

**CURRICULUM
OF
AGRONOMY
MS & PhD**

(Revised 2018)



**HIGHER EDUCATION COMMISSION
ISLAMABAD**

CURRICULUM DIVISION, HEC

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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 to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/ evaluation. 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 regularly 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.

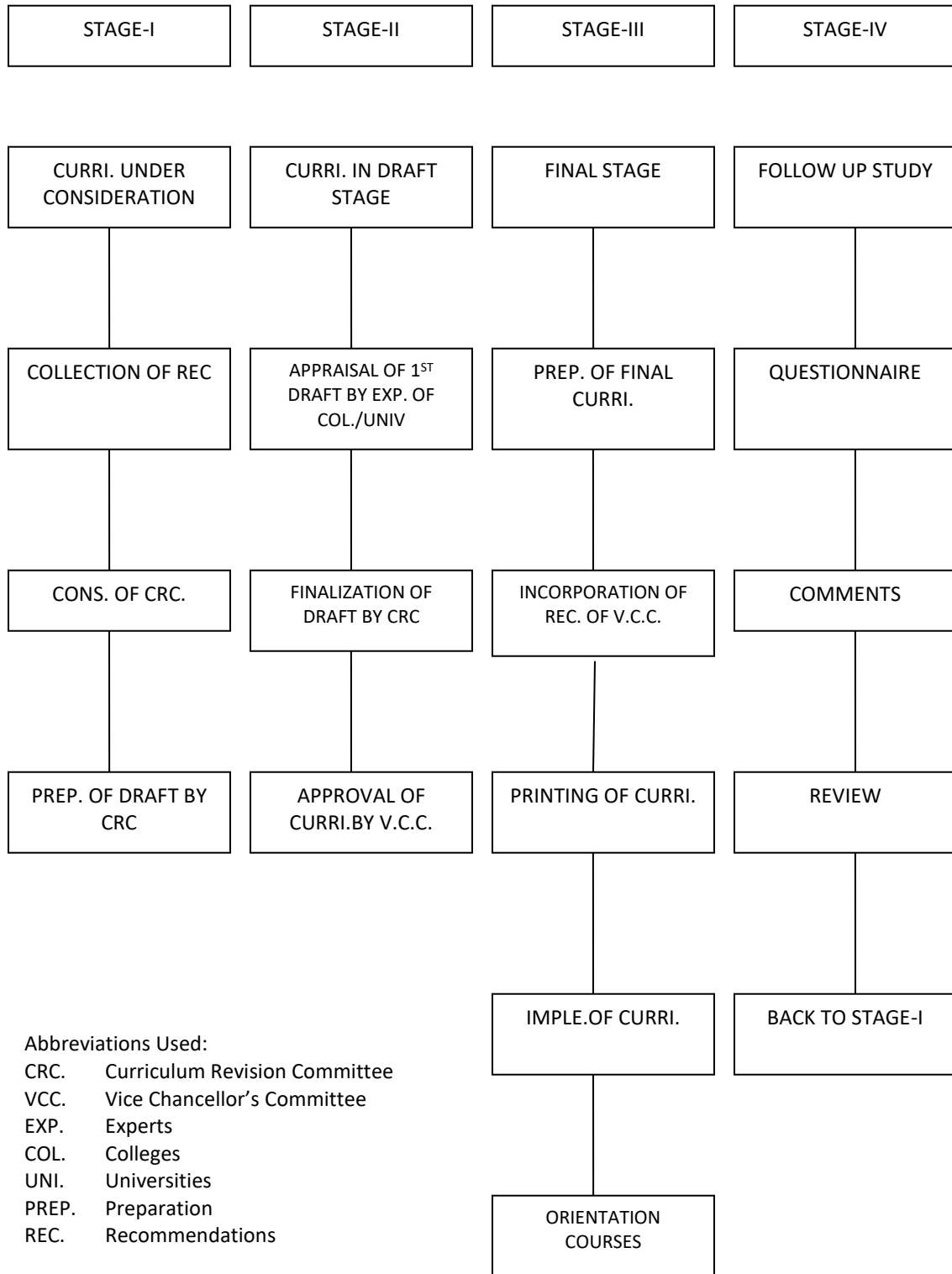
In order to impart quality education which is at par with indigenous needs and international standards, HEC NCRCs have developed unified framework/templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture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

