

CURRICULUM OF AGRONOMY

(Revised 2005)



**HIGHER EDUCATION COMMISSION
ISLAMABAD**

CURRICULUM DIVISION, HEC

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PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

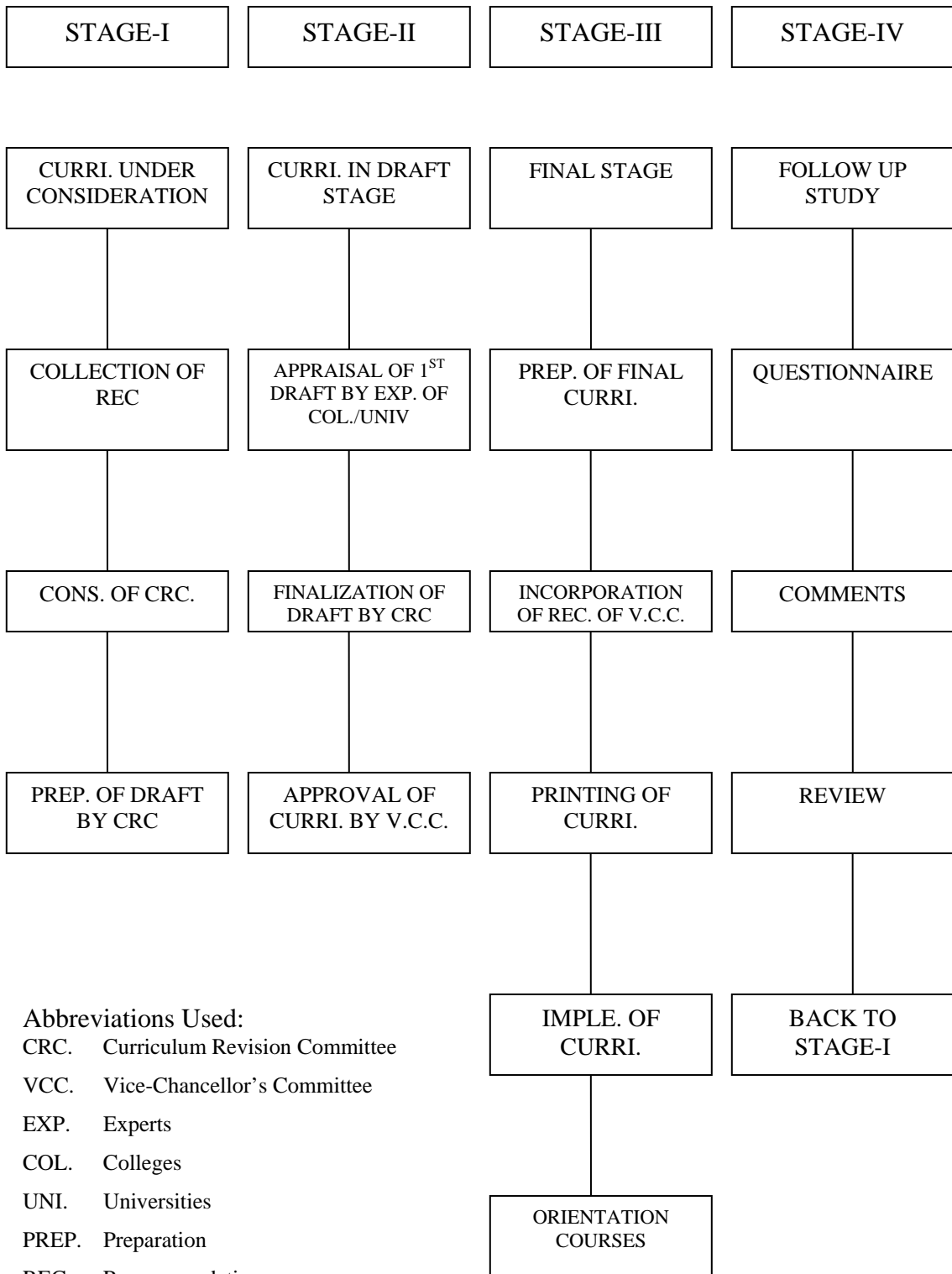
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Agronomy in its meeting held in June 6-8, 2005 at the HEC Regional Centre, Lahore revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by architectural institutions.

(PROF. DR. ALTAF ALI G. SHAIKH)
Adviser (Acad/R&D)

July 2005

CURRICULUM DEVELOPMENT



INTRODUCTION

A meeting of the National Curriculum Revision Committee to finalize the draft curriculum of Agronomy was held at HEC, Regional Centre, Lahore, on 6-8th June, 2005. The following experts attended the meeting:-

1. Prof. Dr. Umed Ali Buriro
Chairman, Department of Agronomy
Sindh Agriculture University
Tandojam. Convener
2. Prof. Dr. Haji Khalil Ahmad
Dean, Faculty of Agriculture
Gomal University
D.I. Khan. Member
3. Prof. (Rtd.) .Dr. Abid Hussain
Department of Agronomy
University of Agriculture
Faisalabad. Member
4. Prof. Dr. Fayyaz Ch.
Department of Biological Sciences
Quaid-i-Azam University
Islamabad. Member
5. Prof. Dr. Muhammad Akmal
Department of Agronomy
NWFP Agricultural University
Peshawar Member
6. Dr. Muhammad Ashraf
Associate Professor, Department of Agronomy
University of Arid Agriculture
Rawalpindi. Member
7. Dr. Muhammad Bismillah Khan
Associate Professor, Department of Agronomy,
University College of Agriculture,
B.Z. University, Multan. Member
8. Prof. Khudai Nazar Babar
Balochistan Agriculture College
Chaman Road, Baleli, Quetta. Member
9. Dr. Salik Nawaz Khan
Assistant Professor
Department of Mycology and Plant Pathology
University of the Punjab, Lahore. Member

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| 10. | Dr. Imtiaz Hussain
Senior Scientific Officer, Wheat Programme
National Agricultural Research Center
Chak Shahzad
Islamabad. | Member |
| 11. | Dr. Inamullah Khan
Research Officer
Cereal Crops Research Institute.
Pirsabak, Nowshera | Member |
| 12. | Ms. Humaira Sultana
Research Fellow
Global Change Impact Studies Centre,
1 st Floor, Saudi Pak Tower, Blue Area,
Islamabad. | Member |
| 13. | Prof. Dr. Mushtaq Hussain Kazmi
Department of Agronomy
Faculty of Agriculture
Rawalakot, Azad Kashmir | Member/Secretary |

Meeting started with recitation from the Holy Quran by Ch. Bashir Ahmad, Deputy Director, HEC, Regional Centre, Lahore.

Mr. Muhammad Tahir Ali Shah, Assistant Director, Curriculum Division, HEC, Islamabad welcomed the participants and briefed them of the obligations of the Commission for review, revision and development of curricula. He explained the procedure for curriculum revision.

The Committee agreed to recommend the Agronomy courses for B.Sc. (Hons), M.Sc. (Hons.) and Ph.D. as detailed below:

Scheme of Study for 4-Year B.Sc (Hons) Agriculture

Mathematics / Biology	6 Credits
Statistics 1 & 2	6
Computers / IT	3
Pak Studies	2
Islamiat	2
Communications Skills	3
English	3
Basic Agriculture	3
Sub-Total	28

One subject from each of the following disciplines

Agronomy	3
Plant Breeding & Genetics	3
Entomology	3
Plant Pathology	3
Food Technology	3
Horticulture	3
Soil Sciences	3
Agriculture Economics	3
Sub-Total	24

Additional Courses from disciplines mentioned below and above

Agriculture Extension	
Forestry & Range Management	
Animal Science	
Marketing & Agri Business	
Rural Development	
Human Nutrition	
Agriculture Chemistry	
Agriculture Engineering	
Water Management	
Sub-Total	21-25
Sub-Total during the first four semesters	73 – 77
Semester 5, 6, 7 19 Credit Hours each	57
Final Semester	15
Grand Total	145 – 149

SCHEME OF STUDIES
For
UNDER-GRADUATE COURSES IN AGRONOMY

Course No.	SUBJECT/TITLE	Credit Hours
Agron-301	Introduction to Agriculture	4(2-2)
Agron-302*	Principles of Agronomy	4(2-2)
Agron-303*	Dry Land Farming	4(2-2)
Agron-401	Field Crop Production-I	4(2-2)
Agron-402	Field Crop Production-II	4(2-2)
Agron-501	Arid Zone Agriculture	3(2-1)
Agron-502	Farming Systems and Farm Records	3(2-1)
Agron-503	Agro-Technology of Major Field Crops	4(3-1)
Agron-504	Fundamentals of Weed Science	3(2-1)
Agron-505**	Field Crop Physiology-I	3(2-1)
Agron-506**	Field Crop Physiology-II	3(2-1)
Agron-507**	Introductory Crop Physiology	3(2-1)
Agron-508**	Crop Nutrients and Growth Regulators	3(2-1)
Agron-509	Water Management in Rainfed area	3(2-1)
Agron-510	Biological Nitrogen Fixation	3(2-1)
Agron-601	Seed Production and Technology	4(3-1)
Agron-602	Agronomic Research and Scientific Writing	4(1-3)
Arong-603	Biological Crop Potential	3(3-0)

Agron-604	Computer Application in Agronomic Research	3(1-2)
Agron-605	Conservation Agronomy	4(3-1)
Agron-606	Field Crop Ecology	3(3-0)
Agron-607	Stress Physiology	3(2-1)
Agron-608	Irrigation Agronomy	3(2-1)
Agron-609	Environment and Crop Production	4(3-1)
Agron-610***	Project Studies	4(1-2)
Agron-611	Internship	20(0-20)

Compulsory General Agronomy Courses are Agron-301, Agron-302, Agron-401 and Agron-402

* The Universities/Faculties/Colleges may adopt one of them accordingly

** The Universities/Faculties/Colleges may adopt Agron-505 and Agron-506 or Agron-507 and Agron-508 accordingly.

*** Where applicable

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

DETAIL OF COURSES

Agron-301

Introduction to Agriculture

4(2-4)

Theory

Agriculture- definition, history, importance, branches and allied sciences. Salient features of Pakistan's agriculture. Agro-meteorology climate and weather of Pakistan. Land utilization in Pakistan. Soil and plant nutrients. Crops of Pakistan. Tillage systems. Irrigation. Dry farming.

Practical

Units of measuring land-conventional British and metric systems. Identification and use of hand tools and implements. Identification of meteorological instruments and their uses. Identification of crop plants, weeds, seeds and fertilizers. Demonstration of various irrigation methods.

