



No: MNS-UAM/RO-09/529

Date: 03.11.2021

NOTIFICATION

The Syndicate in its 31st meeting held on 10.10.2021 has approved the recommendations made by the Academic Council in its 7th meeting held on 09.08.2021, regarding revision in scheme of studies of B.Sc. (Hons.) Agriculture, Major-Agronomy from session 2021 and onwards as per attached appendix.

Aisha

Aisha Bibi

Assistant Registrar (Acad-I)
For Registrar

Distribution:-

- Dean Faculty of Agriculture and Environmental Sciences
- Director Quality Enhancement Cell
- ✓ Chairman Department of Agronomy
- Controller of Examinations
- Deputy Registrar (HR)
- Secretary to the Vice Chancellor
- Office File

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12.11.2021

MNS UNIVERSITY OF AGRICULTURE MULTAN

Registrar Office (Academics Section)

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APPROVED SCHEME OF STUDIES



B.Sc. (HONS.) AGRICULTURE

MAJOR - AGRONOMY

DEPARTMENT OF VETERINARY AND ANIMAL SCIENCES

Approved vide	Meeting	Date
Academic Council	7 th	09.08.2021
Syndicate	31 st	10.10.2021

B.Sc. (Hons.) Agriculture, Major Agronomy.

Program Objectives

The objectives of this program are to;

1. Equip the students with up to date theoretical and practical knowledge related to the field of Agronomy, and enabling them to apply this knowledge to serve the farming community.
2. Capacity building of students about application of the latest crop production techniques and use of ICTs for efficient utilization of resources in a cost-effective manner.
3. Train the students as outstanding educators, practitioners and entrepreneurs in the disciplines of crop production and soil management.
4. Enable the students to gather, assimilate, and process information to reach sound logical conclusions under weather variability and climate change.
5. Anticipate field related issues and seek their promising solutions.
6. Transfer integrated experiences to prepare the graduates for careers in agriculture and related fields.

Program Learning Outcomes (PLOs)

- 1. Disciplinary knowledge/Literacy:** Students will demonstrate knowledge and critical thinking skills in agronomy and various allied disciplines (Integrative skills and technical competences in multiple areas of agricultural sciences).
- 2. Problem solving skills:** Students will apply collaborative and interdisciplinary expertise to identify, analyze and solve agronomic problems.
- 3. Environmental sensitization:** Students will be able to describe human-environment-crop production nexus and associated problems, and to fine tune inputs, techniques and technologies used in crop production in the best interest of the ecosystem.
- 4. Effective communication:** Students will be able to comprehend effective written and oral communications for writing effective reports, blogs, articles, emails, covering letters, design documentation, make effective presentations, and give or receive clear instructions.



5. **Digital citizenship:** Demonstrate the use of ICTs in crop production in particular and agriculture in general. Ability to access information/databases, and use of softwares related to future climate projections and possible effects on crop production.

6. **Entrepreneurship:** Identify and pursue opportunities that provide value to raw agricultural commodities. Reshape the future of crop production by effective service provision and consultancy.

7. **Dynamism:** Students will understand and analyze the current events/issues that are occurring in agriculture, their effects and counteract them dynamically.

8. **Global perspective:** Students will demonstrate knowledge of the interconnectivity and interdependency of individuals, groups, systems and activities, and their implications for the regional and global food security.

9. **Leadership:** Students will be able to demonstrate outstanding leadership in collaborative working environment and interdisciplinary application of their expertise to address national and/or global problems associated with agriculture.

10. **Civic responsibility and Ethical/Professional Behavior:** Understand and commit to professional ethics, responsibilities and norms in the local communities and the diverse agricultural sector. They will be able to explain how human activities impact the environment and how societies are being affected by climate change. Develop an understanding about occupational health and safety, and consider public health in the backdrop of crop production.

11. **Life-long learning:** Articulate how continued learning after graduation will enrich their lives. Identify and participate in new areas for learning beyond the classroom and after graduation.

SEMESTER-I			
Course No.	Title of Course	Credit Hours	Course Type
AGRON-301	Basic Agriculture	2(1-1)	Comp
AGRON-303	Field Crop Production	2(1-1)	Comp
AGRON-304	Weed Control Methods (For the students of Intermediate Pre-Agriculture)	2(1-1)	Comp

SEMESTER-II			
Course No.	Title of Course	Credit Hours	Course Type
AGRON -302	Principles of Agronomy	3(2-1)	FC
SEMESTER-III			
Course No.	Title of Course	Credit Hours	Course Type
SEMESTER-IV			
Course No.	Title of Course	Credit Hours	Course Type
C.PHY-402	General Crop Physiology	3(2-1)	Elective
AGRON-402	Climate Change and Crop Productivity	3(2-1)	Elective
AGRON-404	Introduction to Weed Science	3(2-1)	Elective
AGRON-406	Introduction to Seed Science	2(1-1)	Elective
SEMESTER-V			
Course No.	Title of Course	Credit Hours	Course Type
AGRON-501	Agro-Ecology	3(2-1)	Major
AGRON-503	Irrigation Agronomy	3(2-1)	Major
AGRON-505	Field Crop Physiology	3(2-1)	Major
AGRON-507	Principles of Weed Science	3(2-1)	Major
AGRON-509	Sustainable Agriculture and Organic Farming	3(2-1)	Major
Sub-Total Credit Hours			15
AGRON-511	Global Agriculture	3(3-0)	Elective
AGRON-513	Fodders and Forages	2(1-1)	Elective
AGRON-515	Crop Management under stressful Environments	3(2-1)	Elective
AGRON-517	Water Relations of Crop Plants	2(1-1)	Elective
AGRON-519	Outreach in Agronomy-I	3(2-1)	Elective
FME-503	Fundamentals of Precision Agriculture	2(2-0)	Elective
Total Credit Hours			(15+5)= 20
SEMESTER-VI			
Course No.	Title of Course	Credit Hours	Course Type
AGRON-502	Seed Production Technology	3(2-1)	Major
AGRON-504	Arid and Rainfed Agriculture	3(2-1)	Major
AGRON-506	Agro-technology of Major Field Crops	3(2-1)	Major
AGRON-508	Plant Nutrients and Growth Regulators	3(2-1)	Major
BIOCHEM-502	Fundamental Bio-chemistry	3(2-1)	Supporting
			15
AGRON-510	Crop Growth Modeling and its Application in Agriculture	3(2-1)	Elective
AGRON-512	Eco-Physiological aspects of Weeds	3(2-1)	Elective
AGRON-514	Layout of Field Experiments	2(0-2)	Elective

AGRON-516	Agro-technology of Special Crops	2(1-1)	Elective
AGRON-518	Outreach in Agronomy-II	3(2-1)	Elective
		(15+5)=20	

SEMESTER-VII			
Course No.	Title of Course	Credit Hours	Course Type
AGRON-601	Medicinal and Special Crops	3(2-1)	Major
AGRON-603	Biological Crop Potential	3(2-1)	Major
AGRON-605	Conservation Agronomy	3(2-1)	Major
AGRON-607	Environment and Crop Production	3(2-1)	Major
AGRON-611	Preparation of Research Project and Scientific Writing	2(1-1)	Major
AGRON-615	Farming Systems and Record Management	3(2-1)	Major
Total credit hours		17	
AGRON-609	Application of Allelopathy in Agriculture	3(2-1)	Elective
AGRON-613	Plant and Soil Analysis	3(2-1)	Elective
AGRON-617	Spate Irrigated Agriculture	3(2-1)	Elective
AGRON-619	Digital Agriculture	3(2-1)	Elective
Total credit hours		(17+3)=20	

SEMESTER-VIII			
Course No.	Title of Course	Credit Hours	Course Type
AGRON-612	Internship and External Evaluation	6(0-6)	Major

CORE COURSES			
AGRON-301 BASIC AGRICULTURE 2(1-1)			
Learning Objectives			
The main objectives of the course are to:			
<ul style="list-style-type: none"> • Develop the concept of agriculture and its allied disciplines • Develop understanding about role of different climatic variables influencing crop production • Impart awareness about land and water resources of Pakistan and their effective utilization in agriculture 			
Learning Outcomes			
Upon successful completion of this course, students will be able to:-			
Sr. No.	CLOs	Domains	PLOs
1	Understand basic concepts and importance of Agriculture	Cognitive	1
2	Describe the effects of weather and climate on crop production	Cognitive	3, 8
3	Know the strategies and procedures to utilize land and water efficiently	Cognitive	1
SDGs Addressed in the Course:			
Goal No. 4: Quality education			

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Agriculture, concept, history and importance; Branches and allied sciences in agriculture; Salient features and latest problems of Pakistan's agriculture; Climate, weather and seasons of Pakistan, their major characteristics and impact on crop production; Land resources and their utilization; Crop nutrition; Water resources; Surface and ground water; Canal system; Agro ecological zones of Pakistan; Cropping and farming systems; Agro-based industries.

Practical

Measurement of land; Conventional and metric system; Identification and use of farm tools and implements; Recording weather data; Techniques and instruments for measuring rainfall, light, atmospheric humidity; Identification of various soil types; Determination of soil moisture contents; Saturation percentage; Field capacity and wilting point; Field visits.

Text Book

1. Abbas, M. A. 2006. General Agriculture. Emporium Urdu Bazar, Lahore.

Suggested Readings

1. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 2013. Crop Production. (6th Ed.). National Book Foundation, Islamabad.
2. Khalil, I.A and A. Jan. 2002. Cropping Technology. National Book Foundation, Islamabad, Pakistan.
3. Balasubramaniyan. 2004. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
4. Chandrasekran, B., K. Annadurai and E. Somasundaram. 2010. A textbook of Agronomy. New Age International (P) Ltd., Publishers. New Delhi, India.

AGRON-302 Principles of Agronomy 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Introduce students with concept and implications of principles of agronomy for sustainable crop production
- Elaborate the role of different agronomic factors influencing crop production
- Train the students about integration of various factors of crop production for effective use of agricultural inputs.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Recognize and examine the relationships between inputs and outputs under field conditions to make effective and profitable decisions	Cognitive	1
2	Relate and harmonize	Psychomotor	1, 2

the fundamental principles of agronomy to enhance crop productivity and soil health		
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SDGs Addressed in the Course

Goal No. 12: Responsible Consumption and Production

Goal No. 13: Climate Action

Teaching Mode: Blended learning**Course Contents****Theory**

Agronomy-definition and scope, Principles of Agronomy; Tillage (its objectives and types, Tillth, factors affecting tillage operations, modern concepts of tillage and tillage implements) and crop establishment; Seed: quality seed, seed production, multiplication, certification and distribution systems; Crop nutrition, manures and fertilizers; their classification, composition, sources and methods of application, Green manuring; Irrigation management: irrigation methods, Water use efficiency; Crop protection: losses due to weeds, weed management, use of pesticides in crop production, integrated pest management; Marketing and harvesting; New tools and methods in Agronomy; Agronomy and the sustainability of crop production.