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

<http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx>

(Muhammad Raza Chohan)
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



CURRICULUM DEVELOPMENT CYCLE



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 National Curriculum Revision Committee (NCRC) Final Meeting of Agronomy held from March 05-07, 2018 at HEC Regional Centre, Lahore

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Agronomy for Bachelor, Master and Ph.D Degree programmes was held from March 05-07, 2018 (03 days) at HEC, Regional Center, Lahore. The purpose of the meeting was to finalize the draft curriculum prepared in its preliminary meeting held from 09-11 October, 2017 (03 days) at HEC, Regional Center, Lahore. Experts from academia, research and development organizations participated in the meeting. Mr. Rabeel Bhatti (Assistant Director, Curriculum, HEC, Pakistan) coordinated the NCRC meeting. The list of the participants is as below:

1.	Dr. Bashir Ahmad Professor, Department of Agronomy, University of Agriculture, Peshawar.	Convener
2.	Dr. Aijaz Ahmad Soomro Chairman / Professor, Department of Agronomy, Sindh Agriculture University, Tandojam,	Secretary
3.	Dr. Muhammad Rashid Associate Professor, Department of Agronomy, Lasbela University of Agriculture, Water & Marine Sciences, Uthal, Balochistan.	Co-Secretary
4.	Dr. Nazim Hussain Chairman / Professor, Department of Agronomy, BahauddinZakariya University, Multan.	Member
5.	Dr. Qamaruddin Chachar Chairman / Professor, Department of Crop Physiology, Sindh Agriculture University, Tandojam.	Member
6.	Dr. Riaz Ahmad Chairman / Professor, Department of Agronomy, University of Agriculture, Faisalabad.	Member
7.	Dr. Muzammil Hussain Siddiqui Professor/Chairman, Department of Agronomy, Faculty of Agriculture, The University of Poonch, Rawalakot, AJK,	Member

8.	Dr. Muhammad Naeem Shahwani, Professor, Faculty of Life Sciences & Informatics, Department of Biotechnology, BUIITEMS, Quetta.	Member
9.	Dr. Ghulam Qadir Associate Professor, Department of Agronomy, Faculty of Crop & Food Sciences, PMAS Arid Agriculture University, Rawalpindi.	Member
10.	Dr. Abdul Ghaffar Associate Professor, Department of Agronomy, Muhammad Nawaz Shareef University of Agriculture, Multan.	Member
11.	Dr. Yousaf Jamal Assistant Professor, Department of Agriculture, The University of Swabi, Anbar Swabi.	Member
12.	Dr. Zafar Hayat Khan Associate Professor, Department of Agronomy, Abdul Wali Khan University, Garden Campus, Mardan.	Member
13.	Dr. Muhammad Saleem Principal Scientist, Nuclear Institute for Agriculture & Biology (NIAB), P. O. Box No 128, Jhang Road, Faisalabad.	Member
14.	Dr. Muhammad Naeem Ch. Assistant Professor/Chairman, Department of Agronomy The Islamia University of Bahawalpur, Bahawalpur.	Member
15.	Dr. Muhammad Bilal Chattha Assistant Professor, Institute of Agricultural Sciences, University of the Punjab, Quaid-i-Azam Campus, Lahore.	Member
16.	Dr. Anser Ali Assistant Professor, Faculty of Agricultural Sciences, Department of Agronomy, Ghazi University, D. G. Khan.	Member
17.	Mr. Riaz Ahmad Ghumman Ex- Senior Manager Marketing (Agri Services) Fauji Fertilizer Company Ltd, Lahore.	Member
18.	Dr. Muhammad Aamir Iqbal Assistant Professor, Department of Agronomy, Faculty of Agriculture, The University of Poonch,	Member

	Rawalakot, AJK,	
19.	Mr. Rabeel Bhatti Assistant Director (Curriculum), Higher Education Commission, Islamabad.	Coordinator

The following members attended the preliminary meeting only and could not attend the final meeting due to pre-occupation:

