UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 21st (2/2024) meeting held on 07.06.2024, the Syndicate in its 67th (3/2024) meeting held on 12.07.2024 approved the following curricula for implementation w.e.f. Fall 2024.

I.	M.Sc (Hons.) in Forestry	Annex-'A'
II.	Ph.D in Forestry	Annex-'B'

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/24/923

Dated: 04.12.2024

Distribution:

- Chairman, Department of Forestry
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Agriculture
- Principal College of Agriculture
- Director, QEC
- Additional Registrar (Affiliation & Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

Scheme of Studies for the Degree of

M.Sc. (Hons) FORESTRY

Implementation w.e.f. Fall Semester, 2024

DEPARTMENT OF FORESTRY

COLLEGE OF AGRICULTURE

UNIVERSITY OF SARGODHA

2024

Chairman
Department of Forestry
University of Sargodha

1. **Nomenclature of the Program:**

M.Sc. (Hons.) Forestry

2. **Department brief:**

Department of Forestry, College of Agriculture, Faculty of Agriculture, University of Sargodha, Sargodha, was established in 2012 and initiated the undergraduate program offering Forestry as a major subject. The Department aims at the delivery of the state-of-the-art education mainly focusing on development of trained and skilled human resource in forestry and allied disciplines through quality teaching and research. Department of Forestry intends to develop and foster innovative research skills and teaching programs keeping in view the ever-increasing challenges of the contemporary world and needs of the society and the environment. There are five (05) faculty members, all of them are doctorate in various fields of Forest Sciences, among them one (01) Professor, one (01) Associate Professor and three (03) are Assistant Professors. The Department has produced more 166 undergraduate students since its inception in 2012. The Department has two (02) state of the art labs, equipped with advanced and latest equipments, essentially required for field experimentation, together with vast research area and forest nursery. The Department is seeking links and collaborations with renowned national and international sister forestry research and educational institutions for faculty and students exchange program, which will further refine the skills and qualifications of the faculty as well as students.

3. **Program Learning Objectives:**

1. Prepare students for professional careers in forestry sector on modern lines with ample practical knowledge and advanced sustainable forest management skills, a standard identical to accredited international standards
2. Develop basic problem-solving skills in students and train them about various techniques and methods for the assessment and management of forests and grasslands
3. Create leaders in Forestry and allied natural resource management disciplines both nationally and internationally
4. To strengthen existing linkages between local, regional, national and international institutions/organizations related to forestry research and education

4. **Scope and Career Prospects:**

This degree program has been designed to train forestry professionals for all stakeholders i.e. provincial forest departments (Government Sector), Non-Governmental Organization (NGO's), and private forest owners. The graduates of BS Forestry will be eligible and able to join following sectors for employment:

- Federal Government Departments and Divisions
  - Ministry of Climate Change and Environmental Coordination
  - Capital Development Authority
  - Pakistan Zoological Survey
  - Pakistan Agriculture Research Council
- Provincial Government Departments (Punjab, KPK, GB, Baluchistan etc)
  - Forestry Field Wing (territorial)
  - Forestry Research Wing
  - Wildlife, Zoo and Safari's
- Non-Governmental Organization (NGOs)
  - International
  - National
- Private enterprises
- Teaching and Research

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5. **Program Structure:**

Duration	Minimum 2-Years (4-Semesters), Maximum 4-Years (8-Semesters)
Entry Requirements:	1- Candidates having Bachelor of Science (Hons.) degree in Agriculture with Major Forestry / BS Forestry degree (4-years) from any HEC recognized degree awarding Institutions with minimum CGPA 2.0/4.0 (16 years of education) 2- Pass university entry test/GRE-subject/HAT/GAT with 50% marks
Intra-disciplinary fields allowed for admission	Agriculture* (Any major subject in Agriculture) Plant Sciences*, Botany*, Zoology*, Wildlife*, Earth Science*, Geography*, GIS and Remote Sensing*, Environmental Sciences* and Climate Change* *Subject to pass deficiency courses as advised by the graduate committee of the department.
Degree Completion Requirements:	Total Credit Hours of Course Work: 26 Total Credit Hours of Thesis 06 Total Credit Hours of Program: 32
Program Mode (select one)	Thesis Track
Specialization (if any)	Not Applicable

6. **List of Deficiency Courses of Level-6:** *(for intra-disciplinary admissions only)*

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	FWRW-6703	Silviculture-I	3(3-0)	Nil
2.	FWRW-6726	Agroforestry Systems	2(2-0)	Nil
3.	FWRW-6710	Silviculture-II	3(2-1)	Nil
4.	FWRW-6727	Sustainable Forest Management	3(3-0)	Nil
5.	FWRW-6714	Forest Utilization	3(3-0)	Nil
6.	FWRW-6719	Forest Biometrics	3(2-1)	Nil

7. **List of Mandatory/Compulsory/Core Courses:**

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	FWRW-7101	Forest Resource Management	3(3-0)	Nil
2.	FWRW-7103	Silviculture of Farm Trees	3(2-1)	Nil
3.	FWRW-7121	Forestry and Range Research Methods	3(2-1)	Nil
4.	STAT-7151	Statistical Methods for Agricultural Research-I	3(3-0)	Nil
5.	FWRW-7109	Special Problem-I	1(1-0)	Nil
6.	FWRW-7110	Seminar-I	1(1-0)	Nil
7.	FWRW-7122	Research and Thesis	6(0-6)	Nil

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8. List of Elective Courses:

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	FWRW-7102	Advances in Forest Ecology	3(3-0)	Nil
2.	FWRW-7104	Forestry and Environment	3(3-0)	Nil
3.	FWRW-7105	Grazing Management of Rangelands	3(3-0)	Nil
4.	FWRW-7106	Tree Crop Volume Measurements	3(2-1)	Nil
5.	FWRW-7107	Advances in Forest Utilization	3(3-0)	Nil
6.	FWRW-7108	Advances in Wood Science	3(2-1)	Nil
7.	FWRW-7111	Advances in Agroforestry	3(2-1)	Nil
8.	FWRW-7112	Agroforestry as a Business Enterprise	3(2-1)	Nil
9.	FWRW-7113	Range Vegetation Manipulation and Management	3(3-0)	Nil
10.	FWRW-7114	Developments in Watershed Management	3(3-0)	Nil
11.	FWRW-7115	Forest Soil and Water Conservation	3(2-1)	Nil
12.	FWRW-7116	Forest Diseases and Pest Management	3(2-1)	Nil
13.	FWRW-7117	Ecosystem Resilience to Changing Climate	3(3-0)	Nil
14.	FWRW-7118	Forest and Wildlife Conservation	3(3-0)	Nil
15.	FWRW-7119	Urban Wildlife	3(2-1)	Nil
16.	FWRW-7120	Biofuel and Bioenergy	3(3-0)	Nil

Scheme of Studies M.Sc. (Hons) Forestry

Semester-I

Sr. #	Category	Course Code	Course Title	Credit Hours	Pre-requisite
1	Defeciency-1*	FWRW-67xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
2	Compulsory-1	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
3	Compulsory-2	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
4	Compulsory-3	STAT-7151	Statistical Methods for Agricultural Research-I	3(3-0)	Nil
5	Elective-1	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil

Semester credit hours: 12-15

Semester-II

Sr. #	Category	Course Code	Course Title	Credit Hours	Pre-requisite
1	Defeciency-2*	FWRW-67xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
2	Compulsory-4	FWRW-7109	Special Problem-1	1(1-0)	Nil
3	Compulsory-5	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
4	Elective-2	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil
5	Elective-3	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil

Semester credit hours: 10-13

Semester-III

Sr. #	Category	Course Code	Course Title	Credit Hours	Pre-requisite
1	Defeciency-3*	FWRW-67xx	To be selected from list	03 (2-1) or 3(3-0)	Nil
2	Compulsory-6	FWRW-7110	Seminar-I	1(1-0)	Nil
3	Elective-4	FWRW-71xx	To be selected from list	3 (2-1) or 3(3-0)	Nil

Semester credit hours: 04-07

Semester-IV

Sr. #	Category	Course Code	Course Title	Credit Hours
1	Compulsory	FWRW-7122	Research and Thesis	6(0-6)

Semester credit hours: 06

* for intra-disciplinary admissions only

Note: Intra-disciplinary admissions may need to complete degree in more than four semesters due to deficiency courses as advised by the departmental graduate committee.

Detailed Contents of Mandatory/Compulsory/Core Courses

FWRW-7101 **Forest Resource Management** **3(3-0)**

Introduction

Forest has been regarded as a type of ecosystem. The conservation, restoration, and sustainable use of forest ecosystems and biodiversity are the basic issues for forest resource management. A century ago, a large area of forests disappeared worldwide, because timber production was the major goal for forest resource management during that time, and only a few people were concerned about the sustainability of forest resources. There are two different points of views concerning forest: one sees the forest as a product by human activity that people may conquer nature; the other regards the forest as a natural product, the construction and usage of which should comply with the natural rules of forest dynamics. The later concept is now accepted by most scholars. Although the sustainable use of forest resources in forest ecosystem management has been debated continuously, it is still an important strategy for forest management.