Practical

Demonstration and use of tillage implements, preparatory tillage, seedbed preparation and intercultural operations; Demonstration of sowing methods and crop establishment techniques; Seed purity analysis; Identification of organic and inorganic fertilizers and manures; Calculation of nutrient cum fertilizer unit value; Demonstration and layout of various irrigation methods; Demonstration of harvesting of crops and their threshing protocols; Identification of weeds; Demonstration of weed control methods; Visits to University Farms and research trials.

Text book

1. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 2013. Crop Production. (6th Ed.). National Book Foundation, Islamabad.

Suggested Readings

1. Martin, J.H. R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.
2. Sheaffer, C.C. and K.M. Moncada. 2012. Introduction to Agronomy: Food, Crops, and Environment (2nd Edition). DELMAR CENGAGE Learning, Clifton Park, NY, USA.
3. Khalil, I.A and A. Jan. 2013. Cropping Technology. National Book Foundation, Islamabad.
4. Villalobos, F.J. and E. Fereres (Eds.). 2016. Principles of Agronomy for Sustainable Agriculture. Springer International Publishing, Switzerland.

AGRON-303 Field Crop Production 2(1-1)**Learning Objectives**

The main objectives of the course are to:

- Understand the basic classification of agronomic crops

- Develop the concept and implications of cropping pattern, scheme and systems
- Educate and familiarize the students about production plan of different agronomic crops

Learning Outcomes

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

Sr. No	CLOs	Domain	PLOs
1	Describe concept of crop production and their classification	Cognitive	1
2	Identify different crops and their seeds	Cognitive	1
3	Apply the basic knowledge of various crop production technologies to enhance crop productivity	Psychomotor	2, 7

SDGs Addressed in the Course

Goal No. 2: Zero hunger

Goal No. 15: Life on land

Teaching Mode: Blended learning

Course contents

Theory

Concept of crop production; Classification of field crops; Cropping scheme; Cropping patterns in different ecological zones; Cropping systems; Cropping intensity; Production technology of major field crops: cereals (wheat, rice, maize), sugar crop (sugarcane), fiber crops (cotton) oil seed crops (*i-Traditional*: rapeseed and mustards, groundnut; *ii-Non-traditional*: sunflower and soybean); grain legumes; (chickpea, green gram); super food (quinoa and chia); Green manure crops (Guar, Jantar). Techniques and practices for enhancing crop productivity.

Practical

Identification of crops and their seeds; Demonstration of different sowing methods of crops; Weed control practices and fertilizer application methods, Delinting of cotton seed; Raising of rice nursery and its transplanting; Intercultural practices; Burying of green manure crops; Seed treatments; Demonstration of harvesting and post-harvest operations; Field visits.

Textbook

1. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 2013. Crop Production. (6th Ed.). National Book Foundation, Islamabad.

Suggested Readings

1. Reddy, S.R. 2004. Agronomy of Field Crops. Kalyani Publishers, India.
2. Wolfe, T.K. and M.S. Kipps. 2004. Production of Field Crops: A Textbook of Agronomy. McGraw-Hill Book Co. New York.
3. Martin, J.H. R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.
4. Chandrasekran, B., K. Annadurai and E. Somasundaram. 2010. A textbook of Agronomy.

Learning Objectives:

The main objectives of the course are to:

- Highlight the importance of weeds in agriculture
- Equip the students with utilization of various methods of weed control
- Familiarize students with herbicides and their impact on environment

Learning Outcomes:

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

Sr. No.	CLOs	Domains	PLOs
1	Explain the importance of weeds in Agriculture	Cognitive	1
2	Appraise the herbicides and their impact on environment	Cognitive	3, 7, 10
3	Apply the methods of weed control in crop and non-crop land	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 4: Quality education

Goal No. 13: Climate action

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents**Theory**

Weeds in agriculture; Methods of weed control: Cultural, physical, mechanical, organic, biological, and chemical; Herbicide classification and mode of action; Herbicide tolerant crops and resistant weeds; Herbicides in the environment; Safety consideration in weed control.

Practical

Identification of important weeds; Demonstration of weed control methods: physical, cultural, mechanical and

chemical; Herbicide calibration and application of sprayer; Herbicide dosage calculation.

Text Book

1. Zimdahl, R. 2013. Fundamentals of Weed Science. 4th Ed. Academic press, USA.

SUGGESTED READINGS

1. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.
2. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4th Ed. Waveland Pr Inc.
3. Walia, U.S. 2010. Weed Management. Kalyani Publishers, B-I/292, Rajinder Nagar, Ludhiana-141008, India.

C.PHY-402 General Crop Physiology (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Understand primary and secondary metabolism of crop plants
- Familiarize the students with physiological processes about minerals uptake and their transport in plants
- Develop the understanding about seed development, physiology of germination and dormancy

Learning Outcomes:

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

Sr. No.	CLOs	Domains	PLO
1	Understand basic concepts of primary and secondary metabolism of crop plants	Cognitive	1
2	Describe phenomenon of seed development, physiology of germination and dormancy	Cognitive	1
3	Comprehend the growth regulations in crop plants	Cognitive	1, 2

SDGs addressed in the course:

Goal No. 3: Quality education

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Introduction, Concepts and significance of physiology of crop plants; Introduction to plant structure and functions; Water relations of crop plants and transport; Mineral nutrition of crop plants and their transport; Photosynthesis, respiration and photorespiration; Respiration and factors affecting; Plant growth and development; seed germination; vegetative and reproductive growth; growth regulation and responses; Environmental stresses and their effects on physiology of crop plants.

Practical

Introduction to equipment used in crop physiology; Seed vigor and viability tests; Preparation of various salt and growth regulator solutions; Plant sampling techniques and chlorophyll contents measurement; Introduction to meteorological data recording systems.

Textbook

1. Taiz, L. and E. Zeiger. 2010. Plant Physiology. 5th Ed. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts. USA.

Suggested Readings

1. Bajracharya, D. 1999. Experiments in Plant Physiology. A Laboratory Manual. Narosa Publication, New Delhi, India.
2. Joshi, J.K. and B.D. Singh. 2004. Seed Science & Technology. 1st Ed. Kalyani Pub. New Delhi, India.
3. Sinha, R.K., 2004. Modern Plant Physiology. Narosa Publishing House Ind.
4. Pessaraki, M. 2014. Handbook of Plant and Crop Physiology 3rd Ed. CRC Press, New York, USA.

AGRON-402 Climate Change and Crop Productivity (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

1. Highlight the concept and importance of climate change.
2. Familiarize the students with effects of climatic variables on germination, development, and physiology of crop plants.
3. Train the students regarding use of crop models for simulating climatic effects on crop growth and productivity.

Learning Outcomes

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

Sr	CLOs	Domains	PLOs
1	Understand the importance of climate change for crop production and food security	Cognitive	1, 3
2	Explain climatic variables and their relationship with crop development	Cognitive	1, 2, 3

3	Apply crop models for prediction and decision support under changing climate	Psychomotor	2, 7
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SDGs addressed in the course:

Goal No. 3: Quality education

Goal No. 12: Responsible consumption and production

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Historical perspective; climate change and its implications; Role of climate in food security; Climate and the plants; Geographical variation in plants; CO₂ and plants in future; Radiation and its uses for plants; Impact of wind, moisture, humidity, precipitation, temperature on crop productivity; Crop adaptation to changing climate.

Practical

Introduction of automatic weather station; How to use data of solar radiation, temperature, rainfall, humidity, wind etc.; Introduction to different CO₂ and temperature regimes; Application and use of climate change models.

Text Book

1. Sivakumar, M.V.K. and R.P. Motha. 2007. Managing Weather and Climate: Risks in Agriculture. Springer, Berlin, Heidelberg, New York, USA.

SUGGESTED READINGS

1. Hammer, G.L., N. Nicholls and C. Mitchell. 2000. Application of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems. Kluwer Academic Publisher, London, UK.
2. Hillel, D. and C. Rosenzweig. 2013. Handbook of Climate Change and Agroecosystems: Global and Regional Aspects and Implications. Imperial College Press, London, UK.
3. IPCC-Intergovernmental Panel on Climate Change Reports available at http://www.ipcc.ch/publications_and_data/publications_and_data_reports.html. IPCC Secretariat, World Meteorological Organization Geneva, Switzerland
4. Lenka, D. 2006. Climate, weather and crops in India. Kalyani Publishers, New Delhi, India.

AGRON-404 Introduction to Weed Science (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Impart basic concepts of weed science and educate about importance of weeds

- Acquaint the students with site specific weed management
- Understand weed crop interactions

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Understand weeds and their importance	Cognitive	1
2	Explain weed crop interactions	Cognitive	1
3	Apply site specific weed management practices	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 03: Quality Education

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Introduction, significance and history of weed science; Weeds- definition and classification; Losses caused by weed; Noxious and invasive weeds; Weed survival mechanisms; Propagation of weeds; Dispersal of weed seed and fruits; Critical weed-crop competition period; Economic threshold level; Principles and methods of weed control.

Practical

Identification of common weeds, collection mounting and display of weed specimens; Demonstration of weed control methods under field condition; Calibration of sprayer; Lab. trials for testing the germination of different weeds and treatment for breaking their dormancy; Field visits.

Text Book

1. Zimdahl, R. 2013. Fundamentals of Weed Science. 4th Ed. Academic press.

SUGGESTED READINGS

1. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.
2. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4th Ed. Waveland Pr Inc., USA.
3. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
4. Ziska, L.H. and J. S. Duke. 2011. Weed Biology and Climate Change. Wiley Blackwell, Hoboken, NJ, USA.

AGRON-406 Introduction to Seed Science (E)

Learning Objectives:

The main objectives of the course are to:

- Educate students about physiology of seed development
- Familiarize the students about process of seed multiplication, certification, distribution and constraints to quality seed production
- Enhance the skills regarding seed quality testing.

Learning Outcomes:

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

Sr.	CLOs	Domains	PLOs
1	Learn processes involved in seed development	Cognitive	1
2	Understand about seed vigor and viability related issues	Cognitive	1
3	Apply the seed production, multiplication and testing skills for quality seed production	Psychomot or	2, 7

SDGs addressed in the course:

Goal No. 4: Quality education

Goal No 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Seed: definition, types and significance; Development and maturation; Dormancy and germination; Seed quality: concept, significance and standards; Seed multiplication; Certification and legislation; Seed testing; Storage and longevity; Seed enhancements.

Practical

Seed sampling techniques; Analysis for quality tests: physical purity, seed viability, germination and vigor tests. Seed priming; Demonstration of hermetic seed storage; Demonstration of Seed drying using drying beads; Visit of germplasm testing fields.

Text Book

1. Copeland, L.O. and M.B. McDonald. 2001. Principles of Seed Science and Technology. 4th edition. Kluwer Academic Publishers, Massachusetts, USA.