1.	Dr. Zammurad Iqbal Ahmed Professor, Department of Agronomy, PMAS Arid Agriculture University, Murree Road, Rawalpindi.	Secretary
2.	Dr. Muhammad Shafi Professor, Department of Agronomy The Agriculture University, Peshawar.	Member

The following members attended the final meeting only as special invitee and were not available in preliminary meeting:

1.	Prof. Dr. Abdul Khaliq Professor, Department of Agronomy, University of Agriculture, Faisalabad.	Member
2.	Dr. Muhammad Ashraf, Agronomist, Ex. Manager, Seeds Pioneer, Pak Seed Ltd, Lahore.	Member

The meeting started with recitation from the Holy Quran. Mr. Rabeel Bhatti, Assistant Director, Curriculum, Higher Education Commission (HEC), Islamabad welcomed the members on behalf of the Chairman, HEC. He briefed the members of the responsibilities of the Commission to review/revise the curriculum. He also informed the honourable members regarding the main purpose of revising the curriculum keeping in view the framework/scheme of studies for Bachelor, Master and Ph.D Degree programmes in the discipline of Agronomy. There was a deliberate discussion among the committee members on the preliminary draft prepared in its last meeting held on 09-11 October, 2017 at HEC Regional Center, Lahore. All those members who have already sent their inputs presented their drafts before the committee for further discussion. All queries and questions were satisfactorily answered by the respective expert members of the Committee.

Prof. Dr. Bashir Ahmad, briefed the participants that key objective of final NCRC is to devise a curriculum that provides a unified framework (guidelines) to institutions offering degrees under the title of Agronomy and also match the global modifications of the Agronomy. He further requested the committee that as Dr. Zammurad Iqbal Ahmed, Secretary NCRC could not attend the final NCRC meeting due to personal reasons, Dr. Aijaz Ahmad Soomro may be selected as a secretary of the committee for final NCRC. The house unanimously agreed and Dr. Aijaz Ahmad Soomro was selected as a Secretary of the committee for final NCRC.

The members focused on nomenclatures of various degree programmes, rationale and scope of Agronomy, titles of different courses offered during 4 years Bachelor programmes, credit hours, learning outcomes, and assessment criteria of Agronomy in different Universities of Pakistan. After detailed discussion and in depth analysis of framework/scheme of studies, Course Learning Outcomes (CLOs) and course contents; the curriculum was finalized for Bachelor of Agronomy.

On second day, courses developed/improved by individual members were presented. Each course was discussed in the whole group and with through discussion on course objectives, learning outcomes, contents, teaching methods, assessment and reference books were reviewed, revised and finalized. After thorough deliberation, preliminary draft curriculum of the undergraduate (4-years) programme prepared in the preliminary meeting for Agronomy was finalized.

On third day, Prof. Dr. Bashir Ahmad, Convener of the Committee, briefed the house about progress made on the previous day. The admission criteria and courses of Master program of Agronomy were reviewed by the committee with changes and addition of courses. Furthermore, it was decided that the university may offer the courses keeping in view their expertise and resources with HEC guidelines in consideration. It was decided that the zero final draft finalized during the meeting shall be circulated by the Secretary of the Committee for final review of all the respective members.

In the end, Mr. Rabeel Bhatti thanked the Convener, Secretary, Co-Secretary and all members of the Committee for sparing their time and for their contribution to prepare the revised draft of the curriculum. He further stated that their efforts will go a long way in developing workable, useful and market oriented comprehensive degree programme in Agronomy. The Convener of the NCRC also thanked the members for their inputs in revising/updating the curriculum to make it more practical, competitive, efficient and realistic. The committee highly appreciated the efforts made by the officials of HEC Regional Centre, Lahore for making arrangements to facilitate the committee and their accommodation and recreation tour. The meeting ended with the vote of thanks to HEC and Mr. Rabeel Bhatti and his team from HEC for providing this academic and professional opportunity for national cause.