Books recommended

1. Arnon, I. 1992. Agriculture in Dry Lands – Principles and Practices. Elsevier Pub., Amsterdam.
2. Balasubramaniyan. 2004. Principles and Practices of Agronomy. Pak Book Corp. Lahore.
3. Bashir, E. and R. Bantel. 1996. Soil Science. National Book Foundation, Islamabad.
4. Bhatti, I.M. and A.H. Soomro. 1996. Agricultural inputs and Field Crop Production in Sindh, Directorate General, Agricultural, Research, Hyderabad.
5. De, G.C. 1995. Fundamentals of Agronomy. Oxford and IBH Pub. Co., New Delhi.
6. Khalil, I.A and A. Jan. 2002. Cropping Technology. National Book Foundation, Islamabad.
7. Murthy, V. 2002. Basic Principles of Agricultural Meteorology. Pak Book Corp. Lahore.
8. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
9. Pratley, J.E. 2003. Principles of Field Crop Production. 4th Ed. Oxford University Press Oxford, New York.
10. Rashid, A. 1994. Soil Science. National Book Foundation Islamabad
11. Sankaran, S. and V.T.S. Mudaliar 1996 Principles of Agronomy. The Bangalore Printing and Publishing Co. Ltd., Bangalore

12. Shamshad, K.M. 1988. The Meteorology of Pakistan. Royal Book Co., Karachi.

Agron-302

Principles of Agronomy

4(2-4)

Theory

Agronomy, definition and scope. Tillage-its objectives and types. Quality seed and its uses. Crop nutrients, manures and fertilizers, classification, composition, sources and methods of application, green manuring. Irrigation management, irrigation methods, water-use efficiency. Weeds, insect pests and diseases of major field crops. Crop rotation principles and types. Harvesting storage and marketing of farm produce. Integration of factors of crop production for effective use of various agricultural inputs.

Practical

Demonstration and use of tillage implements, preparatory tillage, seedbed preparation and intercultural operations, Seed identification and purity analysis. Identification of organic and inorganic fertilizers and manures. Calculation of nutrient cum-fertilizer unit value. Visits to university farms and grain stores.

Books recommended

1. Abdullah, M. 1990. Factors Limiting Crop Growth. Govt. of the Punjab, Directorate of Agricultural Information Punjab, Lahore.
2. Arnon, I. 1992. Agriculture in Dry Lands Principles and Practices. Elsevier, London.
3. Balasubramaniyan. 2004. Principles & Practices of Agronomy Pak Book Corp. Lahore.
4. Brady, N.C. and R.R. Weil. 2001. The Nature and Properties of Soils. Prentice Hall, New Delhi
5. De, G.C. 1995. Fundamentals of Agronomy. Oxford and IBH Pub. Co., New Delhi.
6. Havlin, J., S. Tisdale, W.L. Nelson and J.D. Beaton. 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management. 7th Ed. Prentice Hall, New Delhi
7. Khan S.R.A. 2001. Crop Management in Pakistan with Focus on Soil and Water. Directorate of Agricultural information, Punjab, Lahore.
8. Khalil, I.A & A. Jan. 2002 Cropping Technology. National Book Foundation, Islamabad.

9. Michael, A.M. 1990. Irrigation: Theory and Practice. Vikas Pub. House, New Delhi.
10. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
11. Pratley, J.E. 2003. Principal of Field Crop Production. Oxford University Press, Oxford
12. Rashid, A. 1994. Soil Science. National Book Foundation, Islamabad
13. Reddy, SR. 2004. Principles of Agronomy. Kalyani Publishers New Delhi.
14. Sankaran, S. and V.T.S. Mudaliar 1996 Principles of Agronomy. The Bangalore Printing and Publishing Co. Ltd., Bangalore
15. Sing, S.S. 1988. Principles and Practices of Agronomy, 2nd Ed. Kalyani Pub. New Delhi.

Agron-303

Dryland Farming

4(2-4)

Theory

Dryland farming and its concept. Agro-ecological classification of Pakistan. Dryland tracts of the country, their location, extent and traditional land use. Causes of aridity. Production constraints; physical, biological and socio-economic problems. Soil and moisture losses and their conservation. Maintenance of soil fertility, management practices for improved yield. Integrated crop and livestock systems of dryland agriculture.

Practical

Handling of farm machinery and tillage implements. Demonstration of various moisture and soil conservation practices. Temperature and precipitation maps of different regions.

Books Recommended:

1. Abbas, M.A. 2004. General Agriculture. Publisher Emporium, Urdu Bazar Lahore.
2. Fauji Fertilizer Company. 1988. Proc. International Seminar on Dryland Agriculture in Pakistan. FFC, Ltd. Lahore.
3. Govindan. K. And V. Thirumurugan. 2003. Principle and Practices of Dry Land Agriculture, Kalyani Publishers New Delhi.
4. Gupta, U.S. 1995. Crop Production and Improvement: Crops for Drylands. Oxford and IBH Pub. Co., New Delhi.
5. Shamshad, K.M. 1988. The Meteorology of Pakistan. Royal Book Co., Karachi.
6. Sree Ramulu, U.S. 1995. Dryland Farming in India. Oxford and IBH Pub. Co., New Delhi.

Theory

Classification of field crops. Production technology of cereals-crops (Wheat, Barley, Oats, Rice, Maize, Sorghum and Millets), Fibre Crops (Cotton, Jute, Sunhemp, Deccan-hemp, Sugar crops (Sugarcane and Sugarbeet), Green manure crops (Guara, Dhancha, Pigeon pea, Senji), and 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. Demonstration of improved sowing methods. Raising of rice, tobacco nursery and their transplanting and inter-cultural practices. Burying of green manure crops. Visit to University/College research areas.

Books recommended

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. Martin, J.H. W.H. Leonard and D.L. Stamp. 1986. Principles of Field Crop Production 4th Ed. The McMillan Co., New York.
3. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
4. Reddy, SR. 2004 Principles of Crop Production. 2nd Ed. Kalyani publishers New Delhi.
5. Wolfe, T.K. 2004. Production of Field Crops A, Textbook of Agronomy. Pak Book Corp. Lahore.

Theory

Production technology of oilseed-crops (Toria, Raya, Sarsoon, Canola, Taramira, Castor bean, Sunflower, Safflower, Sesame, Linseed, Groundnut, Soybean), grain legume crops (Chickpea, Lentil, Mungbean, Mashbean, Cowpea, Pigeonpea), forage crops (Berseem, Shaftal, Lucerne, Oats, Maize, Sorghum, Millets, Mottgrass), Cropping intensity, cropping schemes and cropping patterns. Cropping patterns in different ecological zones. Factors affecting cropping pattern. Mono versus multiple cropping.

Practical

Identification and plant characteristic of crops, cultivars, and seeds of the crops and their seeds. 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.

Books recommended

1. Baldev, B., S. Ramamjan and H.K. Jain. 1988. Pulse Crops. Oxford and IBH Pub. Co., New Delhi.
2. Byerlee, D. and T. Hussain, 1992. Farming Systems of Pakistan. Vanguard Books, Lahore.
3. Martin, J.H., W.H. Leonard and D.L. Stamp. 1986. Principles of Field Crop Production. 4th Ed., The McMillan Co., New York.
4. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
5. Rahman, A. and M. Munir. 1984. Rapeseed, Mustard Production in Pakistan, PARC, Islamabad.
6. Reddy, S.R. 2004 Principles of Crop Production. 2nd Ed. Kalyani Publishers New Delhi.
7. Shrestha, A. 2003 Cropping System. Food Products Press. Haworth Press, Inc. Binghamton, NY
8. Stoskopf, N.C. 1981. Understanding Crop Production. Reston. Pub. Co., Inc. Reston, Virginia.
9. Wolfe, T.K. 2004. Production of Field Crop: A Textbook of Agronomy. Pak Book Corp, Lahore.

Agron 501

Arid Zone Agriculture

3(2-2)

Theory

Introduction, concept and causes of aridity, features of arid zone. Climatic zones of Pakistan. Climatic factors 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 harvesting and water conservation practices. Tillage practices, mulching, fertilizer use, sowing time, method and plant density. Crop rotations and cropping patterns.

Practical

Demonstration of water harvesting and conservation techniques. Moisture determination techniques. Determination of evapotranspiration. Effect of mulching on soil and moisture conservation.

Books recommended

1. Allen R.G. L.S. Pereira, D. Raes, and M. Smith. 1998. Crop Evapotranspiration: Guidelines for computing crop water requirements. FAO. Irrigation and Drainage paper No. 56. Rome.
2. Arnon, I. 1992. Agriculture in Dry Lands: Principles and Practices. Elsevier, London.
3. Govindan. K. And V. Thirumurugan. 2003. Principle and Practices of Dry Land Agriculture. Kalyani Publishers New Delhi.
4. Saxena. N.P.S 2003. Management of Agricultural Drought. Oxford & IBH Publishing Co. New Delhi.
5. Singh, G., C. Venkataramanan, G. Sastry and B.P. Joshi. 1990. Manual of Soil and Water Conservation Practices. Oxford and IBH Pub. Co., New Delhi.
6. Singh, S.S. 1998 Crop management under irrigated and rainfed conditions. 3rd Ed. Kalyani Publishers New Delhi.
7. Unger, P.W., T.V. Sneed., W.R. Jordan and R. Jensen. 1988. Challenges in Dryland Agriculture: A. Global perspective. Proc. Intl. Con. Dryland Agriculture, Texas.

Agron-502

Farming Systems and Farm Records

3(2-2)

Theory

Definition and principles of farming, system and types of farming. Farming systems and cropping pattern followed in the different zones. Major cropping patterns of Pakistan. Integration of various factors of crop production. Crop appraisal.

Concept of farm management and maintenance of farm records. Objectives and advantages of keeping farm records. Different systems of book keeping. Principles of double entry system and their application. Objectives of Waste book, Journal and ledger. Writing of waste book and journal. 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 cheque, discount, interest, bad debts and depreciation. Appreciation and depreciation of live and dead stock, land and buildings, plant and machinery. Preparation for trading. Salient Features of WTO. Profit and loss account and balance sheet. Provision for discounts and doubtful accounts, suspense account.

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, crop yield estimation. Working out cost of production of major crops grown in irrigated and non irrigated areas. Layout of farms and demonstration plots.

Books recommended

1. Byerlee, D. and T. Hussain, 1992. Farming Systems of Pakistan. Vanguard Books, Lahore.
2. Cousins, D. 1983. Book Keeping. Hodder and Stoughton, U.K.
3. Ghani M.A. 1992. Principles of Counting. Pak Imperial Book Depot Chowk Urdu Bazar, Lahore.
4. Lerner, J.J. 1978. Book Keeping and Accounting: Schaurus outline series in Accounting. McGraw Hill Book Co., New York.
5. Ruthen Berg, H. 1980. Farming systems in the Tropics, Clarendon Press, Oxford.
6. Shresther, A. 2003. Cropping System. Food Products Press. An imprint of the Haworth Press, Inc.
7. Vendermeer, J. 1989. The Ecology of Intercropping. Cambridge University Press.