Suggested Readings

1. Benech-Arnold, R.L. and R.A. Sanchez. 2004. Handbook of Seed Physiology: Applications to Agriculture. Food Products Press New York, USA.

2. Basra, A.S. 2006. Handbook of Seed Science and Technology. Food Products Press New York, USA.
3. Black, M., J.D. Bewley and P. Halmer. (Eds.) 2006. The Encyclopedia of Seeds: Science, Technology and Uses. CABI, USA.

AGRON-501 Agro-Ecology 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Develop the concept of ecosystem, its components and primary productivity
- Inculcate understanding about biogeochemical cycling processes
- Provide knowledge about agro-ecosystem and its sustainability

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Describe the relationship between plants and ecosystem	Cognitive	1
2	Illustrate the role of water, nitrogen, sulfur, phosphorus and CO ₂ in cultivated ecosystem	Cognitive	1
3	Apply principles of ecology to enhance crop productivity	Psychomotor	2, 7

SDGs addressed in the course

Goal No. 4: Quality education

Goal No. 15: Life on land

Teaching Mode: Blended learning

Course contents

Theory

Ecology; Definition and branches. Ecosystem; definition, components and types. Ecosystem Functions; Productivity: types and methods to measure the primary productivity; Concept: food chain, trophic levels and food web; Ecological pyramids; Energy Flow; Biogeochemical cycling process: cycling of CO₂, nitrogen, water, phosphorus and sulphur; Agro-ecosystem: biotic structure, primary producers, consumers, decomposers, primary productivity, energy flow and competition; crop yields variability in relation to the ecological optima; Effect of biotic and abiotic factors on crop plants; Sustainability of agro-ecosystem.

Practical

Methods of quantitative sampling of plant communities; Determination of minimum size and number of quadrat for the study of plants; Determination of frequency of plants species and its comparison with Raunkiaer's standard frequency diagram; Determination of density and abundance of plant

species; Determination of canopy cover and basal area of plant species; Determination of importance value index (IVI) of plant species; Calculation of indices of similarity and dissimilarity; Calculation of index of diversity; Measurement of primary productivity of plants.

Text Book

1. Hussain, S.S. 2003. Manual of Plant Ecology. National Book Foundation, Islamabad, Pakistan.

Suggested Readings

1. Kapur, P. and R.G. Sudha. 2000. Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
2. Gliessman, S.R. 2001. Agroecosystem Sustainability: Developing practical. CRC Press, London.
3. Shukla, R. S. and P. S. Chandel, 2006. A Textbook of Plant Ecology. S. Chand & Co. Ltd. New Delhi, India.
4. Altieri, M. A. 2018. Agroecology: the science of sustainable agriculture. CRC Press.

AGRON-502 Seed Production Technology 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Educate students about fundamentals of seed technology
- Train the students about different seed testing techniques

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Describe major steps in quality seed production	Cognitive	1
2	Understand the seed certification and variety evaluation	Cognitive	1
3	Identify different steps in seed processing	Cognitive	1
4	Conduct and evaluate seed quality tests using the appropriate methodology	Psychomotor	2, 7

SDGs addressed in the course

Goal No. 4: Quality education

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course contents

Theory

Concept and perspective of seed technology; Seed production terms: their definition; Types of seeds; Major steps in production and multiplication of quality seed; Seed production in self and cross

pollinated crops; System of variety development, testing, registration, approval and release in Pakistan; Seed quality problems: germination, stand failures, mixtures, weeds and genetics; Seed certification classes: Nucleus breeder seed, pre-basic, basic, certified and approved class; Seed sampling procedures; Seed processing: drying, cleaning, grading and treatment; Seed viability and vigor: their similarity and differences; Seed longevity and storage; Seed certification system of Pakistan; Seed distribution and marketing; Seed act and laws.

Practical

Seed identification and their structure; Seed testing equipment; Seed sampling techniques in seed testing laboratory; Seed physical purity analysis; Seed moisture test; Seed viability test; Seed germination test (Procedure and methods for Paper, Sand and Soil); Seed vigor tests; Visit of seed production farms/ seed processing industry

Text Book

1. Copeland L.O. and M.F. McDonald. 2001. Principles of Seed Science and Technology, 4th Ed. Burgess Pub. Co., USA.

Suggested Readings

1. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
2. ISTA. 1996. International rules for seed testing. Proceedings of International Seed Testing Association, Zurich.
3. Joshi, A.K. and B.D. Singh 2004. Seed Science and technology. Kalyani Publisher, India.
4. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 2013. Crop Production. (6th Ed.). National Book Foundation, Islamabad.

AGRON-503 Irrigation Agronomy 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Familiarize with basic concepts of irrigation agronomy and water management.
- Acquaint principles of crop water requirements for successful crop production.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Understand the concepts of irrigation management.	Cognitive	1
2	Plan and perform Irrigation scheduling for a given crop over the life cycle based on system type, soil and growing season using various approaches	Psychomotor	2, 3
3	Sensitize farming community about the significance of judicious water use in crop production	Affective	4,7,10

SDGs Addressed in the Course:

Goal 4: Quality education

Goal 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Concept of irrigation agronomy and water management; Sources of irrigation water and their efficient use in crop production; Introduction to different irrigation methods, their feasibility in various regions; Crop water requirements versus irrigation water requirements; Field water balance; Irrigation scheduling and water use efficiency in field crops; Ways to maximize the water use efficiency in field crops; Irrigation water quality: indicators and threshold of water quality, problems with marginal/poor quality irrigation water for crop production; Irrigation water pollution and measures to minimize it; Water management practices in Pakistan: Issues and options for productivity enhancement; Irrigation capacity building; Irrigation and water security: the role of economic instruments and governance; Irrigation to meet growing food demand under climate change, salinity and water trade; Advances in irrigation Agronomy.

Practical

Estimation of potential evapotranspiration by different methods; Estimation of soil moisture constants like field capacity, water holding capacity, permanent wilting point etc.; Calculation of water use efficiency in field crops; Potential soil moisture deficit and its calculation; Measurement of irrigation water; Irrigation scheduling for cotton and wheat; Techniques for soil moisture estimation.

Text Books

1. Ali. M.H. 2010. Fundamentals of Irrigation and On-farm Water Management: Volume 1. Springer-Verlag, New York, USA.

Suggested Readings

1. Ali. M.H. 2011. Practices of Irrigation & On-farm Water Management: Volume 2. Springer-Verlag, New York, USA.
2. Sharma, B., D. Molden and S. Cook. 2015. Water use efficiency in agriculture: Measurement, current situation and trends. In: Drechsel, P., P. Heffer, H. Magen, R. Mikkelsen and D. Wichelns (Eds.). Managing Water and Fertilizer for Sustainable Agricultural Intensification (1sted.). International Fertilizer Industry Association (IFA), International Water Management Institute (IWMI), International Plant Nutrition Institute (IPNI) and International Potash Institute (IPI): Paris, France. pp. 39-64.
3. Chartzoulakisa, K. and M. Bertaki. 2015. Sustainable water management in agriculture under climate change. Agriculture and Agricultural Science Procedia 4: 88-98.
4. Ouda, S., A.E. Zohry and T. Noreldin. 2020. Deficit irrigation: A remedy for water scarcity. Springer Nature, Switzerland.

AGRON-504 Arid and Rainfed Agriculture 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Enhance the crop productivity by utilizing the limited and unreliable moisture efficiently



- Produce properly trained manpower with great emphasis on dryland agriculture

Learning Outcomes:

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

Sr. No.	CLOs	Domains	PLOs
1	Explain the basic concepts and importance of arid and rain-fed agriculture	Cognitive	1
2	Apply strategies for enhanced crop productivity under arid and rain-fed conditions	Psychomotor	2

SDGs addressed in the course:

Goal No. 2: Zero hunger

Goal No. 12: Responsible consumption and production

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Introduction, concept and causes of aridity; Climatic zones of Pakistan and their features; Climatic factors such as light, temperature, rainfall, relative humidity, wind, etc. and their effects on crop yield; Crop growth and yield responses to moisture supply in different soils; Evapotranspiration (ET), relation between crop yield and ET; Dry farming; water conservation practices, tillage, fertilizer use, sowing date and plant density; Weed management in rainfed regions; Crop rotations and cropping patterns in rainfed regions; Water harvesting and water conservation practices; Spate irrigation.

Practical

Demonstration of rainwater harvesting and conservation techniques; Demonstration of cover crops/strip cropping; Determination of soil moisture; Mulching and tillage practices for moisture conservation; Field visits.

Text Book

1. Hudson, N.W. 2004. Soil and Water Conservation in Semi-arid Areas. Scientific Publishers, India.

Suggested Readings

1. Arnon, I. 1992. Agriculture in Drylands: Principles and Practices. Elsevier, Amsterdam.
2. Maloo, S.R. 2002. Sustainable Crop Production under Stress Environments. Agro-tech Publishing Academy, Udaipur, India.
3. Chandrasekaran, B.K., Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Pub., New Delhi, India.
4. Oweis, T.Y., D. Prinz and A.Y. Hachum. 2012. Water Harvesting for Agriculture in the Dry

AGRON-505 Field Crop Physiology 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Educate students about basic concept and importance of crop physiology.
- Familiarize students about internal processes occurring in crop plants.
- Inculcate understanding about plant responses in relation to light and temperature.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Understand basic concepts of primary and secondary metabolism of crop plants	Cognitive	1
2	Describe internal processes of crop plants at various growth stages	Cognitive	1
3	Explain plant responses to abiotic factors	Cognitive	1, 2

SDGs Addressed in the Course:

Goal No. 4: Quality education

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Concepts and importance of Crop Physiology; Carbon metabolism: Factors affecting photosynthesis, respiration and transpiration; Photosynthetic efficiency of different crops; Growth and development; Photomorphogenesis: Physiology of germination, dormancy, seedling establishment, tillering, root, stem, leaf, flower and seed development, maturity, senescence and abscission; Source-sink relationship in crop plants; Photoperiodism, vernalization and tropism; physiological determinants of crop yield.

Practical

Equipment's used in crop physiology; Leaf area measurement; Growth analysis; Measurement of photosynthetic rate, transpiration rate and stomatal conductance; Identification of crop growth stages; Demonstration of various types of seed germination; Measurements of water potential and its components.

Text Book

1. Taiz, L. and E., Zeiger. 2006. Plant Physiology 4th Ed. Sinauers Associate, Inc. Sunderland Massachusetts, USA.



Suggested Readings

1. Bonner, J. 1995. Principles of Plant Physiology. W.H. Freeman, NBF, San Francisco.
2. Lambers, H., F.S. Chapin III and T.L. Pons. 2008. Plant Physiological Ecology (2nd Edition). Springer Science+Business Media, LLC.
3. Sadras, V.O. and D.F. Caldreni. 2009. Crop Physiology: Applications for genetic improvement and agronomy. Academic Press, USA.
4. Duca, M. 2015. Plant Physiology. Springer International Publishing Switzerland.