Course Learning Objectives

1. Develop the concept of protection and preservation of forests for future generation
2. Inculcate the concept of sustainably, by balancing the human needs and forest ecosystem health
3. Harvest the socio economic benefits from forests, providing goods (timber, fuel wood, etc.) and services (tourism, climate amelioration, protection of watersheds)
4. Develop the understanding of ecosystem restoration and strategies for climate change mitigation
5. Enable the students to develop and implement effective forest management policies by involving local communities

Learning outcomes

After studying this course, students should be able to;

1. Understand the concept of forest resource management and conservation on sustainable basis
2. Familiarize with forest types and their distribution and devising management strategies accordingly
3. Conduct forest resource assessment and monitoring and communicate with stakeholders effectively
4. Implement sustainable forest resource management plans with respect to indigenous knowledge and community rights
5. Well aware of local and global forest issues and knowledge of environmental and social impacts of forest management practices

Contents (*Theory)*

1. Introduction and scope of forest resource management and Resource development planning
2. Historical review of forest resource management
3. The status of world forests
4. Approaches of forest resource management
5. Decision making methods for primary forest management activities and methodologies for incorporating non-timber values in forest management operations
6. Forest management for ecosystem service and timber and non-timber production
7. Economic analysis of different management operations in Forestry

Recommended Texts:

1. Gregory S. Amacher, Markku Olikainen, Erkki A. Koskela. 2009. Economics of forest resources. Mc

Graw Hills.
2. Trivedi, P.R. 2004. Natural Resources Conservation. APH Publishing Corporation. India

Suggested Readings:

1. Joseph Buongiorno and J. Keith Gilless. 2003. Decision Methods for Forest Resource Management. 2003. Academic press, Elsevier Science (USA)
2. Kumar, H.D. 2001. Forest Resources Conservation and Management. Affiliated East West Press Pvt. Ltd. New Dehli.

FWRW-7103 **Silviculture of Farm Trees** **3(2-1)**

Introduction

Silviculture is the core subject to understand the basic forestry operations required to perform at field level according to the ecological set up of the site in question. This course is particularly designed for developing the understanding of young foresters with the basic terminology and concepts of growing, protecting and harvesting of farm trees growing solitary or under different agroforestry systems. Silviculture deals with development and growth of forests and trees. The knowledge of silviculture enables the students to understand the specific natural factors that act upon the individual trees and the whole forest stand.

Course Learning Objectives

1. Understand the unique ecological requirements of farm trees
2. Develop the understanding of difference between forest crop and individual trees growing on farms
3. Observe keenly the factors which affect the growth and development of farm trees
4. Devise the management plan for trees on farms interacting with other vegetation types

Learning out comes

After studying this course, students should be able to;

1. Understand the difference in farm, structure and growth habits between trees growing on farms and in forests
2. Manage the trees on farms to get maximum benefits without harming crops
3. Apply different practices to enhance the growth rate of farm trees by understanding their ecological requirements
4. Know the flowering time, seed setting and maturation and seed availability of farm trees

Contents *(Theory)*

1. General description, origin, distribution, site requirements, silvicultural characteristics and operations of following farm-tree species; *Acacia nilotica, Albizzia lebbek, A. procera, Azadirachta indica, Bauhinia purpurea, B. variegata, Bamboosa spp., Casuarina aquiseti-folia, Dalbergia sissioo, Dandro-calamus spp., Eucalyptus citriodora, E, camaldulensis, E. micro-theca, Eugenia jambolana, Heterophragma adenopylhum, Leucanea Leucocephala, Managifera indica, Melia azedarch, Moringa oliefera, Morus alba, Populus ciliata, P. deltoides, P. euromericana, Prosopis cineraria, P. juliflora, Salmalia malabarica, Salix tetrasperma, sesbania aegyptida, S. sesbans. Tamarix articulata, Terminalia arjuna, Zizyphus mauritania, Z. nummuleria* etc.

(*Practical*)

1. Demonstration/observation of various silvicultural operations in the field
2. Collection of seed/planting material from plus trees
3. Raising quality seedlings/saplings in the nursery

4. Visits to farm forests

Recommended Texts:

1. Bravo-Oviedo, A., Pretzsch H. and Del Rio M. 2018. Management of Mixed Forests. Springer International, Singapore.
2. Ashton M.S. and F. Montagnini. 1999. The Silvicultural Basis for Agroforestry Systems. CRC Press. 296
3. Beadle C.L. and A.G. Brown. 2007. Acacia Utilization and Management – Adding value. RIRDC Publication, Australia

Suggested Readings:

1. Champion, H.G. 1967. Manual of silviculture for Pakistan. Pak. Forest Institute Peshawar.
2. David Smith 1986. The Practice of Silviculture. John Wiley and Sons, New York
3. Hensken F.L., M. Battaglia and M.L. Ottenschlaeger. 2008. Silvicultural Design Support for Farm Forestry. RIRDC Publication, Australia
4. Parkash Ram and L.S. Khanna 1979. Theory and Practice of Silviculture System. International Book Distributors, Dehra Dun, India

FWRW-7121 **Forestry and Range Research Methods** **3(2-1)**

Introduction

Forestry and range research methods involve the application of scientific methodologies to study the conservation, management and sustainable utilization of forest and range resources. It includes the sampling and surveying of the area, collection of data on trees and ground vegetation, experimentation and measurement of different tree characteristics, grazing trials, examining tree-soil interactions and evaluating the feasibility of different forest and range management practices for solid foundation and understanding of research in forestry and range resources

Course Learning Objectives

1. Comprehend the fundamentals of forest and range research and its significance
2. Equip the students with the different research methodologies used in forestry and rangelands
3. Learn sampling techniques and measurement methods for forest inventory and analysis
4. Familiarize the students with different experimental designs, tools and technologies and data analysis

Learning Outcomes

After studying this course, students should be able to;

1. Understand different ecological factors affecting forest and range resources and their measurement techniques
2. Apply research methods and experimental designs according to the site characteristics
3. Analyze the sampled data and interpret its findings after experimentation
4. Recognize ethical values in research design and implementation and to apply the inferences to solve the real problems at gross root level

Contents *(Theory)*

1. Definitions and concepts of different research methods/techniques used in range and forest science
2. Principles of research and peculiarities of field research
3. Peculiarities and role of various survey designs
4. Application of bio-mathematical and statistical tools
5. Study plans, layout of experiments, experimental designs, conduct of experiments and analysis

6. Discussion and evaluation of research projects
7. Control measures for plagiarism

(Practical)

1. Designing and planning laboratory and field experiments related to climate, soil, water, forage vegetation, grazing animals, and wildlife and plant communities.
2. Designing experiments related to eco-systems research such as watershed, food chain and nutrient cycle
3. Preparing research plans on selected topics.

Recommended Texts:

1. Hussain, R.W. and M.I. Shieikh. 1988. A guidebook for forestry research, PFI, Peshawar.
2. Katz, M.J. 2007. From Research to Manuscript: A Guide to Scientific Writing. Springer; 1st edition, ISBN-10: 1402040458 ISBN-13: 978-1402040450
3. Korner, A. 2008. Guide to Publishing a Scientific Paper. Routledge; 1st edition, ISBN-10: 041545266X, ISBN-13: 978-0415452663
4. Methews, J.R., Brown, J.M and Methews, R.W. 2000. Successful scientific writing: A step by step guide to bio-medical students. 2nd Ed., Cambridge Uni. Press.

Suggested Readings:

1. Peat, J., Elliot, E., Baur, L an Keena, V. 2002. Scientific Writing: Easy When You Know. BMJ Books; 1 edition, ISBN-10: 0727916254, ISBN-13: 978-0727916259
2. Salem, A. and S.D. Ripley. 1983. Handbook of the Birds of India and Pakistan. Oxford Univ. Press: New York.
3. Schroth, G and Sinclair, F.L. 2003. Trees, Crops and Soil Fertility: Concepts and Research Methods. CABI, ISBN-10: 0851995934, ISBN-13: 978-0851995939
4. Shah, N.H. and W.W. Bryan. 1996. Tropical pasture research. Principles and methods. Common Wealth Agriculture Bureau, UK.

STAT-7151 Statistical Methods for Agricultural Research-I 3 (3-0)

Introduction

This course designed for MSc (Hons)/MPhil programs of agriculture sciences. This course provides the applied statistics background for survey and experimental work in Agriculture. Case studies and critical examples are used to work through commonly experienced research problems (from sampling designs to the ethical consideration) and to explain how they may be approached, solved or prevented with statistical means. The importance of statistical science in agriculture is obvious, where the collection, analysis and interpretation of numerical data are concerned. Statistical principles apply in all areas of experimental work and they have a very important role in agricultural experiments. Statistics plays an important role in experimentation, while many scientific problems could be solved by different statistical procedures.