Agron-503

Agro-technology of Major Crops

4(3-2)

Theory

Origin, history, morphology, adaptation, distribution and agro-technology of wheat, rice, maize, cotton, sugarcane with special emphasis on regional crops. Management constraints and 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.

Books recommended

1. Khalil I.A & 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., W.H. Leonard and D.L. Stamp. 1986. Principles of Field Crop Production. 4th Ed., The McMillan Co., New York.
4. Munro, D.N. 1987. Cotton. Langman Scientific and Technical, New York.
5. Nazir, M.S. (Ed.) 1994. Crop Production. National Book Foundation, Islamabad.
6. Stoskopf, N.C. 1981. Understanding Crop Production. Reston. Pub. Co., Inc. Reston, Virginia.

Agron-504

Fundamentals of Weed Science

3(2-2)

Theory

Importance of weed control. Losses due to weeds, harmful effects of weeds Classification of weeds. Biology of weeds. Weed-crop interference, Competition and allelopathic interactions. Methods of weed management, preventive, cultural , mechanical, biological and chemical. Weed control in major field crops. Integrated weed management. Herbicide resistance and tolerance against weeds and crops, herbicides. Technical information regarding current herbicides. Mulching and soil solarization.

Practical:

Weed collection and identification. Demonstration of various hand tools & implements for weed control. Computation of herbicide doses. Demonstration of the use of sprayers for herbicide application.

Books recommended:

1. Ashiq M., M.M Nayyar and J. Ahmad. 2000. Weed Control: Handbook Directorate of Agronomy. Ayub Agri. Res. Inst. Faisalabad.
2. Anderson. W.P. 1993. Weed Science: Principles 2nd Ed., West Pub. Co. St. Paul. and New York.
3. Gupta, O.P. 1998. Modern Weed Management. Agro Botanica, Bikaner, India.
4. Hance, R.J and K. Holly. 1990 Weed Control Handbook: Principles, Vol-II 8th Ed. Blackwell Scientific Publication, Oxford, U.K.
5. Kumar, J. R. and Jagannathen. 2003. Weed Science: Principles. Kalyani Publishers New Delhi.

6. Narwal. S.S. and Patrick. T. 1992. Allelopathy in Agriculture and Forestry. Scientific Publishers, Jodhpur, India.
7. Nayyar, M. M. Ashiq and J. Ahmad 2001 Manual on Punjab Weeds: Part I and II. Directorate of Agronomy. Ayub Agri. Res. Inst. Faisalabad.
8. Ross, M.A. and C.A. Lembi. 1985. Applied Weed Science. Burgess Pub. Co. Minneapolis.
9. Zimdhal, T.L. 1993 Fundamentals of Weeds Science. Academic Press, Inc. London, New York, Boston, Toronto.

Agron-505

Field Crop Physiology-I

3(2-2)

Theory

Concept of field crop physiology. Water-importance, properties, absorption, translocation and loss. Transpiration-importance and mechanism, opening and closing of stomata. Mineral nutrition-macro and micro nutrients, their uptake, translocation and metabolism.. Biological N₂ fixation. Plant growth hormones- occurrence, biosynthesis, translocation and functions.

Physiology of seed germination. seed dormancy, seedling establishment. Tillering and branching. Root, Stem, leaf, flower and seed growth.. Physiology of plant development.

Practical

Introduction to equipments used in crop physiology. Determination of water content of plant and seed. Demonstration of various types of seed germination. Imbibitions of water by seed. Effect of various seed treatments on seed germination and seedling development. Studies on developmental behavior of crop plants at various temperature, water and salt levels.

Books recommended

1. Bewley, J.D. and M. Black, 1994. Physiology and Biochemistry of seeds in relation to germination. I. Development, Germination and Growth. Springer Verlag. Berlin Heidelberg.
2. Bonner, J. 1995. Principles of Plant Physiology. W.H. Freeman, NBF, San Francisco.
3. Hopkins, G.H. 1999. Introduction to Plant Physiology. John Wiley & Sons, New York.
4. Illahi, I. 1995. Plant Physiology, Biochemical Processes in Plants, HEC Press, Islamabad.
5. Milthorpe F.L. and J. Moorby 1978. An Introduction to Crop Physiology. 2nd Ed., Academic Press, London.

6. Pearcy, R.W., J.R. Ehleringer, H.A. Mooney and P.W. Pundal. 1989. Plant Physiological Ecology-Field: Methods and Instrumentation, Chapman and Hall, London.
7. Salisbury F.B. and Ross C.B. 1992 Plant Physiology. 5th Ed. Wadsworth Publishing Co. Belmont, CA.
8. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th Ed. World worth Pub.Co.Inc.Belmont, California.
9. Tiaz, L. and E., Zeiger. 2002. Plant Physiology. 3rd Ed. Sinauers Associate, Inc. Sunderland Massachusetts, USA.

Agron-506

Field Crop Physiology-II

3(2-2)

Theory

Photoperiodism, Photomorphogenesis. Source-sink relationships in crop plants. Senescence and abscission. Maturity and after-ripening. Photoperiodism, Vernalization and Tropism. Differential plant growth. Physiology of plants under stress. Photosynthesis-light and dark reactions, various modes of atmospheric CO₂ fixation, factors affecting photosynthesis. Respiration, its types and factors affecting it. Biosynthesis and degradation of carbohydrates, lipids and proteins

Practical

Demonstration of the essentiality of light and CO₂ for photosynthesis. Determination of total carbohydrate contents of plant tissues. Measurements of O₂ consumption and CO₂ production in respiration. Demonstration of effects of various growth regulators on seed germination and plant development. Effect of light on plant development. Demonstration of phototropic and geotropic response of crop plants.

Books recommended

1. Bewley, J.D. and M. Black, 1994. Physiology and Biochemistry of seeds in relation to Germination. I. Development, Germination and Growth. Springer Verlag. Berlin Heidelberg.
2. Bonner, J. 1995. Principles of Plant Physiology. W.H. Freeman, NBF, San Francisco.
3. Devlin, R.M. and F.H. Witham. 1986. Plant Physiology. 4th Ed. CBS Pub. and Distributors, New Delhi.
4. Hans, M. and P. Schopfer. 1995. Plant Physiology. Springer Verlag Berlin.
5. Hopkins, G.H. 1999. Introduction to Plant Physiology. John Wiley & Sons, New York.

6. Illahi, I. 1995. Plant Physiology: Biochemical Processes in Plants, HEC Press, Islamabad.
7. Kochhar P.L. and H.N. Krishnamoorthy. 1988. A Text Book of Plant Physiology. A-one Publishers, Lahore.
8. Milthorpe F.L. and J. Moorby 1978. An Introduction to Crop Physiology. 2nd Ed. , Academic Press, London
9. Percy, R.W., J.R. Ehleringer, H.A. Mooney and P.W. Pundal. 1989. Plant Physiological Ecology-Field Methods and Instrumentation Chapman and Hall, London.
10. Salisbury F.B. and Ross C.B. 1992 Plant Physiology. 5th Ed. Wadsworth Publishing Co. Belmont, CA.
11. Tiaz, L. and E., Zeiger. 2002. Plant Physiology 3rd Ed. Sinauers Associate, Inc. Sunderland Massachusetts. USA.
12. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.

Agron-507

Introductory Crop Physiology

3(2-2)

Theory

Introduction and importance of crop physiology. Plant cell components and functions. Soil-plant-water-atmosphere relations. Metabolism of lipids, carbohydrates and proteins in plant. Water and nutrients absorption and translocation in plants. Photosynthesis, light and dark reactions. Types of carbon fixation pathways. Factors affecting photosynthesis and respiration. Photosynthetic efficiency of different crop plants. Physiology of germination, growth and development. Photoperiodism, vernalization and tropism.

Practical

Introduction to equipments used in crop physiology. Preparation of different types of solutions. Demonstration of photosynthesis, water uptake. Comparison of C₃ and C₄ plants. Measurement of water potential and its component.

Books Recommended:

1. Bonner, J. 1995. Principles of Plant Physiology. W.H. Freeman, NBF, San Francisco.
2. Devlin, R.M. and F.H.Witham. 1986. Plant Physiology. 4th Ed CBS Pub. and Distributors, New Delhi.
3. Hans, M. and P. Schopfer. 1995. Plant Physiology. Springer Verlag Berlin.
4. Hopkins, G.H. 1999. Introduction to Plant Physiology. John Wiley & Sons, New York.

5. Illahi, I. 1995. Plant Physiology: Biochemical Processes in Plants, HEC Press, Islamabad.
6. Mengel, K., E. A. Kirkby, H. Kosegarten and T. Appel. 2001. Principles of Plant Nutrition. 5th Ed. International Potash Institute, Bern, Switzerland.
7. Noggle, G.R., and G.J. Fritz. 1992. Introductory Plant Physiology. 2nd Ed. Prentice Hall Inc., Englewood, Cliffs, USA
8. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Ed. Wadsworth Publishing Co. Belmont, CA.
9. Tiaz, L. and E., Zeiger. 2002. Plant Physiology 3rd Ed. Sinauers Associate, Inc. Sunderland Massachusetts, USA.
10. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.

Agron-508 Crop Nutrients and Growth Regulators 4(3-2)

Theory

Criteria for essentiality of mineral nutrients. Mineral nutrients and their classification. Factors affecting nutrient availability, fertilizer types. Ion uptake mechanism of cell and roots. Nutrient uptake and translocation within the plants. Biosynthesis, translocation and functions of growth regulators-Auxins, gibberellins, cytokinins, abscisic acid and ethylene. Root to shoot signals.

Practical

Techniques for growing plants in sand and water culture. Demonstration of nutrient uptake by inducing water stress. Demonstration of the role of growth regulators on plant growth.

Books Recommended

1. Daries, P.J. 1995. Plant Hormones. Dordrecht, Kluwer Academic Publishers, New York.
2. Epstein, E. and A. J. Bloom. 2004 Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
3. Hewitt, E. J. 1966. Sand and water culture methods used in the study of plant nutrition. 2nd Ed. Technical Communication No.22 (Revised) Commonwealth Agricultural bureaux, Farnham Royal, Bucks, England.
4. Hopkins, G.H. 1999. Introduction to Plant Physiology. John Wiley and Sons. New York.
5. Marschner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press Ltd. New York, USA.
6. Mengel, K., E. A. Kirkby, H. Kosegarten and T. Appel. 2001. Principles of Plant Nutrition. 5th Ed. International Potash Institute, Bern, Switzerland.

7. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Ed. Wadsworth Publishing Co. Belmont, CA.
8. Tiaz, L. and E., Zeiger. 2002. Plant Physiology 3rd Ed. Sinauers Associate, Inc. Sunderland Massachusetts, USA.
9. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.

Agron-509

Water Management in Rainfed Area

3(2-2)

Theory

Concept of water management. Sources of water. Soil as a water reservoir. Available water, water holding capacity, intake rates and movement. Effective rainfall, atmospheric variables affecting soil moisture. Measurement of rainfall. 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 evapo-transpiration.

Books Recommended

1. G.O.P. 1997. Irrigation Agronomy Manual. Ministry of Food Agriculture and Livestock, Islamabad.
2. GOP. 1986. On Farm Water Management. Field Manual. (All volumes). Ministry of Food, Agriculture Cooperatives, Islamabad.
3. Kirkham. M.B. 1999. Water Use in Crop Production. Food Products Press, Binghamton, New York
4. Misra, R.D. and M. Ahmad. 1990. Manual of Irrigation Agronomy. Oxford and IBH Publishing Co. New Delhi.
5. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
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

Theory

Perspective, scope, process and mechanism of biological nitrogen fixation. Nitrogen fixation by legumes. Infection and development of nodules. Factors affecting nodulation. Nitrogen fixation by non legumes. Nitrogen fixation by free living organisms. Biological nitrogen fixation associated with rice production. Legume inoculant and inoculation techniques. The influence of environment and management practices on legume-rhizobium symbiosis. Role of mycorrhizae in nutrient absorption. Bioenergetics in biological nitrogen fixation.

Practical

Preparation of quality inoculum. Soil and crop seed inoculation methods. Methods of measuring nitrogen fixation. Study of different types of nodules.

Books recommended

1. Dutta, S.K. 1991. Biological Nitrogen Fixation with Rice Production. Oxford and IBH, New Delhi.
2. Hansen, A. P. 1994 Symbiotic N₂ Fixation of Crop Legumes. Margref Verlag Weikenheim, Germany.
3. Loomis, R.S. and D. J. Connor. 1993. Crop Ecology. Productivity and Management in Agricultural Systems. Cambridge University Press, New York.
4. Sprent, J.I. and P. Sprent. 1990. Nitrogen Fixing Organisms: Pure and applied aspects. Chapman and Hall, London.
5. Stacy, G., R.H. Burris and H.J. Evans. 1992 Biological Nitrogen Fixation. Chapman and Hall, London.
6. Tiaz, L. and E., Zeiger. 2002. Plant Physiology 3rd Ed. Sinauers Associate, Inc. Sunderland Massachusetts, USA.

Theory

Definitions of seed. Morphology of seed. Factors affecting seed germination. Dormancy and its types. Production and multiplication of quality seed. Seed sampling. Seed processing; drying, cleaning, grading, treatment. Seed quality, purity, vigor, and viability tests. Seed longevity and storage. Seed certification. Seed distribution. Seed act and laws.

Practical

Seed identification. Study of seed structures. Sampling techniques for seed testing, Moisture testing. Purity analysis of seed. Seed viability, vigor and germination tests.

Books recommended:

1. Agarwal, R.L. 1991. Seed Technology. Oxford and IBH Pub. Co. New Delhi.
2. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad
3. Copeland, L.O. and M.B. McDonald. 1985. Principles of Seed Science and Technology. Burgess Pub. Co., USA
4. Fauji Fertilizer Corporation. 1992. Proceeding of International Seminar on Seed, Islamabad.
5. ISTA. 1996. International rules for seed testing. Proceedings of International Seed Testing Association, Zurich.
6. Nazir, M.S. 1994. Crop Production. National Book Foundation, Islamabad.
7. Singh G. 2000. Economics of Seed Production at Farm level. Pak Book Corp. Lahore.

Agron-602 Agronomic Research and Scientific Writing 4(2-4)

Theory

Concept of research, scientific method and experiment. Steps in experimentation. Review and writing of research proposal. Basic experimental designs. Layout of field experiments. Observations of field trials, measurements of crop growth and yield. Collection, organization and analysis of data. Measures of experimental variability. Interpretation of results and summary of paper.

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.

Books recommended

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. Gomes. K.A. and A.A. Gomes. 1984. Statistical Procedures for Agricultural Research. 2nd Ed., John Wiley and Sons, New York.
4. Hashmi, N. 1989. Style Manual of Technical Writing, 2nd Ed. Pakistan Economic Analysis Network Project. Ministry of Food and Agric., Islamabad.
5. Little T.M. and F.J. Hills. 1978. Agricultural Experimentation. John Wiley and Sons, New York.
6. Mead, R. 2003. Statistical Methods in Agricultural & Experimental Biology. 3rd Ed. Pak Book Corp. Lahore

Agron-603

Biological Crop Potential

4(3-2)

Theory

Concept of biological crop potential, actual, attainable, record and potential yield. Agro-physiological factors limiting yield potential of arable crops. Principle of limiting factor for growth and yield. Determinants of crop growth. Components of plant leaf area expansion. Optimum and critical leaf area indices. Crop canopy development, canopy architecture and interception of solar radiation. Potential for increasing photosynthetic gains and decreasing respiratory losses. Dry matter partitioning.

Practical

Methods for measuring leaf area. Determination of leaf area and dry weight of field crops to calculate relative growth rate, net assimilation rate etc. Calculation of leaf area index, leaf area duration and harvest index of field crops. Estimation of light interception.

Books recommended

1. Charles-Edwards, D.A. 1982. Physiological Determinants of Crop Growth. Academic Press, Australia.
2. Cooper, J.P. 1975. Photosynthesis and Productivity in Different Environments. Cambridge University Press, London.
3. Gardener. F.P., R.B. Pearce, R.L. Mitchell. 1985. Physiology of Crop Plants. Iowa State University Press.
4. Hay, R.K.M. and A.J. Walker. 1989. An Introduction to Physiology of Crop Yield. Longman Scientific and Technical Group UK Ltd., Essex.
5. Loomis, R.S. and D. J. Connor. 1993. Crop Ecology. Productivity and Management in Agricultural Systems. Cambridge University Press, New York.

6. Nelson, C. J. 2004. Physiology of Crop Plants. 2nd Ed. Amazon, USA.
7. Smith, W.H. and S.J. Banta. 1983. Potential Productivity of Field Crops under different environments. IRRI, Philippines.
8. Stoskopf, N.C. 1981. Understanding Crop Production. Reston Pub. Co., Inc. Reston, Virginia, USA.
9. Squire, G.R. 1990. The Physiology of Tropical Crop Production. CAB international. Wallingford, UK.

Agron-604 Computer Application in Agronomic Research 3(1-4)

Theory

Computer fundamentals and its operating system, Basic commands and their functions. Use and application of crop growth modeling, data collection, model development, model calibration and validation. Use of model software. Introduction to agro informatics.

Practical

Practical training in validation of crop growth models.

Books recommended

1. Charles-Edwards, D.A., D. Doley and G.M. Rimmington. 1986. Modeling Plant Growth and Development. A.P. Sydney.
2. France, J. and J. M.M. Thornley, 1984. Mathematical Models in Agriculture. Butter-worths, London.
3. Hammer, G. and C. Mitchell. 2000 Application of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems. Kluwer Academic Publisher, London.
4. Ritchie J.T. I & R.J Hanks 1991. Modeling Plant and Soil Systems. Agronomy Monograph 31 ASA-CSSA-SSA, Madison, USA.
5. Tsuji, G.Y., G. Hoogenboom, and P.K. Thornton. 1998 Understanding Options for Agricultural Production. Kluwer Academic Publishers, Dordrecht, Boston, London.

Theory

Concept, importance and objectives of conservation. Agronomic practices for resource conservation. Tillage practices such as contouring, terracing, benching, levelling, grading, *watbandi*, Zero tillage and minimum tillage, chiseling, deep ploughing and planking, Species and cultivars, selection. Crop rotation and weed management. Cover cropping. Strip cropping. Fertilizers and green manuring. Mulching and crop residue management. Field drainage. Micro water-shed management under rainfed conditions.

Practical

Visit to different soil and water conservation centers/institutes. Effect of different mulches under different conditions. Effect of tillage practices on crops.

Books recommended

1. Arakeri, 1987. Principles of Soil Conservation and Water Management. IBH. Pub. Co., New Delhi, India.
2. Arnon, I. 1992. Agriculture in Dry Lands. 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 Pub. Co., New Delhi.
4. Morgan, R.P.C. 1981. Soil Conservation: Problems and Prospects. John Wiley and Sons, London.
5. Wild, A. 1988. Russell's Soil Conditions and Plant Growth. 11th Ed., Longman, London.

Theory

Introduction, plant population dynamics in cultivated system, analytical models and quantitative description of field crop communities in relation to interplant competition. Population functions and environmental adaptation. Crop yields and variability in relation to the ecological optima, responses of crop plants in relation to moisture, temperature, light, air, edaphic, biotic, pyric and anthropic factors. Discussion regarding the applicability of ecological principles in overcoming special crop production problems in different ecological zones.

Books recommended

1. Daubenmire, R.F. 1974. Plant and Environment. A text book of Plant Autecology. 3rd Ed. John Wiley and Sons, Inc., London.
2. Hussain, S.S. 2003. Manual of Plant Ecology. National Book Foundation, Islamabad.
3. Larcher, W. 1995. Physiological Plant Ecology. 4th Ed. Springer Verlag Berlin.
4. Loomis, R.S. and D.J. Connor. 1993. Crop Ecology. Productivity and Management in Agricultural Systems. Cambridge University Press, New York.
5. Monteith, J.L. 1975. Vegetation and the Atmosphere. Vol. I. Academic Press, London.
6. Sharma, M.L. 1984. Evaporation from Plant Communities. Elsevier Science Pub., Oxford.
7. Singh, J. and S.S. Dhillon. 1995. Agricultural Geography. 2nd Ed. Tata McGraw Hill Pub. Co. Ltd. New Delhi.
8. Townsend, C.R., Harper, J.L. and M.E. Bego. 2000 Essentials of Ecology. Blackwell Scientific Publications, UK.

Agron-607

Stress Physiology

3(2-2)

Theory

Introduction and importance of different stresses in crop production. Temperature, radiation, water, mineral, salts, chemicals and pollutant stresses. Plant behavior and adaptation to different stresses. Emphasis on the physiological and biochemical basis of injury and plant resistance mechanisms. Management for stress conditions.