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

RECOMMENDATIONS

The following recommendations are made for implementation of these schemes in the country:

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. 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.
4. The course of crop physiology may be included in interdisciplinary foundation courses template.
5. 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.
6. 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.
7. It is proposed to arrange refresher courses for the faculty at national/international level for effective delivery of new topics/courses amended by NCRC.
8. NCRC recommends to regularly hold meetings of all HODs (at least once in six months).
9. It has been observed that the students opt the major subject before entering the 3rd year. In this regard, they submit their options to the Deans themselves or the coordinator of the undergraduate programmes finalize the selection of students for each department. It is strongly recommended that the chairman of the department may finalize the selection of students on merit basis, because the chairman is dealing with such students in coming years. In this way departments will get rapid development smoothly. This policy should be applied in all agriculture universities to develop / create uniformity.

SUGGESTIONS

1. Higher Education Commission is requested to arrange a training of the in-service 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** 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 within the city should be discouraged at MSc (Hons.)/MPhil degree programs.
 5. A final copy of the curriculum (2017) 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.

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-Bashir	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-Rash	3(3-0)
AGR-712	Advanced 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-Ghuman	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 deeply understand modern concepts of crop growth, phenology and development of plants under varying environments

Learning outcomes

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

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

Course outline

- 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, 2nd Ed. Pergamon Press, Oxford.
2. Hay, R.K.M. and J.R. Porter. 2006. The Physiology of Crop Yield. 2nd Ed. Wiley-Blackwell.

3. Hunt, R. 1978. Plant Growth Analysis. Edward Arnold, London.
4. Hunt, R. 1982. Plant Growth Curves: An Introduction to the Functional Approach to Plant Growth Analysis. Edward Arnold, London.
5. Gupta, U.S. 1992. Crop Improvement. Vol-I. Physiological Attributes. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

AGR-702

APPLIED CROP ECOLOGY

3(3-0)

Objective

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

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

Learning outcomes

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

Theory

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. 3rd Ed. Academic Press, Inc., London.
3. Gurevitch, J. M.Schiner and A.F. Gordon. The Ecology of Plant. 2nd Ed. 2006. State University of New York.
4. Kapur, P. and R.G. Sudha. 2000, Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi.
5. Kumar, H.D. 1994. Modern Concepts of Ecology. 7th Ed. Vikas Pub. House New Delhi.
6. Larcher,W. 1995. Physiological Plant Ecology. Ecophysiology and Stress Physiology of Functional Groups. Springer Verlag, Berlin.

7. Schulze, E. B. and K. Muller-Hohenstein. 2005. Plant Ecology. State University of New York.
8. Tivy, J. 1990. Agricultural Ecology. Longman Group U.K. Ltd. Essex
9. Environmental protection act of Pakistan.

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

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

Objective

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

Learning Outcomes

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

1. Describe the relationship between irrigation and crop yields
2. Plan suitable irrigation schedules for field crops under different moisture regimes and prevailing weather conditions
Modify irrigation use with respect to the prevailing weather conditions
3. Use Make use of the drought stress indices for their research endeavors
4. Compare Evaluate the crop growth and yield response under varying irrigation regimesto total water received and drought
5. Interpret the criteria for drought resistance

Course Outlines

- Relationship between irrigation and crop yields
- Effects of irrigation water quality on crop growth and development
- Impact of weather conditions on irrigation scheduling
- 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.

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)

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

Learning Outcomes:

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

1. Describe impact of agricultural practices and industrial/municipal wastes on the environment and ecosystem.
2. Develop strategies to minimize degradation of environment and ecosystem resulting from agro-chemicals and industry.
3. Understand the rules and regulations of environment conservation

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. rules and regulations of environment conservation, EPA rules

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.

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. Agro-meteorology; Principles and applications of climate studies in agriculture. International Book Distributing Co. Charbagh, Lucknow 226004 U.P. India.
5. Panda, B.C. 2009. Remote Sensing; Principles and Applications. Viva Books Pvt. Ltd. 4737/23, Ansari road, New Delhi-110002. India.
6. Prasada, Rao, G.S.L.H. 2008. Agricultural Meteorology. Printice Hall of India, New Delhi.

Learning outcomes

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

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

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

AGR-707 APPLIED CONSERVATION AGRONOMY

3(3-0)

Learning Objective

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

Learning outcomes

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

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

Theory

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.

Learning Objective:

- To understand the problem, limitation and their solution in the arid zone agriculture.
- To explore the potential of Arid area and its contribution in national crop production.

