

**CURRICULUM**  
**OF**  
**AGRONOMY**  
**BS/BSc/MS/MSc (Hons)/PhD**

**(Revised 2014)**



**HIGHER EDUCATION COMMISSION**  
**ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

Prof. Dr. Mukhtar Ahmed

Mr. Fida Hussain

Mr. Rizwan Shoukat

Mr. Abid Wahab

Mr. Riaz-ul-Haque

Chairman, HEC

Director General (Acad)

Deputy Director (Curr)

Assistant Director (Curr)

Assistant Director (Curr)

## CONTENTS

1.	Introduction	07
2.	Standardized Template for 4 years BS/MSc (Hons.) Agriculture	12
3.	Scheme of Studies for BS/BSc (Hons.) Agronomy	13
4.	Details of courses for BS/BSc (Hons.)	14
5.	Scheme of Studies for MS/MSc (Hons.)/PhD	37
6.	Detail of course for MS/BSc (Hons.)/PhD	38
7.	Annexure-I	60
8.	Annexure compulsory courses	72
9.	Recommendations	90

## PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “**Supervision of Curricula and Textbooks and Maintenance of Standard of Education**”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

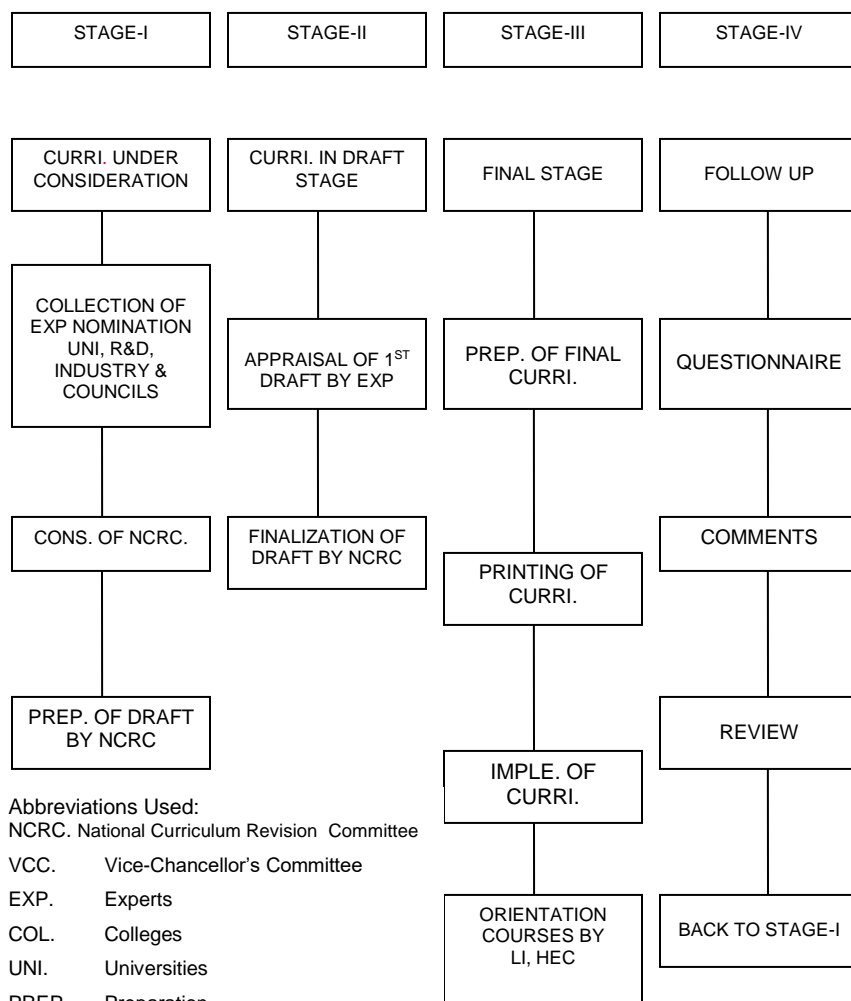
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC ([www.hec.gov.pk](http://www.hec.gov.pk)).

**(Fida Hussain)**  
**Director General (Academics)**

## CURRICULUM DEVELOPMENT PROCESS



**Abbreviations Used:**

NCRC. National Curriculum Revision Committee

VCC. Vice-Chancellor's Committee

EXP. Experts

COL. Colleges

UNI. Universities

PREP. Preparation

REC. Recommendations

LI Learning Innovation

R&D Research & Development Organization

HEC Higher Education Commission

## **RATIONALE OF DEGREE PROGRAMME IN AGRONOMY**

Achieving sustainability in food grain production and food security, in its totality, continues to be a challenge in the developing world including Pakistan. The produce of green revolution, we are harvesting now, seems to be saturated in terms of genetic potential. Over the past two decades, global food production has trebled, largely because of advances in agronomy.

The major challenges to sustainable food grain production in Pakistan include availability of quality seed, declining soil health, fragile cropping systems, looming water crisis, environmental degradation owing to indiscriminate use of farm chemicals, post harvest losses, minimal value addition and product differentiation, inadequate food storage and preservation, and poor marketing system. The imperative need, therefore, is to address these issues more forcefully in order to tap the considerable productivity potential of the agriculture sector through resource conservation.

The objective of the education and training in Agronomy is to generate, integrate, and apply knowledge about crop plants that are grown for food, feed, fiber and the general benefit of people. Education and training programs in agronomy (at under graduate, post graduate and PhD level) aim at developing trained human resource base who conduct basic and applied research in various aspects of crop production and soil management under varying agro-ecological and socio-economic conditions of the farming community. The graduates majoring in agronomy help find and disseminate answers to problems, and discover opportunities concerning efficiency and sustainability of production systems by developing safe and environmentally-sound practices. Manpower so trained serves in different capacity providing advisory services to farmers, NGOs and the relevant agro-based industry, impart short term training to farmers and in-service agri-personnel pertaining to latest developments in this field for better resource management and sustaining crop yields under changing environmental scenario.

**MINUTES OF THE FINAL MEETING OF HEC  
NATIONAL CURRICULUM REVISION COMMITTEE  
FOR AGRONOMY HELD AT HEC RC LAHORE  
FROM FEBRUARY 17-19, 2014**

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Agronomy was held from February 17-19, 2014 to finalize the preliminary draft of Agronomy for BSc (Hons) & Postgraduate programmes, prepared in its meeting held from November 27-29, 2013 at Karachi. The following members attended the meeting:-

Sr.	Name & Address	Contact No. Tel / Cell	Status
1.	Dr. Ehsan Ullah, Professor and Chairman, Department of Agronomy, University of Agriculture, Faisalabad. <b>ehsanchahal@gmail.com</b>	03336536062	Convener
2.	Dr. Bashir Ahmad, Professor & Chairman, Department of Agronomy, University of Agriculture, Peshawar. <b>bashir1259@yahoo.com</b>	03149006134	Secretary
3.	Dr. Muhammad Naeem Chaudhary, Head Agronomy, University College of Agriculture & Environmental Science, Islamia University of Bahawalpur, Bahawalpur. <b>dr.naeemch@gmail.com</b>	062-9255531 03217662772	Member
4.	Prof. Dr. Fayyaz ul Hassan Sahi, Professor & Chairman, Department of Agronomy, PMAS Arid Agriculture University, Rawalpindi.	03009514597	Member

<b>Sr.</b>	<b>Name &amp; Address</b>	<b>Contact No. Tel / Cell</b>	<b>Status</b>
5.	Dr. Amjed Ali, Assistant Professor, Department of Agronomy, University College of Agriculture, University of Sargodha, Sargodha. <b>amjedali@uos.edu.pk</b>	03336800878	Member
6.	Dr. Hakoomat Ali, Professor and Chairman, Department of Agronomy, Bahauddin Zakariya University, Multan.	03006323637	Member
7.	Mr. Riaz Ahmad Ghumman, Sr. Manager Marketing (Agri Services) Fauji Fertilizer Company Ltd, 11-Shahrar-e-Awan-e-Tijarat, Lahore. <b>riazahmad@ffc.com.pk</b>	03218484485	Member
8.	Dr. Shamsuddin Tunio, Professor & Dean, Faculty of Crop Production, Sindh Agriculture University, Tandojam. <b>sd_tunio@hotmail.com</b>	03443421375	Member
9.	Dr. Qamaruddin Chachar, Professor & Chairman, Department of Crop Physiology, Sindh Agriculture University, Tandojam.	03003125641	Member
10.	Dr. Muhammad Akmal, Professor, Department of Agronomy, The University of Agriculture Peshawar, Peshawar.	03005883292	Member



<b>Sr.</b>	<b>Name &amp; Address</b>	<b>Contact No. Tel / Cell</b>	<b>Status</b>
11.	Dr. Farooq Shah, Assistant Professor, Department of Agronomy, Abdul Wali Khan University, Mardan. <b>farooqshah@awkum.edu.pk</b>	03360934308	Member
12.	Dr. Muzzamil Hussain Siddiqui, Professor & Chairman, Department of Agronomy, Faculty of Agriculture, The University of Poonch, Rawalakot. <b>smuzzammil@ymail.com</b>	03007777109	Member
13.	Dr. Ejaz Ahmed Khan, Professor & Chairman, Department of Agronomy, Gomal University, D I Khan. Takreem95@hotmail.com	0345- 9821177 0333- 9985822	Member
14.	Dr. Mushtaq Hussain Kazmi, Controller of Examination, Virtual University of Pakistan,Lahore. <b>kazmimushtaq@yahoo.com</b>	0321- 5557255	Member (Hec Invited)
15.	Dr. Abdul Khaliq, Associate Professor, Department of Agronomy, University of Agriculture, Faisalabad. khaliquaf@gmail.com	0321- 6615848	Member
16.	Dr. Muhammad Bilal Chattha, Professor, Institute of Agricultural Sciences, Quaid-e-Azam Campus, University of the Punjab, Lahore. <b>bilal.iags@pu.edu.pk</b>	04299231846 03007665728	Member

2. The Following member of the NCRC could not attend the meeting due to their official/personal engagement:-

1. Prof. Dr. Muhammad Bismillah Khan  
Department of Agronomy  
Bahauddin Zakariya University, Multan.
2. Mr. Muneer Ahmed,  
Head, Department of Agronomy,  
Lasbella University of Agriculture, Water & Marine  
Sciences,  
Uthal, Balochistan.

3. The meeting started with the recitation of Holy Quran by Mr. Riaz-ul-Haque, Assistant Director, HEC & meeting coordinator. He, on behalf of the Chairperson and the Executive Director, HEC welcomed the participants and thanked all the members of the Committee for sparing precious time for this national cause. He briefed the participants on the procedure of finalization & circulation of final curriculum for implementation through HEC.

4. Prof. Dr. Ehsan Ullah, Convener of the preliminary meeting took charge to conduct proceedings of technical sessions of the meeting for three days while Prof. Dr. Bashir Ahmed, as Secretary reviewed the previous meeting proceedings for update. Dr. Ehsan Ullah thanked the participants for their participation and started proceedings of the meeting in accordance with the agenda.

5. The Committee reviewed and discussed the draft curriculum of BSc (Hons), prepared in preliminary meeting and considered the inputs given by the members of NCRC & after detailed discussion, the Committee incorporated their suggestions in the draft curriculum. The Committee also discussed the agenda item regarding development of Scheme of Postgraduate degree programme and it was concluded that as per HEC policy and international standards credit hours for MSc (Hons) would be 30 credit, 24 credit hours for courses and 6 credit hours for research work.

6. After three days through deliberations the committee unanimously approved the final draft curriculum of the BSc (Hons) and Postgraduate Agronomy degree programmes which was prepared in the preliminary meeting of NCRC. The Committee during its deliberation achieved the following objectives:

1. Reviewed and finalized the draft curriculum for BSc (Hons) and Postgraduate in the discipline of Agronomy so as to bring it at par with international standards.
2. Incorporated latest reading & writing material for each course.
3. Brought uniformity and developed minimum baseline courses in each and every course of study.
4. Made recommendations for promotion/development of the discipline which will be published in the Curriculum for circulation by HEC.

7. The Convener of the NCRC, Prof. Dr. Ehsan Ullah thanked all the members, especially the Secretary of the committee Prof Dr. Bashir Ahmed, for their valuable inputs in finalizing the revised curriculum keeping in view the requirement of the country and to make it more practical competitive and effective. He appreciated their dedication and hard work in this task of national importance. The Committee highly appreciated the efforts made by the HEC Coordinator and all of other officials of HEC Regional Centre, Lahore for providing local hospitality.

8. Mr. Riaz-ul-Haque, Assistant Directors, HEC thanked the Convener and all the members of the Committee on behalf of Prof. Dr. Naeem Khalid , Adviser (Academics) & Mr. Fida Hussain, Director General (Academics), HEC for sparing precious time and for their quality contribution towards preparation of the preliminary draft curriculum in the discipline of Statistics.

9. The meeting ended with vote of thanks to and from the chair.

**STANDARDIZED TEMPLATE FOR 4-YEAR  
BS/BSc (HONS) AGRICULTURE**

<b>1. Compulsory Courses</b>	<b>Credit Hours</b>
Mathematics / Biology (2 courses)	6 (3-0) (2-1)
Statistics 1 & 2	6 (3-0) (3-0)
Computers /IT	3(2-1)
Pak Studies	2(2-0)
Islamic Studies	2(2-0)
Communication Skills	3(3-0)
English	3(3-0)
Basic Agriculture	3(2-1)
<b>Sub-Total</b>	<b>28</b>
<b>2. Interdisciplinary Foundation Courses</b>	
Agronomy	9(----)
Plant Breeding & Genetics	3(2-1)
Entomology	3(2-1)
Plant Pathology	3(2-1)
Food Technology	3(2-1)
Horticulture	3(2-1)
Soil Sciences	3(2-1)
Agriculture Economics	3(2-1)
<b>Sub-Total</b>	<b>24</b>
Agriculture Extension	3(2-1)
Forestry & Range Management	3(2-1)
Animal Science	3(2-1)
Marketing & Agri Business	3(2-1)
Rural Development	3(2-1)
Human Nutrition	3(2-1)
Agriculture Chemistry	3(2-1)
Agriculture Engineering	3(2-1)
Water Management	3(2-1)
Any other discipline recommended by the University/Faculty/College	
<b>Sub-Total</b>	<b>24</b>
<b>Sub-Total during the first four semesters</b>	<b>70-76</b>
<b>Semester 5, 6, 7 &amp; 8</b>	<b>56-60</b>
<b>Project / Internship</b>	<b>04</b>
<b>Grand Total</b>	<b>130-140</b>

## SCHEME OF STUDIES FOR BS/BSc (HONS) IN AGRONOMY

Course Title	Credit Hours No.
AGR-001 Basic Agriculture	3(2-1)
AGR-002 Principles of Agronomy	3(2-1)
AGR-003 Field Crop Production-I	3(2-1)
AGR-004 General Crop Production-II	3(2-1)
AGR-005 Arid and Rainfed Agriculture	3(2-1)
AGR-006 Farm Record Maintenance	3(2-1)
AGR-007 Agro-technology of Major Crops	3(2-1)
AGR-008 Principles of Weed Science	3(2-1)
AGR-009 Field Crop Physiology	3(2-1)
AGR-010 Plant Nutrients and Growth Regulators	3(2-1)
AGR-011 Water Management in Rainfed Area	3(2-1)
AGR-012 Biological Nitrogen Fixation	3(2-1)
AGR-013 Seed Production Technology	3(2-1)
AGR-014 Research and Scientific Writing	3(2-1)
AGR-015 Conservation Agronomy	3(2-1)
AGR-016 Agro Ecology	3(3-0)
AGR-017 Irrigation Agronomy	3(2-1)
AGR-018 Environment and Crop Production	3(2-1)
AGR-019 Forage and Fodder Production	3(2-1)
AGR-020 Organic Farming	3(3-0)
AGR-021 Coastal Agriculture	3(2-1)
AGR-022 Introduction to Weed Science	3(2-1)
AGR-023 Introduction to Crop Modeling	3(2-1)
AGR-024 Crop Management under Stressful Environments	3(2-1)
AGR-025 Medicinal and Special Crops	3(2-1)
AGR-026 Plant and Soil Analysis	3(2-1)
AGR-027 Production Technology of Condiments and spices'	3(2-1)
AGR-028 Project Studies	4(0-4)
AGR-029 Internship*	4(0-4)

**Note:**

*Universities/Faculties/Colleges may adopt their own system for course numbers and credit hours for different courses.*

\* Internship can be performed 5<sup>th</sup> semester onward.