Course Learning Objectives

1. Develop the understanding of descriptive and inferential concepts of statistics
2. Enable the students to apply suitable experimental designs (CRD, RCBD, etc.) and statistical methods (ANOVA, regression analysis, etc.) under different set of experimental circumstances
3. Develop the skills to analyze the data, using different statistical software (R, SAS, SPSS, etc.), to interpret the results scientifically, to communicate the result findings clearly and concisely and to evaluate the research critically by identifying the potential bias and error

Learning Outcomes

After studying this course, students should be able to;

1. Understand the statistical principles and concepts
2. Familiarize with different statistical software and programming languages (R, SAS, SPSS, etc.)
3. Apply statistical methods to agricultural research including experimental designing, data collection and analyzing and interpretation of result findings for problem solving and decision making accordingly

Contents *(theory)*

1. Importance of Statistics in agriculture research.
2. Selection of statistical tools based on scale of measurements.
3. Analysis of Count and Frequency data.
4. Measures of central tendency and dispersion.
5. Some concepts of hypothesis testing. T, Z, Chi-square and F tests. Contingency Tables.
6. Diversity Indices.
7. Concept of ANOVA and its types.
8. Correlation Analysis: Simple correlation, multiple correlation, and Partial correlation.
9. Regression Analysis: Simple and multiple regression.
10. Generalized linear models: logistic regression, Poisson regression, Gamma regression, Inverse Gaussian regression.
11. Non-linear regression.
12. Dose Response Curves.

Recommended Texts:

1. Montgomery, D. C. (2017). *Design and analysis of experiments* (9th ed.). New York: John Wiley & Sons.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2nd ed.). BS Publication.
3. Lawal, B. (2014). *Applied statistical methodsin agriculture, health and life sciences*. USA: Springer.

Suggested Readings:

1. Sahu, P. K. (2016). *Applied statistics for agriculture,veterinary, fishery, dairy and alliedfields*. USA: Springer.
2. Gbur, E. E., Stroup, W. W.,McCarter, K. S., Durham, S., Young, L. J., Christman, M.,West, M. & Kramer, M. (2012). *Analysis ofgeneralized linear mixed modelsin the agricultural and natural resources sciences*. USA: Soil Science Society of America.

Detailed Contents of Elective Courses

FWRW-7102 **Advances in Forest Ecology** **3(3-0)**

Introduction

A forest is an ecological system or biotic community dominated by trees and is governed largely by a variety of environmental factors and ecological patterns which influence each and every process of this diverse living entity. This course is primarily designed to understand to know the factors which control the patterns of distribution and abundance of different organisms in forests of the world. The relevance of forest ecology to understanding biodiversity lies in the observations that forests dominate the natural landscape over much of the world and that forests harbor a large proportion of the world's species. Moreover, because forests are valuable to humans for the products and services that they provide, especially wood, many forest ecosystems are extensively manipulated and modified by human societies, often disrupting the natural ecological patterns. In addition, many forests occur where climate and soil are suitable for intensive agricultural production and conversion of forests to farms results in radical changes in the composition of the biota. Hence, detailed knowledge of forest ecology is necessary to predict and ameliorate the effects of forest utilization and conversion on biodiversity.

Course Learning Objectives

1. Impart the basic and advanced concepts of forest ecology under the changing environmental conditions
2. Develop the understanding about the spatial and temporal bases of existence and distribution pattern of various vegetation types
3. Give the concept of environmental factors at micro and macro levels, which influence the forms, functions, structures, complexity and biodiversity of forests under various ecological conditions
4. Use of modern technologies like GIS, remote sensing and IoTs for forest surveys and mapping

Learning outcomes

After studying this course, students should be able to;

1. Understand the concept of forest ecology and its role in understanding the distribution of vegetation types in different terrestrial and aquatic ecosystems
2. Learn the climatic, physiographic, edaphic, biotic and pyric factors which influence growth of individual trees and forest crops
3. Understand different forest ecological processes; like, succession and retrogression, forest regeneration and restoration, migration and adaptation, competition and survival and stabilization at population and community levels

Contents *(Theory)*

1. Ecology Concept and scope, Autecology and Synecology, Plant vs Forest Ecology
2. Environment, Complex, Influence of Environment on Forest, Micro environment
3. Environmental factors (climate, soil, water, temperature, light, atmosphere, topography, biotic and pyric factors, etc.)
4. Climatic and Edaphic Regions of Pakistan
5. Concept of sites, Determining site quality, Method of vegetation surveys
6. Application of GIS and Remote Sensing, IoTs in Forest surveys and mapping
7. Relationship between over storey and understory
8. Plant-animal interactions in forest ecosystems
9. Regeneration/restoration ecology, Competition and effects of natural and human disturbance regimes

at multiple scales

10. Forest succession and stand dynamics, Forest canopies, Natural disturbance in forest environments
11. Biological impacts of deforestation and fragmentation

Recommended Texts:

1. Panday, N.N. and Jyoto M.K. 2006. Ecology and Environment. Efficient Offset Printers. India
2. Florencia, M. and Carl F. Jordan. 2005. "Tropical Forest Ecology: The Basis for Conservation and Management". Springer 1 edition.
3. Burton, V. B., Donald, R. Z., Shirley, R. D., & Stephen, H. S. (1998). *Forest ecology*. (4th ed.). New York, USA: John Wiley & Sons Inc.

Suggested Readings:

1. Vicky, M. T., Richard J., Tim, N. and Stefan, H. 2004. Assembly Rules and Restoration Ecology: *Bridging the Gap between Theory and Practice.* Society for Ecological Restoration International island press.
2. Hussain, S. S. 1995. Fundamental of Plant Ecology. National Book Foundation. Islamabad.

FWRW-7104 **Forestry and Environment** **3(3-0)**

Introduction

This course is specifically designed to discuss the attributes of modern forest management practices in the light of globally changing environment. The key attributes of the forest ecosystem, particularly its productivity, stability, complexity, nutrient cycling and ability to protect the environment are briefly covered in this course. The influence of forests on environmental quality, together with the role of forests as a habitat for wildlife, is discussed at global and local levels. Forests have an impact on the most important properties of the earth's surface which influence climate and which are likely to be affected by human activities. The course describes the physiological, mechanical and psychological influences of the forests to control environmental pollution, global warming, long drought episodes resulting in desertification and other aspects of ecosystem degradation induced by global climate change. The role of forests to create climatic resilience and ecosystem restoration is also discussed with emphasis on establishing strong collaboration and frequent interaction at national and international level.

Course Learning Objectives

1. Give conceptual insight on interactions between forests and environment
2. Explain the process of influences of environment on complexity, productivity and stability of forests
3. Develop understanding of role of forests to control environmental pollution and ecosystem degradation
4. Teach about forests of Pakistan, its environmental settings and ways and means to combat the problems associated with environmental pollution and to restore the degraded lands and ecosystems

Learning Outcomes

After studying this course, students should be able to;

1. Understand mutual relationship between forests and their environment and how they influence each other
2. Know the forest types of Pakistan and threats posed by drastic changes in the environment

3. Understand the process of degradation in different ecosystems due to climate change
4. Understand the role of forests to combat the environmental pollution, desertification, water logging and salinity and to conserve biodiversity

Contents *(Theory)*

1. Global concerns for forests
2. Forests and climate control, global warming and green house effect
3. Forest types of Pakistan
4. Effects of fuel wood use on environment
5. Pakistan's environmental settings
6. Major deserts of Pakistan, forests and desertification control
7. Mountain Forest Ecosystems
8. Control of water logging and salinity, role of trees in water logging and salinity control
9. Conservation of biodiversity
10. Trees and noise abatement, benefits of home and urban planting, guidelines for tree planting
11. Nursery establishment, site preparation, thinning and tending operations
12. Major tree species used in mountain areas, plain areas and desert areas

Recommended Texts:

1. Freer-Smith, P.H.; Broad Meadow, M. S. J. 2007. Forestry & Climate Change. CAB International.
2. Innes, J.L.; Hickey, G.M.; Hoen, H. F. 2005. Forestry & Environmental Change. CAB International.

Suggested Readings:

1. K.M. Siddiqui. 1997. Forestry and Environment. PFI, Peshawar
2. Champion, Seth and Khattak. 1965. Silviculture of Pakistan, Feroze sons, Peshawar.

FWRW-7105 **Grazing Management of Rangelands** **3(3-0)**

Introduction

Managing rangelands is both art and science. Scientific knowledge is combined with practical local experience to find solutions to specific management problems. This course will focus on how scientific principles can be applied to manage grazing animals. Grazing management entails managing how grazing animals, forage plants, and soils interact to meet specific ecological and economic objectives. A successful grazing manager needs to know the way plants grow and reproduce if he wants to understand the effects of grazing animals on plants by the amount of plant material removed, hoof action and other aspects of grazing. This course will also focus on understanding the behavior of grazing animals in diet selection, specifically, their nutritional needs at critical points of the production cycle of vegetation.