Learning Outcomes:

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

- Characterize the features of Arid Agriculture
- Apply the techniques to address the constraints and problems of Arid zone agriculture.
- Manage the dry spell period during the crop growth.
- Recommend practices for moisture conservation, water shed management

and sustainable crop production in dry land Agriculture.

Theory

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(2-1)

Objective

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

Learning Outcomes

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

1. Understand modern concepts of biological crop potential
2. Describe the relationship between agro-physiological factors and potential yield of crop
3. Collect and analyse the data of growth parameters of crop
4. Examine the determinants of crop growth
5. Analyze the relationship between crops and environment

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 4th 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.

Learning outcome

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

Course outline

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. 5th 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.

Learning outcome

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

1. Understand the problem soils and their types
2. Manage different types of problem soils
3. Apply different crop management practices to reduce the intensity of problem soils

Course outline

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

Teaching Methodology

- Lecturing
- Home Assignments
- Field visits/work
- Assessment
- Mid Term
- Written (Long Questions, Short Questions, MCQs)
- Assignments/Quiz
- Final Term
- Written (Long Questions, Short Questions, MCQs)

- Assignments/Quiz

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.

Learning Outcomes:

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

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

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.

Learning Outcomes:

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

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

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

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

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

Learning Outcomes:

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

1. Understand the concepts and significance of farming/cropping systems
2. Assess input use efficiencies in various farming/cropping systems
3. Use allied enterprises in agriculture based systems
4. Apply the acquired knowledge 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. Balasubramanian, 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.

Learning outcomes

1. formulate null and alternate hypothesis.
2. select appropriate experimental design and execute its layout in the field.
3. analyse the data and interpret the results
4. determine possible relationships among variables
5. summarize the findings of the research and reporting

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. 2nd Ed. John Wiley and Sons, New York, USA.
3. Leclergy, E.L., W.H. Leonard and A.G. Clark. 1980. Field Plot Technique, 1st Ed. Reprinted by the National Book Foundation, Islamabad.
4. Steel, R.G.D., J.H. Torrie and D. Dickey. 1997. Principles and Procedures of Statistics: A Biometric Approach, 3rd Ed. McGraw-Hill Book Co. Inc., New York. USA.

AGR-717 HERBICIDES IN PLANT AND SOIL SYSTEMS

3(2-1)

Objective

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

Learning outcomes

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

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

Theory

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. 2nd Ed. Kalyani Publisher, Ludhiana, India.

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

AGR-718 INTEGRATED AGRICULTURE

3(3-0)

Objective

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

Learning objectives

To integrate crop hasubandry with livestock, fisheries, cottage and poultry industry for sustainable agriculture (Dr. Nazim, will discuss next meeting)

Learning outcomes

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

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

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

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

Laerning outcomes

1. Acquire indepth modern knowledge of crop productivity
2. Analyse the issues of crop production with refrence to modern concepts
3. Apply modern techniques for maximizing crop harvest.

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;
- Zero tillage: conditions, areas and crops
- Alternate wetting and drying (AWD) techniques: conditions, areas and crops
- Biofertilization of staple food crops: concept, significance and crops
- Biotechnology in improving crop production;

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;
- Filed visits and observation on GAP;
- Demonstrations on the simulation of effects of global warming on agricultural productivity;

- Methods of biofortification of crops (Zn, Fe, Ca etc).
- Visits to different agricultural research institutes and farmers field (where Zero tillage, AWD are under practice).

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.

Learning Objectives

- To adapt the current research and developments in agronomic research

Learning Outcomes

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

1. Analyze the recent technologies for enhancing field crop productivity
2. Compare traditional and new interventions
3. Evaluate the new tools for agronomic research and development

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.

Objective

To enhance students' understanding of physiological processes in seeds.