**Theory**

Agronomy-definition and scope; Principles of Agronomy, Tillage: objectives and types; Use of improved seed, seed multiplication and distribution systems; Nutrient management; manures and fertilizers, their classification, composition, methods of application; Irrigation management; methods and scheduling. Water use efficiency; Crop protection; Harvesting, postharvest management and marketing; Crop rotations and types; Mono vs multiple cropping; Modern concepts in agronomy.

**Practical**

Demonstration and use of tillage implements; Preparatory tillage, seedbed preparation and intercultural operations; 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; Identification of crop pests; Visits to University farms.

**Recommended Books**

1. Abass, M. A. 2006. General Agriculture. Emporium Urdu Bazar, Lahore.
2. Balasubramaniyan. 2004. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
3. Khalil, I.A. and A. Jan. 2002. Cropping Technology. National Book Foundation, Islamabad.
4. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.
5. Martin, J.H. R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.
6. Michael, A. M. 1990. Irrigation theory and practices. 2<sup>nd</sup> Ed., Vikas Pub. House Pvt. Ltd., New Delhi.
7. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 1994. Crop Production. Ed. E. Bashir & R. Bantel. National Book Foundation, Islamabad.
8. Reddy, .S.R. 2004. Principles of Crop Production. Kalyani Publishers, New Delhi.
9. Reddy, T.Y. and G.H.S. Reddi. 2004. Principles of Agronomy. Kalyani Publishers, New Delhi.
10. Zimdahl, R. 2008. Fundamentals of Weed Science. 3<sup>rd</sup> Third edition. Academic Press, USA.

**AGR-003      FIELD CROP PRODUCTION-I****3(2-1)****Objective**

To understand the production technology of cereals, fibre, sugar and green manure crops.

**Theory**

Concept and classification of field crops; Cropping intensity, cropping schemes and cropping patterns; Cropping patterns in different ecological zones, factors affecting cropping patterns. Mono versus multiple cropping; Production technology of cereals (wheat, barley, oats, triticale, rice, maize, sorghum and millets), Fibre crops (cotton, jute, sun hemp, deccan-hemp), Sugar crops (sugarcane and sugar beet), Green manure crops (guara, dhancha, pigeon pea, senji, etc.).

**Practical**

Identification and plant characteristic of crops, cultivars, and seeds; Demonstration of improved sowing methods; Raising of crop nurseries and their transplanting; Intercultural practices; Delinting of cotton seed; Burying of green manure crops; Visits to University/College research area.

**Recommended Books**

1. Bhatti, I.M. and A.H. Soomro. 1996. Agricultural inputs and Field Crop Production in Sindh, Directorate General, Agri., Res. Institute, Sindh, Hyderabad.
2. Byerlee, D. and T. Hussain, 1992. Farming Systems of Pakistan. Vanguard Books, Lahore.
3. Martin, J.H., R.P.Waldren and D.L. Stamp. 2006. Principles of Field Crop Production 4<sup>th</sup> Ed. The McMillan Co., New York.
4. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 1994. Crop Production. National Book Foundation, Islamabad.
5. Reddy, SR. 2004 Principles of Crop Production. 2nd Ed. Kalyani publishers New Delhi.
6. Shrestha, A. 2003 Cropping System. Food Products Press. Haworth Press, Inc. Binghamton, New York NY.
7. Wolfe, T.K. and M.S. Kipps. 2004. Production of Field Crops: A Textbook of Agronomy. McGraw-Hill Book Co. New York.

**AGR-004      FIELD CROP PRODUCTION-II****3(2-1)****Objective**

To familiarize the students with production technology of oil seeds, grain legumes, forages and miscellaneous crops.



### **Theory**

Production technology of oilseed crops (toria, raya, sarsoon, canola, taramira, castor bean, sunflower, safflower, sesame, linseed, groundnut, soybean); Grain legumes (chickpea, lentil, mungbean, mashbean, cowpea, pigeon pea), Forage crops (berseem, shaftal, lucerne, oats, maize, sorghum, millets, mottgrass); Miscellaneous crops (potato, sweet potato, tobacco, tea, medicinal crops); Techniques and practices for enhancing crop productivity.

### **Practical**

Identification and plant characteristic of crops, cultivars, and seeds of the crops; Demonstration of improved sowing methods; Inoculation of legume seeds; Interculture practices; Weed control practices; Demonstration of harvesting and threshing operations; Visits to University/College research areas.

### **Recommended Books**

1. Baldev, B., S. Ramamjan and H.K. Jain. 1988. Pulse Crops. Oxford and IBH Pub. Co., New Delhi.
2. Martin, J.H. R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.
3. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 1994. Crop Production. National Book Foundation, Islamabad.
4. Rahman, A. and M. Munir. 1984. Rapeseed, Mustard Production in Pakistan, PARC, Islamabad.
5. Reddy, S.R. 2004 Principles of Crop Production. 2<sup>nd</sup> Ed. Kalyani Publishers New Delhi.
6. Wolfe, T.K. and M.S. Kipps. 2004. Production of Field Crop: A Textbook of Agronomy. McGraw-Hill Book Co. New York.

**AGR-005**

**ARID AND RAINFED AGRICULTURE**

**3(2-1)**

### **Objective**

To educate the students for enhancing crop production under limited moisture regimes.

### **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; Crop rotations and cropping patterns in rainfed

regions; Water harvesting and water conservation practices.

### **Practical**

Demonstration of rainwater harvesting and conservation techniques; Determination of soil moisture; Mulching and tillage practices for moisture conservation; Field visits.

### **Recommended Books**

1. Arnon, I. 1992. Agriculture in Drylands: principles and practices. Elsevier, Amsterdam.
2. Chandrasekaran, B. K., Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Pub., New Delhi, India.
3. Hudson, N.W. 2004. Soil and Water Conservation in Semi-arid Areas. Scientific Publishers, India.
4. Khan, S. R. A, 2001. Crop Management in Pakistan with Focus on Soil & Water. Agr. Deptt. Govt. of Punjab. Lahore.
5. Maloo, S.R. 2002. Sustainable Crop Production under stress environments. Agro-tech Publishing Academy, Udaipur. India.
6. Panda, S.C. 2005. Agronomy. Agrobios, Jodhpur, India.

**AGR-006                      FARM RECORD AND MAINTENANCE                      3(2-1)**

### **Objective**

To impart awareness regarding principles of farm management and maintenance of farm records.

### **Theory**

Concept of farm management and maintenance of farm records; Definition and fundamental principles of farming system and types of farming; Objective and advantages of keeping farm records; Different systems of book keeping; Principles of double entry system and their application; Objective of journal and ledger; 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; Appreciation and depreciation of live and dead stock, land and buildings, plant and machinery; Preparation of trading, profit and loss account and balance sheet.

### **Practical**

Training in maintenance of crop, livestock and dead stock registers; Preparation of a balance sheet and different types of accounts; Calculation of appreciation and depreciation of different farm articles; Working out cost of production of major crops grown in irrigated and non

irrigated areas; Layout of farms and demonstration plots.

#### **Recommended Books**

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

#### **AGR-007      AGRO-TECHNOLOGY OF MAJOR CROPS      3(2-1)**

#### **Objective**

To comprehend crop husbandry of major field crops with special emphasis on critical production factors.

#### **Theory**

Food security (food availability, access, nutritional security), from different angles (history, policy, agronomy, food aid, agri. food chains, GMOs, organic, etc.) and different scales (global, national, household, individual); Origin, history, morphology, adaptation, distribution, economic importance and agro-technology of major field crops such as wheat, rice, maize, cotton, sugarcane and potato with special focus on regional crop;. Management of irrigation, the timing of planting and harvesting, pest management, fertilization, postharvest handling and marketing, etc. ; Management, constraints and technological measures to optimize 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.

#### **Recommended Books**

1. Khalil I.A and A. Jan. 2002. Cropping Technology. 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. Martin, J.H., R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production, 4<sup>th</sup> Ed., The Macmillan Co., New York.
4. Stoskopf, N.C. 1981. Understanding Crop Production. Reston. Pub. Co., Inc. Reston, Virginia.

**AGR-008                      PRINCIPLES OF WEED SCIENCE                      3(2-1)**

**Objective**

To strengthen students' understanding regarding principles of weed science and control methods.

**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**

Weed collection and identification; 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.

**Recommended Books**

1. Jaya K. R. and R. Jagannathan. 2007. Weed Science Principles. Kalyani Publishers, New Delhi.
2. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4<sup>th</sup> Ed. Waveland Press Inc., USA.
3. Naylor, R.E.L. 2002. Weed Management, Principles and Practices. Blackwell Science, UK.
4. Zimdahl, R. 2013. Fundamentals of Weed Science 4<sup>th</sup> Edition. Academic Press. New York.
5. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
6. Walia, U.S. 2003. Weed Management. Kalyani Publishers, New Delhi, India.

**AGR-009 FIED CROP PHYSIOLOGY****3(2-1)****Objective**

To study mechanisms, processes and functions involved in plants under field conditions.

**Theory**

Concept and importance of crop physiology; Carbon metabolism; Factors affecting photosynthesis and respiration; Photosynthetic efficiency of different crop plants; Physiology of germination, dormancy, seedling establishment, tillering, root, stem, leaf, flower and seed development; Maturity, senescence and abscission; Source-sink relationships in crop plants; Stress physiology; Biological nitrogen fixation; Plant growth regulators, their synthesis, translocation, and mode of action; Physiological determinants of crop yield.

**Practical**

Equipment used in crop physiology; Preparation of solutions of various strengths; Demonstration of various types of seed germination; Respiratory losses of food reserves during seed germination; Imbibition of water by seed; Determination of water content of plant and seed; and water transpired by plants; Influence of growth regulators on plant growth; Identification of crop growth stages.

**Recommended Books**

1. Lambers, H., F.S. Chapin, and T.L. Pons. 2009. Plant Physiological Ecology. Springer-Verlag New York Inc.
2. Pessarakli, M. 2014. Handbook of Plant and Crop Physiology, 3<sup>rd</sup> Ed. Taylor and Francis, Boca Raton, USA.
3. Ross, C.W and F. B. Salisbury. 2011. Plant Physiology 5<sup>th</sup> Ed., Wadsworth Publ. Co., Belmont, California, USA.
4. Taize, L. and E., Zeiger. 2010. Plant Physiology 5<sup>th</sup> Ed. Sinauers Associate, Inc. Sunderland, Massachusetts, USA.

**AGR-010 PLANT NUTRIENTS AND GROWTH REGULATORS 3(2-1)****Objective**

To provide know-how about mineral nutrition and growth regulators.

**Theory**

Mineral nutrients, classification, functions and deficiency symptoms; Criteria for essentiality of mineral nutrients; Factors affecting nutrient availability; Mechanisms of nutrient uptake and translocation in the plants; Composition and types of fertilizers; Biosynthesis, translocation

and functions of growth regulators-auxins, gibberellins, cytokinins, abscisic acid and ethylene.

### **Practical**

Raising plants in different growth media with various nutrients; Identification of deficiency symptoms; Demonstration of nutrient uptake; Demonstration of plant responses to growth regulators.

### **Recommended Books**

1. Epstein, E. and A. J. Bloom. 2004 Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
2. Havlin, J.L., Tisdale, S.L., J.D. Beaton and W.L. Nelson. 2005. Soil Fertility and Fertilizers. 7<sup>th</sup> Ed. Macmillan Publishing Co., NY, USA.
3. Mengel, K., E. A. Kirkby, H. Kosegarten and T. Appel. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. International Potash Institute, Bern, Switzerland.
4. Rashid, A. and K.S. Memon. 2005. Soil Science. Ed. E. Bashir and R. Bantel. National Book Foundation, Islamabad.
5. Taize, L. and E., Zeiger. 2006. Plant Physiology 4<sup>th</sup> Ed. Sinauers Associate, Inc. Sunderland, Massachusetts, USA.

## **AGR-011 WATER MANAGEMENT IN RAINFED AREAS 3(2-1)**

### **Objective**

To educate students about moisture resource management in rainfed areas.

### **Theory**

Concept of water management; Rainfed areas of Pakistan; Sources of water, soil as a water reservoir; Available water, water holding capacity, intake rates and movement; Effective rainfall; atmospheric variables affecting soil moisture; Rainfall, pattern and frequency; Appropriate cropping patterns and water budgeting; Water requirement and water use efficiency of crops; Water harvesting and run-off farming; Irrigation systems; *Rodhkohi* system.

### **Practical**

Determination of bulk density and water holding capacity of soil; Measurement of moisture content; Calculation of water-use efficiency; Measurement of rainfall and evapo-transpiration.

### **Recommended Books**

1. Arnon, I. 1992. Agriculture in Drylands: principles and practices. Elsevier, Amsterdam.

2. Anonymous. 1997. Irrigation Agronomy Manual. Ministry of Food Agriculture and Livestock, Islamabad.
3. Khan, S. R. A. 2001. Crop Management with focus on soil and water. Agric. Deptt. Govt. of Punjab, Lahore.
4. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.
5. Misra, R.D. and M. Ahmad. 1990. Manual of Irrigation Agronomy. Oxford and IBH Publishing Co. New Delhi.
6. Prihar S.S. 2003. Intensive Cropping, Efficient use of Water, Nutrients, and Tillage. Pak Book Corp. Lahore.
7. Rashid, A. 1994. Soil Science. National Book Foundation Islamabad

**AGR-012                      BIOLOGICAL NITROGEN FIXATION                      3(2-1)**

**Objective**

To educate students about mechanism of biological nitrogen fixation and its utilization in agriculture systems.