Practical:

Demonstration of different stresses in the field and laboratory. Demonstration of, morphological features of crop plants for stress resistance. Mineral toxicity and deficiency symptoms in crop plants.

Books Recommended:

1. Alscher, R.G., and J.R. Cumming. 1990. Stress responses in Plants: Adaptation and Acclimation Mechanisms. Wiley-Liss, New York.
2. Basra, A.S. and Basra, R.K. 1997. Mechanism of Environmental Stress Resistance in Plants. CRC Press, India.
3. Fowden, L., T. Mansfield, J. Stoddart. 1993. Plant Adaptation to Environmental Stresses. Springer Verlag, Berlin.

4. Hoone, H.A., W.E. Winner and E.J. Pell. 1991 Responses of Plants to Multiple stresses. Academic Press, San Diego, USA.
5. Katterman, F. 1990. Environmental Injury to Plants. Academic Press, New York.
6. Larcher, W,1995. Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Verlag, Berlin.
7. Mckersie, B.D. and Y. Y. Leshem. 1999. Stress and Stress Coping in Cultivated Plants. Springer Verlag, Berlin.
8. Salisbury F.B. and C.W. Ross. 1992. Plant Physiology, 4th Ed. Wadsworth Pub. Co. Inc. Belmont, California.
9. Turner, H.C. and J.B. Passioura. 1986. Plant Growth, Drought and Salinity. CSIRO Publishers, Australia.

Agron-608

Irrigation Agronomy

3(2-2)

Theory

Concept of irrigation agronomy and water management. Sources of irrigation water and their efficient use in crop production. Introduction to different irrigation methods, their feasibility in various regions. Irrigation scheduling and water use efficiency in field crops. Current agro-technology for efficient use of irrigation water in crops. Irrigation water losses and their control through on-farm water management practices. 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.

Books recommended

1. Ahmad, N. and G.R. Chaudhry. 1988. Irrigated Agriculture of Pakistan. Publisher, Shahzad Nazir, Lahore.
2. Allen R.G. L.S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. FAO. Irrigation and Drainage paper No. 56. Rome.
3. Khan, S.R.A 1994. Irrigation Agronomy. Pak. Engineering Consultant, Lahore.
4. Michael, A.M. 1990. Irrigation: Theory and Practice, 2nd reprint. Vikas Pub. House, New Delhi.
5. Sankara, R. G. H. and T. Y. Reddy. 2002. Efficient Use of Irrigation Water. Kalyani Publishers New Delhi.

6. Singh, S.S. 1998. Crop Management under Irrigated and Rainfed conditions. 3rd Ed. Kalyani Publishers New Delhi.
7. Stewart, B.A., Nielsen, D.R. 1990. Irrigation of Agricultural Crops. ASA Series 30. ASA/CSSA/SSA, Madison, Wisconsin, USA
8. Taylor, H.M., W.R. Jordan and T.R. Sinclair. 1983. Limitations to Efficient Water use in Crop Production. American Society of Agronomy, Madison.

Agron-609

Environment and Crop Production

4(3-2)

Theory

Concept of environment and environmental physiology. The aerial and soil environments. Macro and micro environments. Influence of different environmental factors, radiation, temperature, water, wind, vapour pressure on crop growth processes such as photosynthesis, respiration and transpiration. Evapotranspiration and water-use efficiency. Effect of drought on crop growth processes and yield. Greenhouse effect on crop production, *El Nino and La Nino* phenomenon. Yield improvement under different environmental and edaphic conditions.

Practical

Measurements and estimation of different environmental variables. Calculations of potential transpiration rate and different drought indices. Estimation of water use efficiency.

Books Recommended

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London & New York.
2. Fitter, A.H. and P.K.M. Hay. 1987. Environmental Physiology of Plants. 2nd Ed. Academic Press Inc. London.
3. Hammer, G.L., N. Nicholls and C. Mitchell. 2000 Application of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems. Kluwer Academic Publisher, London.
4. Landsberg, J.J. and C.V. Cutting. 1977. Environmental effects on Crop Physiology. Academic Press, London.
5. Monteith, J.L. 1975. Vegetation and the atmosphere. Vol-I. Academic Press, London.
6. Percy, 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.

7. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York, London, Sydney, Tokyo, Montreal.
8. Rowan Sewing, C., T.T. Richer, J.W. Jael. G.Y. Tsuji & Hi Ledyard 1995 Climate Change Agriculture: Analysis of Potential international impact ASA Special Publication, USA.
9. Sharma, M.L. 1984. Evaporation from Plant Communities. Elsevier Science Publishers, Oxford.
10. Squire, G.R. 1990. The Physiology of Tropical Crop Production. CAB International, Wallingfords.

Agron-610

Project Studies

4(1-6)

The students will be assigned projects in different areas of agronomy. They will deliver a seminar which will be evaluated by a committee constituted by the department. In addition, they will write a comprehensive report at the completion of the project which will be evaluated by external and internal examiners.

Agron-611

Internship

20(0-40)

Practical training/work at the farms of progressive farmers and at research stations / institutes / organizations / companies. This involves 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 departments 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
POST GRADUATE COURSES
and Ph. D. Agronomy**

Agron-701	Modern Concepts in Crop Production	4(3-2)
Agron-702	Herbicides and Crop Production	4(3-2)
Agron-703	Principles of Crop Nutrition	4(3-2)
Agron-704	Advanced Irrigation Agronomy	4(3-2)
Agron-705	Advanced Crop Ecology	3(3-0)
Agron-706	Field Crop Experimentation	4(3-2)
Agron-707	Advanced Agronomy	4(3-2)
Agron-708	Applied Conservation Agronomy	3(3-0)
Agron-709	Advanced Seed Technology	4(3-2)
Agron-710	Cropping and Farming Systems	3(3-0)
Agron-711	Agro-meteorology	3(3-0)
Agron-712	Allelopathy in Crop Production	4(3-2)
Agron-713	Weed Management	4(3-2)
Agron-714	Arid Zone Agronomy	4(3-2)
Agron-715	Crop Environment	3(3-0)
Agron-716	Agricultural Research Organizations	3(3-0)
Agron-717	Sustainable Agriculture	3(3-0)
Agron-718	Recent Advances in Agronomy	3(3-0)
Agron-719	Water Relations in Plant	3(2-2)

Agron-720	Seed Physiology	4(3-2)
Agron-721	Crop Management on Problem Soils	4(3-2)
Agron-722	Integrated Agriculture	3(3-0)
Agron-723	Agro-Environment Conservation	3(3-0)
Agron-724	Experimentation in Controlled Conditions	2(1-2)
Agron-725	Special Problem	2(2-0)
Agron-726	Seminar	1(1-0)
Agron-727	Thesis M.Sc. (Hons.) Agronomy	10(0-20)
Agron-728	Thesis Ph.D. Agronomy	20(0-40)

Note: A minimum of 20 credit hours courses should be selected from the above courses for M.Sc. (Hons.) Agronomy and Ph.D. respectively according to the needs and mandate of the institution. Courses selected / qualified for M.Sc. (Hons) Agronomy will not be permitted to take again in Ph.D.

DETAILS OF COURSES

AGRON-701 Modern Concepts in Crop Production 4 (3-2)

Theory

Crop productivity in relation to seed germination and seedling establishment. Sowing time, growth duration, plant population, planting pattern, mineral nutrition and irrigation management. Multiple cropping. Conservation tillage and residue management. Manipulation of crop development by the use of growth regulators. Concept of biodynamic farming. Organic farming. Sustainable agriculture. Global warming in relation to crop productivity. Remote sensing. Integrated crop management in rainfed and irrigated areas. Improved production technology.

Practical

Impact of varying plant population on crop development. Visit to the various agricultural research stations. Phenological development of crop plants. Measurement of growth and yield determinants. Planning multiple cropping systems. Calculation of Land Equivalent Ratio (LER), Area Time Equivalent Ratio (ATER), Crowding Coefficient, Competition Index etc.

Books recommended

1. ASA. 1983. Multiple Cropping, ASA Special Publication No.27, Madison, Wisconsin.
2. Benett.H.H.2003. Soil Conservation for Sustainable Agriculture. Agrobios, Jodhpur India.
3. Bezedicek, D.F. and J.F. Powers. 1984. Organic Farming: Current technology and its role in sustainable agriculture. Special Publication No. 46 Ed. ASA, Madison, USA.
4. Epstein, E. and A. J. Bloom. 2004. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
5. Hunsigi, G. 1998. Science of Field Crop Production. Oxford and IBH, New Delhi.
6. Logan, T.J., J. M. Davidson, J.L. Baker and M.R. Overcash. 1987. Effects of conservation tillage on groundwater quality. Nitrates and pesticides. Lewis Publisher, Chelsea, MI, USA.
7. Nelson, C.J. 2004. Physiology of Crop Plant. 2nd Ed. Amazon, USA.
8. Philips, S.L., W.L. Nelson and J.D. Beaton. 1984. No. Tillage Agriculture: Principles and Practices. Van Norstand Rheinhold Co., New York, USA.

9. Redders 1992. Conservation Tillage Systems & Management: Crop residue Management with no-fill, ride till and mulch till. MWPS – 45. Midwest Plan Service, Agriculture & Bio System Engineering Deptt., Iowa State University, Ames Iowa, USA
10. Unger, P.W. 1994 Managing Agricultural Residues. Lewis Publication, FL, USA.

AGR- 702

Herbicides and Crop Production

4 (3-2)

Theory

Herbicides nomenclature and classification systems. Herbicide registration, storage, transportation and disposal. Herbicide selection. Herbicide formulations: surfactants and adjuvant. Herbicide application and incorporation techniques and equipments. Absorption of soil and foliar applied herbicides. Translocation, mechanism and mode of action of herbicides. Basis of herbicide selectivity. Herbicide degradation in soil and plants. Residual effects of herbicides on soil and crop. Herbicide hazards, toxicity, pollution etc. Herbicide resistance in weeds and crops. Bioherbicides, mycoherbicides.

Practical

Exercise on herbicide dosage calculation. Determination of active ingredients in various herbicide formulations. Type of sprayers, their parts and spray calibration. Boom height adjustment and study of overlapping. Study of residual effects on soil and succeeding crop. Tank mixing.

Books Recommended

1. Anderson. W.P. 1993. Weed Science: Principles. 2nd Ed., West Pub. Co. St. Paul. and New York.
2. Ashiq M., M.M Nayyar and J. Ahmad. 2000. Weed Control Handbook Directorate of Agronomy. Ayub Agriu Res. Inst. Faisalabad.
3. Gupta, O.P. 1998. Modern Weed Management, Agro Botanica. Bikaner, India.
4. Hance, R.J and K. Holly. 1990 Weed Control Handbook Principles, Vol-II 8th Ed. Blackweel Scientific Publication, Oxford, U.K.
5. Hansan, G.W. F.E., Oliver and N.E. Otto 1983. Herbicide Manual Ist. Ed., U.S. Dept. Interior Bur. Reclamation, Denver, Colorado, USA.
6. Mandal, R.C., 1990. Weed, Weedicides and Weed control: Principles and Practices. Agrobios, Jodhpur, India.