Course Learning Objectives

1. Develop understanding about fundamentals of grazing and principles of grazing ecology
2. Impart knowledge on types of grazing systems and their suitability to the site conditions
3. Identify the vegetation types and to evaluate the range resources of the country in different areas
4. Enable the students to manage the rangelands according to the grazing potential and stocking rates
5. Enable students to monitor grazing impacts, using latest technology and adjust grazing plans accordingly, keeping in view the ecological, social and economic factors
6. Enable the students to address the social and cultural considerations in grazing management decisions

Learning outcomes

After studying this course, students should be able to;

1. Understand grazing ecology principles and rangeland ecosystems and familiarize with grazing management strategies and methodologies
2. Develop and implement effective grazing systems and workable plans
3. Monitor and evaluate the health and quality of rangelands and grazing impacts
4. Identify and address the potential problems and limitations and develop creative solutions to deal with the complex grazing management challenges
5. Interact and collaborate with stakeholders, the knowledge and skills, to achieve grazing management goals

Contents *(Theory)*

1. Management of rangelands for grazing
2. Principles of grazing management, carrying capacities
3. Range-animal interactions: response of plants to grazing, avoidance of disturbance, tolerance of disturbance
4. Plant morphology and Plant physiology in relation to grazing
5. Challenges herbivores face in foraging, variation in nutrients, plant chemical defenses
6. Plant morphological defenses
7. Temporal and spatial variations, unfamiliar environments
8. Diet selection, learning diet selection, habitat selection
9. Forage ingestion and intake
10. Animal nutrition in relation to range management

Recommended Texts:

1. Vallentine, John, F. 2000. Grazing Management. Academic Press (Elsevier Science & Technology Books). Heady, Harold F. and R. Dennis Child. 1994. Rangeland Ecology & Management. West View Press, Boulder, Co. USA.
2. Holechek, J. et al., 1989. Range Management, Principles and Practices. Prentice Hall, Inc. Newberry. USA.

Suggested Readings:

1. Lemaire, G.; Hodgson, J.; Moraes, A.; Carvalho, P.C.F.; Nabinger, C. 2000. Grassland Ecophysiology and Grazing Ecology. CAB International. International Development Research Center, Ottawa, Canada. Pp.349
2. Skerman, P. J. Tropical Forage Legume. FAO. Rome, 1997.
3. Stoddart, L.A., Smith A.D. and Box T.W. 1975. Range Management 3rd Edition. Mc Graw Hill Book Co. New York.

FWRW-7106 **Tree Crop Volume Measurements** **3(2-1)**

Introduction

Forest crop measurement, also called forest mensuration and forest inventory, is one of the most fundamental disciplines within forest and related sciences. This course deals with the measurement of trees and stands and the analysis of the resultant information. The main emphasis of these measurements is the systematic collection of data on the forestry resources within a given area. It allows assessment of the current status and lays the ground for analysis and planning, constituting the basis for sustainable forest management. The purpose of a forest inventory is to obtain comprehensive information about the current state and dynamics of a timber stand to be used in strategic management planning. Measurement of different forest resources is very important in forest management since it provides the data for planning, monitoring, evaluation, research, growth and yield, biodiversity and timber sale. Including this course at post graduate level will be helpful for future forest manager to equip themselves with the modern gadgets and latest tools being used for measurement and calculation of different forest resources.

Course Learning Objectives:

1. Understand forest measurement principles and to familiarize with basic concept and terminology
2. Understanding of measurement techniques and different tools used for measurement of various tree parts
3. Measure tree and stand characteristics, like stand density, tree height, basal area, diameter, volume, etc.
4. Understand growth patterns and models and estimate future yields and harvest potential
5. Develop inventory and monitoring plans and harvesting decisions

Learning Outcomes

After studying this course, students should be able to;

1. Understand forest mensuration principles, methods and applications
2. Use forest measurements techniques, tools and software
3. Accurately measure tree and stand characteristics and analyze the interpret forest mensuration data
4. Apply measurement techniques to forest management decisions

Contents *(Theory)*

1. Scope of Forest mensuration
2. Height and crown measurements
3. Crown measurements and its relationship with diameter and height
4. Volume measurements, standing tree volume and felled tree volume
5. Kinds of felled material, timber, small wood
6. Measurement of large volumes by using different methods and techniques
7. Stacked wood measurements, stacked volumes vs. solid volume
8. Measurement of bark thickness and bark volume, use of instruments like bark hammer and bark gauge
9. Measurement of converted or sawn timber, timber calculations, timber tables and log rules
10. Measurement of weight of wood, moisture content of wood, charcoal
11. Crop measurements; age, diameter, increments
12. Forest inventory, crop volume, site index, yield tables

Practical

1. Volume calculation of single tree
2. Field exercise with the measuring instrument

3. Data processing by full enumeration
4. Height, diameter, age curves, data processing of fixed area plots
5. Data processing of horizontal point sampling

Recommended Texts:

1. Hassan Abbas. 1996. Elements of Forest Mensuration. PFRI, Faisalabad.
2. Hunsch, B., Beers, T.W and Kershaw, J. 2003. Forest mensuartion. (4th Edition). John Wiley and Sons.

Suggested Readings:

1. Negi S.S. 1986. A Handbook of Forestry. International Book Distributors. Dehra Dun, India.
2. West, P.W. 2009. Tree and Forest Measurement. Springer; 2nd edition,ISBN-10: 3540959653 ISBN-13: 978-540959656

FWRW-7107 **Advances in Forest Utilization** **3(3-0)**

Introduction

Forest Utilization is the branch of Forestry which deals with the most suitable and most beneficial methods by which forest produce is collected and converted into useful products. The term "forest utilization" includes all those activities which are required in order to produce goods and commodities from forests and its derived products. It is considered as a science as well as an art, and is considered as an important branch of forestry. The science of Forest Utilization may be defined as a systematic arrangement of the most appropriate methods of harvesting, converting and profitably disposing of forest produce, in accordance with the results of experience and study. In general, Forest Utilization includes the knowhow of harvesting, conversion and disposal of major and minor forest produce, and study of forest based industries.

Course Learning Objectives

1. Understand the latest technologies and innovations in forest management and utilization
2. Analyze the environmental and economic benefits of advanced forest utilization practices
3. Evaluate the applications and potential of emerging technologies like biotechnology and nanocellulose
4. Develop skills in sustainable forest management, including certification and standards

Learning Outcomes

After studying this course, students should be able to;

1. Apply advanced knowledge and skills in forest utilization
2. Promote sustainable forestry practices
3. Drive innovation in forest products and services
4. Address complex environmental and social challenges
5. Contribute to climate change mitigation and bioenergy solutions

Contents *(Theory)*

1. Structure of Wood: Softwoods and hardwoods, sapwood and heartwood, pores and vessels, pits, trachieds and fibres, arenchyma, rays, tyloses, resin canals, gum ducts, ripple marks, grain, texture and figure, identification of important timbers
2. Defects in Wood: Knots, compression and tension wood, brashness, defects due to direction of grain, shakers, frost injuries, pitch defects, bark pockets, mineral streaks and chemical stains, seasoning defects,

sap stain and decay, insect attack pith flecks

3. Physical and mechanical properties: Physical properties, color, Luster, odor and taste, density and hardness, shrink age, wood-moisture relations, thermal and electrical conductivity of wood; calorific value of wood. Mechanical properties of wood, tests for bending strength, compression, tension, impact, hardness, shear, cleavage and nail-holding power
4. Wood seasoning: Air and kiln seasoning; types of air seasoning, sheds and seasoning kilns for timber
5. Wood preservation: Types of wood preservatives; Treating processes and cost of treatment
6. Sawmilling and wood working: Various types of sawing machines, their operation and maintains
7. Pulp and Paper: Essential requirements for suitability of raw material for pulp and paper manufacture, distribution and supply of raw material in Pakistan. Principal physical and chemical treatments involved in pulp and papermaking
8. Uses of wood: Characteristics and suitability of timbers for different industrial and domestic uses
9. Utilization of wood waste and integration of forest industries: Types of wood waste, uses of wood waste

Recommended Texts:

1. Carl Alwin Schenck. 2009. Forest Utilization, Mensuration and Silviculture. University of Michigan, USA.
2. S.S. Negi. 1992. Text Book of Forest Utilization Wood and Non-Wood Forest Products. Dehradun, India.
3. Andrew J. baker. (Ed.). 1983. Advances in Production of Forest Products. American Institute of Chemical Engineers. New York.

Suggested Readings:

1. R.L. Anderson and Ronald W. Rousseau (Ed.). 1974. Advances in Processing & Utilization of Forest products. American Institute of Chemical Engineers. New York.
2. Desh, H.E. 1948. Timber its structure and properties. Macmillan and Co. Ltd., London.
3. K.M. Siddiqui and Ayaz. 1996. Wood properties and Uses. PFI, Peshawar.

FWRW-7108 **Advances in Wood Science** **3(2-1)**

Introduction

Wood science covers, in particular, the areas of the formation and composition as well as the biological, chemical, physical and mechanical properties of wood. Detailed knowledge of wood is required for the processing of wood, the production of wood-based materials, and the utilization of wood and wood-based materials in buildings and various products such as furniture. This course gives a brief overview including historical aspects of wood biology, wood chemistry, and the physical–mechanical properties of wood and wood-based materials. These fundamentals are also essential for understanding technological processes and product development.