**Theory**

Importance of nitrogen; Nitrogen cycle; Assimilation of nitrate and ammonium ions; Nitrogen fixation; Biological nitrogen fixation, its potentialities, perspectives and limitations; BNF in a symbiotic and nonsymbiotic association in legumes and non legumes, stages in nodulation; Nitrogenase: structure and function; Mechanism and biochemistry of BNF; Gaseous exchange in nodules; Role of leghemoglobin; Effect of environment on nitrogen fixation; Stem nodules; Prospects for making new symbiosis; Physiological limitations and genetic improvements of biological nitrogen fixation; Possibilities of engineering non- legume plants for nitrogen fixation.

**Practical**

Demonstration of inoculation methods; Study of nodule formation under different environmental conditions; Career material for effective inoculants; Identification of effective and non-effective nodule; Methods used to measure biologically fixed nitrogen.

**Recommended Books**

1. John L. H., J. D. Beaton, S. L. Tisdale, and W. L. Nelson. 2010. Soil Fertility and Fertilizers-An introduction to nutrient management, 7<sup>th</sup> edition. Pearson Prentice Hall, New Delhi, India.
2. Ross, C. W and F. B. Salisbury. 2011. Plant Physiology 5<sup>th</sup> Ed., Wadsworth Publ. Co., Belmont, California, USA.
3. Hansen, A.P. 1994. Symbiotic N<sub>2</sub> fixation of crop legumes. Margref verleg weikenheim, Germany.

4. Stacy, G., R.H. Burris and H.J. Evans. 1992. Biological Nitrogen Fixation. Chapman and Hall, London.
5. Taize, L. and E. Zeiger. 2002. Plant Physiology 3<sup>rd</sup> ed. Sinauers Associate, Inc. Sunderland, Massachusetts, USA.
6. Yi- Peng Wang, Min Lee, Zhe- Xian Tian, William E. Newton. Eds. 2005. Biological Nitrogen Fixation, sustainable agriculture and the environment. Proc. 14<sup>th</sup> Int. Congress Biological Nitrogen Fixation. Springer, Netherlands.

**AGR-013            SEED PRODUCTION TECHNOLOGY            3(2-1)**

**Objective**

To familiarize students about fundamentals of seed technology.

**Theory**

Introduction, orientation, concept and perspective of seed technology; Seed production terms, their definition and types of seeds; Origin of seed industry; National and international seed centers; Origin of new varieties, variety development and plant variety production; Seed problems: Germination, stand failures, mixtures, weeds, genetics. Seed certification classes: Nucleus breeder seed, pre-basic, basic, certified and approved class. Seed analysis, sampling, processing, conditioning drying, cleaning, grading, treatment, vigor and viability: Their similarity and differences; Seed longevity and storage; Seed certification: Regulations schemes and field inspection; Seed distribution and marketing; Seed act and laws; Promotion of seed industry; biotechnology and seed development; Economic liberalization and seed trade.

**Practical**

Seed identification; Seed testing equipment; Study of seed structures; Sampling techniques for seed testing; Moisture testing. Purity analysis of seed; Seed viability, vigor and germination tests; Study visits to seed production farms/ processing industry.

**Recommended Books**

1. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
2. Anonymous. 1992. Proceeding of International Seminar on Seed, Fauji Fertilizer Corporation. Islamabad.
3. Anonymous. 2001. A Dictionary of seed technological terms. Kalyani Publisher, India.
4. Basra, A.S. (Ed). 2006. Handbook of Seed Technology. Haworth Press New York, USA.



5. Copeland L.O. and M.F. McDonald. 2001. Principles of Seed Science and Technology – 4<sup>th</sup> Ed. Burgess Pub. Co., USA
6. ISTA. 1996. International rules for seed testing. Proceedings of International Seed Testing Association, Zurich.
7. Khare, D. and M.S. Bhale. 2000. Seed Technology. Sci. Pub., India.
8. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press / Ames, USA
9. Singh G. 2000. Economics of Seed Production at Farm level. Pak Book Corp. Lahore.

**AGR-014            RESEARCH AND SCIENTIFIC WRITING            3(2-1)**

**Objective**

To provide guidelines for research methodology, develop and improve skills in scientific writing.

**Theory**

Concept of research, scientific method and experiment; Planning and execution of trials; Experimental designs and layout; Research trial observations; collection, processing and analysis of data; Measures of experimental variability; Interpretation and summarization of results; Types of scientific writing and developing a research proposal.

**Practical**

Writing of research proposal; Layout of field experiments; Collection, tabulation and analysis of data; Presentation of data in tables, curves, histograms, etc. Writing of scientific paper/report.

**Recommended Books**

1. Alan G. Clewer and David H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, Ltd. Chichester, England.
2. Anonymous. 1988. Publications Handbook and Style Manual. ASA-CSSA-SSSA, Madison.
3. Khalil, S K. and P. Shah, 2007. Scientific Writing and Presentation. HEC, Monograph, Islamabad.
4. Martha, D. 2005. Scientific Papers and Presentations. Academic Press, San Deigo, California, USA.
5. Mead, R. 2003. Statistical Methods in Agricultural & Experimental Biology. 3<sup>rd</sup> Ed. Pak Book Corp. Lahore
6. Youdeowei, A., P. Stapleton, and R. Obubo. (eds.). 2012. Scientific Writing for Agricultural Research Scientists-A Training Resource Manual, Wageningen, The Netherlands.

**AGR-015            CONSERVATION AGRONOMY****3(2-1)****Objective**

To develop the concept of soil and water conservation for sustaining productivity.

**Theory**

Concept and objectives of soil and water conservation; Agronomic practices for conservation-tillage (contouring, terracing, benching, levelling, grading, deep ploughing, etc.), species selection, crop rotations, cover cropping, strip cropping, etc. Farmyard and green manuring for conservation; Stubble and crop-residue management for resource conservation; Field drainage. Watershed management under rainfed conditions.

**Practical**

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

**Recommended Books**

1. Advances in Agronomy, All volumes. Academic Press Inc., New York.
2. Arnon, I. 1992. Agriculture in Drylands: Principles and Practices. Elsevier, London.
3. Gurmel Sing, C. Venkatarmanan, G. Sastry and B.P. Joshi. 1990. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Hudson, N.W. 2004. Soil and water conservation in semi-arid areas. Scientific Publishers, India.
5. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Dehli, India.
6. Maloo, S.R. 2002. Sustainable Crop Production under stress environments. Agro-tech Publishing Academy, Udaipur.
7. Chandrasekaran, B., K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Publishers. New Delhi, India.
8. Rashid, A. 1994. Soil Science. National Book Foundation Islamabad.

**AGR-016            AGRO ECOLOGY****3(3-0)****Objective**

To inculcate understanding about ecological principles for sustainable cropping systems.

### **Theory**

Ecosystem; definition and components. Ecological pyramids; process within the ecosystem; Primary production processes; measuring primary production; Estimation of primary production in ecosystems; Biogeochemical cycling process; cycling of CO<sub>2</sub>, nitrogen, water, phosphorus and sulphur; Factors within the ecosystem; Agroecosystem; biotic structure, primary producers, consumers, decomposers; Primary productivity; Energy flow; Competition, crop yields and variability in relation to the ecological optima; responses of crop plants to biotic and abiotic factors.

### **Recommended Books**

1. Hussain, S.S. 2003. Manual of Plant Ecology. National Book Foundation, Islamabad.
2. Kapur, P. and R.G. Sudha. 2000. Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
3. Brown C.S. and T. Toadwine (eds.) 2007. Nature's Edge- Boundary Explorations in ecological theory and practice. State University of New York Press, Albany, USA.
4. Shukla, R. S. and P. S. Chandel, 2006. A Textbook of Plant Ecology. S. Chand & Co. Ltd. New Delhi, India.
5. Townsend, C.R., Harper, J.L. and M.E. Bego. 2000. Essentials of Ecology. Blackwell Scientific Publications, UK.

**AGR-017**

**IRRIGATION AGRONOMY**

**3(2-1)**

### **Objective**

To provide knowledge about irrigation principles and management.

### **Theory**

Concept of irrigation agronomy and water management; Sources of irrigation water and their efficient use in crop production; Irrigation scheduling and water use efficiency in field crops; Irrigation water losses and their control through on-farm water management practices; Current agro-technology for efficient use of irrigation water in crops; Irrigation water pollution and measures to minimize it.

### **Practical**

Estimation of potential evapotranspiration by different methods; Calculation of water use efficiency in field crops; Potential soil moisture deficit and its calculation.

### **Recommended Books**

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

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

### **AGR-018 ENVIRONMENT AND CROP PRODUCTION**

**3(2-1)**

#### **Objective**

To familiarize students about components of environment and their relationship with crop productivity.

#### **Theory**

Environment, climate change and food security. Types and classification of environment; Dynamics of aerial and soil environment in a crop canopy at macro and micro level; Influence of different environmental factors-radiation, temperature, relative humidity, wind and CO<sub>2</sub> on crop growth and development; Greenhouse effect; *El Nino and La Nino* phenomenon; Crop adaptation to changing climate.

#### **Practical**

Measurement and estimation of different environmental variables; Calculations of potential evapotranspiration and different drought indices; Estimation of radiation interception and its use efficiency in field crops.

#### **Recommended Books**

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
2. Dris, R., J. Mohan and I.A. Khan. 2002. Environment and Crop Production. Science Pub. Inc., New York.
3. Fitter, A.H. and P.K.M. Hay. 2002. Environmental Physiology of Plants. 3rd Ed. Academic Press Inc. London.
4. Hammer, G.L., N. Nicholls and C. Mitchell. 2000 Application of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems. Kluwer Academic Publisher, London.
5. Pearcy, R.W., J.R. Ehleringer, H.A. Mooney and P.W. Rundal. 1989. Plant Physiological Ecology: Field Methods and Instrumentation. Chapman and Hall, London, New York.

6. Rowan Sewing, C., T.T. Richer, J.W. Jael. G.Y. Tsuji and Hi Ledyard. 1995 Climate Change Agriculture: Analysis of potential international impact ASA Special Publication, USA.
7. Hay., R.K.M. and J.R. Porter. 2006. The Physiology of Crop Yield. 2<sup>nd</sup> Ed. Blackwell publishing Ltd Oxford, UK.

### **AGR-019 FORAGE AND FODDER PRODUCTION**

**3(2-1)**

#### **Objective**

To enhance skill of students for fodder production and its preservation.

#### **Theory**

Importance of forages and fodders; Terminology and taxonomy of forage and fodder crops; Forage production in Pakistan-current status and future scenario; Agro techniques for production of legume/nonlegumes forages and fodders for sustainable forage production; Rangeland status, increasing productivity of pastures and range lands; Seed production of forages, nutrient management in fodders/forages; Forage quality-its status and improvement, fodder/forage production constraints and remedies; Fodder preservation (hay and silage); Fodder research studies in Pakistan.

#### **Practical**

Identification of fodder/forage crops and seed; estimation of sprout density and plant population; silage and hay making practices; preparation of fodder calendar; determination of forage quality parameters; visits of university farms.

#### **Recommended Books**

1. Dovrat, A. 1993. Irrigated Forage Production. Elsevier Scientific Publishers, The Netherlands.
2. Khalil, I.A and A. Jan. 2006. Cropping Technology. National book foundation, Islamabad, Pakistan.
3. Mukherjee, A.K. and S.Maiti.2009. Forage Crop Production and Conservation. Kalyani publishers, New Delhi, India.
4. Martin, J.H., R.P., Waldern and D.L. Stamp.2006. Principles of Field Crop Production. 4<sup>th</sup> ed. Pearson- Prentice Hall, Ohio, USA.
5. Singh, A.K., M.A. Khan, N. Subash and K.M. Singh. 2011. Forages and Fodders. Daya Publishing House, Delhi, India.
6. Singh, J.V., B.S. Chhilar, B.D. Yadav and U.N. Joshi. 2010. Forage Legumes. Scientific Publishers, Jodhpur, India.

**AGR-020                      ORGANIC FARMING    3(3-0)**

**Objective**

To familiarize students with the concept of organic farming and its field application

**Theory**

Concept and brief history of organic farming; Quality of food and crop productivity under natural ecological systems; Principles of organic agriculture; Merits and demerits-organic vs inorganic farming; Components of organic farming (weed, insect, pest and fertilizer management); Maintenance of buffer zone; Preparation of organic manures-humus, sewage sludge, organic compost; Farm waste recycling, organic mulches, bio-fertilizers, etc.; Natural products for control of crop pests (weeds, insects and diseases).

**Recommended Books**

1. Dahama, A.K. 2002. Organic Farming for Sustainable Agriculture. 2<sup>nd</sup> Enlarged Ed. Pub. Agrobios, Jodhpur, India.
2. Eric, L. 2009. Organic Farming, Pest Control and Remediation of Soil Pollutants. Springer Dordrecht Heidelberg London New York.
3. Fossel, P.V. 2007. Organic Farming: Everything you need to know. MBI Publishing Co., USA.
4. Hari, M., S. Seshadri, K. Perumal. 2010. Biofertilizer (Phosphobacteria). Shri AMM Murugappa Chettiari Research Centre, India.
5. Niir, B. 2004. The Complete Technology Book on Bio-Fertilizer and Organic Farming. National Institute of Industrial Research, India.
6. Palaniappan, and K. Annadurani. 2006. Organic Farming Theory and Practice. Scientific Publishers. Jodhpur, India.
7. Rachel, F., S. Heather and T. Robbin. 2012. All the Dirt: Reflections on Organic Farming. TouchWood Editions, Canada.
8. William, L. 2007. Organic Farming an International History. CAB International, UK.

**AGR-021                      COASTAL AGRICULTURE    3(2-1)**

**Objective**

To educate students about potential of agriculture in coastal areas

**Theory**

Coastal agriculture and its scope; Farming trends in coastal areas of Pakistan; Saline agriculture, halophytes and their classification; Coastal land management; Agronomic techniques for use of sea water;

Production and processing of coastal and biofuel crops; Post harvest techniques.

### **Practical**

Identification of halophytes; Measurement of soil and water salinity; Plant screening for tolerance to sea water; Determination of soil texture in coastal areas; Visits to coastal areas.

### **Recommended Books**

1. Beatley. T., D. Brower and A. Schwab. 2002. An Introduction to Coastal Zone Management. Island Press, 1718 Connecticut Avenue, N.W. Suite 300, Washington, D.C.
2. Hinrichsen, D., 1998. Coastal Waters of the World: Trends, Threats, and Strategies. Island Press, Washington, DC, USA
3. John R. Clark. 1995. Coastal Zone Management Handbook. Mote Marine Laboratory of Sarasota, Florida, USA.
4. John R. Clark. 1998. Coastal Seas: The Conservation Challenge. 989 Market Street San Francisco, CA.
5. Kay, R. and J. Alder. 2005. Coastal Planning and Development. Taylor and Francis, London.
6. Sukumar, B., 2008. Water Quality Management for Coastal Aquaculture. Daya Publishing House, India.