7. Narwal. S.S. and Patrick. T. 1992. Allelopathy in Agriculture and Forestry. Scientific Publishers, Jodhpur, India.
8. Nayyar, M. M. Ashiq and J. Ahmad. 2001. Manual on Punjab Seeds Part I and II. Directorate of Agronomy. Ayub Agri. Res. Inst. Faisalabad.
9. Rao, V.S. 1983. Principles of Weed Science. Oxford and IBH Pub. Co. New Delhi.
10. Ross, M.A., and C.A. Lembi. 1985. Applied Weed Science. Burgess Pub. Co., Minneapolis, USA
11. Zimdhal, T.L. 1993. Fundamentals of Weeds Science. Academic Press, Inc. London, New York, Boston, Toronto.

AGR-703

Principles of Crop Nutrition

4(3-2)

Theory

Concept of crop nutrition and its role in crop productivity. Essential crop nutrients. Uptake, assimilation and physiological functions of macro and micronutrients. Foliar application of mineral nutrients. Uptake of mineral elements by leaves and other aerial plant parts. Nutrient requirement of legumes and non-legumes crops in mono-and multicultures. Integrated nutrient management under dry and irrigated cropping systems. Nutritional disorder and deficiency symptoms in crops. Relationship between mineral nutrition and plant diseases.

Practical

Demonstration of nutrient deficiency. Preparation of different nutrient solutions. Interpretation of leaf, tissue and plant analysis tests. Analyses and interpretation of leaf tissue and plant organs.

Books recommended

1. Epstein, E. and A. J. Bloom. 2004. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., USA.
2. Hewitt, E. J. 1966. Sand and Water Culture methods used in the study of plant nutrition. 2nd Ed. Technical Communication No.22. (Revised). Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England.
3. Marschner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press Ltd. New York.
4. Mengel, K., E. A. Kirkby, H. Kosegarten, and T. Appel. 2001. Principles of Plant Nutrition. 5th Ed. International Potash Institute, Bern, Switzerland.

Theory

Concept and aims of irrigation scheduling. Methods of irrigation scheduling, moisture sensitive periods. Indices of drought: stress degree days, canopy temperature variability, canopy temperature difference, crop water stress index, maximum allowed depletion, etc. Response of yield to irrigation: Penman's irrigation-yield response analysis, concept of maximum potential soil moisture deficit and limiting deficit. Crop response to total water received and drought, criteria for drought resistance. Concepts of lost time for growth and crop yield. Water use efficiency and factors affecting it.

Practical

Measurements of plant and soil moisture contents. Estimation of potential evapotranspiration and different indices of drought severity. Calculations of different water use efficiencies..

Books recommended:

1. Allen R.G. L.S. Pereira, D. Raes, and M. Smith. 1998 Crop evapotranspiration: Guidelines for computing crop water requirements. FAO. Irrigation and Drainage paper No. 56. Rome.
2. Brouwer, C., K. Prins and M. Heibloem, 1989. Irrigation Scheduling: Irrigation Water Management Training Manual No.4. FAO Land and water Development Division, Rome.
3. Doorenbos, T. and A.H. Kassam, 1979. Yield response to Water. FAO Irrigation and Drainage Paper 23: United Nations, Rome.
4. Misra, R.D. and M. Ahmed. 1987. Manual on Irrigation Agronomy. Oxford and IBH Pub. Co., New Delhi.
5. Stewart, B.A., Nielsen, D.R. 1990. Irrigation of Agricultural Crops. ASA Series 30. ASA-CSSA-SSA, Madison, Wisconsin, USA
6. Taylor, H.M., W.R. Jordan. and T.R. Sinclair, 1983. Limitations to Efficient Water Use in Crop Production. ASA-CSSA-SSSA. Madison, Wisconsin.

Theory

Concept of ecosystem and population dynamics. Dynamics of agro-ecosystems, carbon utilization and dry matter production. Analysis of ecological factors. Crop-plant domestication. Evaluation of different farming systems. Ecological characteristics of intensive agriculture with special reference to environmental pollution. Crop productivity and ecological optima. Root growth, distribution and foraging activities.

Books recommended

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London & New York.
2. Fitter, A.H. and R.K.M. Hay. 1987. Environmental Physiology of Plants. Academic Press, Inc., London.
3. Kroon, H. and E. J. W. Visser. 2003. Root Ecology. Springer Verlag. Berlin.
4. Kumar, H.D. 1994. Modern Concepts of Ecology, 7th Ed. Vikas Pub. House New Delhi.
5. Larcher, W. 1995. Physiological Plant Ecology. Ecophysiology and Stress Physiology of Functional Groups. Springer Verlag, Berlin.
6. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York.
7. Silvertown, J. 1987. Introduction to Plant Population Ecology. Longman Group U.K. Ltd. Essex.
8. Tivy, J. 1990. Agricultural Ecology. Longman Group U.K. Ltd. Essex.

AGR-706

Field Crop Experimentation

4(3-2)

Theory

Methods of scientific inquiry. Types of experiments. Principles of experimental designs. Basic experimental designs. Single factor and factorial experiments. Split plot and split block arrangements in time and space. Data collection and sampling techniques. Tabulation and compilation of data. Statistical analysis of the data. Analysis of variance and comparison of treatment means. Chi square test. Regression and correlation. Transformation of experimental data. Results and their statistical interpretations.

Practical

Statistical calculations based on sample data. Exercise in the lay-out of experiments. Preparation of analysis of variance table. Use of different tests of significance. Separation of means. Factorial experiments and their uses in scientific research. Reporting results of experiments. Calculation of linear regression and correlations. Transformation of experimental data and use of statistical packages for data analysis on computer.

Books recommended

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. Gomes, K.A. and A.A. Gomes. 1984. Statistical Procedures for Agricultural Research 2nd Ed. John Wiley and Sons, New York.
3. LeClerg, E.L., W.H. Leonard and A.G. Clark. 1990. Field Plot Technique. National Book Foundation, Islamabad.
4. Little, T.M. and F.J. Hills. 1978. Agricultural Experimentation. John Wiley & Sons, New York.
5. Petersen, R.G. 1994. Agricultural Field Experiments: Design & Analysis. Marcel Dekker AG., Switzerland.
6. Peterson, R.G. 1985. Design and Analysis of Experiments. Marcel Dekker, Inc. New York.
7. Peterson. R.G. 1989. Experimental Designs in Agriculture. Special Topics in Biometry. PARC, Islamabad.
8. Steel, R.G.D. and J.H. Torrie. 1986. Principles and Procedures of Statistics. McGraw Hill Book Co., Inc. New York.

AGR-707

Advanced Agronomy

4(3-2)

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 fittings in crop growth studies. Use of computers in plant growth analysis and applicability in crop science. Modeling of crop growth.

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.

Books Recommended

1. Causton, D.R. and J.C. Venus, 1981. The Biometry of Plant Growth. Edward Arnold, London.
2. Coombs, J., D.O. Hall, S.P. Long and J.M.O. Scurlock. 1987. Techniques in Bioproductivity and Photosynthesis, 2nd Ed. Pergamon Press, Oxford.

3. France, J. and J. M.M. Thornley, 1984. Mathematical Models in Agriculture. Butter-worths, London.
4. Gupta, U.S. 1992. Crop Improvement. Vol-I. Physiological Attributes. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
5. Hay, R.K.M. and A.J. Walker, 1989. An Introduction to the Physiology of Crop Yield. Longman Scientific and Technical Group, U.K. Ltd. Essex.
6. Hunt, R. 1978. Plant Growth Analysis. Edward Arnold, London.
7. Hunt, R. 1982. Plant Growth Curves: An Introduction to the Functional Approach to Plant Growth Analysis. Edward Arnold, London.
8. Johnson, C.B. 1981. Physiological Processes Limiting Plant Productivity. Butterworths, London.
9. Tsuji, G.Y., G. Hoogenboom, and P.K. Thornton. 1998. Understanding Options for Agricultural Production. Kluwer Academic Publishers, Dordrecht, Boston, London.

AGR-708

Applied Conservation Agronomy

3(3-0)

Theory

Objectives. Types of conservation. Biological conservation and evaluation. Current problems of conservation agronomy. Farming systems in relation to water logging, salinity, drought and erosion hazards. Conservation of resources for sustainable agriculture. Developments in soil conservation and crop productivity.

Books Recommended

1. Arnon, I. 1992. Agriculture in Dry Lands: Principles and Practices. Elsevier, London.
2. Gurmel, S., C. Venkataraman, G. Sastry and B.P. Joshi. 1990. Manual of Soil and Water Conservation Practices. Oxford and IBH Pub. Co., New Delhi.
3. Logan, T.J., J. M. Davidson, J.L. Baker and M.R. Overcash. 1987. Effects of conservation tillage on groundwater quality. Nitrates and pesticides. Lewis Publisher, Chelsea, MI, USA.
4. Morgan, R.P.C. 1981. Soil Conservation: Problems and Prospects. John Wiley and Sons, London.
5. Philips, W.L. Nelson and J.D. Beaton Ed. 1984 No. Tillage Agriculture: Principles and Practices. Van Norstand Rheinhold Co., New York.
6. Redders, I.K. 1992. Conservation Tillage Systems and Management: Crop Residue Management with no-fill, ride till and mulch till. MWPS – 45. Midwest Plan Service, Agriculture and Bio System Engineering Department, Iowa State University, Ames Iowa, USA

7. Spellerberg, I.F. 1981. Ecological Evaluation for Conservation. The Institute of Biology's Studies, Biology No.133. Edward Arnold Ltd., London.
8. Wild, A. 1988. Russell's Soil Conditions and Plant Growth. 11th Ed., Longman, London.

AGR-709

Advanced Seed Technology

4(3-2)

Theory

Concept and perspective of seed production. Production and multiplication of quality seed. Hybrid seed production in field crops Seed testing problems, sampling and its techniques. Seed drying, cleaning, treatment, storage, import and export. Kind of seeds. Seed vigor and quality tests. Ecological aspects of seed production. Seed processing, cleaning and separation. Seed certification standards, seed act and seed laws. Terminology used in seed production. Seed storage and related problems. Seed industry. Quarantine laws.