AGRON-506 Agro-Technology of Major Field Crops 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Comprehend the crop husbandry of major field crops with special emphasis on critical production factors.
- Impart the significance of about biotic and abiotic factors affecting growth and yield of crops
- Develop capability of students to grow these crops successfully under varying soil and environmental conditions.
- Develop crop management strategies of major field crops with special emphasis on resource conservation technologies.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Explain effect of environment on plant growth and crop yield	Cognitive	1, 3
2	Describe causes of stagnant/low yield of major crops	Cognitive	1
3	Apply the acquired knowledge to abridge the existing yield gap by optimizing site-specific agronomic practices	Psychomotor	2, 7

SDGs Addressed in Course

Goal No. 3: Decent work and economic growth

Goal No. 12: Responsible consumption and production

Goal No. 4: Quality Education

Teaching Mode: Blended learning

Course Contents

Theory

Food security (food availability, access, nutritional security); Origin, history, morphology, adaptation, distribution, economic importance and agro-technology of major field crops such as Wheat, Cotton, Sugarcane, Maize, Rice, and Potato with special focus on regional crops;. Management of irrigation, the timing of planting and harvesting, pest management, fertilization, Management constraints towards crop productivity; Modern techniques for crop improvement.

Practical

Demonstration of improved sowing methods; Raising and transplanting of rice nursery; Delinting of



cotton seed by conventional and modern techniques, its impact on seed germination and seedling establishment; Techniques of maintaining optimum plant population under field conditions; Plant characteristics and phenological development of major crops; Introduction to sugar industry; Demonstration of methods used for estimating crop yields for major crops.

Text Book

1. Chandrasekran, B., K. Annadurai and E. Somasundaram. 2010. A textbook of Agronomy. New Age International (P) Ltd., Publishers. New Delhi, India.

Suggested Readings

1. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 2013. Crop Production. (6th Ed.). National Book Foundation, Islamabad.
2. Khan, S. R. A. 2001. Crop Management in Pakistan with Focus on Soil and Water. Directorate of Agricultural Information, Punjab. Lahore.
3. Khalil I.A and A. Jan. 2002. Cropping Technology. National Book Foundation, Islamabad.
4. Martin, J.H., R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production, 4th Ed., The Macmillan Co., New York.

AGRON-507 Principles of Weed Science 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Introduce students with importance of weeds as an important crop pest
- Familiarize students with classification and biology of weeds
- Acquaint the students with approaches for efficient weed management in field crops
- Strengthen students' understanding regarding principles of weed science and control methods.

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Discuss weeds as an important crop pest	Cognitive	1
2	Describe classification and biology of weeds	Cognitive	1
3	Identify and implement approaches for efficient weed management in field crops	Cognitive	3, 7

SDGs addressed in the course:

Goal No. 2: Zero hunger

Goal No. 4: Quality education

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Definition and importance of weed control; Harmful effects of weeds; Classification and biology of weeds; Weed-crop interference (competition and allelopathy); Merits and limitations of different weed control approaches; Formulation and mode of actions of herbicides; Weed control in major field crops; Integrated weed management.

Practical

Collection and identification of weeds; Demonstration of various hand tools & implements for weed control; Trials for testing the germination of different weeds and treatment for breaking their dormancy; Calibration and demonstration of sprayers for herbicide application; Survey into weed flora of different agro-ecological zones.

Text Book

1. Zimdahl, R. 2013. Fundamentals of Weed Science. 4th Ed. Academic press.

Suggested Readings

1. Ashiq, M. and J. Ahmad. 2001 Manual on Punjab Weeds: Part I and II. Directorate of Agronomy. Ayub Agri. Res. Inst. Faisalabad.
2. Naylor, R.E. 2002. Weed Management Handbook. Published for the British Crop Protection Council Blackwell Science. Osney Mead, Oxford OX2 OEL, UK.
3. Ashiq M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Handbook Directorate of Agronomy. Ayub Agri. Res. Inst. Faisalabad.
4. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.

AGRON-508 Plant Nutrients and Growth Regulators 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Develop the concept of crop nutrition and growth regulators
- Provide knowledge about integration of crop production with effective use agricultural inputs.
- Explain the methods of fertilizer and growth regulators application and their feasibilities.

Learning Outcomes:

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

Sr. No.	CLOs	Domain	PLOs
1	Describe various aspects of crop nutrition and growth regulators	Cognitive	1
2	Identify the nutrients deficiency symptoms, severity and correction	Psychomotor	1
3	Apply the acquired knowledge of various fertilizer and growth regulators and their application skills	Psychomotor	2, 7, 10

SDGs Addressed in the Course

Goal No. 2: Zero hunger

Goal No. 3: Good health & well-being

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Plant nutrition: Basic concept and principles;

Criteria for essentiality of mineral nutrients;

Elements required in plant nutrition; Factors affecting nutrient availability; Primary and secondary nutrients; Sources and uptake of nutrients; Fertilizer application and soil amendments; Nitrogen in the soil; Nitrogen fertilization; Fertilizer use in relation to environment; Fertilizer placement; Economics of fertilization; Nutrient management in precision agriculture; Nutrition sustainable sources; Biosynthesis, translocation and functions of growth regulators-auxins, gibberellins, cytokinins, abscisic acid and ethylene.

Practical

Soil sampling for evaluation of essential nutrients; Plant sampling for determination of essential nutrient; Raising plants in different growth media with various nutrients; Visual symptoms of nutrient deficiency in field crops; Identification of fertilizers and their calculations for field and green house experiments; Nutrition recipe for hydro-phonics; Methods of fertilizer applications; Demonstration of plant responses to growth regulators; Field visits.

Text book

1. Rashid, A. and K.S. Memon. 2005. Soil Science. Ed. E. Bashir and R. Bantel. National Book Foundation, Islamabad, Pakistan.

Suggested Readings

1. Mengel, K., E. A. Kirkby, H. Kosegarten and T. Appel. 2001. Principles of Plant Nutrition. 5th Ed. International Potash Institute, Bern, Switzerland.
2. Epstein, E. and A. J. Bloom. 2004 Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
3. Havlin, J.L., Tisdale, S.L., J.D. Beaton and W.L. Nelson. 2005. Soil fertility and fertilizers. 7th Ed. Macmillan Publishing Co., NY, USA.
4. Marschner, P. 2012. Mineral Nutrition of Higher Plants. Academic Press, USA.

AGRON-509 Sustainable Agriculture and Organic Farming 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Inculcate the concept of sustainable agriculture and organic farming
- Enhance skills of students for integrated pest and nutrient management in crops.
- Train the students about basic techniques of sustainable and organic farming.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Describe basic concept and principles of sustainable agriculture and organic farming	Cognitive	1
3	Compare sustainable agriculture, organic farming and inorganic	Psychomotor	2, 10

	farming		
3	Apply techniques to prepare organic fertilizers and natural products to maintain soil fertility and to control crop pests	Psychomotor	2, 7

SDGs Addressed in the Course

Goal No. 2: No poverty

Goal No. 3: Good health and well-being

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Introduction; Principles of sustainable Agriculture; Components of sustainable Agriculture; Scope of botanicals; bio-pesticides, bio-agents, pheromones, bio-fertilizers; Sustainable utilization of land and water resources and agro-biodiversity; Preparation of organic matter, humus, sewage sludge, organic compost; Conversion of conventional to organic farming; Components of organic farming; Hazards of inorganic farming; Farm waste recycling, organic mulches and nature safe products for control of weeds and diseases management; Quality of food and crop productivity under natural ecological systems; Organic certifications; Climate change and carbon sequestration. Introduction to Carbon neutral farm.

Practical

Identification of pests of high valued crops; Calibration of the spray material; preparation and installation of pheromones in crops; Preparation and application of composts, crop residue incorporation organic products manures and bio-pesticides and organic products; Practical demonstration of pest scouting in crops; Concept of carbon neutral farms. Field visits.

Text Book

1. Lichtfouse, E. M. Nanarrete, B. Debacke, and V. Souchere. 2009. Sustainable Agriculture. Springer, The Netherland.

Suggested Readings

1. Niir, B. 2004. The Complete Technology Book on Bio-Fertilizer and Organic Farming. National Institute of Industrial Research, India.
2. William, L. 2007. Organic Farming an International History. CAB International, UK.
3. Eric, L. 2009. Organic Farming, Pest Control and Remediation of Soil Pollutants. Springer Dordrecht Heidelberg London New York, USA.
4. Trivedi, P.C. 2011. Organic farming for sustainable Agriculture. Aavishkar Publishers, Distributors. Jaipur (Raj) India.

AGRON-510 Crop Growth Modeling and its Application in Agriculture (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Learn basic concepts of crop modeling and system modeling approaches
- Educate about the structure of crop model and development of a simple model for crop prediction

- Train the students for application of different crop growth models for crop improvement

Learning Outcomes:

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

Sr	CLOs	Domains	PLOs
1	Understand concepts and significance of crop modeling, and components of a model	Cognitive	1
2	Know about minimum data require for analysis of growth parameters of crop	Cognitive	1
3	Application DSSAT and APSIM crop model for yield predictions	Psychomotor	2, 7

SDGs Addressed in the Course:

Goal 4: Quality education

Goal 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

History and introduction of crop growth modeling; Fundamental concepts of crop modeling, their importance and uses; System analysis and dynamic modelling; Introduction to decision support system for agro-technology transfer; Components of a model, input data set for different model; Development of a simple dynamic crop growth model, model calibration, evaluation, sensitivity analysis, climate change impact assessment; Modelling and crop improvement; Modelling a tool for future predictions. Crop modeling: A Pakistan perspective.

Practical

Demonstration and practice of crop growth models: Cropping system model DSSAT; Modeling framework of APSIM, how to development of a simple dynamic crop growth model by modelling and simulation software "Simile". Model application, Calibration, validation and sensitivity and climate change analysis.

Text Books

1. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.

Suggested Readings

1. Vohnout, K.D. 2003. Mathematical modeling for System Analysis in Agricultural Research. Elsevier Sci. Amsterdam, The Netherlands.
2. Wallach, D., D. Mackowski, J.W. Jones. 2006. Working with Dynamic Crop Models Evaluation, Analysis, Parameterization, and Applications. Elsevier Sci. Amsterdam, The

Netherlands.

- Singh, P. 2008. Modeling Crop Production Systems: Principles and applications. Science publishers. Enfield, New Hampshire 03784.USA.
- Floor, M.B. and M. van Ittersum. 2010. Environmental and Agricultural Modelling: Integrated Approaches for Policy Impact Assessment. Springer, Heidelberg, Germany.

