Department of Soil Science
Faculty of Agricultural Sciences
University of the Punjab, Lahore
Course Outline

Program	B.Sc. (Hons) Agriculture (Major: Soil Science)	Course Code	NAG-130	Credit Hours	3(2-1)
Course Title	**CARBON SEQUESTRATION IN SOIL**				

Course Introduction

Soil as a carbon sink and implications of its release to the atmosphere, relation of soil management with carbon emission, and international carbon budget & trade will be taught in the course. The students will learn effective organic carbon sequestration techniques for reduced carbon emission.

Learning Outcomes

On the completion of the course, the students will:

1. Understand the Carbon Cycle and Sequestration
2. Analyze Carbon Emissions and Climate Change Impacts
3. Apply Soil and Crop Management Strategies
4. Evaluate Biochar Production and Application
5. Understand and Critique International Carbon Trading Systems

	Course Content	Assignments/Readings
Week 1	**Unit 1** 1.1.Introduction to Carbon Sequestration, Definition and significance 1.2.Role of soil in carbon sequestration	
Week 2	**Unit 2** 2.1. Description and Historical Perspective of the Carbon Cycle 2.1.1. Basic concepts of the carbon cycle and Historical changes and impacts	
Week 3	2.1.2. Carbon Cycle: Processes and Pathways 2.1.3. Detailed mechanisms of carbon movement in nature, Interaction with soil	Draw carbon cycle on chart paper and explain how carbon emission affect carbon cycle?
Week 4	**Unit 3** 3.1. Estimates and rate of carbon emission and climate change	

	3.1.1. Methods for estimating carbon emissions	
Week 5	**Unit 4** 4.1. Partitioning and transformations of carbon in soil 4.1.1. Relationship between carbon emissions and climate change	How global warming and climate change influence Carbon emission?
Week 6	**Unit 5** 5.1. Soil and crop management strategies for carbon sequestration in soil; Crop residue incorporation, composting, agronomic practices 5.1.1. Crop management strategies for carbon sequestration in soil 5.1.2. Techniques for increasing soil carbon	
Week 7	5.1.3. Crop residue incorporation 5.1.4. Composting 5.1.5. Importance of composting in carbon sequestration	Write on the importance of soil organic carbon in maintaining soil health and mitigating climate change
Week 8	5.1.6. Soil carbon and soil fertility 5.1.7. Impact on soil carbon and fertility 5.1.8. Benefits of crop residues incorporation 5.1.9. Partitioning and transformations of carbon in soil	
Week 9	5.1.10. Agronomic Practices for Carbon Sequestration 5.1.11. Soil tillage, cover crops, and other practices	
Week 10	**Unit 6** 6.1. Biochar production, application, challenges and opportunities 6.1.2. Application of biochar	

Week 11	6.1.3. Challenges and opportunities in biochar production	
Week 12	**Unit 7** 7.1. Land Use Patterns in Relation to Carbon Emission 7.1.1. Definition and types of land use patterns 7.1.2. Historical evolution of land use	
Week 13	7.1.3. Carbon Emission Sources 7.1.4. Natural vs. anthropogenic sources	
Week 14	7.1.5. Role of land use in carbon emissions 7.1.6. Land Use Change and Carbon Emissions	
Week 15	9.2.3. Deforestation and reforestation 9.2.4. Urbanization and its effects	
Week 16	**Unit 8** 8.1. International Carbon Trading 8.1.1. Carbon Trading Mechanisms	Collect data regarding carbon trading in different countries
Course Content (Practical)		**Assignments/Readings**
Week 1	**Unit 1** 1.1.Estimation of Soil Organic Carbon 1.1.1. Overview of soil organic carbon (SOC) 1.1.2. Importance of SOC in soil health and carbon sequestration	Visit to Laboratory for instrumentation
Week 2	1.1.3. Factors affecting SOC levels 1.1.4. Methods of Estimating Soil Organic Carbon	Practical notebook completion
Week 3	1.1.5. Overview of various methods (e.g., Walkley-Black, dry combustion) 1.1.6. Pros and cons of each method	
Week 4	1.1.7. Walkley-Black Method	Practical notebook completion

	1.1.8. Detailed procedure of the Walkley-Black method	
Week 5	1.1.9. Laboratory session: Hands-on practice of the Walkley-Black method	
Week 6	1.1.10. Dry Combustion Method 1.1.11. Detailed procedure of the dry combustion method	Practical notebook completion
Week 7	1.1.12. Data Analysis and Interpretation 1.1.13. How to analyze and interpret SOC estimation results	
Week 8	**Unit 2** 2.1. Measurement of CO2 Emission in Soil under Different Land Use 2.1.2. Overview of soil respiration and CO2 emissions	Practical notebook completion
Week 9	2.1.3. Factors affecting soil CO2 emissions	
Week 10	2.1.4. Measurement of CO2 Emission in Soil under Different Land Use-Practical demonstration	Practical notebook completion
Week 11	2.1.5. Methods for Measuring Soil CO2 Emissions 2.1.6. Overview of various methods (e.g., chamber method, infrared gas analyzers)	
Week 12	**Unit 3** 3.1. Biochar Preparation and Characterization 3.1.1. Introduction to biochar 3.1.2. Applications of biochar in agriculture and soil health	Practical notebook completion
Week 13	3.1.3. Methods of Biochar Preparation 3.1.4. Overview of different methods (e.g., pyrolysis, gasification) 3.1.5. Pros and cons of each method	
Week 14	3.1.6. Pyrolysis Method for Biochar Preparation 3.1.7. Detailed procedure of the pyrolysis method	Practical notebook completion

	3.1.8. Laboratory session: Hands-on practice of the pyrolysis method	
Week 15	3.1.9. Characterization of Biochar 3.1.10. Physical and chemical properties of biochar 3.1.11. Methods for characterizing biochar (e.g., surface area, porosity, elemental analysis)	
Week 16	3.1.12. Data Analysis, Interpretation, and Applications 3.1.13. How to analyze and interpret biochar characterization results 3.1.14. Discussion of biochar application case studies 3.1.15. Review and wrap-up of the course content	Practical notebook completion

Textbooks and Reading Material

1. Hartemink, A. E. and K. McSweeney (Ed.). 2014. Soil Carbon: Progress in Soil Science. Springer International Publishing, Switzerland.
2. Lal, R., M. Suleimenov, B.A. Stewart, D.O. Hansen and P. Doraiswamy. 2007. Climate Change and Terrestrial Carbon Sequestration in Central Asia, Taylor and Francis, the Netherlands.
3. Piccolo, A. (Ed.). 2012. Carbon Sequestration in Agricultural Soils. Springer-Verlag Berlin Heidelberg, Germany.
4. Verheijen, F. G. A., S. Jeffery, A.C. Bastos, M. van der Velde and I. Diafas. 2010. Biochar application to Soils: A critical scientific Review of Effects on Soil Properties, Processes and Functions. Official publications, European Communities, Luxembourg

Teaching Learning Strategies

1. Multimedia
2. White Board
3. Group discussion
4. Quiz/Assignments
5. Demonstration/Activity

Assignments: Types and Number with Calendar

1. Write on the importance of soil organic carbon in maintaining soil health and mitigating climate change
2. Visit to Laboratory for instrumentation
3. Draw carbon cycle on chart paper and explain how carbon emission affect carbon cycle?
4. How global warming and climate change influence Carbon emission.

5. Write on the importance of soil organic carbon in maintaining soil health and mitigating climate change
6. Practical notebook completion

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.