Course Learning Objectives

1. Stay updated on the latest advances in wood science and technology
2. Develop expertise in wood properties seasoning and preservation techniques and applications
3. Drive innovation in wood products and manufacturing using modern technologies
4. Contribute to sustainable forestry and bio-based economies
5. Enhance their skills in wood research, development, and industry applications

Learning Outcomes

After studying this course, students should be able to;

1. Apply advanced knowledge and skills in wood science and technology
2. Drive innovation in wood products and manufacturing
3. Contribute to sustainable forestry practices and promotion of bio-based economies
4. Enhance their careers in wood science, research, and industry
5. Stay updated on the latest advances and technologies in wood science

Contents *(Theory)*

1. General anatomical characteristics of wood, uses of wood
2. Wood defect: knots, compression and tension wood, shakes, pitch pockets, mineral streaks, sap stain
3. Insect and fungal degradation and defects due to grain
4. Physical and mechanical properties of wood, factors affecting strength properties of wood
5. Wood Seasoning: Importance of wood seasoning and its application, air and kiln seasoning techniques and their relative importance, method of stacking, seasoning defects, seasoning characteristics of important local timbers
6. Wood Preservation, sawmilling and wood working
7. Panel Products: Description and uses of panel products, plywood, multiply construction, laminated board, batten board, blackboard, particleboard; low, medium and high density particleboard, fiberboard: compressed and non-compressed, semi-rigid insulation and rigid insulation board, hardboard, standard and tempered
8. Advantages and disadvantages of panel products over solid wood

Practical

1. Preparation of wood for microscopic examination
2. Macroscopic and microscopic features of local timbers will be examined including Deodar, Partal, Chir, Shisham, Babul, Mango, Siris, Bakain, Semal, Ber, Oak, Eucalyptus and Popular
3. Measurement of wood drying defects
4. Methods of testing the effectiveness of various preservatives including laboratory and field tests
5. Visit to any wood industry to evaluate the application of wood technology

Recommended Texts:

1. Anonymous (1981). Plywood, its manufacture and uses. Timber Research and Development Association, England.
2. Armstrong, F.H. (1960). The Strength Properties of Timber. F.P.R. Bulleting No.45 HMSO, UK
3. Brown, H.P., et al. (1949). Text Book of Wood Technology Vol.I and II. McGraw-Hill, New York.

Suggested Readings:

1. Kollman, F.F. and Pan, W.A. (1974). Principles of Wood Science Technology, Vol. 1 and II. Springer Village, New York.
2. Masood, Q. 2005. Basics of Forestry and allied Sciences. A-One Publisher Al Fazal Market Urdu Bazar Lahore.
3. Wangaard, F.F. (1950). The Mechanical Properties of Wood. John Wiley and Sons, Inc. NY.

FWRW-7109 **Special Problem-I** **1(1-0)**

Introduction

The special problem is intended to instruct students on proper techniques for scientific research and methodologies. The students are expected to prepare directed assignment and collect information and material related to current research interest. Special problem means an assignment that is expected to be temporary and is designated as a special assignment by the academic supervisor in its sole discretion to increase the learning capabilities of students. The more we use our brains, the more they develop. Students learn a lot more when they read or practice something by themselves. Similarly, the purpose of assignments is to increase the practical skills of students.

Course Learning Objectives

The main objectives of special problem assigned to students are;

1. Enhance the knowledge of a subject on a specific topic in more depth
2. Provide an opportunity to students to concentrate on the assigned projects and train them to investigate the issues, problems and other related elements required to be documented to highlight them so that they may be taken into consideration for further research and analysis
3. Develop writing skills and to enhance time management and organizing skills
4. Enhances the planning and organizing skills by prioritizing the needs and time frames
5. Help students and train them in completing all tasks very peacefully instead of creating any panic

FWRW-7110 **Seminar-I** **1(1-0)**

The seminar is intended to instruct students on proper techniques for presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit written documentation supporting that seminar. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone is requested to participate. Seminars provide a chance to interact with experts from the specific field. Discussing about the relevant topics of the particular subject, students tend to learn about the latest information and new skills related to the concerned subject. Seminars are important and beneficial for those who have difficulty learning in a typical classroom setting where reading and writing are required. There is often a sense of friendship associated with seminar attendance, because everyone is attending with a like interest in learning about a subject important to them. Attending a seminar has numerous benefits, including improving communication skills, gaining expert knowledge, networking with others and renewing motivation and confidence.

Learning Objectives Assigning a Seminar

1. Develop advanced skills in critical thinking, communication, and collaboration
2. Apply theoretical knowledge to practical problems
3. Enhance their professional development and networking skills
4. Contribute to meaningful discussions and debates
5. Cultivate a deeper understanding of the subject matter
6. Prepare for future academic, professional, or personal pursuits

Presentation on any forestry related topic as advised by the course incharge

FWRW-7111 **Advances in Agroforestry** **3(2-1)**

Introduction

Agroforestry involves the deliberate growing of trees and shrubs with crops, sometimes with animals, in interacting combinations for a variety of objectives. Agroforestry farming practices have been used throughout the world for millennia but have only attracted scientific attention and attained prominence as relevant land use practice since the late 1970s. Today, acting as an interface between agriculture and forestry, agroforestry is considered to be a promising and sustainable approach to land use. Improvement and utilization of multipurpose trees that produce food, fodder, timber and fuel wood in integrated farming systems offer sustainable solutions to several serious land management issues such as food security, environmental protection, and climate change, in both developing countries and the industrialized world. This course deals with the latest trends and advances followed in the practices of agroforestry systems in the light of research findings for the benefits of the farming community at grassroots level.

Course Learning Objectives

1. Develop a comprehensive understanding of agroforestry systems
2. Apply innovative practices and technologies to improve agricultural and forestry productivity
3. Promote sustainable land use and ecosystem services
4. Enhance their skills in agroforestry design, planning, and management
5. Contribute to climate change mitigation and adaptation efforts
6. Support rural development and livelihood improvement

Learning Outcomes

After studying this course, students should be able to;

1. Apply advanced knowledge and skills in agroforestry design and management
2. Promote sustainable land use and ecosystem services and enhance agricultural and forestry productivity
3. Support rural development and livelihood improvement
4. Contribute to climate change mitigation and adaptation efforts
5. Drive innovation in agroforestry practices and technologies

Contents *(Theory)*

1. Introduction and scope of agroforestry and its importance
2. Need and potential of agroforestry
3. Agroforestry as a tool for rural development
4. Ecological, social and economical aspects of agroforestry system
5. Classification of agroforestry systems and choice of specie for agroforestry system
6. Components of agroforestry systems and classification, functions on applications
7. Ecology of agroforestry systems: interaction as a result of addition of domestic animals to the plant-soil complementary relationships, adverse relationships
8. Influence of forest components on field crop yield
9. Existing agroforestry of Pakistan and of the world
10. Financial Analysis of a system

Practical

1. Field visits to various agroforestry systems; observing their peculiarities and suitability
2. Report writing
3. Valuation of products and benefits

4. Cost benefits ratio, IRR, NPV

Recommended Texts:

1. Nuberg, Dr Ian (ed.); George, Mr Brendan (ed.); Reid, Rowan (ed.). 2009 Agroforestry for Natural Resource Management Published by: CSIRO Publishers.
2. Janaki R.R., Alavalapati and D. Evan Mercer. 2004. Valuing Agroforestry Systems: Methods and Applications (Advances in Agroforestry). Kluwer Academic Publishers. Springer, UK.
3. Nair, P. K. R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.p.399.

Suggested Readings:

1. Sahibzada M. Hafeez. 1996. Agroforestry Vol. I, II, III, IV, V and VI. PFRI Faisalabad.
2. Buck, Lassoie, Fernandes, 1999.Agroforestry in Sustainable Agriculture. Systems: CRC Press.
3. Nair P.K.R and Latt, 1998: Directions in Tropical Agroforestry Research, Kluwer Academic Publishers, Dordrecht, the Netherlands.
4. Huxley O. 1996. Tree Crop Interactions, Commonwealth Agriculture Bur. U.K.
5. McDicken and Vergara: 1990. Agroforestry. Wiley, New York.

FWRW-7112 **Agroforestry as a Business Enterprise** **3(2-1)**

Introduction

Agroforestry has been accepted as a land-use system that is capable of producing both food and wood while at the same time reduce forest resource user de-pendency as a means of livelihood thereby conserving and rehabilitating ecosystems. Agroforestry practice has a long history but recently has received more attention owing to the problems long-faced on forest reserves depletion and shortage of food supply. Enterprise in agroforestry is seen as a practice that serves as an alternative to the use and overuse of forest reserve resources. Agroforestry enterprise, as a product of agroforestry practice, simply deals with value addition in an existing product that is either used as a raw material or those forest products that were not packaged or branded. This course emphasizes on developing the innovative ideas and improved techniques of presenting agroforestry products to ensure more acceptances and helps better preservation and purification.