AGRON-511 Global Agriculture (E) 3(3-0)

Learning Objectives

The main objectives of the course are to:

- Introduce the concept of global agriculture
- Familiarize with intervention in agriculture system
- Acquaint with entry points for linkages with industries

Learning Outcomes

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

Sr	CLOs	Domains	PLOs
1	Explain the scenario of agriculture sector innovations at international level	Cognitive	1
2	Describe the infrastructure of global agriculture	Cognitive	1
3	Apply the knowledge of value added products at all stakeholder level	Psychomotor	2, 7

SDGs Addressed in the Course

Goal No. 4: Quality education

Goal No. 13: Climate action

Course Contents

Theory

Concept and issues in global agriculture; International agricultural development- a historical perspective; Recent interventions in agricultural production systems; Strategies for transformation from traditional to global agriculture; International agricultural system and its subsidiaries, Sister organizations and centre with their respective mandate; Emerging issues related to internationalization of agriculture; A look into global agri-food industries and markets.

Text Book

- Reddy, T.Y. and G.H.S. Reddy. 2002. Principles of Agronomy. 3rd Edition, Kalyani Publishers, New Delhi, India.

Suggested Readings

- Brase, T. 2006. Precision Agriculture. Thomson Delmar Learning, New York, ISBN 13:978-1-4018-8105-4.
- Lo, C.P. and Yeung, A.K.W. 2007. Concepts and Techniques in Geographic Information Systems, Second Edition. Pearson Prentice Hall.
- Pillarsetti, J.R., R. Lawrey and A. Ahmad. 2013. Multifunctional Agriculture, Ecology and

AGRON-512 Eco-Physiological Aspects of Weeds (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Familiarize the student with the concept of weed-crop ecology
- Inculcate the knowledge of eco-physiological aspects of weeds and their impact on crop production
- Train the students to integrate the ecological learning for weeds management

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Understand the basic concept of weed-crop ecosystem	Cognitive	1
2	Explain the eco-physiological aspects and environmental interaction of weeds	Cognitive	1, 2
3	Evaluate the competitiveness of weeds in changing climate	Cognitive	1, 2
4	Apply practical knowledge of weed-crop competition and its economics	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 4: Quality education

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Human influences on weed ecology, Weed-crop ecosystem, Environmental interactions, Fundamental ecological concepts, Plant competition, plant characteristics & competitiveness, Relationship between weed density & crop yield; Magnitude of competitive loss; Duration of competition, Economic analysis; Weed seed dormancy, germination and seedling establishment in ecological perspective; Weed reproduction & dispersal; Weed ecology and biology in a changing climate; Ecology of weed diversity and composition; Ecological foundation for sustainable weed management; Managing agro-ecosystem vulnerability to weeds; Ecological principles for sustainable weed management; Ecological approaches to benefit agro-ecosystem

Practical

Techniques to study weed-crop competition; Bioassay study of weeds; Techniques to study weed dormancy under varying ecological optima; Economic analysis of weed-crop competition.

Text Book

1. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.



SUGGESTED READINGS

1. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
2. Walia, U.S. 2003. Weed Management. Kalyani Publishers, New Delhi – 110 002.
3. Zimdahl, R. 2013. Fundamentals of Weed Science. 4th Ed. Academic Press, USA.
4. Ziska, L.H. and J.S. Duke. 2011. Weed Biology and Climate Change. Wiley Blackwell, Hoboken, N.J, USA.

AGRON-513 Fodders and Forages (E) 2(1-1)

Learning Objectives

The main objectives of the course are to:

- Enhance the skills of students for production of fodders and its preservation.
- Familiarize the students with pastures and rangeland management.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Understand the basics of forage and fodder production	Cognitive	1
2	Elaborate the principles of sustainable forage production	Cognitive	1, 2
3	Demonstrate the qualitative parameters of legume and non-legume fodders	Cognitive	1, 4
4	Apply acquired knowledge for hay and silage preparation	Psychomotor	2, 7

SDGs addressed in the course

Goal No. 1: Decent work and economic growth

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

Importance of forages and fodders with respect to changing climate; Terminology and taxonomy of forage and fodder crops; Comparison of legume and non-legume forages; Rangeland and pastures; Types of pastures; Agro-techniques for production of legume/non-legumes forages and fodders for sustainable forage production; Factors affecting chemical composition and nutritive value of forages (biotic and abiotic factors); Constraints in fodder seed production (research, multiplication, adaptability, farmer practices, market and storage); Hay and silage, making and their storage;

Different types of additives for nutritional improvement; Factors affecting silage making, causes of silage toxicity, comparison of different feed sources; Silage and hay feeding requirements for livestock.

Practical

Identification of fodder/forage crops and seed; Estimation of sprout density and plant population; Silage and hay making practices; Preparation of fodder calendar; Legume inoculation; Forages nutritional status; Nutrient requirements for livestock; Forage toxicity; Forage nutritional improvement techniques and methods; Determination of forage quality parameters.

Text Book

1. Singh, A.K., M.A. Khan, N. Subash and K.M. Singh. 2011. Forages and Fodders. Daya Publishing House, Delhi, India.

Suggested Readings

1. Martin, J.H., R.P. Waldern and D.L. Stamp. 2006. Principles of Field Crop Production. 4th ed. Pearson- Prentice Hall, Ohio, USA.
2. Mukherjee, A.K. and S.Maiti. 2009. Forage Crop Production and Conservation. Kalyani publishers, New Delhi, India.
3. Reddy, D.V. 2006. Fodder Production and Grassland Management for Veterinarians. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Singh, J.V., B.S. Chhilar, B.D. Yadav and U.N. Joshi. 2010. Forage Legumes. Scientific Publishers, Jodhpur, India.

AGRON-514 Layout of Field Experiments (E) 2(0-2)

Learning Objectives

The main objectives of the course are to:

- Educate about the experimentation and selection of appropriate experimental design
- Familiarize the students with layout of field experiments
- Train the students for statistical analysis of the data and interpretation of the results

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Describe the basic knowledge and skill of planning an experiment	Cognitive	1
2	Plan and perform design and layout of experiments	Psychomotor	1, 2
3	Implement the experimental treatments and record pertinent data and analyze the same	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 4: Quality education

Goal No. 8: Decent work and economic growth

Teaching Mode: Blended learning

Course Contents

Practical

Scientific method and logical steps in scientific experimentation; Cause and effect relationship; Field Experiments- concept, importance and their uses in Agronomy; Layout plan, plot types, computing net and gross plot sizes; non-experimental area, Nature of field trials – fertilizers, crop/ variety tests, irrigational, etc.; Lay-out designs and their suitability under varying conditions; criteria for site selection; factors affecting use and criterion for number of replicates; Basic statistical concepts for hypothesis testing; Classification of designs - Paired Plot Design; Completely Randomized Design; Randomized Complete Block Design; Latin Square Design; randomization and its methods; Layout of experiments in the field following different designs; Demonstration of randomization in the field; Working out the quantities of inputs on experimental unit basis; Sampling and data recording; Data compilation, processing and presentation.

Text Books

1. Clewer A.G. and D.H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, Ltd. Chichester, England.

Suggested Readings

1. Gerber, A.S. and D.P. Green. 2012. Field Experiments: Design, Analysis, and Interpretation. W.W. Norton. Ney York.
2. Gupta, V.K., R. Parsad and B.N. Mandal. 2015. Significance of Experimental Designs in Agricultural Research. ICAR-Indian Agricultural Statistics Research Institute Library Avenue, Pusa, New Delhi, India.
3. Hinkelmann, K. and O. Kempthorne. 2008. Design and Analysis of Experiments. Vol. I. Introduction to Experimental Design. John Wiley & Sons, New Jersey.
4. Muhammad, F. 2004. Statistical methods and data analysis. AbidUmair Printing Press, Faisalabad.

AGRON-515 Crop Management under Stressful Environments (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Familiarize with various concepts of stress and stressful environments
- Impart knowledge about various types of stress and their individual and interactive impact on plant development
- Acquaint with suitable agro-management practices for successful crop husbandry under different types of abiotic stresses

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Recognize and describe the linkage of plant physiological processes with morphological, ontogenetic and ecological factors.	Cognitive	1

2	Differentiate the influence of stressful abiotic factors in the environment (water, temperature, mineral nutrient disorders, light and pollutants) on the physiological processes in plants, as well as on their growth, development and yield formation.	Psychomotor	2,3,7
3	Manipulate stress indicators in plants by the analysis of phenotypic and biochemical parameters and suggest pragmatic strategies to confer stress tolerance	Psychomotor	2, 3, 7

SDGs addressed in the course:

Goal No. 4: Quality education

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Components of crop productivity; Crop environment and its components; Environmental optima for crop growth and development; Concept of stress and stressful environments under field conditions; Types of biotic and abiotic stresses under field conditions; Modifications in growth and developmental patterns of crop plants under various stressful conditions, Oxidative stress and anti-oxidative defense systems in plants growing under abiotic stresses; Crop plant responses to rising CO₂ and climate change; Approaches for ameliorating the effects of stress for crop production.

Practical

Acquaintance with the symptoms of stresses on crop; Bioassays to ascertain the effect of abiotic stresses on crop growth and development; Visits to stress affected areas/fields and observing the patterns of vegetative and reproductive growth of crop plants.

Text Book

1. Pessaraskli, M.A. 2011. Hand Book of Plant and Crop Stress Physiology, CRC Press, NY, USA.

Suggested Readings

1. Fageria, N.K., V.C. Baligar and C.A. Jones. 2011. Growth and Mineral Nutrition of Field Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL., USA.
2. Hasanuzzaman, M., K.R. Hakeem, K. Nahar and H.F. Alharby (eds.). 2019. Plant Abiotic Stress Tolerance: Agronomic, Molecular and Biotechnological Approaches. Springer Nature, Switzerland.
3. Minhas, P.S., J. Rane, R.K. Pasala (eds.). 2017. Abiotic Stress Management for Resilient Agriculture. Springer Nature, Singapore.
4. Shabala, S. 2012. Plant Stress Physiology. CAB International. Cambridge, USA.

AGRON-516 Agro-technology of Special Crops (E) 2(1-1)

Learning Objectives

The main objectives of the course are to:

1. Familiarize the students regarding adaptation, identification, propagation and cultivation of selected condiments and spices crops.



2. Demonstrate methods for extraction of useful ingredients of condiments and spices.
3. Comprehend crop husbandry of condiments and spices crops with special emphasis on critical production factors.

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Explain the present status, economic importance, constraints and cultivation technologies of important condiments and spices crops	Cognitive	1
2	Describe the appropriate and sustainable production techniques of condiments and spices crops	Cognitive	1, 2
3	Identify and suggest possible solutions related to the agronomic practices, planting material production and profit-oriented marketing strategies of condiments and spices crops	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 2: Zero hunger

Goal No. 12: Responsible production and consumption

Teaching Mode: Blended learning

Course Contents

Theory

Concept and scope of condiments and spices; their classification and value addition; Production technology for: condiments (Chillies, onion, garlic, ginger and turmeric) and spices (Cumin seed, ajwain, fenugreek, fennel, black seed, coriander, mint and black cumin).