**AGR-022**

**INTRODUCTION TO WEED SCIENCE**

**3(2-1)**

### **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; Field visits.

### **Recommended Books**

1. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4<sup>th</sup> Ed. Waveland Pr Inc., USA.
2. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.
3. Jaya Kumar, R. and R. Jagannathan. 2007. Weed Science Principles. Kalyani Publishers, New Delhi.

4. Ziska, L.H. and J. S. Duke. 2011. Weed Biology and Climate Change. Willey Backward.
5. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
6. Walia, U.S. 2003. Weed Management. Kalyani Publishers, New Delhi – 110 002.
7. Zimdahl, R. 2013. Fundamentals of Weed Science. 4<sup>th</sup> Ed. Academic press.

**AGR-023                    INTRODUCTION TO CROP MODELING                    3(2-1)**

**Objective**

To familiarize students with the concept and application of crop modeling

**Theory**

History and introduction of crop growth modeling; Fundamental concepts of crop modeling, their importance and uses; Introduction to decision support system for agro-technology transfer; Components of a model, input data set for different model; Modelling and crop improvement; Modelling a tool for future predictions.

**Practical**

Demonstration and practice of crop growth models: CERES-wheat, DSSAT V. 4, APSIM, Measurement of different environmental variables from observatories.

**Recommended Books**

1. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
2. Singh, P. 2008. Modeling Crop Production Systems: Principles and applications. Science publishers. Enfield, New Hampshire 03784.USA
3. Sivakumar, M. V. K. and R. P. Motha. 2007. Managing Weather and Climate: Risks in Agriculture. Springer, Berlin, Heidelberg, New York.
4. Sivakumar, M. V. K. and J. Hansen. 2007. Climate Predictions and Agriculture. Springer, Berlin, Heidelberg, New York.

**AGR-024                    CROP MANAGEMENT UNDER STRESSFUL ENVIRONMENTS                    3(2-1)**

**Objective**

To elaborate the concept of stress in field crops and approaches to sustain yields under such conditions.

**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; Modifications in



growth and developmental patterns of crop plants under biotic and abiotic stresses; Approaches for ameliorating the stress effects for crop production.

### **Practical**

Acquaintance with the symptoms of stresses on crop,; visits to affected areas and noting the patterns of vegetative and reproductive growth of crop plants.

### **Recommended Books**

1. Arnon, I. 1992 Agriculture in Drylands: Principles and Practices. Elsevier, Amsterdam.
2. Nosberger, J.H. H. Geiger and P.C. Struik. 2001. Crop Science Progress and Prospects. CABI Pub., Oxon, UK.
3. Pessaraskli, M. A. 2000. A Hand Book of Stress Physiology, Marker and Deekar.
4. Taize, L., E. Zeiger. 2006. Plant Physiology. Sinauer Pub. U.S.A.

**AGR-025            MEDICINAL AND SPECIAL CROPS            3(2-1)**

### **Objective**

To introduce a production technology for medicinal and special purpose crops

### **Theory**

Economic importance, origin, history, adaptation, distribution and production technology of medicinal and special purpose crops-tea, aloe, mint, aloevera, chamomile, kava, red sorrel, jojoba, castor bean, jatropha, plantains, salicornia, safflower, poppy, tobacco, indigo, oil palm, fennel, *ajwain*, fenugreek, sweet basil, sesamum, *balangu*, *haloon*, *kalvanji*, *guar*, *senna*, quinoa, bitter gourd, etc.; Integrated pest management and precision farming for special purpose 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 soil types for medicinal plants; Methods for extraction of useful ingredients of medicinal plants.

### **Recommended Books**

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

2. Martin, J.H., R.P. Waldren and D.L. Stamp. 2006. Principles of Field Crop Production, 4<sup>th</sup> Ed., the MacMillan Co., New York.
3. Narayan, D.P., S.S. Purohit, A.K. Sharma and Tarun, K. 2003. A Handbook of Medicinal Plants. Agrobios, India.
4. Palaniappan, and K. Annadurani. 2006. Organic farming; theory and practice. Scientific Publishers, Jodhpur, India.
5. Ravindra, S. 2004. Agro-Techniques of Medicinal Plants. Daya Publishing House, New Delhi, India.
6. Reddy, S.R. 2004. Principles of Field Crop Production. 2nd Ed. Kalyani Publishers, New Delhi, India.
7. Sharma, K. 2005. Hand Book of Agriculture. Indian Council of Agricultural Research, New Delhi
8. Sharma. R. 2004. Agro-techniques of Medicinal Plants. Daya Publishing House, Delhi.

**AGR-026                      PLANT AND SOIL ANALYSIS    3(2-1)**

**Objective**

To train the students about different methods of soil and plant analysis.

**Theory**

Types and use of different balances; Preparation of solutions of known concentrations-normal, molar, molal, ppm, etc.; Preparation of stock solutions for drawing standard curves; Soil and plant sampling techniques; Preparation of plant and soil samples for analytical work; Estimation of EC, pH, N, P, K, Na, organic matter, etc.

**Practical**

Demonstration of analytical methods in the laboratory, recording data, computation work and recommendations.

**Recommended Books**

1. Basak, R.K. 2004. Soil Testing and Recommendation. Kalyani Publisher, New Delhi.
2. Hussain, T. and A. Jabbar. 1985. Soil and Plant Analysis. Department of Soil Science, University of Agriculture, Faisalabad.
3. Ryan, J., G. Estefan and A. Rashid. 2001. Soil and Plant Analysis Laboratory Manula. 2<sup>nd</sup> Ed., ICARDA, Aleppo, Syria and NARC, Islamabad, Pakistan.
4. Tandon, H.L.S (Ed.). 2001. Methods of Analysis of Soils, Plants, Waters and Fertilizer. Development and Consultation Organization, New Delhi, India.
5. Westerman, R.L. (Ed.). 1990. Soil Testing and Plant Analysis. 3<sup>rd</sup> Ed. Soil Sci. Am. Inc., Madison, WI, USA.



report writing by the student and the student will also present report in a seminar.

**Note:** *The farmers/farm managers/Director will evaluate the practical work by the student. An expert committee to be appointed by the board of studies/Chairman of the department will also evaluate the student's participation at the farms and at the universities. The committee will also evaluate and grade/mark the report and seminar. The seminar/presentation delivered for internship will be mandatory but not be considered extra credit.*

## SCHEME OF STUDIES FOR MS/MSC (HONS) AND PHD AGRONOMY

AGR-701	Advanced Agronomy	3(2-1)
AGR-702	Applied Crop Ecology	3(3-0)
AGR-703	Advanced Irrigation Agronomy	3(2-1)
AGR-704	Agro-Environment Conservation	3(3-0)
AGR-705	Agro-meteorology	3(3-0)
AGR-706	Allelopathy in Crop Production	3(2-1)
AGR-707	Applied Conservation Agronomy	3(3-0)
AGR-708	Arid Zone Agronomy	3(3-0)
AGR-709	Biological Crop Potential	3(3-0)
AGR-710	Crop and Environment	3(3-0)
AGR-711	Crop Management on Problem Soils	3(3-0)
AGR-712	Crop Modeling	3(2-1)
AGR-713	Crop Nutrition Management	3(2-1)
AGR-714	Crop Production and Herbicides	4(3-1)
AGR-715	Farming and Cropping Systems	3(3-0)
AGR-716	Field Crop Experimentation	4(3-1)
AGR-717	Herbicides in Plant and Soil Systems	3(2-1)
AGR-718	Integrated Agriculture	3(3-0)
AGR-719	Modern Concepts of Crop Production	3(2-1)
AGR-720	Recent Advances in Agronomy	3(3-0)
AGR-721	Seed Physiology	3(2-1)
AGR-722	Seed Science and Technology	3(2-1)
AGR-723	Stress Agronomy	4(3-1)
AGR-724	Sustainable Agriculture	3(3-0)
AGR-725	Water Relations of Plant	3(2-1)
AGR-726	Weed Management	3(2-1)
AGR-727	Climate Change and Agriculture	3(3-0)
AGR-728	Postharvest Technology of Crops	3(2-1)
AGR-729	Special Problem	1(0-1)
AGR-730	Seminar	1(0-1)
AGR-731	Thesis MSc (Hons.) Agronomy	6(0-6)
AGR-732	Thesis PhD Agronomy	12(0-12)

**Note:** *Universities/Faculties/Colleges may adopt their own system for course numbers and credit hours for different courses selected/qualified for MSc (Hons) Agronomy will not be permitted to take again in PhD.*

## **DETAIL OF COURSES FOR MS/MSC (HONS.) AND PHD IN AGRONOMY**

**AGR-701                      ADVANCED AGRONOMY                      3(2-1)**

### **Objective**

To deepen understanding about advanced concepts of crop growth and development

### **Theory**

Phenological development of crop plants; Determinants of crop growth; Factors affecting development of crop canopy, Photosynthesis and respiration; Photosynthetic efficiency and respiration in relation to crop productivity; Crop management for improving photosynthetic efficiency and harvest index; potential for increasing dry matter accumulation in crop plants, dry matter partitioning; Crop growth analysis, its objectives and agronomic uses; Growth analysis of individual plants and crops, classical and functional growth analysis, biological relevance of different growth functions and curve fitting in crop growth studies.

### **Practical**

Phenological development stages of crop plants. Use of classical growth formulae for determining various crop growth indices. Estimation of crop growth rates derived from different fitted growth functions. Demonstration and calculation of radiation interception and use efficiency.

### **Recommended Books**

1. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. Techniques in Bioproductivity and Photosynthesis, 2<sup>nd</sup> Ed. Pergamon Press, Oxford.
2. Hay, R.K.M. and J.R. Porter. 2006. The Physiology of Crop Yield. 2<sup>nd</sup> Ed. Wiley-Blackwell.
3. Hunt, R. 1978. Plant Growth Analysis. Edward Arnold, London.
4. Hunt, R. 1982. Plant Growth Curves: An Introduction to the Functional Approach to Plant Growth Analysis. Edward Arnold, London.
5. Gupta, U.S. 1992. Crop Improvement. Vol-I. Physiological Attributes. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

**AGR-702      APPLIED CROP ECOLOGY****3(3-0)****Objective**

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

**Theory**

Ecosystem concepts; Dynamics of Agro-ecosystems; Ecology of crop plant domestication; Ecological risk assessment, Ecological evaluation of different farming systems; Ecological characteristics of intensive agriculture with special reference to environmental pollution; Air pollution; noise pollution; Insecticide pollution, Nuclear pollution, Soil pollution; Pollution due to socio economic factors; Crop productivity and ecological optima; Biodiversity and its ecological role in agro-ecosystems; Ecology of economic crops, oil seed crops, pulses & misc. crops, sugar crops, etc.

**Recommended Books**

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
2. Fitter, A.H. and R.K.M. Hay. 2002. Environmental Physiology of Plants. 3<sup>rd</sup> Ed. Academic Press, Inc., London.
3. Gurevitch, J. M.Schiner and A.F. Gordon. The Ecology of Plant. 2<sup>nd</sup> Ed. 2006. State University of New York.
4. Kapur, P. and R.G. Sudha. 2000, Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
5. Kumar, H.D. 1994. Modern Concepts of Ecology. 7<sup>th</sup> Ed. Vikas Pub. House New Delhi.
6. Larcher, W. 1995. Physiological Plant Ecology. Ecophysiology and Stress Physiology of Functional Groups. Springer Verlag, Berlin.
7. Schulze, E. B. and K. Muller-Hohenstein. 2005. Plant Ecology. State University of New York.
8. Tivy, J. 1990. Agricultural Ecology. Longman Group U.K. Ltd. Essex.

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

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

**Theory**

Relationship between irrigation and crop yields; Methods of irrigation scheduling; Moisture sensitive periods; Indices of drought: Stress degree days, canopy temperature variability; Crop water stress index; maximum allowable depletion, etc.; Response of yield to irrigation; Penman's

irrigation-yield response analysis; Concept of potential soil moisture deficit and limiting deficit; Crop response to total water received and drought; Criteria for drought resistance; Concept of lost time for growth and crop yield; Water use efficiency and factors affecting it.

### **Practical**

Measurement of plant and soil moisture contents; Demonstration of irrigation scheduling for different crops; Water flow measurements with different techniques; Visits to controlled irrigation systems.

### **Recommended Books**

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

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

### **Objective**

To enhance the understanding of agro-environment for sustainable productivity.

### **Theory**

Agro-chemicals: use, abuse, uptake, persistence, degradation and residual effects on ecosystem; Management and recycling of agro-industrial wastes: solid waste, farm waste, sewage sludge etc.; Role of agriculture in environmental conservation; Integrated approaches to reduce the use of agro-chemicals in agriculture.

### **Recommended Books**

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
2. Hudson, N.W. 2004. Soil and water conservation in semi-arid areas. Scientific Publishers, India.
3. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.



4. Maloo, S.R. 2002. Sustainable Crop Production Under Stress Environments. Agro-tech Publishing Academy, Udaipur, India.
5. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York.

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

**Objective**

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

**Theory**

Scope of agricultural meteorology; Agricultural zones of Pakistan; Crop adaptation and distribution in relation to climate; Crop weather-relationships regarding crop growth and yield formation; Diurnal and seasonal variation in photoperiod and light integral; Atmospheric pollution and plant productivity; Climate change and its potential effects on crop production; Weather and pests of crops; Crop monitoring and forecasting; Drought monitoring and planning for mitigation; Remote sensing; Geographical Information System (GIS); Global Positioning System (GPS) and their application in agricultural meteorology; Use of climate information to improve agricultural productivity.

**Recommended Books**

1. Ahrens, C. D. 2008. Meteorology Today Brooks/Cole Cengage Learning, Belmont, USA.
2. Brunt, D. 2007. Meteorology. Oxford University Press. UK.
3. Hall, A. E. 2001. Crop responses to environment. CRC Press. LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431. USA.
4. Mavi, H.S. and G.J. Tupper. 2005. Agrometeorology; Principles and applications of climate studies in agriculture. International Book Distributing Co. Charbagh, Lucknow 226004 U.P. India.
5. Panda, B.C. 2009. Remote Sensing; Principles and Applications. Viva Books Pvt. Ltd. 4737/23, Ansari road, New Delhi-110002. India.
6. Prasada, Rao, G.S.L.H. 2008. Agricultural Meteorology. Printice Hall of India, New Delhi.

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

**Objective**

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

**Theory**

Concept and history of allelopathy; Allelopathic plants; Types of

allelochemicals; Mechanism of allelochemicals' action; Factors influencing production and effectiveness of allelochemicals; Production, release, absorption and translocation of allelochemicals; Role of allelopathy in agro-eco systems; Interactions among cropping systems; Utilization of allelopathy for pest management; Enhancing crop productivity by utilizing allelopathy; Recent research trends in allelopathy.