Course Learning Objectives

1. Develop a comprehensive understanding of agroforestry as a business enterprise
2. Apply business principles to agroforestry practices
3. Enhance their skills in agroforestry entrepreneurship and management
4. Identify opportunities for innovative agroforestry businesses
5. Support rural development and livelihood improvement

Learning Outcomes

After studying this course, students should be able to;

1. Establish and manage successful agroforestry businesses
2. Develop innovative agroforestry products and services
3. Enhance their skills in agroforestry entrepreneurship and management
4. Support rural development and livelihood improvement
5. Drive growth and profitability in agroforestry enterprises

Contents *(Theory)*

1. Economic concepts, detailed discussions on the interaction between various trees and crops with respect to different methods of mixtures, land capability classes locations and climatic conditions
2. Scope and extent of agroforestry as the only feasible solution of Forestry crises in Pakistan, discussions of formulating a suitable strategy for its development
3. Business of agroforestry: Establishment costs and interim income, marketing and evaluating agroforestry options
4. Role of small sized forest based industries involving low capital investment
5. Role of large industries associated with raw material collection points and processing units widely scattered in the rural areas.

Practical

1. Critical evaluation of agricultural farms in various ecozones with respect to agroforestry
2. Identification of problems and suggesting their solutions
3. Report writing

Recommended Books:

1. Beadle C.L. and A.G. Brown. 2007. Acacia Utilization and Management – Adding value. RIRDC Publication, Australia
2. Godsey and D. Larry. 2000. Economic Budgeting for Agroforestry Practices. Publication UMCA-3-2000. University of Missouri Agroforestry, Columbia, MO. 20 p.
3. Hensken F.L., M. Battaglia and M.L. Ottenschlaeger. 2008. Silvicultural Design Support for Farm Forestry. RIRDC Publication, Australia

Suggested Readings:

1. Jha L.K. and P.K. Sen Sharma. 2008. Agroforestry – Indian Perspective.
2. John, M. and B. Mortimer. 1996. Shelter and Shade: Creating a Healthy and Profitable Environment for Our Livestock with Trees. Green Park Press, Jackson, MS. 161 p.
3. Knowles, Leith and P. Middlemiss. 1999. Evaluating Agroforestry Options. A Continuing Professional Development course held at Hot Springs, AR, June 12, 1999. p. 6.
4. Sheikh M.I. 1993. Trees of Pakistan. Winrock International Institute for Agricultural Development, Pictorial Printers (Pvt.) Ltd., Islamabad.

FWRW-7113 **Range Vegetation Manipulation and Management** **3(3-0)**

Introduction

The modern era of natural resource management has been characterized by human efforts to reduce variability and increase predictability in natural systems. Rangelands are a dynamic natural landscape, composed of many resources, which produce many products. The rangeland and its resources, especially vegetation, are constantly being modified by a suite of non-human forces, including grazing, fire, flood and drought and climate or weather. Humans also modify rangelands directly through development e.g. energy, mining, and transportation and communications infrastructure and recreation. People also affect the other forces of change

by introducing invasive species, controlling or igniting fires, managing grazing and potentially impacting the climate and weather patterns through human caused changes in atmospheric chemistry. Range managers need a way to predict how management practices or natural disturbance will impact the vegetation on rangelands and to describe vegetation change or plant succession, from a specific disturbance based on the current vegetation community, the soils and climate of a site.

Course Learning Objectives

1. Understand the principles of range ecology and role of climate, soil, and topography in range vegetation dynamics
2. Learn to design and implement effective range vegetation management plans
3. Familiarize with various vegetation manipulation techniques (e.g., grazing management, prescribed burning, seeding)
4. Develop adaptive management plans for responding to climate change and other disturbances
5. Develop expertise to monitor and evaluate the effectiveness of vegetation management practices

Learning Outcomes

After studying this course, students should be able to;

1. Effectively manage and conserve range ecosystems and improve range vegetation health
2. Balance multiple management objectives (e.g., livestock production, wildlife habitat, ecosystem services)
3. Adapt to changing environmental conditions (e.g., climate change, drought)
4. Make informed decisions about range vegetation management
5. Communicate effectively with stakeholders on range vegetation management practices

Contents *(Theory)*

1. Methods of manipulating range vegetation for multiple use purposes
2. Ecological and biological principles, structural and functional aspects of manipulated ecosystems
3. Range plant growth and development. Integration of vegetation manipulation technologies and management
4. Site specificity vs. general application
5. Brush Management, invasive forbs and grass species management
6. Ecological Restoration
7. Collaborative adaptive management
8. Sustainability in rangelands
9. Fire as a management tool
10. Mechanical control of woody plants, chemical control of range plants
11. Biological manipulation of range vegetation

Recommended Text:

1. McNew, L.B., Dahlgren, D.K. and Beck, J.L., 2023. *Rangeland Wildlife Ecology and Conservation*. Springer Nature.
2. Briske, D.D., 2017. *Rangeland systems: processes, management and challenges*. Springer Nature.
3. Holechek, J. et al., 1989. *Range Management, Principles and Practices*. Prentice Hall, Inc. Newberry. USA.

Suggested Readings:

1. Noor, M. 1989. Rangeland Management in Pakistan. ICIMOD, Katmandu, Nepal.
2. Quraishi, M.A.A., G.S.Khan and S.Y. Mian. 1998. Range Management in Pakistan. University of Agriculture, Faisalabad.

3. Quraishi, M.A.A., M. Ishaque, 1995. Practical Manual of Range Management, University of Agriculture, Faisalabad.
4. Call, C.A. 2002. Lecture notes. Utah State University, Logan, Utah, USA.

FWRW-7114 **Developments in Watershed Management** **3(3-0)**

Introduction

Watershed is a geo-hydrological unit draining to a common point by a system of drains. All land-based productive activities are dependent on the topography of the area, soil type, available biomass and water and call for adopting an integrated management approach, which can be better evolved within a natural domain such as the watershed. This is because a watershed is an intricate, dynamic and natural functional unit established by physical relationships and social communication and actions. Thus, watershed as a unit enables planners and implementing agency to consider all inputs, processes and expected outputs systematically which are essential for a holistic development approach. This course intends to shed light on importance of watersheds and the latest developments needs to be opted for their conservation and management.

Course Learning Objectives

1. Understand the concept and importance of watershed management
2. Identify and analyze watershed characteristics and processes
3. Learn approaches and techniques for watershed assessment and planning
4. Develop skills in designing and implementing watershed management projects
5. Understand the role of stakeholders and community involvement in watershed management

Learning Outcomes

After studying this course, students should be able to;

1. Apply knowledge of hydrology, ecology, and geology to watershed management
2. Analyze the impact of human activities on watershed health and function
3. Develop strategies for managing water resources, preventing pollution, and restoring degraded watersheds
4. Understand policy and legal frameworks for watershed management
5. Apply knowledge and skills to real-world watershed management scenarios and case studies

Contents *(Theory)*

1. Forest meteorology, layers of atmosphere, composition and troposphere
2. Solar radiation/Heat balance, heat exchange, energy balance, time lag, effects of forest measurement
3. Clouds identification, their use as weather indicator
4. Atmospheric moisture: vapor pressure, relative humidity, absolute humidity
5. Winds: speed, frontal winds, convective winds, floods/flash floods/torrents and their control
6. Watershed planning and analysis, development of integrated watershed plan
7. Watershed management policies and institutions, policy analysis and development process
8. Watershed management systems, watershed management planning application,
9. Watershed management inventory, watershed analysis
10. Making the management decisions, implementing and evaluation of decisions
11. Social sciences in watershed management research rural people, their condition and constraints
12. Socio-economic evaluation of watershed management programs

Recommended Texts:

1. Isobel W. Heathcote. 2009. Integrated Watershed Management: Principles and Practice. John Wiley & Sons. UK.
2. Dunne, Thomas and Luner B. Leopold 1978. Water in Environmental Planning, W.H. Freeman and Company, San Francisco. USA.
3. FAO. 1978. Forestry for Local community development.

Suggested Readings:

1. Johnston, Bruce F. and William Clark. 1982. Redesigning Rural Development (A Strategic Perspective). The John Hopkins University Press, Baltimore and London.
2. Satterlund, Donald R. 1972. Wild land Watershed Management. John Wiley & Sons, New York.
3. Chow, Ven Te. 1964, Handbook of Applied Hydrology Chapter 26.1.
4. J.E Raeder- Roitzsch. 1968. Abstract of Lectures held at PFI for Watershed Management.

FWRW-7115 Forest Soil and Water Conservation 3(2-1)

Introduction

Soil and water constitute two major natural resources of forest ecosystem and their conservation is a key aspect of the economic and environmental sustainability of any country as they directly affect the status, health and composition of all types of agricultural and forestry systems. It is, therefore, obvious to make every effort for the conservation of soil and water to sustain the plant and animal life and to maintain fertile soils, clean water supplies, and productive agriculture to feed the world's population. Forests play a vital role in the water cycle. There has been a continuous depletion of soil and water resources due to various land degradation processes like soil erosion, large scale deforestation, unscientific mining activities, overgrazing, etc. These processes lead to degradation and deterioration of physical property of soils including loss of fertile soil thereby influencing largely the structure, productivity and regeneration of the forests. There is an urgent need for sustainable management of soil and water for conservation and management of forest ecosystems, and environmental planning and policy.