Practical

Identification of seed and crop plants; Identification of seeds and propagation materials of condiments and vegetables; Demonstration of sowing methods; Raising and transplanting of nursery; Demonstration and practice of harvesting, digging, picking and processing of different crops; Methods for extraction of useful ingredients of medicinal plants.

Text Book

1. Lenk, D. 2006. Commercial Spice Crops. Kalyani, Publishers New Delhi.

Suggested Readings

1. Altaf, Z. and A. Qarshi. 2013. Medicinal Plants. Qarshi Industries, Lahore.
2. Majeedano, H. I. 2012. Agro Digest. Agriculture Research Institute, Tandojam.
3. Tunio, S. D. 2004. Condiment Crops. Directorate of Agriculture Information, Hyderabad, Sindh.
4. Tunio, S. D. 2010. Vegetables and Spices of Sindh. Roshni Publication, Kandiaro.

AGRON-517 Water Relations of Crop Plants (E) 2(1-1)

Learning Objectives

The main objectives of the course are to:

1. Highlight the importance of water status in plant life
2. Develop understanding of physical and chemical characteristics of water affecting the physiological status of plants
3. Familiarize with mechanisms involved in water uptake through plant roots and stems

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Demonstrate the effects of environmental factors on the dynamics of water absorption by plants	Cognitive	1, 2
2	Understand the importance of water in plant growth and development	Cognitive	1
3	Implement the techniques and tools necessary to measure the plant water relations	Cognitive	2, 7

SDGs Addressed in the Course

Goal 13: Climate action

Goal 15: Life on land

Teaching Mode: Blended learning

Course Contents

Theory

Significance of plant water relations; role of water in plant functioning; prospective of water stresses; structure and properties of water; Root structure, root growth, environmental factors affecting root growth, root absorption of water; Passive absorption by transpiring plants; root pressure and osmotic absorption; Radial path way of water in roots; conducting systems in stem; cohesion theory; hydraulic lift; Leaf, stomatal resistance; Water potential gradients in the continuum; transpiration, effects of soil drying on leaf conductance, control of stomatal movements; Movement of water in the soil-plant atmosphere system.

Practical

Quantitative plant-water stress; Techniques for measurement of relative water content, water potential and pressure potential; Thermocouple psychrometer; Osmometer; Lysimeter; Measurement of potential evapotranspiration and water use efficiency; Methods of inducing water stress.

Text Book

1. Lambers, H., F.S. Chapin III and T.L. Pons. 2008. Plant Physiological Ecology. Springer-Verlag, Inc., New York, USA.

Suggested Books

1. Waisel, Y., Eshel, A., and Kafkafi, U. 2002. Plant Roots: The Hidden Half. 3rd Ed. CRC Press, Taylor and Francis LLC.
2. Kirkham, M.B. 2004. Principles of Soil and Water Relations, Academic Press, London.

3. Gregory, P.J. 2006. Plant Roots: Growth, Activity and Interaction with Soils. Blackwell Publishing Ltd. UK.
4. Ali. M.H. 2010. Fundamentals of Irrigation and On-farm Water Management: Volume 1. Springer Science Business Media, LLC 2010.



Learning Objectives

The main objectives of the course are to:

- Educate the students about concept of outreach
- Polish communication skills of students for effective extension and outreach of the subject matter.
- Promote agriculture journalism among students and role of social media in technology transfer

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Explain the concept of outreach	Cognitive	1
2	Describe the basic steps of communication	Cognitive	1, 4
3	Apply the acquired knowledge for outreach	Psychomotor	2, 4, 7, 10

SDGs addressed in the course:

Goal No. 4: Quality Education

Goal No. 8: Decent work and economic growth

Teaching Mode: Blended learning

Course Contents**Theory**

Introduction of outreach in Agronomy; Concept of Education; Various types of education and their characteristics; Theories and methods of instruction; Farmers as a learner and learner characteristics, evaluation of learning process; Agronomic extension methods; Individual contact methods: Farm visit, Office calls, informal contacts; Group contact methods: Method demonstration, contests, field trips and tours; Field day, informal discussion, symposium, seminar, workshop, discussion group; Mass contact methods: Print media; newspapers, newsletters, leaflets. Audio-visual media: radio, television, Static media; posters, exhibits, and displays; Recent trends in Agronomic extension teaching methodologies: teleconferencing, cyber extension. Participatory methods: critical incident, describing visual images, interviews, making puzzles; Participatory discussion, preference ranking, problem solving, two circle exercise and venn diagram.

Practical

Plan and conduct an evaluation and submit the evaluation report to the concerned teacher; Farmer field days, Advisory services; Writing of extension articles and blogs; Informational videos.

Text Book

1. Muhammad, S. 2005. Communication and Leadership Development. Unitech Communications, Faisalabad, Pakistan.

Suggested Readings

1. Memon, R.A. and E. Bashir. (Eds.). 1993. Extension Methods. National Book Foundation, Islamabad.

2. Huang, L.S. 2010. Academic Communication Skills: Conversation Strategies for International Graduate Students. Lanham, MD: University Press USA.
3. Rogers, A & N. Horrocks, 2010. Teaching Adults, 4th Ed. McGraw Hill Publishers, online available on www.openup.co.uk.

AGRON-519 Outreach in Agronomy-I (E) 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Polish communication skills of students for effective extension and outreach of the subject matter.
- Promote knowledge transfer, feedback, and research dissemination ability of graduate students.
- Introduce students with experiential and fact-based learning.

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Explain elements of communication process and their role in effective communication	Cognitive	1
2	Exhibit proficiency in written and oral communication for professional and non-professional audiences.	Cognitive	1, 4
3	Apply knowledge to comprehend and write effective reports, blogs, articles, emails, covering letters, design documentation, make effective presentations	Psychomotor	2, 4, 7

SDGs addressed in the course:

Goal No. 4: Quality Education

Goal No. 8: Decent work and economic growth

Teaching Mode: Blended learning

Course Contents

Theory

Concept, purpose, and scope of communication in agronomic extension and outreach; Communication process: Elements of communication process and their role in effective communication; Principles of communication; Communication models: Linear models, circular models and convergence models; Forms of communication: Interpersonal, intrapersonal and impersonal; Written, verbal and non-verbal communication; Improving communication skills: Writing, reading, speaking, and listening; Verbal message principles; Types of non-verbal expressions and their role in making communication effective; Conditions for communication success; Barriers to communication and measures to overcome these barriers; Group communication: Factors affecting group communication.

Practical

Each student will select agronomic extension method/project for evaluation; Plan and conduct an evaluation and submit the evaluation report to the concerned teacher; Participation in farmer conventions and outreach programs; Presentation for effective communication

Text Book

1. Huang, L.S. 2010. Academic Communication Skills: Conversation Strategies for International Graduate Students. Lanham, MD: University Press USA.

Suggested Readings

1. Memon, R.A. and E. Bashir. (Eds.). 1993. Extension Methods. National Book Foundation, Islamabad.
2. Rosengren, K.E. 2000. Communication: An Introduction. Sage Publication, London.
3. Swanson, B.E., R.P. Bentz, and A.J. Sofarranco, 1997. Improving Agricultural Extension: A Reference Manual, FAO, Rome, Italy.

FME-503 Fundamentals of Precision Agriculture 2(2-0) (E)**Learning Objectives:**

The main objectives of the course are to:

- Educate about principles and applications of technologies supporting precision farming.
- Acquaint the students about variable rate technologies.
- Enable the students to manage agri-inputs based on data management and IoT.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Explain the basic concepts of irrigation systems, farming systems, precision farming, global positioning system, remote sensing, and satellite.	Cognitive	1
2	Analyze the crop health using crop, soil and nutrient mapping obtained from remote sensing technologies	Cognitive	2
3	Identify individual elements of the precision farming system	Cognitive	1, 2
4	Evaluate the effects of variable rate technology on crop health using crop, soil and nutrient mapping obtained from remote sensing technologies for development of decision support systems	Psychomotor	2, 3

SDGs addressed in the course:

Goal No.8: Decent work and economic growth

Goal No.12: Responsible consumption and production

Teaching Mode: Blended learning

Course Contents

Theory

History and introduction of precision agriculture (PA): Basics of precision agriculture, tools for implementation PA; current status, uncertainties, future trends, constraints in the adoption of PA and site-specific management technologies; Sensing technology for precision crop farming; Basis of precision agriculture, spatial location, basics of GPS, information acquisition sensors, crop condition, weed detection, grain yield and quality, Assembling and interpreting information, application and control, patch spraying, fertilizers; Data processing and Utilization in PA; Control of PA production; Intelligent agricultural machinery and field robots; precision agriculture in large scale mechanized farming; Soil sensors for PA; Site specific nutrient management (SSNM); Precision water management; Site specific weed management; Site specific crop diseases management.

Text Book

1. Zhang, Q. 2016. Precision Agriculture Technology for Crop Farming. Taylor & Francis, FL, USA.

Suggested Readings

1. Stafford, J.V. 2000. Implementing precision agriculture in the 21st century. Journal of Agricultural Engineering Research 76(3): 267-275.
2. Stafford, J., and A. Werner (Eds.). 2003. Precision Agriculture. Wageningen Academic Publishers.
3. Hamrita, T.K., J.S. Durrence and G. Vellidis. 2009. Precision Farming Practices. IEEE Industry Applications Magazine, 15(2): 34-42.
4. Kent Shannon, D., D.E. Clay and K.A. Sudduth. 2018. An Introduction to Precision Agriculture. Precision agriculture Basics, American Society of Agronomy and Soil Science Society of America. 1-12.

AGRON-601 Medicinal and Special Crops 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Inculcate the students with importance and uses of medicinal and special purpose crops
- Familiarize the students with agro-technology of medicinal and special crops

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Understand the economic importance and status of medicinal and special crops	Cognitive	1
2	Grow and manage special and medicinal crops on commercial scale	Cognitive	2
3	Apply postharvest value addition of medicinal crops	Psychomotor	2, 7

SDGs addressed in the course:

Goal No. 2: Zero hunger

Goal No. 3: Good health and well being

Goal No. 4: Quality education

Teaching Mode: Blended learning

Course Contents

Theory

Economic importance, origin, history, adaptation, distribution and production technology of medicinal and special purpose crops-tea, mint, aloevera, jojoba, castor bean, jatropha, safflower, poppy, tobacco, indigo, fennel, ajwain, fenugreek, ispaghol, sesame, balangu, blackseed, clusterbean, quinoa, durum wheat, prosomillet, olive, stevia, buckwheat, jute, tulsi and linseed; Integrated pest management and precision farming for special and medicinal crops; Processing; Postharvest technology; Products; Utilization and marketing of medicinal crops.