### **Practical**

Preparation of allelopathic plant water extracts; Comparison of crop cultivars for their allelopathic effects; Demonstration of allelopathic effects of crop extracts/residues on seed germination and seedling growth of crops/weeds; Identification of allelopathic chemicals.

### **Recommended Books**

1. Gliessman, S. R. 2007. Field and Laboratory Investigations in Agroecology (2<sup>nd</sup> Ed.). Taylor and Francis, USA.
2. Kohli, K.R., H.P. Singh and D. R. Batish. 2004. Allelopathy in Agroecosystems. IDBC Lucknow, India.
3. Macias, F.A., C.G. Galindo and J.M. G. Molinillo. 2003. Allelopathy: Chemistry and Mode of Action of Allelochemicals. CRC Press, New York, USA.
4. Reigosa, M. J., N. Petdrol and L. Gonzalez. 2006. Allelopathy: A physiological process with ecological implications. Springer, Heidelberg, Germany.
5. Rice, E.L. 1997. Allelopathy. (4<sup>th</sup> Ed.). Academic Press, Inc. Orlando, Florida, USA.
6. Zeng, R.S, A.U. Mallik and S.M. Luo. 2008. Allelopathy in Sustainable Agriculture and Forestry. Springer, USA.

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

### **Objective**

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

### **Theory**

Principles, objective and types; Water resources, their conservation and economic use in irrigated and non-irrigated regions; Modern conservation practices in irrigated and non-irrigated areas; Integrated resource conservation in different farming systems; Conservation agronomy and climate change; Use of farm machinery in conservation techniques; Conservation structures; Biological conservation; Recent developments in the field of conservation agronomy.

### **Recommended Books**

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

**AGR-708**

**ARID ZONE AGRONOMY**

**3(3-0)**

### **Objective**

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

### **Theory**

Constrains and techniques of arid agriculture; Characteristics of dry land agriculture; Problems, prospects and strategies of dry land agriculture; Moisture availability index; Aridity index; Moisture deficit index; Agronomic approaches for dry land agriculture (tillage requirement, selection of most adaptive crops, sowing of crops, cropping pattern, pasture management, cropping plans to meet the weather conditions, weed control, plant protection measure); Managing dry spells during crop periods, Lay farming for non-arable lands; Recommendations for dry farming areas; Plant adaptation to water stress; Soil and rainfall characteristics in dry land farming; Soil and moisture conservation techniques; Water shed management; Water harvesting; Sustainable dry land crop production.

### **Recommended Books**

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

6. Shaw, T. 2010. Dryland Farming. Nabu Press, USA.
7. Chandrasekaran, B.,K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Pub., New Delhi, India.

**AGR -709                      BIOLOGICAL CROP POTENTIAL                      3(3-0)**

**Objective**

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

**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; Components of plant leaf area expansion, crop canopy development, canopy architecture and interception of solar radiation; Potential for increasing photosynthetic efficiency; Dry-matter partitioning; Modern agro-physiological techniques for harvesting maximum potential of field crops; Crop plants in relation to environment.

**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 study of crop canopy development in cereals, oilseeds and grain legumes.

**Recommended Books**

1. N. R. Das, 2008. Tillage and Crop Production. Sci. Pub., India.
2. Premjit Sharma, 2007. Precision Farming. Gene Tech Book, New Delhi, India
3. M. A. Khan, 2012. Water Resources Management and Sustainable Agriculture.
4. John H. Martin, Richard P, Waldren and David L. Stamp, 2006. Principles of Field Crop Production 4<sup>th</sup> Ed. The McMillan Co., New York

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

**Objective**

To broaden the understanding of relationships between crop and environment.

### **Theory**

Crop environment, components, determinants and their role in crop productivity; Microclimate in relation to crop management; Global warming and green house effects; Environmental pollution and plant growth; Energy exchange by plants in ecosystem; Evapotranspiration and its reduction approaches; Antitranspirants, reflectants; Plant physiological aspects and plant architecture.

### **Recommended Books**

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

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

### **Objective**

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

### **Theory**

Concept and perspective of crop productivity in eroded, salt affected, water deficit and water-logged soils; their improvement and reclamation; Site specific cultural practices; Fertilizer and irrigation adjustments; Specific cropping patterns and crop management practices for economic crop production in problem soils; Demonstration of degraded soils.

### **Recommended Books**

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

**AGR-712 CROP MODELING****3(2-1)****Objective**

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

**Theory**

Philosophy and terminology of system science, scope of system analysis; Crop modeling, concept and types of models, specification and uses; Statistical parameters in modeling; Parameterization and evaluation of crop models; Model application in crops, soil, water and agrometeorology; Modeling for crop improvement and risk assessment; Crop models application in research, education and extension; Integration of crop models with GIS and remote sensing.

**Practical**

Working with different models like DSSAT, APSIM, AQUACROP; Setting of appropriate coefficients for cultivars, calibration, evaluation and validation; Preparation of different input files; crop management, and experimental data files; Preparation of weather and soil files; Working with sequence, seasonal, economic analysis, easy grapher, etc.

**Recommended Books**

1. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
2. Floor M. B. and M. van Ittersum. 2010. Environmental and Agricultural Modeling: Integrated Approaches for Policy Impact Assessment, Springer, Heidelberg, Germany.
3. Singh, P. 2008. Modeling crop production systems: Principles and applications. Science publishers. Enfield, New Hampshire 03784.USA.
4. Vohnout, K. D. 2003. Mathematical modeling for system analysis in agricultural research. Elsevier Sci., Amsterdam, The Netherlands.
5. Wallach, D., D. Makowski, J.W. Jones. 2006. Working with Dynamic Crop Models Evaluation, Analysis, Parameterization, and Applications. Elsevier Sci., Amsterdam, The Netherlands.

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

To equip students with latest developments in crop nutrition.

**Theory**

Crop nutrition in modern agriculture; Rationale for use of fertilizers; Biofortification; Physiological classification of minerals; Dynamics of plant

nutrients in normal, flooded and salt affected soils; Nutrient uptake and assimilation; Nutrient losses and causes of low efficiency; Improving nutrient use efficiency; Balanced nutrition and integrated plant nutrient management systems; Concept of remote sensing in crop nutrition; Nutrient indexing.

#### **Practical**

Demonstration of nutrient deficiency symptoms. Preparation of different nutrient solutions for field, pots and hydroponic cultures; Nutrient analysis (macro and micro) of soil and plants.

#### **Recommended Books**

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

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

#### **Objective**

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

#### **Theory**

Herbicides: importance, nomenclature, registration; classification systems; Chemical classification; Bio-herbicides; Herbicide formulations; surfactants and adjuvants; Application and incorporation techniques and equipment; Spray drift management; Herbicide selectivity; Herbicide mixtures and compatibility; Effect of herbicide residues on succeeding crops; Herbicide hazards, toxicity, environmental pollution; Storage, transportation and disposal of herbicides.

#### **Practical**

Calculation of herbicide dosage; Determination of active ingredients in various herbicide formulations; Types of sprayers, their parts and spray calibration; Boom height adjustment and study of overlapping. Study of residual effects on soil and succeeding crops. Tank mixing of herbicides.

**Recommended Books**

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

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

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

**Theory**

Concept, scope, classification and components; Agricultural resources, their utilization and management; Major farming and cropping systems of Pakistan; Role of tillage, root dynamics, cover crops, crop residues in cropping system; Assessing input use efficiencies in various farming/cropping systems; Role of precision agriculture in farming system; Study of allied enterprises (livestock, poultry, aquaculture, mushroom culture, tunnel farming); Emerging trends in farming/cropping system research; Researchable issues and research methods in farming and cropping systems.

**Recommended Books**

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

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

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



### **Theory**

Methods of scientific inquiry; general types of experiments; Principles of experimental design; Planning, layout and conducting field experiments; Recording research observations; Transformation of data ; Planned F test; Data processing, analyses and its statistical interpretation; Means separation; Probability; F and t distributions; Regression and correlation; Research results reporting.

### **Practical**

Statistical calculations based on sample data; Exercise in the layout of experiments; Transformation of Experimental data; Preparation of analysis of variance table; Use of different tests of significance; Factorial experiments and their uses in scientific research; Reporting results of experiment; calculation of linear regression and correlations; Use of statistical packages for data.

### **Suggested Readings**

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

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

### **Objective**

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

### **Theory**

Absorption and translocation of herbicides; Effects of herbicides on photosynthesis; respiration, protein, nucleic acid metabolism and enzymes; Metabolism of herbicides in plants; Sub lethal effects of herbicides; Herbicides and soil interaction; Fate of herbicides in soils; Herbicide residues in soil. Bioassay techniques in herbicide residue analysis; Instrumentation techniques for herbicide analysis; Herbicides resistance; Methods to combat herbicide resistance.

### **Practical**

Demonstration of herbicide resistance through dose response test, Demonstration of residual effect on germination and seedling growth of succeeding crops, Demonstration of herbicide movement in soils.

### **Recommended Books**

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

**AGR-718**

**INTEGRATED AGRICULTURE**

**3(3-0)**

### **Objective**

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

### **Theory**

Concept of integrated agriculture; Challenges in Pakistan's Agriculture; Present scenario and future prospects; Analytical overview: issues and strategies for improvement of crop management, livestock management, fisheries; Cottage industry, national resource management and rural development; Institutions and policies: issues and options.

### **Recommended Books**

1. Ahmad, N. and A. Hamid. 1997. Plant Nutrients Management for Sustainable Agriculture Growth. Proc. Symposium held on December 8-10, 1997. Planning & Development Division, National Fertilizer Development Center, Islamabad.
2. Anonymous. 1999. Sustainable Agriculture Solutions. Novellow Press, Ltd. London.
3. ICIMOD. 1997. Appropriate Farm Technologies in Arid and Semi-Arid Mountainous Areas of Pakistan. Katmandu, Nepal.
4. Virmani, S. M. J. C. Katyal, Eswaru, and I. P. Abarol. 1994. Stressed Ecosystems and Sustainable Agriculture. Oxford & IBH Pub. Co., New Delhi.

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

### **Objectives**

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

### **Theory**

Concept and indices of agricultural productivity; Key issues limiting agricultural productivity in Pakistan; Significance of crop management in determining crop productivity; Dynamics of stand establishment; Multiple cropping; Manipulation of different tillage systems; Manipulation of crop development by the use of growth regulators; Concept and components of good agricultural practices (GAP), Organic farming; Precision agriculture and its tools; Remote sensing and its application in Agriculture; Biotechnology in improving crop production; Global warming in relation to crop productivity.

### **Practical**

Study of different factors influencing stand establishment under field conditions; Evaluation of some case histories for economic feasibility of different cropping systems; Field observation of different tillage systems; Field visits and observation on GAP; Demonstrations on the simulation of effects of global warming on agricultural productivity; Visits to various agricultural research facilities to acquaint the students about contemporary practices in farming.

### **Recommended Books**

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

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

### **Objective**

To inculcate knowledge with respect to current developments in agronomic research.

### **Theory**

Selected topics on recent advances in agronomy; Evaluation of the recent research of the entire field; Lectures and discussions by the specialists in the areas of their research.

### **Recommended Books**

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

**AGR-721**

**SEED PHYSIOLOGY**

**3(2-1)**

### **Objective**

To enhance students' understanding of physiological processes in seeds.

### **Theory**

Seeds and human beings; Review of embryogenesis; Physiological development of "seed"; Implications of seed maturation; Chemical composition of seed, its phylogenetic implications, importance in storage, energy relationships; Dormancy, its survival value, occurrence and persistence of dormancy in cultivated, weedy and wild species, methods of overcoming dormancy; Role of growth regulators in seed development and dormancy; Seed sink strength and intensity; Seed food reserves, location and composition; Physiological and biochemical manifestation of seed aging; Seed deterioration-factors influencing rate of deterioration, theories of seed dying; Concept of seed vigor; Seed enhancement-production and yield; Requirements for germination-re-hydration and water relations, temperature and oxygen relations.

### **Practical**

Seeds germination, monocot, dicot flower & seed structure. Seed priming techniques and their performance under different moisture regimes. Changes in protein and carbohydrate contents of seeds during germination. Determination of enzyme activities (amylase, glutamine synthetase) in germinating seeds.

### **Recommended Books**

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

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

#### **Objective**

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

#### **Theory**

Functional concept of seed production; Recent trends in seed technology and management; Hybrid and synthetic seed production; Seed vigor and quality; Ecological aspects of seed production; Seed certification standards; Seed storage, structures and related problems; Seed industry. Import/export of seed; Seed legislation and quarantine laws; Genetically modified seeds (GMOs); Transgenetics for crop improvement; Seed quality, control and management; Seed fortification and invigoration; Seed health. Organic seed production.

#### **Practical**

Analysis for quality tests: physical purity, seed viability, germination and vigor tests. Seed cleaning, grading, treatment. Seed priming. Sampling techniques involved in seed testing. Visit to seed farms, storage houses and processing plants.

### **Recommended Books**

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

5. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press / Ames, USA .

**AGR-723                      STRESS AGRONOMY                      3(2-1)**

**Objective**

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

**Theory and Stress Agronomy**

Concepts of stress Agronomy; Plant stress factors and their impact on productivity of cropping systems; Types of stresses (water, nutrient, salt, temperature, CO<sub>2</sub>, light, inter and intra plant competition, etc.), Crop responses and adaptation to different stresses and their individual and interactive impact on plant growth and development; Agro-management practices for successful crop husbandry under stress environments.

**Practical**

Experiments will be designed to invoke understanding among the students about plant behavior to various types of stresses. Field visits to demonstrate types of stresses and their impact on crop productivity.

**Recommended Books**

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

**AGR-724                      SUSTAINABLE AGRICULTURE                      3(3-0)**

**Objective**

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

**Theory**

Definition, concept and significance; Evolution of sustainable agriculture; Management practices for sustainable agriculture; Sustainable utilization

of land water, resources and agro-biodiversity; Integrated nutrient management; Sustainable Weed management; Integrated farming systems to sustain farm productivity; Alternate and uses; Agriculture; Climate change and carbon sequestration; Latest research methodologies related to the above topics.

#### **Recommended Books**

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

**AGR-725**

**WATER RELATIONS OF PLANTS**

**3(2-1)**

#### **Objective**

To enhance the understanding of relationship between plants and water.

#### **Theory**

Importance of water in plants; Physical and chemical properties of water; The ascent of sap; The cohesion mechanism, anatomy of pathway; water potential gradient, capillary rise in xylem; Free energy and chemical potential; Water potential and its components; analysis of chemical potential; Standard state, hydrostatic pressure, water activity and osmotic potential; Van't Hoff equation, matric potential; Ohm's law to study the movement of water in the soil-plant atmosphere system.

