pathmarajah and V.R. Reddy. 2012. Climate Change in Asia and the Pacific: How can Countries Adapt? SAGE Publication India Pvt. Ltd.
3. Sivakumar, M.V.K. and R.P. Motha. 2007. Managing Weather and Climate: Risks in Agriculture. Springer, Berlin, Heidelberg, New York.
4. Sivakumar, M.V.K. and J. Hansen. 2007. Climate Predictions and Agriculture. Springer, Berlin, Heidelberg, New York.
5. Mavi, H.S. and G.J. Tupper. 2005. Agrometeorology Principles and Application of Climate Studies in Agriculture. International Book Distribution Co., Lucknow, India.
6. Sivakumar, M.V.K. and R.P. Motha. 2005. Increasing Climate Variability and Change: Reducing the vulnerability of agriculture and forestry. Springer, Dordrecht, The Netherland.

AGR-728 POSTHARVEST TECHNOLOGY OF CROPS 3(2-1)

Pre-requisites course requirements/ skills

Basic concept and knowledge of harvest techniques and losses at harvest and post-harvest handling of crops.

Objective

To educate students with harvesting post-harvest technology, losses and marketing of crop produce

Learning outcomes

After studying this course, the students will be able to:

- Describe the importance of post-harvest technology and optimum harvesting time of crops.
- Understand about the processing, grading, seed treatment, storage of different crops
- Impart new techniques for harvesting and processing of crop produce
- Demonstrate different harvesting and post harvesting processes along with packing and marketing of crops

Theory

1. **Post-Harvest Technology**
   - 1.1. Concepts and objectives
   - 1.2. Importance of post-harvest technology in field crops
   - 1.3. Objects of harvesting, threshing, processing, cleaning and grading
   - 1.4. Seed treatment and storage
2. **Modern Technologies**
   - 2.1. Modern technology of harvesting
   - 2.2. Latest threshing machinery
   - 2.3. State of the art shelling
   - 2.4. Mechanized cleaning, drying, grading of cereal grains
3. **Produce Gathering of Different Crops**
   - 3.1. Reaping, beating/threshing, cleaning and drying of wheat and paddy rice.
   - 3.2. Picking, ginning and separating lint and seed of cotton.
   - 3.3. Cutting, stripping and topping of sugarcane.
   - 3.4. Harvesting, beating/threshing and cleaning of grain legumes and oilseeds.
   - 3.5. Digging, cleaning, topping and washing of root and tuber crops
4. **Marketing**
   - 4.1. Marketing of different crops
   - 4.2. Marketing of crop products

Practical

1. **Demonstrations**
   - 1.1. Demonstration of harvesters
   - 1.2. Demonstration of reapers and pickers

1.3. Demonstration of threshers

1.4. Demonstration of air screen cleaners (wheat and paddy)

1.5. Demonstration of ginners (cotton)

2. Field Visits

2.1. Field demonstration for sugarcane cutting

2.2. Field demonstration of sugar beet digging by manual methods

2.3. Visits of local farms

3. Post-Harvest Handling

3.1. Seed processing, cleaning, grading and packing practices in cereals

3.2. Seed processing, cleaning, grading and packing practices in legumes

3.3. Seed processing, cleaning, grading and packing practices in oilseeds

3.4. Seed processing, cleaning, grading and packing practices in condiments

3.5. Seed processing, cleaning, grading and packing practices in spices

3.6. Seed processing, cleaning, grading and packing practices in vegetables

Recommended Books

1. ARNON, I. 1972. Crop production in dry regions. Volume II: Plant Science Monographs Series. by I. Edited by Nicholas Polunin.
2. Bhatti, I. M and A. H. Soomro. 1996. Agriculture Inputs and field crop production in Sindh, Directorate of Agriculture Research Sindh, Hyderabad.
3. Nazir, M. S. 1994. Crop Production. National Book foundation, Islamabad
4. Reddy, S. R. 2004. Principles of Crop Production (2nd edition). Kalyani Publishers, New Delhi.

AGR-736 SPECIAL PROBLEM 1(0-1)

Objective

To broaden student capacity for handling a project independently.