Practical

Identification of seed and crop plants; Demonstration of improved sowing methods. Studies on phenological development of crops. Optimization of growing media for medicinal and special purpose plants; Methods for extraction of useful ingredients of medicinal plants.

Text Book

1. Altaf, Z. and A. Qarshi. 2013. Medicinal Plants. Qarshi Industries, Lahore.

Suggested Readings

1. Narayan, D.P., S.S. Purohit, A.K. Sharma and Tarun, K. 2003. A Handbook of Medicinal Plants. Agrobios, India.
2. Ravindra, S. 2004. Agro-Techniques of Medicinal Plants. Daya Publishing House, New Delhi, India.
3. Martin, J.H., R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production, 4th Ed., the MacMillan Co., New York, USA.
4. Palaniappan, and K. Annadurani. 2006. Organic Farming; Theory and Practice. Scientific Publishers, Jodhpur, India.

Learning Objectives

The main objectives of the course are to:

1. Educate the students about biological crop potential and agro-physiological factors limiting yield potential of crops
2. Elaborate agronomic measures to harness maximum yield potential of crops
3. Impart knowledge about ecological optima in relation to crop productivity.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Understand modern concepts of biological crop potential	Cognitive	1
2	Establish the relationship between agro-physiological factors and potential yield of crop	Cognitive	1
3	Collect and analyze the data of growth parameters of crop and examine the determinants of crop growth	Psychomotor	2, 7
4	Construct the relationship between crop production and environment	Psychomotor	2, 3, 7

SDGs Addressed in the Course:

Goal No. 12: Responsible consumption and production

Goal No. 13: Climate Action

Teaching Mode: Blended learning

Course Contents

Theory

Concept of biological crop potential; Agro-physiological factors limiting yield potential of crops; Ecological optima in relation to crop productivity; Blackman's principle of limiting factor; Determinants of crop growth; Solar radiation effects on crop production; Components of plant leaf area expansion, crop canopy development, canopy architecture and interception of solar radiation; Potential for increasing photosynthetic efficiency; Photosynthesis and dry-matter partitioning; Source-Sink relationships; Sink strength as a determinant of dry matter partitioning in the whole plant; Formation of economic yield; Modern agro-physiological techniques for harvesting maximum potential of field crops; Crop plants in relation to environment; Crop yield potential, yield trends, and global food security in a changing climate.

Practical

Collection of data pertaining to actual and potential yields of various crops/varieties; Determination of leaf area and dry weight of field crops to calculate relative growth rate, net assimilation rate, etc. Determination of leaf area index, leaf area duration and harvest index of various field crops. Comparative illustrations of growth stages of different field crops using Feekes, and Zadoks scales

TEXTBOOKS

Fageria, N. K. VB.C. Baligar, R.B. Clark and R. B. Clark. 2006. Physiology of Crop Production. Haworth Press, USA.

SUGGESTED READINGS

1. Smith, D.L. and C. Hamel. 1999. Crop Yield: Physiology and Processes. Springer-Verlag Berlin, Germany.
2. Hay, R.K.M. and J.R. Porter. 2006. The Physiology of Crop Yield, 2nd Edition. Wiley-Blackwell, Oxford, UK.
3. Sadras, V.O. and D.F. Caldreni. 2009. Crop Physiology: Applications for genetic improvement and agronomy. Academic Press, USA.
4. Connor, D.J, R.S. Loomis and K.G. Cassman. 2011. Crop Ecology: Productivity and Management in Agricultural Systems. 2nd edition. Cambridge University Press, New York, USA.

AGRON-605

Conservation Agronomy

3(2-1)

Learning Objectives

The main objectives of the course are to:

- Elaborate the concept of soil and water conservation for sustaining environment and crop productivity.
- Impart awareness to students for using the diminishing resources in most profitable way on sustainable basis.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Describe the concept of soil and water conservation for sustaining productivity	Cognitive	1
2	Manage the shrinking resources in most profitable way on sustainable basis	Psychomotor	2
3	Apply the acquired knowledge for water shed, crop residues and soil fertility management	Psychomotor	2, 3, 7

SDGs addressed in the course:

Goal No. 12: Responsible consumption and production

Goal No. 13: Climate action

Goal No. 15: Life on land

Teaching Mode: Blended learning

Course Contents

Theory

Concept and objectives of soil and water conservation; Soil erosion: types and management; Agronomic practices for conservation-tillage (contouring, terracing, benching, leveling, grading, deep ploughing, etc.); Species selection; Crop rotations; Cover cropping; Strip cropping; Farmyard and green manuring for conservation; Stubble and crop-residue management for resource conservation; Field drainage; Watershed management under rainfed conditions; Crop residue management; Water

harvesting.

Practical

Demonstration of soil water conservation structures; Effect of different mulches; Demonstration of mulching techniques; Demonstration of tillage practices for soil and water conservation; Measurement of runoff and soil erosion; Visit to different soil and water conservation centers/institutes.

Text Book

1. Farooq, M and K.H.M. Siddique. 2015. Conservation Agriculture. Springer International Publishing Switzerland.

Suggested Readings

1. Bennett, H.H. 2003. Soil Conservation for Sustainable Agriculture Agrobios, Jodhpur 342002, India.
2. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Dehli, India.
3. Chandrasekaran, B.K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Publishers. New Delhi, India.
4. Oweis, T.Y., D. Prinz and A.Y. Hachum. 2012. Water harvesting for agriculture in the dry areas. CRC Press. Balkema, Netherlands.

AGRON-607 Environment and Crop Production 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Familiarize the students with basic concepts of environmental factors affecting the crop productivity.
- Impart the understanding of the physiology of plants' adaptation to their environment for sustainable crop production.
- Provide knowledge about physiological basis for crop production and management practices.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Understand of crop-environment relationship for better crop production	Cognitive	1
2	Demonstrate physiological processes involved in regulation of crop growth and development	Psychomotor	2, 3
3	Integrate crop physiological approaches to solve problems related to crop production	Psychomotor	2, 7



SDGs Addressed in the Course

Goal No. 4: Quality education

Goal No. 13: Climate action

Teaching Mode: Blended learning**Course Contents****Theory**

Concept of environment and environmental physiology; Classification of environment; The aerial environment; Analytical framework for studying the influence of different environmental factors (i.e. radiation, temperature, water, wind, vapor pressure, etc.) on crop growth processes such as photosynthesis, respiration, and transpiration; Evapotranspiration; Water use efficiency; Greenhouse effect on crop production; Agronomic techniques for yield improvement in different environmental conditions.

Practical

Measurements and estimation of different environmental variables; Calculation of potential transpiration rate; Determination of stress tolerance index; Measurement of plant physiological processes under stressful conditions.

Text Books

1. Pessaraki, M. 2014. Handbook of Plant and Crop Physiology. 3rd Ed. CRC Press Inc., New York, USA.

Suggested Books

1. Fitter, A.H. and P.K.M. Hay. 2001. Environmental Physiology of Plants. 2nd ed. Academic Press Inc., London, UK.
2. Jenks, M.A. and Hasegawa, P.M. (eds.). 2005. Plant Abiotic Stress. Blackwell Publishing. USA.
3. Lambers, Hans, F. Stuart Chapin III, and Thijs L. Pons. 2008. Plant Physiological Ecology. Springer Science & Business Media, New York, USA.
4. Sheaffer, C.C. and K.M. Monca. 2011. Introduction to Agronomy Food, Crops and Environment. 2nd ed. Delmar, Cengage Learning, USA.

AGRON-609 Application of Allelopathy in Agriculture E (1-1)

Learning Objectives

The main objectives of the course are to:

- Develop the concept of different aspects of allelopathy.
- Enhance the understanding of allelopathic interactions.
- Discuss possible role of allelopathic phenomenon in agroecosystem management.

Learning Outcomes

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

Sr	CLOs	Domains	PLO
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1	Explain the influence of allelopathic interaction on plant growth and crop yield	Cognitive	1
2	Describe the allelopathic phenomena and its utilization for sustainable crop production	Cognitive	3
3	Apply the acquired allelopathic knowledge in agroecosystem management	Psychomotor	7

SDGs Addressed in the Course:

Goal No. 3: Decent work and economic growth

Goal No. 4: Quality Education

Goal No. 13: Climate Action

Teaching Mode: Blended learning

Course Contents

Theory

Definition and history of Allelopathy; Allelopathic interactions; Pathways for release of allelochemicals; Allelopathic residues and their management; Effect of allelochemicals on nutrient uptake, germination of weeds and crops on soil, microorganism; Role of allelopathy in agroecosystems; Allelopathy for sustainable pest management; Possible use of allelopathic natural products; Allelopathic research in Pakistan.

Practical

Identification of allelopathic plants, weeds, crops; Allelopathic bioassays to demonstrate allelopathic interactions among different organisms including microbes, weeds, crops, trees.

Text Book

1. Macias, F.A., C.G. Galindo and J.M. G. Molinillo. 2003. Allelopathy: Chemistry and Mode of Action of Allelochemicals. CRC Press, New York, USA.

Suggested Readings

1. Kohli, K.R., H.P. Singh and D. R. Batish. 2004. Allelopathy in Agroecosystems. IDBC Lucknow, India.
2. Reigosa, M. J., N. Petdrol and L. Gonzalez. 2006. Allelopathy: A physiological process with ecological implications. Springer, Heidelberg, Germany.
3. Zeng, R.S, A.U. Mallik and S.M. Luo. 2008. Allelopathy in Sustainable Agriculture and Forestry. Springer, USA
4. Cheema, Z.A., M. Farooq and A. Wahid. 2013. Allelopathy: current trends and future applications. Springer, New York, USA.

AGRON-611 Preparation of Research Project and Scientific Writing 2(1-1)

Learning Objectives

The main objectives of the course are to:

1. Guide the students to develop and improve skills in scientific writing and research methodology.
2. Teach various concepts of scientific communication and learn about types of scientific

publications.

3. Prepare and organize scientific work for presenting to scientific community while following publication ethics.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Describe the concept of scientific method and main features of scientific writing	Cognitive	1
2	Distinguish among various forms of scientific communication and discuss the function, structure and writing style of each element of scientific publications	Cognitive	1
3	Practice the academic integrity, honesty and ethics of scientific writing	Affective	5, 7, 10, 12
4	Exhibit proficiency in written and oral communication for professional and non-professional audiences	Psychomotor	4, 5, 8

SDGs Addressed in the Course:

Goal No. 4: Quality education

Goal No. 8: Decent work and economic growth

Goal No. 17: Partnerships for the goals

Teaching Mode: Blended learning

Course Contents

Theory

The concept of science and scientific method; Reading skills; The concept, purpose and kinds of research; Types of Scientific Communication; Collection and organizing source materials; Searching and reviewing the literature and preparing bibliography; The techniques of composition: rules of scientific writing; Organization of a Research Paper: The IMRAD format; Writing thesis, scientific papers, and project reports; Presenting data: Tables and Figures; Language Pitfalls: Native versus Non-native English speakers; Numbers, Units, Dates, Abbreviations, Nomenclature; Words and sentences; Manuscript preparation, submission, and follow-up; Writing research proposals; Preparation of PC forms; Oral and Poster presentations; Scientific misconduct and publication ethics; Plagiarism, its types and testing methods; Policy of HEC on plagiarism.