Learning outcomes;-

1. Understand embryogenesis and flowers identification
2. Comprehend seed formation and development
3. Classify the chemical composition of seed.
4. Understand growth regulators and their role in seed development and dormancy.
5. Analyse Moisture content, temperature and oxygen relations to germination process

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

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

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

Learnig outcome

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

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 – 4th Ed. Burgess Pub. Co., USA
4. ISTA. 1996. International rules for seed testing, Vol. 26, 31, 35, and 37. Proceedings of International Seed Testing Association, Zurich, Switzerland.
5. McDonald, M.B. and L.O. Copeland. 1989. Seed Science and Technology Laboratory Manual. Iowa State University Press / Ames, USA .

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

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

Learning Outcomes:

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

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

Theory

Concepts of stress Agronomy; Plant stress factors and their impact on productivity of cropping systems; Types of stresses (water, nutrient, salt, temperature, CO₂, 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. 3rd Ed. Academic Press, Inc., London.
3. Guar, R.K. and P. Sharma, 2014 Approaches to Plant Stress and their Management. Springer, India
4. Nösberger, J., H.H. Geiger and P.C Struik. 2001. Crop Science: Progress and Prospects. CABI, Pub., Oxon, UK.
5. Pessarakli, M. (Ed.). 1994. Handbook of Plant and Crop Stress. 2nd Edition. Marcel and Dekker Inc., New York.

AGR-724 SUSTAINABLE AGRICULTURE **Learning objective**

3(3-0)

Objective

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

Learning Outcomes

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

5. pollution.

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, 3rd Edition. Kalyani Publishers, New Delhi.
7. Trivedi, P. C. 2011. Organic farming for sustainable Agriculture. Aavishkar Publishers, Distributors. Jaipur (Raj) India.

AGR-725 WATER RELATIONS OF PLANTS

3(2-1)

Objective

To enhance the understanding of relationship between plants and water.

Learning Outcomes:

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

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

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. 4th Ed. Waveland Pr Inc
2. Andrew H. Cobb and John P.H. Reade. 2010 Herbicide and plant Plant physiology Physiology-2nd Edition. Willey Blackwell, UK.
3. Cobb, A.H. and J.P.H. Reade. 2010. Herbicides and Plant Physiology. 2nd Ed. Wiley Blackwell, UK.
4. M.K. Upadhyaya and R.E. 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-4th 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. 4th Ed. Academic press.
8. Zimdahl, R.L. 2004. Weed-Crop Competition- a review. 2nd Ed. Wiley Blackwell, UK.

AGR -727 CLIMATE CHANGE AND AGRICULTURE

3(3-0)

Objective

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

Learning Outcomes

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

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

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

AGR-728 POSTHARVEST TECHNOLOGY OF CROPS

3(2-1)

Objective

Learning objectives

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

Learning outcomes

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

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

Theory

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 ginner (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 (2nd 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.*

AGR-729 SEMINAR 1(0-1)

Objective

To improve students' communication and presentation skills.

Selection of topic, preparation of material for presentation, and presentation by the student in the class on a particular topic.

Note: *M.Sc (Hons.) students will deliver one seminar while PhD students will deliver two seminars. The Seminar delivered on synopsis/research proposal and/or thesis will not be considered extra credit hour for academic purposes.*

AGR-730 THESIS MSc (HONS) AGRONOMY
AGR-731 THESIS PhD

6(0-6)
12(0-12)

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. 4th Ed. West Publishing Co. St. Paul. New York.
16. Andrew H. Cobb and John P.H. Reade. 2010 Herbicide and Plant physiology. 2nd 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. 2nd 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.
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39. Cao, W., J.W. White and E. Wang. 2009. Crop Modeling and Decision Support. Springer, Heidelberg, Germany.
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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*. 2nd Ed. Wiley Blackwell, UK.
44. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. *Techniques in Bioproductivity and Photosynthesis*, 2nd Ed. Pergamon Press, Oxford.
45. Copeland L.O. and M.F. McDonald. 2001. *Principles of Seed Science and Technology*. 4th Ed. Burgess Pub. Co., USA.
46. *Critical Review in Plant Sciences*. All Volumes. Taylor and Francis, New York.
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50. Dixit, R.S. 2007. *Cropping System Research*. Kalyani Publishers, New Delhi, India.
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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*. 3rd Ed. Academic Press, Inc., London.
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61. G.O.P. 1997. *Irrigation Agronomy Manual*. Ministry of Food Agriculture and Livestock, Islamabad.
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