#### **Practical**

Techniques and experimental approaches for measurement of plant water status: Measurement of water content, water potential, pressure chamber technique and psychrometric techniques. Methods of inducing water stress in plants.

### **Recommended Books**

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

**AGR-726**

**WEED MANAGEMENT**

**3(2-1)**

### **Objective**

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

### **Theory**

Concept of weed management and its significance in modern agriculture; Weed management using principles of competition, Integrated weed management; weed management for field crops, Weed Management for Horticultural crops, Weed management in lawn, turf grass, pastures, forestry and range lands, Management of problematic, parasitic and non-cropped area, Invasive weeds and their management, Herbicide tolerant crops, herbicide resistant weeds and their management, Natural products as lead for new herbicides.

### **Practical:**

Identification and collection of weeds; Demonstration of competitive effect of weeds on crop growth, Determination of critical period of weed interference in crops; use of tillage implements for effective and economical weed control. Testing of herbicide resistance in weeds.

### **Recommended Books**

1. Anderson, W.P. 2007. Weed Science: Principles and Applications. 4<sup>th</sup> Ed. Waveland Pr Inc
2. Andrew H. Cobb and John P.H. Reade. 2010 Herbicide and plant Physiology-2<sup>nd</sup> Edition. Willey Blackwell, UK.
3. Cobb, A.H. and J.P.H. Reade. 2010. Herbicides and Plant Physiology. 2<sup>nd</sup> Ed. Wiley Blackwell, UK.
4. M.K. Upadhyaya and R.E. Blackshaw. 2007. Non-chemical weed management. Principle concepts and technology. Biddle Ltd. Kings Lynh UK.
5. Monaco T.J. 2002. Weed Science Principles and practices-4<sup>th</sup> Edition. Johnwiley & Sons Inc. USA.
6. Tanveer, A., A. Khaliq, A. Ali and M.A. Khan. 2005. Weed Science Research in Pakistan – A Compendium. Agriculture Department,.



Government of Punjab.

7. Zimdahl R.L. 2013. Fundamentals of Weed Science. 4<sup>th</sup> Ed. Academic press.
8. Zimdahl, R.L. 2004. Weed-Crop Competition- a review. 2<sup>nd</sup> Ed. Wiley Blackwell, UK.

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

**Objective**

To develop link about crop production under changing climate.

**Theory:**

Climate and agriculture; Climate variability and change-past, present and future scenario; Impact of climate change in different regions; Influence of climate change on productivity of major and minor crops; Implications of changing climatic scenario for pests, livestock and natural resources; Strategies for managing climate change and vulnerability; Capacity building and action plan for policy makers and planners.

**Recommended Books**

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

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

**Objective**

To introduce and educate students with post-harvest technology of different field crops.

### **Theory**

Concepts, objectives and importance of Post harvest Technology in field crops. Objects of harvesting, threshing, processing, cleaning and grading, Seed treatment and storage. Modern technology of harvesting, threshing, shelling, cleaning, drying, grading of cereal grains. Reaping, beating/threshing, cleaning and drying of wheat and paddy rice. Picking, ginning and separating lint and seed of cotton. Cutting, stripping and topping of sugarcane. Harvesting, beating/threshing and cleaning of grain legumes and oilseeds. Digging, cleaning, topping and washing of root and tuber crops. Marketing of field crop products.

### **Practical**

Demonstration of harvesters, reapers and pickers, threshers, air screen cleaners (Wheat and paddy) and ginners (Cotton). Field demonstration for sugarcane cutting and sugar beet digging by manual methods. Seed processing, cleaning, grading and packing practices in cereals, legumes, oilseeds, condiments, spices and vegetables etc. Visits of local farms.

### **Recommended Books**

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

**AGR-729**

**SPECIAL PROBLEM**

**1(0-1)**

### **Objective**

To broaden student capacity for handling a project independently.

Preparation of research proposals for plant science. Field/Laboratory Experiment. Collection, Compilation and presentation. Interpretation of results and report writing by the student.

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



### **LIST OF RECOMMENDED BOOKS FOR AGRONOMY**

1. Abbas, M.A. 2006. General Agriculture. Emporium Urdu Bazar, Lahore.
2. Advances in Agronomy, All volumes. Academic Press Inc., New York.
3. Vanangamudi, K. Advances in Seed Science and Technology. 2008. AgroBios, India.
4. Agronomy for Sustainable Development. All volumes of last three years. INRA-CMSE-PME, Dijon, Francis and Springer, The Netherlands.
5. Ahmad, N. and A. Hamid. 1997. Plant Nutrients Management for Sustainable Agriculture Growth. Proc. Symposium held on December 8-10, 1997. Planning & Development Division, National Fertilizer Development Center, Islamabad.
6. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
7. Ahrens, C.D. 2008. Meteorology Today Brooks/Cole Cengage Learning, Belmont, USA.
8. Alan G. Clewer and David H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, Ltd. Chichester, England.
9. Ali, M.H. 2011. Practice of irrigation and on-farm water management Vol. 2, Springer, New York, USA.
10. Ali, M.H. 2010. Fundamentals of irrigation and on-farm water management Vol. 1, Springer, New York, USA.
11. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London.
12. Allen R. O and R. V. Scholtz III 2002. Mathematical Models of Crop Growth and Yield. CRC Press, USA.
13. Altaf, Z. and A. Qarshi. 2013. Medicinal Plants. Qarshi Industries, Lahore.
14. Anboumozhi, V., M. Breiling, S. Pathmarajah and V.R. Reddy. 2012. Climate Change in Asia and the Pacific: How can Countries Adapt? SAGE Publication India Pvt. Ltd.
15. Anderson, W.P. 2007. Weed Science Principles and Application. 4<sup>th</sup> Ed. West Publishing Co. St. Paul. New York.
16. Andrew H. Cobb and John P.H. Reade. 2010 Herbicide and Plant physiology. 2<sup>nd</sup> Ed. Willey Blackwell, UK.
17. Anonymous. 2001. A Dictionary of Seed Technological terms. Kalyani Publisher, India.

18. Anonymous. 1988. Publications Handbook and Style Manual. ASA-CSSA-SSSA, Madison.
19. Anonymous. 1992. Proceeding of International Seminar on Seed, Fauji Fertilizer Corporation. Islamabad.
20. Anonymous. 1997. Irrigation Agronomy Manual. Ministry of Food Agriculture and Livestock, Islamabad.
21. Anonymous. 1999. Sustainable Agriculture Solutions. Novellow Press, Ltd., London.
22. Arnon, I. 1992 Agriculture in Drylands: Principles and Practices. Elsevier Amsterdam.
23. ASA. 1995. Climate Change and Agriculture: Analysis of Potential International Impacts. ASA Special Publication No. 59. American Society of Agronomy, Inc., Madison, Wisconsin, USA
24. Ashiq, M., M.M. Nayyar and J. Ahmad. 2003. Weed Control Hand Book. Directorate of Agronomy, AARI, Faisalabad.
25. Balasubramaniyan, P. and S.P. Palaniappan. 2009. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
26. Balasubramaniyan, P. and S.P. Palaniappan. 2005. Principles and Practices of Agronomy. Agrobios, Jodhpur, India.
27. Baldev, B., S. Ramamjan and H.K. Jain. 1988. Pulse Crops. Oxford and IBH Pub. Co., New Delhi.
28. Basak, R.K. 2004. Soil Testing and Recommendation. Kalyani Publisher, New Delhi.
29. Bashir, E. and R. Bantel. 1996. Soil Science. National Book Foundation, Islamabad.
30. Basra, A.S. (Ed). 2006. Handbook of Seed Technology. Haworth Press New York, USA.
31. Beatley. T., D. Brower and A. Schwab. 2002. An Introduction to Coastal Zone Management. Island Press, 1718 Connecticut Avenue, N.W. Suite 300, Washington, D.C.
32. Bennett, H.H. 2003. Soil Conservation for Sustainable Agriculture. Agrobios, Jodhpur, India.
33. Beth, Lanfalvaj, C.J. and R.C. Linduman. 1992. Mycorrhizae in Sustainable Agriculture, Pub. No. 54. ASA. Madison, USA.
34. Bewley, J.D. and M. Black. 1994. Seeds: Physiology of Development and Germination. 2<sup>nd</sup> Ed. Plenum Press, New York.
35. Bhatti, I.M. and A.H. Soomro. 1996. Agricultural Inputs and Field Crop Production in Sindh, Directorate General, Agri., Res. Institute, Sindh, Hyderabad.
36. Brown C.S. and T. Toadwine. 2007. Nature's Edge- Boundary Explorations in ecological theory and practice. State University of New York Press, Albany, USA.
37. Brunt, D. 2007. Meteorology. Oxford University Press, UK.
38. Byerlee, D. and T. Hussain, 1992. Farming Systems of Pakistan. Vanguard Books, Lahore.

39. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
40. Causton, D.R. and J.C. Venus. 1981. The Biometry of Plant Growth. Edward Arnold, London.
41. Chandrasekaran, B.K., Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International Pub., New Delhi, India.
42. Choudhary, M.R. 2009. A Text book of irrigation and Drainage Practices for Agriculture. University of Agric. Faisalabad, Pakistan.
43. Cobb, A.H. and J.P.H. Reade. 2010. Herbicides and Plant Physiology. 2<sup>nd</sup> Ed. Wiley Blackwell, UK.
44. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. Techniques in Bioproductivity and Photosynthesis, 2<sup>nd</sup> Ed. Pergamon Press, Oxford.
45. Copeland L.O. and M.F. McDonald. 2001. Principles of Seed Science and Technology. 4<sup>th</sup> Ed. Burgess Pub. Co., USA.
46. Critical Review in Plant Sciences. All Volumes. Taylor and Francis, New York.
47. Dahama, A.K. 2002. Organic Farming for Sustainable Agriculture. 2<sup>nd</sup> Ed. Agrobios, Jodhpur, India.
48. Das, N.R. 2006. Agronomic Research Management. Agrotech Publishing Academy, Udaipur, India.
49. Das, P.C. 2000. Crops and their production technology under different conditions. Kalyani Publishers, New Delhi, India.
50. Dixit, R.S. 2007. Cropping System Research. Kalyani Publishers, New Delhi, India.
51. Dovrat, A. 1993. Irrigated Forage Production. Elsevier Scientific Publishers, The Netherlands.
52. Dris, R., J. Mohan and I.A. Khan. 2002. Environment and Crop Production. Science Pub. Inc., New York.
53. Epstein, E. and A. J. Bloom. 2004 Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
54. Eric, L. 2009. Organic Farming, Pest Control and Remediation of Soil Pollutants. Springer Dordrecht Heidelberg, Germany.
55. European Journal of Agronomy. All Volumes. Elsevier, Amsterdam, the Netherlands.
56. Fageria. N.K. 2009. The Use of Nutrients in Crop Plants. CRC Press, London.
57. Fitter, A.H. and R.K.M. Hay. 2002. Environmental Physiology of Plants. 3<sup>rd</sup> Ed. Academic Press, Inc., London.
58. Floor M.B. and M. van Ittersum. 2010. Environmental and Agricultural Modeling: Integrated Approaches for Policy Impact Assessment, Springer, Heidelberg, Germany.
59. Fossel, P.V. 2007. Organic Farming: Everything you need to know. MBI Publishing Co., USA.

60. France, J. and J.M.M. Thornley, 1984. *Mathematical Models in Agriculture*. Butter-worths, London.
61. G.O.P. 1997. *Irrigation Agronomy Manual*. Ministry of Food Agriculture and Livestock, Islamabad.
62. George A. 2004. *Principles of Crop Production: Theory, Teaching and Technology*. Printice Hall, New Jersey, USA.
63. Ghani, M.A. and E. Ahmad. 2000. *Principles of Accounting*. Pak. Imperial Book Depot, Chowk Urdu Bazar, Lahore.
64. Gliessman, S.R. 2007. *Field and Laboratory Investigations in Agroecology*. 2<sup>nd</sup> Ed. Taylor and Francis, USA.
65. Gomez, K.A. and A.A. Gomez, 1984. *Statistical Procedures for Agricultural Research*. 2<sup>nd</sup> Ed. John Wiley and Sons, New York, USA.
66. Govindan, K. and Thriumurugam. 2003. *Principles and Practices of Dry Land Agriculture*. Kalyani Publishers, New Delhi, India.
67. Guar, R.K. and P. Sharma, 2014 *Approaches to Plant Stress and their Management*. Springer, India
68. Gupta, U.S. 1992. *Crop Improvement*. Vol. I. *Physiological Attributes*. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
69. Gupta, U.S. 2005. *Physiology of Stressed Crops: Nutrient relations*. Science Pub., India.
70. Gurevitch, J., M. Schiner and A.F. Gordon. *The Ecology of Plant*. 2<sup>nd</sup> Ed. 2006. State University of New York.
71. Gurmel, S., C. Venkatarmanan, G. Sastry and B.P. Joshi. 1990. *Manual of Soil and Water Conservation Practices*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
72. Hall, A.E. 2001. *Crop Responses to Environment*. CRC Press, Boca Raton, Florida, USA.
73. Hammer, G.L., N. Nicholls and C. Mitchell. 2000 *Application of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems*. Kluwer Academic Publisher, London.
74. Hansen, A.P. 1994. *Symbiotic N<sub>2</sub> fixation of crop legumes*. Margref verleg weikenheim, Germany.
75. Hari, M., S. Seshadri, K. Perumal. 2010. *Biofertilizer (Phosphobacteria)*. Shri AMM Murugappa Chettiari Research Centre, India.
76. Harinder P.S., D.R. Batish and R.K. Kohli. 2006. *Handbook of Sustainable Weed Management*. Haworth Press, USA.
77. Hashmi, N. 1989. *Style Manual of Technical Writing*, 2<sup>nd</sup> Ed. Pakistan Economic Analysis Network Project. Ministry of Food and Agric., Islamabad.
78. Havlin, J.L., Tisdale, S.L., J.D. Beaton and W.L. Nelson. 2005. *Soil Fertility and Fertilizers*. 7<sup>th</sup> Ed. Macmillan Publishing Co., New York, USA.