Course Learning Objectives

1. Understand the importance of forest soil and water conservation as precious natural resources
2. Develop skills in sustainable forest management for soil and water conservation
3. Identify factors affecting forest soil health and water quality
4. Learn different techniques to prevent soil erosion and landslides
5. Understand watershed management principles and practices

Learning Outcomes

After studying this course, students should be able to;

1. Understand the need for conserving forest soil and water for improving the productivity of agricultural and forestry systems
2. Prevent the loss of soil and landslides and minimize the process of sedimentation of the reservoirs
3. Apply knowledge and skills of soil conservation and hydrology for forest and watershed conservation

4. Analyze the impacts of human activities on forest soil and water quality
5. Develop strategies to reduce the depletion of natural resources through soil and water conservation

Contents *(Theory)*

1. Characteristics of forest soils and difference between agricultural and forest soil
2. Soil erosion control, contour ditches and their design criteria, types and design of terraces
3. Construction of check dams
4. Stream bank stabilization, rip-raping, retaining walls, gabions, revetments
5. Vegetative control, landslide erosion control
6. Identification and delineation of factors responsible for landslide hazards
7. Engineering and vegetative control measures
8. Water Conservation, water harvesting techniques for surface water
9. Resource development and range improvement
10. Dry Zone afforestation techniques
11. Role of water harvesting in dry land forestry, water spreading methods

Practical

1. Visit to watershed areas for collecting data to design terraces
2. Water Pond, rip-raping for channel and Retaining walls

Recommended Texts:

1. Mingyuan Du, Peiming Du, Taichi Maki and Shigeto Kawashima. 2009. *Modelling Soil Erosion, Sediment Transport and Closely Related Hydrological Processes*. USDA Agricultural Research Service, Agricultural handbook no. 703.
2. FAO. 2007. Conservation guides No.1,2,3,4 for Watershed Mgt. & Conservation

Suggested Readings:

1. Shah, B.H. 2006. Filed Manual on the role of water harvesting for dryland management in Pakistan. Verve Communication, Islamabad.
2. Morgan, R. P. C. 2005. Morgan Soil Conservation: Problems and Prospects. Springier publisher.
3. Bill Mollison. 1998. A Designer's Manual, Tagari Press, India

FWRW-7116 **Forest Diseases and Pest Management** **3(2-1)**

Introduction

Insect pests, diseases and other biotic agents have considerable impacts on forests and the forest sector. They can adversely affect tree growth and the yield of wood and non-wood products. Damage caused by forest pests can significantly reduce wildlife habitat thereby reducing local biodiversity and species richness. They can alter natural forest landscapes by decimating one or more tree species as has been observed throughout the world. Some pests have necessitated changes in management regimes often forcing forest managers to switch to alternative tree species in plantations. This course has been designed specifically to give the students insight about the forest diseases and damaged caused by insects and fungi at different phases of development of individual trees and forest crops in nurseries and established forests and plantations.

Course Learning Objectives

1. Develop a comprehensive understanding of forest diseases and pests and their management
2. Enable students to apply effective management strategies to minimize impacts caused by forest pests
3. Promote sustainable forestry practices by minimizing the insect attacks at nurseries and mature forests
4. Contribute to maintaining healthy and resilient forest ecosystems

Learning Outcomes

After studying this course, students should be able to;

1. Understand the principles of forest pathology and entomology and identify and diagnose common forest diseases and pests
2. Analyze the impact of diseases and pests on forest ecosystems and develop strategies for preventing and managing forest diseases and pests
3. Understand the role of integrated pest management (IPM) in sustainable forestry
4. Learn about chemical and biological control methods for disease and pest management
5. Develop skills in monitoring and forecasting disease and pest outbreaks.

Contents *(Theory)*

1. An overview of forest insects
2. Ecology of insects in the forest environment
3. Insect pests in natural forests and plantations
4. Insect pest of stored timber
5. Management of forest insect pests
6. Mycology, fungi classification,
7. Bacteria, Viruses, Nematodes and other pathogens
8. Specific fungi, causing different diseases, such as wood decay, discoloration, cankers and foliage diseases, etc.
9. Forest Pathology, plant diseases and their effects. Pathology in relation to forestry practices
10. Principles of forest diseases control, symptoms, causal organisms, modes of infection
11. Biology and control diseases of important forest tree species
12. Pest of shisham, kail, chir, deodar, poplar, kikar, eucalyptus, etc.
13. Vertebrate pest of forests
14. Important nursery pests, important seed pests, general control methods
15. Integrated pest management approaches

(Practical)

1. Identification and Collection of major fungi and insects causing diseases in forest trees
2. Field study of important insects of major forest tree species and their identification
3. Identification of important diseases of forest trees
4. Field study of forest tree diseases in different ecological zones

Recommended Texts:

1. NAIR, K. S. S. 2007. Tropical Forest Insect Pests: Ecology, Impact, and Management,. Kerala Forest Research Institute Peechi, Kerala, India. Cambridge university press, UK.
2. Wain and David. 2004. Ecological Methods in Forest Pest Management.OUP Oxford.

Suggested Readings:

1. Mehrotra, R.S. Plant Pathology 2nd edition. 2003. TATA McGraw Hills.
2. Blanchard, R.O. and T.A. Tattar. 1981. Field and laboratory Guide to Tree Pathology. Academic Press, London.

FWRW-7117 **Ecosystem Resilience to Changing Climate** **3(3-0)**

Introduction

The course introduces basic terminology used by practitioners of disaster risk management (DRM) in the study of resilience of agricultural systems. The main thrust in building resilience of rural social ecological systems .This Course provides a broader paradigm where resilience of agro-ecological systems is entwined with concepts of sustainable livelihoods and food security. It embraces a view of agro-ecosystems inclusive of land farming systems & livestock, aqua culture, fishery and forestry practices which strengthen rural livelihoods, their sustainability and diversity, and contribute to food security.

Course Learning Objectives

1. Give knowledge about climate change and its impacts on the Agro-ecosystems
2. Furnish students with strategies regarding Agro-ecosystem resilience
3. Enable the students to analyze the factors that influence sustainability and resilience of agro-ecosystems
4. Develop interventions to sustain productivity of agro-ecosystems in the face of climate change by integrating weather and climate information

Learning Outcomes

After studying this course, students should be able to;

1. Understand adverse effects of climate change on Agro-ecosystems and their productivity
2. Comprehend the factors, which contribute to cause climate change and enhance its impacts on productive potential of the Agro-ecosystems
3. Develop understanding to climate change mitigation strategies
4. Generate innovative ideas for rehabilitation and restoration of degraded agro-ecosystems by changing the behaviors and attitudes of the society towards these natural productive systems

Contents *(Theory)*

1. Basic concepts of Disaster Risk Management (DRM) and Impacts on Agriculture
2. Climate Change and its Impacts with Emphasis on Agriculture Sector
3. Agro-ecosystem as a Social Ecological System, and its Resilience and Sustainability
4. Introduction to Ecosystem based Approaches to build Resilience of Agro-ecosystems
5. Weather and Climate Forecasting, Information Dissemination and its Potential Applications
6. Project Formulation for Design of Interventions to Build Resilience of Ecosystems
7. Theory of Change

Recommended texts:

1. The impact of disasters on agriculture and food security. FAO. 2015. FAO Rome Italy. http://www.fao.org/3/a-i5128e.pdf

2. Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programs. Béné, C.; Wood, R.G.; Newsham, A.; Davies, M.2012. Wiley`s New York, NY, USA.

Suggested Readings:

1. Resilience of social-ecological systems in European areas: Theory and Prospects Schouten, Marleen. Van der Heide, Martijn., and Heijman, Wim., 2009. Belgrade http://www.fao.org/docrep/008/a0032e/a0032e04.html
2. Resistance, acquiescence or incorporation? Introduction to land grabbing and resistance. Ben White, Ian Scoones, Marc Edelman, Ruth Hall, Saturnino M. Borras and Wendy Wolford.2015. Institute for Food & Development Policy. USA: 390p.

FWRW-7118 **Forest and Wildlife Conservation** **3(3-0)**

Introduction

This course highlights the importance of both forest and wildlife conservation in different ecological zones of Pakistan. The knowledge of forest and wildlife resource conservation will help the environmentalist to realize the importance of these integral parts of ecosystems. Forests and wildlife are necessary to regulate the population of different species of animals and birds. The forest ecosystem has primary, secondary, and tertiary consumers in the food chain, which help in maintaining biodiversity as various species of organisms takes shelter in the woods. Microorganisms that are necessary for the biosphere to survive, such as nitrogen-fixing bacteria, also take refuge in forest soils. They regulate the nitrogen content of the earth and make it sustainable for living. To ensure forest sustainability for future generations, it is necessary to increase tree planting and make every necessary step for the conservation of existing forest resources.