Practical

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

Books recommended

1. Agarwal, R.L. 1981. Seed Technology. Oxford and IBH Pub. Co., New Delhi.
2. Ahmad, S.I. 1992. Seed Certification Manual. National Book Foundation, Islamabad.
3. Anonymous. 1984. Regulations and Procedures for Seed Certification System in Pakistan. Federal Seed Certification Department, Ministry of Food, Agriculture and Cooperatives, Islamabad.
4. Copeland, Z.O. and M.B. McDonald. 1985. Principles of Seed Science and Technology. Burgess Pub. Co., USA.
5. ISTA. 1996. International rules for seed testing, Vol. 26, 31, 35, and 37. Proceedings of International Seed Testing Association, Zurich, Switzerland.
6. Singh, G., S.R. Asokan and V.N. Asopa. 1990. Seed Industry in India: A Management Perspective. Oxford and IBH Pub. Co., New Delhi.

7. Thomson, J.R., 1979. An Introduction to Seed Technology. John Wiley and Sons, New York.

AGR-710

Cropping and Farming Systems

3(2-2)

Theory

Farming system, scope, classification, components of farming system. Interaction between components. Cropping system. Complementary and competitive interaction. Effect of preceding crops and associated crops. Indices of evaluation for cropping systems. Agronomic requirements in management of cropping system. Cropping scheme. Sustainable agriculture. Role of integrated farming system in sustainable agriculture. Factors governing choice and size of enterprises and resource allocation in farming system. Organic farming. Resource management under constraint situations. Low Input Sustainable Agriculture (LISA) concepts and principles. Low cost technology and non monetary inputs.

Practical

Preparation of cropping systems for varying resource availability. Working out input requirement and preparation of calendar of operations. Case studies on Integrated Farming System (IFS) and development of IFS for different resource situations. Visit to different units of IFS.

Books recommended

1. Byerlee, D. and T. Hussain. 1992. Farming Systems of Pakistan. Vanguard Books Pvt. Ltd. Lahore.
2. Edwards, C.A., R. Lal, P. Madden, R. Miller and G. House. 1993. Sustainable Agriculture Systems. St. Lucie Press, Boca Raton, Florida.
3. Ghonsikar, C.P. and V.S. Shinde. 1997. Nutrient Management Practices in Crops and Cropping systems. Scientific Pub., Jodhpur, India.
4. Hargrove, W.L. 1988. Cropping Strategies for Efficient Use of Water and Nitrogen. ASA Special Pub. No.51. ASA-CSSA-SSSA, Madison, Wisconsin
7. Jayanthi.C. et.al., 2002. Integrated Farming System: A Path to Sustainable Agriculture. TNAU publication Nol.14/2002
8. Ladha, J.K., J.E. Hill, J.M. Duxbury, R.K. Gupta and R.J. Buresh. 2003. Improving the Productivity and Sustainability of Rice – Wheat Systems: Issues and Impacts. ASA Publication 65, CSSA-SSSA, Madison, Wisconsin, USA.

9. Palaniappan, SP and K. Sivaraman.1996. Cropping Systems in the Tropics: Principles and Management. New Age International Publishers, New Delhi
10. Panda, S.C. 2003. Cropping and Farming systems. Agro bios, Jodhpur, India.
11. Rangasamy, A., K.Annadarai, P. Subbian and C. Jayanthi.2002. Farming Systems in the Tropics. Kalyani Publishers, India
12. Shrestha, A. 2003 Cropping System. Food Products Press. Haworth Press, Inc. Binghamton, New York.

AGR-711

Agro-meteorology

3(3-0)

Theory

Scope of agricultural meteorology. Climate and weather of different zones of Pakistan. Crop distribution in relation to climate. Diurnal and seasonal variation in photoperiod and light integral. Quantitative analysis of crop-weather relationship and crop yield. Atmospheric pollution and plant productivity. Simulation modeling of climatic factors in relation to growth, development and crop yield. Remote sensing, Geographical Information System (GIS) and their application in agriculture. Crop monitoring and forecasting. Climatic change and its impact on productivity.

Books Recommended

1. Charles-Edwards, D.A., D. Doley and G.M. Rimmington.1986. Modeling Plant Growth and Development. A.P. Sydney.
2. Jackson, I.J. 1989. Climate, Water and Agriculture, 2nd Ed. McGraw-Hill International Book. Inc. New York.
3. Keulen, H. Van and J. Wolf. 1996. Modeling of Agricultural Production. Pudoc, Wageningen, Netherlands.
4. Kimball. B.A. 1990. Impact of Carbon dioxide, Trace Gases and Climate Change on Global Agriculture. ASA-CSSA-SSSA, Madison Wisconsin.
5. Monteith, J.L. 1975. Vegetation and the Atmosphere. Vol.1. Academic Press, London.
6. Shamshad, K.M. 1988. The Meteorology of Pakistan. Royal Book Co., Karachi.
7. Steven, D.M. and A.J. Clark, 1990. Applications of Remote Sensing in Agriculture, Butterworth, London.
8. Woodward, F.I. 1987. Climate and Plant Distribution, Cambridge University Press, London.

Theory

Allelopathy and its role in agro-ecosystem. Biochemical interactions among plant communities. Plants having allelopathic effects. Types of allelochemicals. Mechanism of allelochemicals action. Chemicals identified as allelopathic compounds from plants, their movement, absorption and translocation in other plants. Factors influencing the production of allelochemicals. Allelopathy and weed-management. Enhancing crop yields through allelopathy. Research trends in allelopathy.

Practical

Preparation of water extracts from allelopathic plants. Demonstration of allelopathic effects of crop extracts/residues on seed germination of crops and weeds. Comparison of crop cultivars for their allelopathic effects.

Books Recommended

1. Narwal, S. S. 1994. Allelopathy in Crop Production. Scientific Pub. Jodhpur.
2. Narwal, S. S. and P. Tauro. 1994. Allelopathy in Agriculture and Forestry. Scientific Pub. Jodhpur.
3. Rice, E.L. 1984. Allelopathy. 2nd Ed. Academic Press Inc. Orlando, Florida.
4. Rizvi, S. J. H. and V. Rizvi. 1992. Allelopathy. Basic and Applied Aspects. Chapman & Hall, London.
5. Thompson, A. C. 1985. The Chemistry of Allelopathy. Biochemical Interactions Among Plants. ACS Symposium Series No.268. Division of Pesticide Chemistry of the American Chemical Society, USA.
6. Waller, G. R. 1987. Allelochemicals. Role in Agriculture and Forestry ACS. Symposium Series 330. American Chemical Society. Washington. D. C.

Theory

Principles of weed management. Classification and characteristics of weeds. Crop yield losses and economics of weed control. Current developments and trends in weed management. Integrated weed management and its role in weed control. Crop rotation and crop competition. Critical period of weed interference. Tillage equipments for weed control. Merits and limitations of different weed control approaches. Advantages and disadvantages of herbicides. Invasive weed species. Economic threshold level.

Weed control strategies for wheat, rice, cotton, sugarcane, maize, pulses, oil seeds and fodder crops.

Practical

Collection, identification and classification of weeds. Demonstration of competition, duration and timing on crop growth. Demonstration of integrated weed management.

Books recommended

1. Camper, N.D. 1986. Research Methods in Weed Science. 3rd Ed. Southern Weed Science Society, Campaign.
2. Rice, E.L. 1984. Allelopathy. Academic Press Inc., Orlando.
3. Rizvi, S.J. and V. Rizvi. 1992. Allelopathy-Basic and Applied Aspects. Chapman and Hall, London.
4. Ross, M.A., and C.A. Lembi. 1985. Applied Weed Science. Burgess Pub. Co., Minneapolis.
5. Zimdahl, R.L. 1980. Weed-Crop Competition-A review. International Plant Protection Center, Corvallis.

AGR-714

Arid Zone Agronomy

3(3-0)

Theory

Classification of dry areas. Causes of aridity. Climatic factors affecting crop production. Vegetation of the arid zones. Water resources, their conservation and development in irrigated and non-irrigated regions. Crop water relations. Plant adaptation to water stress. Sustainable agriculture in dry regions. Soil fertility and irrigation management. Modern tillage methods in arid soils. Plant population, planting geometries, cropping patterns and crop sequences in arid and semi arid regions.

Books recommended

1. Arnon, I. 1992. Agriculture in Dry Lands: Principles and Practices. Elsevier, Amsterdam.
2. Gupta, U.S. 1975. Physiological aspects of Dryland Farming. Oxford and IBH Pub. Co., New Delhi.
3. Unger, P.W., T.V. Sneed, W.R. Jordan and R. Jensen. 1988. Challenges in Dryland Agriculture: A. Global Perspective. Proceeding of International Conference on Dryland Agriculture. Texas, USA.

Theory

Definition and its components. Major determinants of the environment and their role in crop production. Microclimate in relation to crop management. Green house effects. Environmental pollution and plant growth. Energy exchange by plants in ecosystem. Evapotranspiration and approaches to reduce evapotranspiration, antitranspirants, reflectants, plant physiological aspects and plant architecture.

Books recommended

1. Boote, K. J., J.M. Bennett and G.M. Paulsen. 1994. Physiology and Determination of Crop Yield. ASA. Madison, Wisconsin.
2. Loomis, R.S. 1992. Crop Ecology. Productivity and Management in Agricultural System. Cambridge University Press, U.K.
3. Nobel, P.S. 2005. Physiochemical and Environmental Plant Physiology. 5th Ed. Academic Press, New York.
4. Rosenberg, N.J., B.L. Blad and S.B. Verma. 1983. Microclimate. The Biological Approach. 2nd Ed. John Wiley and Sons. New York.
5. Schultz, E.D. 2005. Plant Ecology. Springer Verlag, Berlin. Heidelberg.
6. Townsend, C.R., Harper, J.L. and Bego, M.E. 2000. Essentials of Ecology. Blackwell Scientific Publications, UK.

Theory

National and Provincial agricultural research centers Consultative Group on International Agricultural Research (CGIAR) and its centers. UN organizations. Need of their establishment, goals, functions and achievements.

Consultative Group on International Agricultural Research (CGIAR)

Africa Rice Center (WARDA)

CIAT - Centro Internacional de Agricultura Tropical

CIFOR - Center for International Forestry Research

CIMMYT - Centro Internacional de Mejoramiento de Maiz y Trigo

CIP - Centro Internacional de la Papa

ICARDA - International Center for Agricultural Research in the Dry Areas

ICRISAT - International Crops Research Institute for the Semi-Arid Tropics

IFPRI - International Food Policy Research Institute

IITA - International Institute of Tropical Agriculture

ILRI - International Livestock Research Institute
IPGRI - International Plant Genetic Resources Institute
IRRI - International Rice Research Institute
IWMI - International Water Management Institute
World Agro forestry Centre (ICRAF)
World Fish Center

AGR-717

Sustainable Agriculture

3(3-0)

Theory

Concept of sustainable agriculture. Threatened agricultural resources in Pakistan. Soil, water and environment. Sustaining soil resources. Organic farming. Soil erosion control. Soil amendments, sewage sludge and other organic wastes. Sustaining water resources. Control of run-off and evaporation losses, reduction of water losses from deep percolation, use of salt tolerant and drought resistant crops and varieties. Reduction of agricultural pollutants. Optimum use of agricultural chemicals, fertilizers. Cropping systems to sustain productivity. Multiple cropping, rotations, N-fixation and mycorrhizae and alternate land uses, compromise between higher yields and resource conservation. Site specific technological options for sustainable crop production.