79. Hay, R.K.M. and J.R. Porter. 2006. *The Physiology of Crop Yield*. 2<sup>nd</sup> Ed. Wiley-Blackwell, USA.
80. Hester, R.E. and R.M. Harrison. 2005. *Sustainability in Agriculture*. Vol. 21. RSC Publishing, Thomas Graham House, Sci. Park, Milton Road, Cambridge, UK.
81. Hillel, D. and C. Rosenzweig. 2013. *Handbook of Climate Change and Agroecosystems: Global and Regional Aspects and Implications*. Imperial College Press, London, UK.
82. Hinrichsen, D., 1998. *Coastal Waters of the World: Trends, Threats, and Strategies*. Island Press, Washington, DC, USA
83. Hudson, N.W. 2004. *Soil and Water Conservation in Semi-arid Areas*. Scientific Publishers, India.
84. Hunt, R. 1978. *Plant Growth Analysis*. Edward Arnold, London.
85. Hunt, R. 1982. *Plant Growth Curves: An Introduction to the Functional Approach to Plant Growth Analysis*. Edward Arnold, London.
86. Hussain, S.S. 2003. *Manual of Plant Ecology*. National Book Foundation, Islamabad.
87. Hussain, T. and A. Jabbar. 1985. *Soil and Plant Analysis*. Department of Soil Science, University of Agriculture, Faisalabad.
88. ICIMOD. 1997. *Appropriate Farm Technologies in Arid and Semi-Arid Mountainous Areas of Pakistan*. Katmandu, Nepal.
89. IFPRI. 2012. *Reshaping Agriculture for Nutrition and Health*. International Food Policy Research Institute, Washington DC, USA.
90. IIMI. 1997. *Salinization, Alkalinisation and Sodification on Irrigated Areas in Pakistan*. Lahore.
91. ISTA. 1996. *International Rules for Seed Testing*, Vol. 26, 31, 35, and 37. Proceedings of International Seed Testing Association, Zurich, Switzerland.
92. Jaya K.R. and R. Jagannathan. 2007. *Weed Science Principles*. Kalyani Publishers, New Delhi.
93. Thornley, J. H.M. and I. R. Johnson. 2000. *Plant and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology*. The Blackburn Press, Caldwell, New Jersey, USA.
94. John H. Martin, R. P. Waldren and D. L. Stamp. 2006. *Principles of Field Crop Production* 4<sup>th</sup> Ed. The McMillan Co., New York.
95. John L.H., J.D. Beaton, S.L. Tisdale, and W.L. Nelson. 2010. *Soil Fertility and Fertilizers-An introduction to nutrient management*, 7<sup>th</sup> Ed. Pearson Prentice Hall, New Delhi, India.
96. John R. Clark. 1995. *Coastal Zone Management Handbook*. Mote Marine Laboratory of Sarasota, Florida, USA.
97. John R. Clark. 1998. *Coastal Seas: The Conservation Challenge*. 989 Market Street San Francisco, CA.
98. Johnson, C.B. 1981. *Physiological Processes Limiting Plant*



- Productivity. Butterworths, London.
99. Jones, J. Benton. 2012. Plant Nutrition and Soil Fertility Manual. 2<sup>nd</sup> Ed. CRC Press, Taylor & Francis, London, UK.
  100. Kapur, P. and R.G. Sudha. 2000, Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
  101. Kay, R. and J. Alder. 2005. Coastal Planning and Development. Taylor and Francis, London.
  102. Khalil, S.K. and P. Shah, 2007. Scientific Writing and Presentation. HEC Monograph, Islamabad.
  103. Khan, S.R.A. 2001. Crop Management with focus on soil and water. Agric. Dept. Govt. of Punjab, Lahore.
  104. Khare, D. and M.S. Bhale. 2000. Seed Technology. Sci. Pub., India.
  105. Kirkham, M.B. (Editor). 2004. Water Use in Crop Production. Narosa Publishing House Pvt. Ltd. New Delhi, India.
  106. Kirkham, M.B. 2004. Principles of Soil and Water Relations, Academic Press, London.
  107. Kohli, K.R., H.P. Singh and D. R. Batish. 2004. Allelopathy in Agroecosystems. IDBC Lucknow, India.
  108. Kramer, P.J. and J.S. Boyer. 1995 Water Relations of Plants and Soils. Academic Press, San Diego, USA.
  109. Krishna, K.R. 2002. Soil Fertility and Crop Production. Oxford and IBH publishing Co. New Delhi, India.
  110. Kumar, H.D. 1994. Modern Concepts of Ecology. 7<sup>th</sup> Ed. Vikas Pub. House New Delhi.
  111. Kumar, R.J. and R. Jagannathan. 2007. Weed Science Principles. 2<sup>nd</sup> Ed. Kalyani Publisher, Ludhiana, India.
  112. Lambers, H., F.S. Chapin, and T.L. Pons. 2009. Plant Physiological Ecology. Springer-Verlag, Inc., New York.
  113. Lampkin, N. 2002. Organic Farming. Old Pond Publishing. UK.
  114. Larcher, W. 2003. Physiological Plant Ecology. 4<sup>th</sup> Ed., Springer Verlag, Berlin.
  115. Lauchli, A. and U. Luttge. 2002. Salinity: Environment-plant-molecules. Lavoisier, France.
  116. Leclergy, E.L., W.H. Leonard and A.G. Clark. 1980. Field Plot Technique, Reprinted by the National Book Foundation, Islamabad.
  117. Lenk, D. 2006. Commercial Spice Crops. Kalyani, Publishers, New Delhi.
  118. Lichtfouse, E.M. Nanarrete, B. Debacke, and V. Souchere. 2009. Sustainable Agriculture. Springer, The Netherland.
  119. Loomis, R.S. 1992. Crop Ecology. Productivity and Management in Agricultural System. Cambridge University Press, U.K.
  120. Khan, M.A. 2012. Water Resources Management and Sustainable Agriculture.

121. Upadhyaya, M.K. and R.E. Blackshaw. 2007. Non-chemical weed management. Principle concepts and technology. Biddle Ltd. Kings Lynh, UK.
122. Macias, F.A., C.G. Galindo and J.M. G. Molinillo. 2003. Alleopathy: Chemistry and Mode of Action of Allelochemicals. CRC Press, New York, USA.
123. Majeedano, H.I. 2012. Agro Digest. Agriculture Research Institute, Tandojam.
124. Maloo, S.R. 2002. Sustainable Crop Production under Stress Environments. Geeta Soman; Agrotech Publishing Academy, Udaipur, India.
125. Marschner, H. 1995. Mineral Nutrition of Higher Plants. Elsevier, Amsterdam.
126. Martha, D. 2005. Scientific Papers and Presentations. Academic Press, San Deigo, California, USA.
127. Mavi, H.S. and G.J. Tupper. 2005. Agrometeorology: Principles and Application of Climate Studies in Agriculture. International Book Distribution Co., Lucknow, India.
128. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press, Ames, USA.
129. Mead, R. 2003. Statistical Methods in Agricultural & Experimental Biology. 3<sup>rd</sup> Ed. Pak Book Corp. Lahore.
130. Mengel, K., E.A. Kirkby, H. Kosegarten and T. Appel. 2001. Principles of Plant Nutrition. 5<sup>th</sup> Ed. International Potash Institute, Bern, Switzerland.
131. Michael, M.A. 2003. Irrigation Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi. India.
132. Misra, R.D. and M. Ahmad. 1990. Manual of Irrigation Agronomy. Oxford and IBH Publishing Co., New Delhi.
133. Pessarakli, M. 2008. Handbook of Turf Grass Management and Physiology, CRC Press, UK.
134. Monaco T.J. 2002. Weed Science Principles and practices-4<sup>th</sup> Ed. John Wiley & Sons Inc., USA.
135. Moses, B. and Carson. 2009. Book Keeping and Accounts for Beginners. Custom Books, India.
136. Muhammad, F. 2004. Statistical Methods and Data Analysis. Abid Umair Printing Press, Faisalabad.
137. Mukherjee, A.K. and S.Maiti. 2009. Forage Crop Production and Conservation. Kalyani Publishers, New Delhi, India.
138. Murthy, V. 2002. Basic Principles of Agricultural Meteorology. Pak Book Corp. Lahore.
139. Das, N.R. 2008. Tillage and Crop Production, Sci. Pub., India
140. Narayan, D.P., S.S. Purohit, A.K. Sharma and Tarun, K. 2003. A Handbook of Medicinal Plants. Agrobios, India.

141. Naylor, R.E.L. 2002. Weed Management, Principles and Practices Practices. Blackwell Science, UK.
142. Nazir, M.S., E. Bashir and R. Bantel. (Eds.) 1994. Crop Production. National Book Foundation, Islamabad.
143. Niir, B. 2004. The Complete Technology Book on Bio-Fertilizer and Organic Farming. National Institute of Industrial Research, India.
144. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology. Academic Press, San Diego, New York.
145. Nosberger, J.H.H. Geiger and P.C. Struik. 2001. Crop Science Progress and Prospects. CABI Pub., Oxon, UK.
146. Palaniappan, and K. Annadurani. 2006. Organic Farming Theory and Practice. Scientific Publishers. Jodhpur, India.
147. Panda, B.C. 2009. Remote Sensing; Principles and Applications. Viva Books Pvt. Ltd. 4737/23, Ansari road, New Delhi-110002. India.
148. Panda, S.C. 2005. Agronomy. Agrobios, Jodhpur, India.
149. Panda, S.C. 2006. Crop Management and Integrated Farming. Agrobios, Jodhpur, India.
150. Paul C. Struik. 2007. Plant Research International and Wageningen University, Netherland
151. Pearcy, R.W., J.R. Ehleringer, H.A. Mooney and P.W. Rundal. 1989. Plant Physiological Ecology: Field Methods and Instrumentation. Champman and Hall, London, New York.
152. Pessarakli, M. (Ed.). 2014. Handbook of Plant and Crop Physiology, 3rd Ed. Taylor and Francis, Boca Raton, USA.
153. Pessaraskli, M.A. (Ed.). 2000. A. Hand Book of Stress Physiology, Marker and Deekar.
154. Petersen, R.G. 1994. Agricultural Field Experiments: Design and Analysis. Marcel Dekker AG., Switzerland.
155. Powles, S.B. and J.A.M. Holtum. 1994. Herbicide Resistance in Plants: Biology and Biochemistry, Lewis Pub., Albany, USA.
156. Prado, R. De. J. Jossin and L.G. Torres. 1997. Weed and Crop Resistance to Herbicides. Kluwer Academic Publishers. Dordrecht/Boston/London.
157. Prasada, Rao, G.S.L.H. 2008. Agricultural Meteorology. Printice Hall of India, New Delhi.
158. Premjit Sharma, 2007. Precision Farming, Gene Tech. Book, New Delhi, India
159. Prihar S.S. 2003. Intensive Cropping, Efficient use of Water, Nutrients, and Tillage. Pak Book Corp. Lahore.
160. Pritchard, S.G., J.S. Amthor. 2005. Crops and Environmental Changes: an introduction of global warming. CSSA, Madison, Wisconsin, USA.
161. Qureshi, M.A. M.A. Zia and M.S. Qureshi. 2006. Pakistan

- Agriculture Management and Development. A-One Publisher, Urdu Bazar, Lahore.
162. Rachel, F., S. Heather and T. Robbin. 2012. All the Dirt: Reflections on Organic Farming. TouchWood Editions, Canada.
  163. Rahman, A. and M. Munir. 1984. Rapeseed, Mustard Production in Pakistan, PARC, Islamabad.
  164. Rao, V.S. 2002. Principles of Weed Science. Science Publishers. U.S.A.
  165. Rashid, A. and K.S. Memon. 2005. Soil Science. Ed. E. Bashir and R. Bantel. National Book Foundation, Islamabad.
  166. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York.
  167. Ravindra, S. 2004. Agro-Techniques of Medicinal Plants. Daya Publishing House, New Delhi, India.
  168. Reddy, S.R. 2004 Principles of Crop Production. 2<sup>nd</sup> Ed. Kalyani Publ., New Delhi.
  169. Reddy, T.Y. and G.H.S. Reddy. 2002. Principles of Agronomy. 3<sup>rd</sup> Ed., Kalyani Pub., New Delhi.
  170. Reigosa, M.J., N. Petdrol and L. Gonzalez. 2006. Allelopathy: A physiological process with ecological implications. Springer, Heidelberg, Germany.
  171. Rice, E.L. 1997. Allelopathy. 4<sup>th</sup> Ed. Academic Press, Inc. Orlando, Florida, USA.
  172. Ross, C.W and F.B. Salisbury. 2011. Plant Physiology 5<sup>th</sup> Ed., Wadsworth Publ. Co., Belmont, California, USA.
  173. Ross. M.A. and C.A. Lembi, 2009. Applied Weed Science: including the Ecology and Management of Invasive plants. 3<sup>rd</sup> edition, Practice Hall, USA.
  174. Rowan, S. C., T.T. Richer, J.W. Jael. G.Y. Tsuji and Hi Ledyard. 1995 Climate Change Agriculture: Analysis of potential international impact ASA Special Publication, USA.
  175. Ryan, J., G. Estefan and A. Rashid. 2001. Soil and Plant Analysis Laboratory Manual. 2<sup>nd</sup> Ed., ICARDA, Aleppo, Syria and NARC, Islamabad, Pakistan.
  176. Sankara, R.G.H. and T.Y. Reddy. 2002. Efficient Use of Irrigation Water. Kalyani Publishers, New Delhi.
  177. Schultz, E.D. 2005. Plant Ecology. Springer Verlag, Berlin. Heidelberg.
  178. Schulze, E.B. and K. Muller-Hohenstein. 2005. Plant Ecology. State University of New York, USA.
  179. Sergey Shabla, 2012. Plant stress Physiology.
  180. Shamshad, K.M. 1988. The Meteorology of Pakistan. Royal Book Co., Karachi.
  181. Sharma, K. 2005. Hand Book of Agriculture. Indian Council of Agricultural Research, New Delhi

182. Sharma. R. 2004. Agro-techniques of Medicinal Plants. Daya Publishing House, Delhi.
183. Shaw, T. 2010. Dry land Farming. Nabu Press, USA.
184. Shrestha, A. 2003 Cropping System. Food Products Press. Haworth Press, Inc. Binghamton, New York NY.
185. Shrestha, A. 2003. Cropping Systems Trends and Advances. Food Products Press, Binghamton, NY, USA.
186. Shukla, R.S. and P. S. Chandel, 2006. A Text Book of Plant Ecology. S. Chand & Co. Ltd. New Delhi, India.
187. Singh G. 2000. Economics of Seed Production at Farm level. Pak Book Corp. Lahore.
188. Singh, A.K., M.A. Khan, N. Subash and K.M. Singh. 2011. Forages and Fodders. Daya Publishing House, Delhi, India.
189. Singh, J.V., B.S. Chhilar, B.D. Yadav and U.N. Joshi. 2010. Forage Legumes. Scientific Publishers, Jodhpur, India.
190. Singh, N.P. and R.A. Singh. 2002. Scientific Crop Production. Kalyani Publishers, Ludhiana, India.
191. Singh, P. 2008. Modeling Crop Production Systems: Principles and applications. Science publishers. Enfield, New Hampshire 03784. USA
192. Singh, S.S. 1998. Crop management under irrigated and rain fed conditions, 3rd Edition. Kalyani Publishers, New Delhi.
193. Singh, S.S. 2003. Soil Fertility and Nutrient Management. Kalyani Publishers, India.
194. Sivakumar, M.V.K. and R. P. Motha. 2007. Managing Weather and Climate: Risks in Agriculture. Springer, Berlin, Heidelberg, New York.
195. Sivakumar, M.V.K. and J. Hansen. 2007. Climate Predictions and Agriculture. Springer, Berlin, Heidelberg, New York.
196. Sivakumar, M.V.K. and R.P. Motha. 2005. Increasing Climate Variability and Change: Reducing the vulnerability of agriculture and forestry. Springer, Dordrecht, The Netherland.
197. Stacy, G., R.H. Burris and H.J. Evans. 1992. Biological Nitrogen Fixation. Chapman and Hall, London.
198. Stanwood, P.C. and M.B. McDonald. 1989. Seed Moisture. ASA, Madison, Wisconsin.
199. Steel, R.G.D., J.H. Torrie and D. Dickey. 1997. Principles and Procedures of Statistics: A Biometric Approach, 3rd Ed. McGraw Hill Book Co. Inc., New York. USA.
200. Stephen B. Pawles and Dale L. Shanner. 2001. Herbicide Resistance and World Grain. CRX press LLC,
201. Stoskopf, N.C. 1981. Understanding Crop Production. Reston. Pub. Co., Inc. Reston, Virginia.
202. Sukumar, B., 2008. Water Quality Management for Coastal Aquaculture. Daya Publishing House, India.