Course Learning Objectives:

1. Furnish knowledge about status of Pakistan regarding wildlife, forest resources and protected areas.
2. Impart knowledge among students about general causes of wildlife and forest threats
3. Link up Social , Economic and Environmental Factors leading towards loss of Wildlife and forest resources

Learning Outcome:

After studying this course, students should be able to;

1. This course will make the students familiar with the concepts of wildlife and forest management practices
2. It further aims to introduce factors that lead towards loss of wildlife and forest resources and its consequences on ecosystems.

Contents *(Theory)*

1. Philosophy and concepts in wildlife management
2. Biological, scientific, commercial, recreational, philosophical, educational, ethical, social values of wildlife and forests
3. Variety of wildlife, abundance, evolution, ecological niches, competition and population dynamics
4. National parks, wildlife sanctuaries and game reserves of Pakistan

5. Impact of human population on habitat degradation and fragmentation
6. Effect of pollution and overgrazing on wildlife and forest resources
7. Role of databases in wildlife management
8. Wildlife and habitat measurements, indices of ecological density and analyses for wildlife management Forests, their ecological and economic importance, factors affecting forest growth and management
9. Status of forests in Pakistan, their types, distribution, management, deforestation and its control
10. Participatory forest management
11. Sustainable forest management
12. Rangeland management as mitigating measure to resolve human wildlife conflicts

Recommended Texts:

1. Essential readings in wildlife management and conservation. Paul R. Krausman and Bruce D. Leopold .The Wildlife Society, John Hopkins University Press . 2013. 696 pp
2. Wildlife management and conservation Contemporary Principles and Practices .Paul R. krausman and James W. Cain.The Wildlife Society John Hopkins University Press. 2013.60pp

Suggested Readings:

1. Wildlife Ecology, Conservation and Management. Sinclair, A. R. E., J. M. Fryxell and G. Caughley. 2006. 2nd Ed. Blackwell Publishing, New York, USA.

FWRW-7119 **URBAN WILDLIFE** **3(2-1)**

Introduction

This course introduces the students with the wildlife in urban and suburban environments and its management implications. Wildlife conservation and biodiversity in urban and suburban areas is greatly threatened due to urban development characterized by high human population density and human-wildlife coexistence is being contested in suburban, peri-urban and exurban areas. Concerning to wildlife management today, the earth is becoming more urbanized associated with expansive human-built features, a trend that is projected to continue well throughout the world with significant effects on wildlife management.

Course Learning Objectives

1. Identify the urban wildlife species and their ecological role in the urbanized concrete environment
2. Provide firsthand knowledge to maintain the ecological balance, keeping in view the importance of wildlife and its advantages in urban environment
3. Impart knowledge about the beneficial and nuisance wildlife species and their management requirements in the light of legal framework of the country
4. Train students about the management strategies of wildlife species without compromising the human concerns

Learning Outcomes

After studying this course, students should be able to;

1. Know the urban wildlife and their ecological requirement in the urban environment
2. Understand the importance of ecological balance and role of urban wildlife to maintain this balance
3. Identify the beneficial and nuisance wildlife species and their management strategies

4. Comprehend the specific wildlife rules to deal with the urban wildlife and to maintain minimum threshold level for the benefit of the society

Contents *(Theory)*

1 Introduction and importance of urban wildlife
2 Definition and explanation of important terms related to wildlife
3 Wildlife of urban areas of Pakistan and their current status
4 Factors reducing urban wildlife
5 Benefits of wildlife in urban areas, how to promote urban wildlife
6 Related rules and regulations related to manage urban wildlife
7 Role of urban areas in wildlife conservation
8 Food chain and food web
9 Management problems associated with urban wildlife
10 Planning resources for urban wildlife enrichment
11 Management of nuisance wildlife species
12 Role of parks and recreation sites in urban wildlife
13 Needs for the establishment of zoo and wildlife parks in urban environment

(Practical)
1 Visit to different urban areas and identification of urban wildlife species
2 Study of food and feeding habits of urban wildlife
3 Useful and harmful impacts of wildlife species in urban areas
4 Visit to zoological gardens and museums for wildlife identification
5 Specimen collection and preservation in laboratory
6 Data collection on urban wildlife

Recommended Texts:

1. Chaudhri, A. B. (2003).*Wild and ground flora*. India: Arumina Printing Works.
2. Hosetti, B. B. (2003). *Wildlife management in India*. Jaipur, India: Pointer publishers.
3. Hosetti, B. B. (2005). *Concepts in wildlife management* (Rev. ed.). New Dehli, India: Daya Publishing house.

Suggested Readings:

1. Hudson, R. J. (1989). *Wildlife production systems*. UK: Cambridge University Press.

Singh, S. K. (2005). *Wildlife management*. Charbagh, India: International Books Distributing Co.

FWRW-7120 **Biofuel and Bioenergy** **3(3-0)**

Introduction

Introduction to Bioenergy and biofuels technologies" provides an introductory understanding to biomass, biomass to low-carbon energy systems including biopower, bioheat and biofuels, with a scientific examination of feedstocks, conversion technologies and scale up for industrial production, end products, and their applications. The course will also provide entry-level understanding of the concepts of sustainability, systems thinking and Life Cycle Analysis (LCA) and incorporation of these concepts into bioenergy systems.

Course Learning Objectives

1. Acquisition of knowledge and enhancement of comprehension of information regarding biomass and bioenergy technologies and their sustainable applications
2. Develop knowledge-based critical thinking and solutions offering emerging innovative bioenergy technologies and incorporation of these concepts into bioenergy systems
3. Explore the potential advantages of low-carbon energy in developing a low-carbon economy and society
4. Exposure to the Eco-Complex, "Clean Energy Innovation Center and Business Incubator" and potential group projects at the center based on the students' preference

Learning Outcomes

After studying this course, students should be able to;

1. Identify potential biomass feed stocks including energy crops
2. Have an understanding of the existing and emerging biomass to energy technologies
3. Have an understanding of the concept of Life Cycle Analysis (LCA) and its applications
4. Determine potential solutions for energy needs and problems by incorporating the bioenergy technologies being explored

Contents *(Theory)*

1. Current energy consumption, global and national overview
2. Biomass as a fuel, material characteristics of biomass a fuel
3. Physical, chemical and mechanical properties of biomass
4. Elemental composition of biomass, renewable and environment friendly role of biomass
5. Renewable energy sources and biomass, potential of biomass as energy
6. Energy content and calorific value of various biomass materials
7. Agriculture and Forest Residues
8. Waste to value-addition approach
9. Advance technologies in bioenergy

Recommended Texts:

1. Lu, S., Sun, Y.H., Amerson, H. and Chiang, V.L. (2007). MicroRNAs in loblolly pine (Pinus taeda L.) and their association with fusiform rust gall development. Plant J. 51: 1077-1098.
2. Shiro Suzuki, Laigeng Li, Ying-Hsuan Sun and Vincent L. Chiang (2006). The cellulose synthase gene superfamily and biochemical functions of xylem-specific cellulose synthase-like genes in Populus trichocarpa. Plant Physiol. 142: 1233-1245.
3. Song, J., Lu, S., Chen, Z.Z., Lourenco, R., and Chiang, V.L. (2006). Genetic transformation of Populus trichocarpa genotype Nisqually-1: A functional genomic tool for woody plants. Plant and Cell Physiol. 47: 1582-1589.

Suggested Readings:

1. Lu, S. F., Zhou, Y. H., Li, L. G., & Chiang, V. L. (2006). Distinct roles of cinnamate 4-hydroxylase genes in Populus. Plant and Cell Physiology, 47(7), 905-914.
2. Chiang, V. L. (2006). Monolignol biosynthesis and genetic engineering of lignin in trees, a review. Environmental Chemistry Letters, 4(3), 143-146.
3. Yamada, T., Yeh, T. F., Chang, H. M., Li, L. G., Kadla, J. F., & Chiang, V. L. (2006). Rapid analysis of transgenic trees using transmittance near-infrared spectroscopy (NIR). Holzforschung, 60(1), 24-28.
4. Alper, H.; Moxley, J.; Nevoigt, E.; Fink, G.; Stephanopoulos, G., Engineering yeast transcription machinery for improved ethanol tolerance and production. Science 2006, 314, (5805), 1565-1568.

5. Fargione, J.; Hill, J.; Tilman, D.; Polasky, S.; Hawthorne, P., Land clearing and the biofuel carbon debt. Science 2008, 319, (5867), 1235-1238.
6. Himmel, M., Biomass recalcitrance: Engineering plants and enzymes for biofuels production (vol 315, pg 804, 2007). Science 2007, 316, (5827), 982-982.
7. Himmel, M.; Ding, S.; Johnson, D.; Adney, W.; Nimlos, M.; Brady, J.; Foust, T., Biomass recalcitrance: Engineering plants and enzymes for biofuels production. Science 2007, 315, (5813), 804-807.

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