Practical

1. Preparation of research proposals for plant science.

1.1. Field/Laboratory Experiment.

1.2. Collection, Compilation and presentation.

1.3. Interpretation of results and report writing by the student.

Note: *The post-graduate students will be assigned the topics on recent developments in agronomy by the concerned teacher.*

AGR-738 SEMINAR 1(0-1)

Objective

To improve students' communication and presentation skills.

Practical

1. **Seminar**
   1.1. Selection of topic
   1.2. Preparation of material for presentation
   1.3. Presentation by the student in the class on a particular topic

Note: *PhD students will deliver two seminars. The Seminar delivered on synopsis/research proposal and/or thesis will not be considered extra credit hour for academic purposes.*

AGR-742 PhD THESIS 12(0-12)

- **Teaching-learning Strategies**

Lecturing by using the latest technologies

PowerPoint presentations

Latest scientific publications from internationally reputed journals

Question and answer sessions

Online and physical libraries

Surprise quiz tests

Practical work by assigning different pieces of experimental area to different groups of students

- **Assignments- Types and Number with calendar**

Take home assignments on different topics

Models or practical demonstrations of the current problems

- **Assessment and Examinations:**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- Textbooks. In the detail course outline, one may mention chapters of the textbook with the content topics
- **Suggested Readings**
    - Books
    - Journal Articles/ Reports

1. Abbas, M.A. 2006. General Agriculture. Emporium Urdu Bazar, Lahore.
2. Advances in Agronomy, All volumes. Academic Press Inc., New York.
3. Vanangamudi, K. Advances in Seed Science and Technology. 2008. Agrobios, India.
4. Agronomy for Sustainable Development. All volumes of last three years. INRA-CMSE-PME, Dijon, Francis and Springer, The Netherlands.
5. Ahmad, N. and A. Hamid. 1997. Plant Nutrients Management for Sustainable Agriculture Growth. Proc. Symposium held on December 8- 10, 1997. Planning & Development Division, National Fertilizer Development Center, Islamabad.
6. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
7. Ahrens, C.D. 2008. Meteorology Today Brooks/Cole Cengage Learning, Belmount, USA.
8. Alan G. Clewer and David H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, Ltd. Chichester, England.
9. Ali, M.H. 2011. Practice of irrigation and on-farm water management Vol. 2, Springer, New York, USA.
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11. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
12. Allen R. O and R. V. Scholtz III 2002. Mathematical Models of Crop Growth and Yield. CRC Press, USA.
13. Altaf, Z. and A. Qarshi. 2013. Medicinal Plants. Qarshi Industries, Lahore.
14. Anboumozhi, V., M. Breiling, S. Pathmarajah and V.R. Reddy. 2012. Climate Change in Asia and the Pacific: How can Countries Adapt? SAGE Publication India Pvt. Ltd.
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24. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.
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28. Basak, R.K. 2004. Soil Testing and Recommendation. Kalyani Publisher, New Delhi.
29. Bashir, E. and R. Bantel. 1996. Soil Science. National Book Foundation, Islamabad.
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31. Beatley. T., D. Brower and A. Schwab. 2002. An Introduction to Coastal Zone Management. Island Press, 1718 Connecticut Avenue, N.W. Suite 300, Washington, D.C.
32. Benett, H.H. 2003. Soil Conservation for Sustainable Agriculture. Agrobios, Jodhpur, India.
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42. Choudhary, M.R. 2009. A Text book of irrigation and Drainage Practices for Agriculture. University of Agric. Faisalabad, Pakistan.
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44. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. Techniques in Bioproductivity and Photosynthesis, 2nd Ed. Pergamon Press, Oxford.
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46. Critical Review in Plant Sciences. All Volumes. Taylor and Francis, New York.
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48. Das, N.R. 2006. Agronomic Research Management. Agrotech Publishing Academy, Udaipur, India.
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Checklist for a New Academic Program

Parameters	Attachment
1. Department Mission and Introduction	☑
2. Program Introduction	☑
3. Program Alignment with University Mission	☑
4. Program Objectives	☑
5. Market Need/ Rationale	☑
6. Admission Eligibility Criteria	☑
7. Duration of the Program	☑
8. Assessment Criteria	☑
9. Courses Categorization as per HEC Recommendation	☑
10. Curriculum Difference	☑
11. Study Scheme / Semester-wise Workload	☑
12. Award of Degree	☑
13. Faculty Strength	☑
14. NOC from Professional Councils (if applicable)	☐ (In Process)

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