Books recommended

1. Beth, Lanfalvaj, C.J. and R.C. Linduman. 1992. Mycorrhizae in Sustainable Agriculture. Pub. No.54. ASA, Madison, USA.
2. Poincelot, R.D. 1986. Towards a more Sustainable Agriculture. AVI Pub. Co., Inc., Westport. Connecticut, USA.
3. Pearson, C.J. 1995. Sustainable Dryland and Cropping in Relation to Soil Productivity. Oxford and IBH Co., New Delhi.
4. Rogland, J. and R.Lal. 1993. Technologies for Sustainable Agriculture in the Tropics. ASA. Special Publication No.56. ASA, Madison, Wisconsin.
5. Ruttan, V.W. 1992. Sustainable Agriculture and the Environment. Westview Co. USA.
6. Unger, P.W., T.V. Sneed, W.R. Jordan and R. Jensen. 1988. Challenges in Dryland Agriculture. A Global Perspective. Proc. Intl. Conf. Dryland Farming. Amarillo/Bushland, Texas.

AGR-718

Recent Advances in Agronomy

3(3-0)

Theory

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

Periodicals recommended

1. Advances in Agronomy. Academic Press Inc., New York, USA.
2. Agronomy Journal. American Society of Agronomy, Madison, USA
3. Crop Science. Crop Science Society of America, Madison, USA.
4. European Journal of Agronomy, Elsevier, Amsterdam.
5. Field Crops Research, Elsevier, Amsterdam.
6. Plant and Soil, Kulwer Publishers, Amsterdam.
7. Australian Journal of Agricultural Research, CSIRO Pub. Australia.
8. Other latest technical journals/reports related to the subject.

Agron-719

Water Relations in Plant

3(2-2)

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 relations, matric potential. Water potential and plant cells. Plasmolysis, chemical and water potential of water vapors, plant air interface, water flux and kinetics of volume change.

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.

Books recommended

1. Hans, M. and P. Schopfer. 1995. Plant Physiology. Springer Verlag Berlin.

2. Hopkins, G.H. 1999. Introduction to Plant Physiology. John Wiley & Sons, New York.
3. Kramer, P.J. 1983. Water Relations in Plant. Academic Press. New York.
4. Nobel, P.S. 2005. Physio-chemical and Environmental Plant Physiology. 5th Ed. Academic Press, New York.
5. Turner, N.C. 1981. Techniques and Experimental Approaches for Measurement of Plant Water Status. Plant and Soil. Vol. 58. Dr. W. Junk Publishers. Hague, Netherlands.

Agron-720

Seed Physiology

4(3-2)

Theory

Flower structure and anatomy. Pollination, fertilization, pollen compatibility and incompatibility. Physiology of seed development: transport of assimilates to the developing seed. Starch and protein synthesis. Role of growth regulators in seed development and dormancy. Seed sink strength and intensity. Seed food reserves, location and composition. Metabolism in the germinating seed. Physiological and biochemical manifestation of seed aging and deterioration. Seed priming: osmo-conditioning and matri-conditioning.

Practical

Seeds germination, monocot, dicot flower & seed structure. Osmotic content for root and shoot development in water potentials. 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.

Books recommended

1. Bewley, J.D. and M. Blac. 1994. Seed: Physiology of Development and Germination. 2nd Ed. Plenum Press, New York.
2. Khan. A. 1982. The Physiology and Biochemistry of Seed Development, Dormancy and Germination. Amsterdam: Elsevier Biomedical Press.
3. Nelson, M.B.M.A.C.J. 1986. Physiology of Seed Deterioration. Las Vegas, CVSSA, Special Publication No.11.
4. Stanwood, P.C. and M.B. McDonald. 1989. Seed Moisture. ASA, Madison, Wisconsin.

Theory

Perspective and problems of crop production in eroded, salt affected, water deficient and water-logged soils. Site specific cultural practices. Fertilizer and irrigation adjustment. Specific cropping patterns and crop management practices for economic production. Soil improvement/reclamation.

Practical

Visits to research projects areas. Raising plants on problem soils. Demonstration of soil amendments.

Books recommended.

1. IIMI. 1997. Salinization, Alkalinisation and Sodification on Irrigated Areas in Pakistan. Lahore.
2. Proceedings of International Conference on Water-logging and Salinity. Oct. 13-17, 1975. University Engineering. and Technology, Lahore.
3. Qureshi, R.H., S. Muhammad and M. Aslam. 1970. Biophysics and Development of Salt Tolerance in Plants. Seminar Proc., University of Agriculture, Faisalabad.

Theory

Challenge in Pakistan Agriculture. Analytical overview: issues and strategies for improvement of crop management, livestock management, national resource management and rural development. Institutions and policies: issues and options.

Books recommended

1. Ahmad, N. and A. Hamid. 1997. Plant Nutrients Management for Sustainable Agricultural Growth. Proceedings of the Symposium held on December 8-10, 1997. Planning & Development Division, National Fertilizer Development Centre, 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. Unger, P.W., T.V. Sneed, W.R. Jordon and R. Jensen. 1988. Challenges in Dryland Agriculture: A Global Perspective. Proceedings of International Conference on Dryland Farming held on August 15-19, 1988 at Amarillo/Bushland, USA.
5. Virmani, S.M., J.C.Katyal, H. Eswaru, and I.P. Abarol. 1994. Stressed Ecosystems and Sustainable Agriculture. Oxford & IBH Publishing Co., New Delhi.
6. Wilson, G.P., R.A. Markel, L.D. McGilliard and V.J. Rhodes. 1980. Animal Agriculture. Westview Press/Boulder, Colorado, USA.

Agron-723

Agro-Environment Conservation

3(3-0)

Theory

Agro-chemicals: use, abuse, uptake, persistence, degradation and residual effects. 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.

Books recommended

1. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London and New York.
2. Clapp, C.E., W.E. Larson and R.H. Dowdy. 1994. Sewage Sludge: Land Utilization and Environment. ASA, Madison, Wisconsin.
3. Miller, G.T. 1986. Living in the Environment: An Introduction to Environment Science. Woods Worth, Inc.
4. Raven, P.H. Berg, L.R. and G.B. Johnson. 1993. Environment. International Ed. Saunders College Publishing, New York.
5. Robinson, W.D. 1986. Solid Waste Handbook. John Wiley and Sons.
6. Wentz., C.A. 1989. Hazardous Waste Management. McGraw Hill Book Co.

Agron-724

Special Problem

2(2-0)

Theory

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.

Agron-725 Experimentation in Controlled Conditions 2(1-2)

Theory

Site selection, energy optima, frame and coverings for greenhouse. Light arrangement for greenhouse. Control of light, temperature. CO₂ and relative humidity in greenhouse. Hydroponics. Characteristics of nutritional media.

Practical

Preparation of growth media. Calculation and application of fertilizers in greenhouse experiments. Designing and conducting short term experiments.

Books recommended

1. Hewitt, E. J. 1966. Sand and Water Culture Methods used in the study of Plant Nutrition. 2nd Ed. Technical Communication No.22. Commonwealth Agricultural Bureau, Farnham Royal, Bucks, England.
2. Nelson, P.V. 1991. Greenhouse Operation and Management. 4th Ed. Prentice-Hall, Inc. New York.

Periodicals recommended

1. Advances in Agronomy. Academic Press Inc., New York.
2. Agronomy Journal. American Society of Agronomy, Madison, USA
3. Crop Science. Crop Science Society of America, Madison, USA.
4. European Journal of Agronomy, Elsevier, Amsterdam.
5. Field Crops Research, Elsevier, Amsterdam.
6. Plant and Soil, Kulwer Publishers, Amsterdam.
7. Australian Journal of Agricultural Research, CSIRO Pub. Australia.
8. Other latest technical journals/reports related to the subject.

Agron-726

Seminar

1(1-0)

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

Note:

M.Sc. students will deliver one seminar while Ph. D 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.

Agron-727	<u>Thesis M.Sc. (Hons) Agronomy</u>	10(0-20)
Agron-728	<u>Thesis Ph.D.</u>	20(0-40)

RECOMMENDATIONS

After thorough discussion, the participants of the National Curriculum Revision Committee of agronomy -2005 formulated the following recommendations.

- ▶ The HEC is requested to ensure availability/supply of **5-10 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.
- ▶ HEC is requested to provide training facilities to **in-service University teachers** and to ensure **Sabbatical leave** to all the faculty members.
- ▶ **Uniform system of agricultural education** should be followed with minor changes according to the local conditions and mandate of the educational institutions. However, slight modifications in certain courses should be made to suit specific conditions. An **expert committee** of renowned scholars should be formulated to harmonize the courses. Suggested requirement for various degrees are given below:

B.Sc. (Hons.) Agri. Degree	Credit Hours
Core / Compulsory / University requirement	08
Basic Science Courses	12
Social Sciences Courses	08
Elective / Minor Courses	12
Compulsory Agriculture Courses	60
Major / Specialization Courses	45
Internship	20
Total	165
M.Sc. (Hons.) Agri. Degree	
Elective / minor courses (1/3 rd of credit hours)	10
Major courses (2/3 rd of credit hours)	20
Thesis	10
Total	40
Ph. D. Agronomy Degree	
Elective / minor courses (1/3 rd of credit hours)	10
Major courses (2/3 rd of credit hours)	20
Thesis	20
Total	50

It was observed that in some of the institutions undue importance has been given to the supporting courses. Realistic decisions must be made to include important courses in the scheme of studies and remove the ones which are less important in the professional development.

Books Recommended for Agronomy

1. Abbas, M.A. 2004. General Agriculture. Publisher Emporium Urdu Bazar Lahore.
2. Agarwal, R.L. 1991. Seed Technology. Oxford and IBH Pub. Co. New Delhi.
3. Ahmad, N. and G.R. Chaudhry. 1988. Irrigated Agriculture of Pakistan. Publisher, Shahzad Nazir, Lahore.
4. Allaby, M. 2000. Basics of Environmental Science. Rutledge, London and New York.
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