Practical

Exercise of scientific writing and research proposal, Exercise of collecting material from different sources on assigned topics, oral presentations. Using Track Change in MS word for editing drafts. Use of reference managers, Endnote, Mendeley and Turnitin software.

Text Book

1. Nair, P.K.R. and V.D. Nair. 2014. Scientific Writing and Communication in Agriculture and Natural Resources. Springer International Publishing, Switzerland.

Suggested Readings

1. Lindsay, D. R. 2011. Scientific writing = thinking in words. CSIRO Publishing, Collingwood, Australia.
2. Margaret Cargill and Patrick O'Connor. 2013. Writing Scientific Research Articles Strategy and Steps. Wiley-Blackwell, West Sussex, UK.
3. Blackwell, J. and J. Martin. 2011. A Scientific Approach to Scientific Writing. Springer-Verlag New York, USA.
4. Brookshire, R.H. and S.B. Brundage. 2016. Writing Scientific Research in Communication Sciences and Disorders. Plural Publishing, Inc., San Diego, California, USA.

AGRON-613**Plant and Soil Analysis (E)****2(1-1)****Learning Objectives:**

The main objectives of the course are to:

- Acquaint with the basic concepts of plant and soil analysis
- Familiarize with the analytical methods used in the laboratory for sample analysis
- Appraise the nutrient status of the soil and plan a nutrient management program for sustainable crop production

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Assess level of nutrients availability in the soils	Cognitive	1
2	Integrate inputs and techniques used for sample analysis	Psychomotor	2, 7
3	Devise recommendations of nutrient management based on soil and plant analysis	Psychomotor	2, 7

SDGs Addressed in the Course:

Goal No. 4: Quality education

Goal No. 8: Decent work and economic growth

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning

Course contents**Theory**

Various concepts of soil and plant analyses; Soil analysis; objectives and categories; Soil sampling procedures and phases involved in soil testing; Plant analysis; concepts and facts; Sampling; Sample

preparation and processing; Solutions and their types; Standard curve; Dry ashing and wet digestion; Determination of soil reaction and conductivity; Determination of soil organic matter content; Determination of soil moisture content; Laboratory safety rules; Quality control and data handling in the laboratory.

Practical

Demonstration of analytical methods in the laboratory, recording data, computation work and recommendations; Preparation of solutions of known concentrations; molar, percent, ppm and dilute solutions etc.; Nitrogen determination by Kjeldahl method; Determination of potassium and phosphorus.

Text Book

1. Ryan, J., G. Estefan and A. Rashid. 2001. Soil and Plant Analysis Laboratory Manual. 2nd Ed., ICARDA, Aleppo, Syria and NARC, Islamabad, Pakistan.

Suggested Readings

1. Benton, J. Jr. 2001. Laboratory guide for conducting soil tests and plant analysis. CRC Press, London.
2. Basak, R.K. 2004. Soil testing and recommendation. Kalyani Publisher, New Delhi.
3. Estefan, G., Sommer, R. and Ryan, J., 2013. Methods of soil, plant, and water analysis. A manual for the West Asia and North Africa region, 3.
4. Singh, D., P.K. Chhonkar and B.S. Dwivedi. 2013. Manual on soil, plant and water analysis. Westville Publishing House. New Delhi.

AGRON-615 Farming Systems and Record Management 3(2-1)

Learning Objectives

The main objectives of the course are to:

- Develop the concept of farm management and need for maintenance of farm records.
- Enhance skills of students for analysis of productivity of a farm and efficient utilization of available resources.
- Train the students about maintaining farm records.

Learning Outcomes

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

Sr. No.	CLOs	Domain	PLOs
1	Understand the fundamental principles of farming system and types of farming	Cognitive	1
2	Describe the concept of farm management and maintenance of farm records	Cognitive	1
3	Identify and Solve the problems of a farm and efficient utilization of available resources	Psychomotor	1, 2
4	Apply the acquired knowledge for economic management of	Psychomotor	2, 7

SDGs addressed in the course

Goal No. 4: Quality Education

Goal No. 8: Decent work and economic growth

Goal No. 12: Responsible consumption and production

Teaching Mode: Blended learning**Course contents****Theory**

Concept of farm management and maintenance of farm records; Definition and fundamental principles of farming; System and types of farming; Objectives and advantages of keeping farm records; Different systems of book keeping; Principles of double entry system and their application; Journal and Ledger: objectives, classification of accounts, drawing ledger, opening, posting and closing of ledger accounts; Cash book; Drawing up a trial balance; Profit and loss account/income statement; Bank accounts; Bank cheques, discount, interest, bad debts; Valuation and depreciation: live and dead stock, land and buildings, plant and machinery.

Practical

Training in maintenance of crop, livestock and dead stock registers; Preparation of a balance sheet and different types of accounts; Calculation of valuation and depreciation of different farm assets; Working out cost of production of major crops; Layout of farms and demonstration plots.

Text Book

1. Johl, S.S. and T. R. Kapur. 2016. Fundamentals of Farm Business. Kalyani Publishers, India.

Suggested Readings

1. Ghani, M. A. and E. Ahmad. 2000. Principles of Accounting. Pak. Imperial Book Depot, Chowk Urdu Bazar, Lahore.
2. Shresther, A. 2003. Cropping System. Food products Press. An imprint of the Haworth Press Inc., USA.
3. Moses, B. and Carson. 2009. Book Keeping and Accounts for Beginners. Custom Books, India.
4. Wood, F. and S. Robinson 2009. Book Keeping and Accounts. 7th Ed. Trans-Atlantic Publication Inc. India.

AGRON-617

Spate Irrigated Agriculture E

3(2-1)

Learning Objectives

The main objectives of the course are to:

- Familiarize the students about the potential resources for improved agricultural productivity in spate irrigated areas.

- Acquaint the students with water conservation practices in hill torrent affected areas.
- Familiarize the students with spate irrigated ecologies to exploit its potential for improved productivity.

Learning Outcomes

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

Sr. No.	CLOs	Domains	PLOs
1	Elaborate the potential of spate irrigated agriculture	Cognitive	1
2	Judiciously use rain water	Psychomotor	2, 3
3	Apply the acquired knowledge of crop production under spate irrigated systems	Psychomotor	7

SDGs addressed in the course:

Goal No. 2: Zero hunger

Goal No. 12: Responsible production and consumption

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course Contents

Theory

Spate irrigation: concept and facts; Spate irrigation in World and Pakistan; Hill torrents in Pakistan: Problems and potential, Sedimentation and soil fertility; soil and water conservation techniques in spate irrigated areas (mulching, cover cropping, strip cropping); Cropping pattern and cropping intensity; crop yield comparison and economic analysis; Agronomic management of crops; Crop selection: Minor crops; Livestock and fodder production in spate irrigated area; Irrigation Water Rights (Diversion / distribution of water in spate irrigation); Groundwater recharge and farm ponds; Water harvesting techniques; Effect of climate change on spate irrigation.

Practical

Comparative investigations into water conservation techniques under spate irrigation; Determination of soil infiltration rate; Determination of soil water holding capacity; Field visit to spate irrigated area.

Text Book

1. Khan, R.S., K. Nawaz, F.V. Steenbergen, A. Nizami and S. Ahmad. 2014. The dry Side of the Indus – Exploring Spate Irrigation in Pakistan, Lahore Pakistan. ISBN: 978-94-90792-03-9.

Suggested Readings

1. Anonymous. 2010. Guidelines on Spate Irrigation. FAO Rome, Italy.
2. Farooq, M. and K.H.M. Siddique. 2016. Innovations in dry land agriculture. Springer International Publishing AG, Switzerland.

3. Practical Notes Spate Irrigation Number 03. Improving soil diversion Bunds. Spate Irrigation Network, Pakistan.
4. www.spate-irrigation.org

AGRON-619 Introduction to Digital Agriculture 3(2-1) (E)

Learning Objectives

The main objectives of the course are to:

- Educate the students about basics of innovative digital agriculture technologies (DATs).
- Acquaint with underlying processes in digital technologies focus on agricultural issues and challenges related to precision management
- Develop and apply simple decision support system (DSS) for better utilization of resources for agriculture.

Learning Outcomes

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

Sr.	CLOs	Domains	PLOs
1	Understand core concepts of DATs in agriculture focus on case study and potential impacts	Cognitive	1, 5
2	Develop and apply digital tools and DSS in agriculture to understand the basic processes in the agricultural system	Psychomotor	2, 5
3	Apply the basic knowledge of ICT and digital technologies for better resource utilization in agriculture	Psychomotor	2, 3 7

SDGs Addressed in the Course

Goal No. 4: Quality education

Goal No. 8: Decent work and economic growth

Goal No. 13: Climate action

Teaching Mode: Blended learning

Course contents

Theory

Overview and basics concepts of digital and information communication technologies (ICTs) and decision support systems (DSS) for agriculture. Understanding of innovative and latest digital technologies including sensors, unmanned aerial vehicle (UAVs) robotics, communication networks, artificial intelligence, machine learning, and big data analysis tools for agriculture and sustainable crop production. Introduction and basic concepts of bioinformatics, and phenotyping, and other innovative latest digital tools. ICT and digital tools for enhancing farm productivity. Understanding the basic components of a simple digital tool and mobile apps for agronomic data collection.

Practical

Demonstration of the latest digital tools for agriculture and decision-making. Understanding and concept for the development and application of a decision support system for agronomic management (sowing time and irrigation) and crop management data collection by mobile apps and decision making in agriculture. Weather and crop monitoring system. Weather forecast tools and application in agriculture. Project design, working, and submission of the report.

Textbook

- 1- Singh, G. and G.Kaur. "Digital Technologies for Smart Agriculture." Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, Tomar, P. and G.Kaur (Eds.), IGI Global, 2021, pp. 54-67. <http://doi:10.4018/978-1-7998-1722-2.ch004>

Suggested Readings

- 1- Kishor, K.P.B., R. Bandopadhyay and P. Suravajhala (eds.). 2014. Agricultural Bioinformatics. Springer, New Delhi, India.
- 2- Normanly, J. 2012. High-Throughput Phenotyping in Plants: Methods and Protocols. Humana Press, Springer New York, USA.
- 3- Bouwman, H., B. van den Hooff, L.van de Wijngaert & J. van Dijk. 2005. Information and Communication Technology in Organizations: Adoption, Implementation, Use and Effects. SAGE Publications Ltd. London, UK.