203. Sustainable Agriculture Reviews. All volumes of last three years. Springer, the Netherlands.
204. Taize, L. and E. Zeiger. 2002. Plant Physiology 3rd ed. Sinauers Associate, Inc. Sunderland, Massachusetts, USA.
205. Taize, L. and E., Zeiger. 2010. Plant Physiology 5th Ed. Sinauers Associate, Inc. Sunderland, Massachusetts, USA.
206. Tandon, H.L.S (Ed.). 2001. Methods of Analysis of Soils, Plants, Waters and Fertilizer. Development and Consultation Organization, New Delhi, India.
207. Tanveer, A. 2008. Biology and Ecology of Weed. HEC, Pakistan.
208. Tanveer, A., A. Khaliq, A. Ali and M.A. Khan. 2005. Weed Science Research in Pakistan – A Compendium. Agriculture Department, Government of Punjab.
209. Tivy, J. 1990. Agricultural Ecology. Longman Group U.K. Ltd. Essex.
210. Townsend, C.R., Harper, J.L. and M.E. Bego. 2000. Essentials of Ecology. Blackwell Scientific Publications, UK.
211. Trivedi, P. C. 2011. Organic farming for sustainable Agriculture. Aavishkar Publishers, Distributors. Jaipur (Raj) India.
212. Tsuji, G.Y., G. Hoogenboom, and P.K. Thornton. 1998. Understanding Options for Agricultural Production. Kluwer Academic Publishers, Dordrecht, Boston, London.
213. Tunio, S.D. 2004. Condiment Crops. Directorate of Agriculture Information, Hyderabad, Sindh.
214. Tunio, S.D. 2010. Vegetables and Spices of Sindh. Roshni Publication, Kandiaro.
215. Turner, N.C. and P.J. Kramer. 1980. Adaptation of Plants to Water and High Temperature Stress.
216. Virmani, S.M.J. C. Katyal, Eswaru, and I.P. Abarol. 1994. Stressed Ecosystems and Sustainable Agriculture. Oxford & IBH Pub. Co., New Delhi.
217. Vohnout, K.D. 2003. Mathematical modeling for system analysis in agricultural research. Elsevier science B.V. Sara Burgerharstraat 25, Amsterdam, the Netherlands.
218. Walia, U.S. 2003. Weed Management. Kalyani Publishers, New Delhi, India.
219. Walia. U.S. 2010. Weed Management. Kalyani Publishers B-1/292. Rahinder Nagar. Ludhiana-141008.
220. Wallach, D., D. Makowski, J.W. Jones. 2006. Working with Dynamic Crop Models Evaluation, Analysis, Parameterization, and Applications. Elsevier science B.V. Sara Burgerharstraat 25, Amsterdam, The Netherlands.
221. Weixing, C., W.W. Jeffrey and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
222. Westerman, R.L. 1990. Soil Testing and Plant Analysis. 3rd Ed.

- Soil Sci. Am. Inc., Madison, WI, USA.
223. William, L. 2007. Organic Farming an International History. CAB International, UK.
  224. Wolfe, T.K. and M.S. Kipps. 2004. Production of Field Crop: A Textbook of Agronomy. McGraw Hill Book Co. New York.
  225. Wood, F. and Sheila Robinson 2009. Book Keeping and Accounts. 7th Ed. Trans-Atlantic Publication Inc. India.
  226. Yi- Peng Wang, Min Lee, Zhe- Xian Tian, William E. Newton. (eds.). 2005. Biological Nitrogen Fixation, sustainable agriculture and the environment. Proc. 14th Int. Congress Biological Nitrogen Fixation. Springer, Netherlands.
  227. Youdeowei, A., P. Stapleton, and R. Obubo. (eds.). 2012. Scientific Writing for Agricultural Research Scientists-A Training Resource Manual, Wageningen, The Netherlands.
  228. Zeng, R.S, A.U. Mallik and S.M. Luo. 2008. Allelopathy in Sustainable Agriculture and Forestry. Springer, USA.
  229. Zimdahl R.L. 2013. Fundamentals of Weed Science. 4th Ed. Academic press.
  230. Zimdahl, R. 2012. Weed Science A plea for thought-Revisited. Springer press Heidelberg New York.
  231. Zimdahl, R.L. 2004. Weed-Crop Competition- a review. 2<sup>nd</sup> Ed. Wiley Blackwell, UK.
  232. Ziska, L.H. and J. S. Duke. 2011. Weed Biology and Climate Change. John Willey, Hoboken, NJ, USA.

**DETAIL OF COMPULSORY COURSES  
IN ENGLISH FOR  
UNDERGRADUATE LEVEL**

**English I (Functional English)**

**Credit Hrs. 3**

**Objective:** Enhance language skills and develop critical thinking.

**Course Contents**

Basics of Grammar

Parts of speech and use of articles

Sentence structure, active and passive voice

Practice in unified sentence

Analysis of phrase, clause and sentence structure

Transitive and intransitive verbs

Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

*Note: Extensive reading is required for vocabulary building*

**Recommended Books**

1. **Functional English**

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492



2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
- b) Writing
    1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
  - c) Reading/Comprehension
    1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
  - d) Speaking

**English II (Communication Skills)**

**Credit Hrs. 3**

**Objective**

Enable the students to meet their real life communication needs.

**Course Contents**

**Paragraph writing**

Practice in writing a good, unified and coherent paragraph

**Essay writing**

Introduction

**CV and job application**

Translation skills

Urdu to English

**Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

**Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

**Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review.*

**Recommended Books:**

**Communication Skills**

- a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
  2. Reading and Study Skills by John Langan
  3. Study Skills by Richard Yorkey.

### **English III (Technical Writing and Presentation Skills) Crh. 3**

#### **Objective**

Enhance language skills and develop critical thinking

#### **Course Contents**

##### **Presentation skills**

##### **Essay writing**

Descriptive, narrative, discursive, argumentative

##### **Academic writing**

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

##### **Technical Report writing**

##### **Progress report writing**

*Note: Extensive reading is required for vocabulary building*

#### **Recommended Books**

Technical Writing and Presentation Skills

##### a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for

discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

## ISLAMIC STUDIES (COMPULSORY)

### Objective:

This course is aimed at:

- 1 To provide Basic information about Islamic Studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

### Detail of Courses

#### Introduction to Quranic Studies

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul-Quran

#### Study of Selected Text of Holy Quran

- 1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- 5) Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

#### Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Ihزاب Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

#### Seerat of Holy Prophet (S.A.W) I

- 1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah

- 3) Important Lessons Derived from the life of Holy Prophet in Makkah

#### **Seerat of Holy Prophet (S.A.W) II**

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important Events of Life Holy Prophet in Madina
- 3) Important Lessons Derived from the life of Holy Prophet in Madina

#### **Introduction To Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

#### **Selected Study from Text of Hadith**

##### **Introduction To Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

##### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

##### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quran & Science

##### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

##### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty
- 3) Basic Institutions of Govt. in Islam

**Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

**Social System of Islam**

- 1) Basic Concepts of Social System of Islam
- 2) Elements of Family
- 3) Ethical Values of Islam

**Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

## PAKISTAN STUDIES (COMPULSORY)

### Introduction/Objective

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

### Course Outline

#### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

### Recommended Books

1. Burki, Shahid Javed. *State & Society in Pakistan*, the Macmillan Press Ltd 1980.

2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.



## COMPULSORY MATHEMATICS COURSES FOR BSC (HONS) AGRICULTURE

### 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

**Boston (suggested text)**

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston.

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

*Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

*Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

**Recommended Books**

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley, New York

Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)

Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston

Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA

## 3. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of

equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle*: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections*: Parabola, ellipse, hyperbola, the general-second-degree equation

**Recommended Books:**

Abraham S, *Analytic Geometry*, Scott, Freshman and Company, 1969  
Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston  
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

*Note:*

1. *Two courses will be selected from the following three courses of Mathematics.*
2. *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

## **STATISTICS-I**

### **Credit 3 (2-1)**

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

#### **Practicals**

- a. Frequency Distribution
- b. Stem-and-Leaf digram
- c. Various types of Graphs
- d. Mean, Geometric mean Harmonic Mean,
- e. Median, Quartiles Deviation, mean Deviation.
- f. Standard Deviation, Variance, Coefficient of variation,
- g. Skewness and kenosis

#### **Recommended Book**

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crawshaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomes J. Keans

#### **Statistics-II**

### **Credit 3 (2-1)**

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and

type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using  $\chi^2$  (chi-square) Testing hypothesis about variance.

#### **Practical**

- a. Sampling random sampling
- b. Stratified random sampling.
- c. Sampling distribution of mean
- d. Testing of hypotheses regarding population mean
- e. Testing of hypotheses about the difference between population means
- f. Chi-square test
- g. Testing of Correlation Coefficient
- h. Fitting of simple linear regression
- i. One-way ANOVA
- j. Two-way ANOVA

#### **Recommended Book**

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2<sup>nd</sup> Edition, 1980 by R.G.D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K.A. Gomez and A.A. Gomez

**Note:** *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

**Course Name:**

## **INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGIES**

**Course Structure:** Lectures: 2 Labs: 1 **Credit Hours: 3**  
**Pre-requisite: None** **Semester: 1**

**Course Description:**

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and world wide web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT.

**Course Contents**

- Basic Definitions & Concepts
- Hardware: Computer Systems & Components
- Storage Devices, Number Systems
- Software: Operating Systems, Programming and Application Software
- Introduction to Programming, Databases and Information Systems
- Networks
- Data Communication
- The Internet, Browsers and Search Engines
- The Internet: Email, Collaborative Computing and Social Networking
- The Internet: E-Commerce

- IT Security and other issues
- Project Week
- Review Week.

**Text Books/Reference Books:**

Introduction to Computers by Peter Norton,6th International Edition (McGraw HILL) Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition (McGraw HILL) Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer Fundamentals of Information Technology by Alexis Leon, Mathewsleon Leon Press.

**Functional Biology-I**

***Credit Hours 3+0***

**Biological Methods**

Principles of Cellular Life  
 Chemical Basis  
 Structure and Function  
 Principles of Metabolism  
 Energy Acquisition

**Principles of Inheritance**

Mitosis and Meiosis  
 Chromosomes  
 Observable Inheritance Patterns  
 DNA Structure and Function  
 RNA and Proteins  
 Genes  
 Genetic Engineering and Biotechnology

**Biodiversity**

Fundamental Concept of Biodiversity  
 One or two examples of each of the following from commonly found organism  
 Prions  
 Viruses  
 Bacteria  
 Protistans  
 Algae  
 Fungi  
 Plants  
 Crops  
 Animals

Invertebrates  
Vertebrates

**Reading**

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**Functional Biology-II**

***Credit Hours 3+0***

Myths and Realities of Evolution  
Microevolution  
Speciation  
Macroevolution  
Level of Organization

Plants

Tissues  
Nutrition and Transport  
Reproduction  
Growth and Development

Animals

Tissue, Organ System and Homeostasis  
Information Flow and Neuron  
Nervous System  
Circulation and Immunity  
Nutrition and Respiration  
Reproduction and Development

Ecology and Behavior

Ecosystems  
Biosphere  
Social Interactions  
Community Interactions  
Human Impact on Biosphere  
Environment Conservation

**Reading**

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.



2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**Note:** *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

## Recommendations

After thorough discussion, the participants of the National Curriculum Revision Committee in Agronomy 2014 formulated the following recommendations for uniform and effective implementation of the HEC policies at national level.

1. The committee appreciates HEC's role in improvement of Higher Education in the country and recommends uniform implementation of its policies including work load and financial matters in all public sector universities.
2. The committee strongly recommends that mathematics/biology should be considered as deficiency courses and shall not be counted towards the total credit hours of the B.Sc. (Hons.) degree.
3. As proposed earlier in the meeting of 2010 of NCRC in agronomy, the courses of Statistics 1 & 2 should be merged into one course in the proposed scheme of studies. It has been adopted by some of the universities and others need to implement the same for its uniformity across the country.
4. The existing template should be revised by the HEC before arranging the final meetings of all NCRCs in agricultural disciplines.
5. To strengthen the background of agriculture students in different specializations, it is proposed to allocate at least three foundation courses from agronomy during the first four semesters.
6. The course of crop physiology may be included in interdisciplinary foundation courses template.
7. It is recommended that periodic inter-university/inter-provinces visits of the faculty along with PhD scholars should be made compulsory to enhance the exchange of views and observe the site specific technology developed in different provinces/universities.
8. HEC is requested to review the policy for funding Lab establishment with priority for the proposal relevant to practical facilities of the newly developed courses being offered at different institutions.
9. It is proposed to arrange refresher courses for the young faculty at national/international level for effective delivery of new topics/courses amended by NCRC.
10. NCRC recommends to regularly hold meetings of all HODs (at least once in six months).

## Suggestions

1. Higher Education Commission is requested to arrange a training of the in-service young faculty through using the capabilities and expertise of the experts from public/private sector for the areas where universities feel deficiency.
2. HEC is requested to ensure availability of **at least 10 copies of all recommended books** (Annexure enclosed) to the departmental libraries of all the Agricultural Universities/Faculties/Colleges of the country and to improve the **library/documentation** of the institutions.
3. Professors and Associate Professors should also be considered for different administrative courses run by national policy institutes/public administration staff colleges to enhance administrative and financial management skills.
4. To improve the standard of the higher education at national level, the committee recommends that the appointment of local examiners should be discouraged at MSc (Hons.)/MPhil degree programs.
5. A final copy of the curriculum (2014) must be provided to at least every faculty member of agronomy all over the country.
6. A viable mechanism for follow up of implementation of recommendations/suggestions should be developed.
7. NCRC nominated Prof. Dr. Fayyaz ul Hassan, Chairman Department of Agronomy, PMAS-Arid Agriculture, Rawalpindi to act as Focal Person for such follow up.