Course Description, Learning Outcomes, General Questions, and Module Outline for Animal Science and Health, Natural Resource Management, and Plant and Soil Sciences Curricula

College of Agriculture and Sustainable Development (CASD)

Cuttington University (CU)

Purpose of document:

In order to implement new curricula in *Animal Science and Health*, *Natural Resource Management*, and *Plant and Soil Sciences*, a general framework and expected learning outcomes or objectives need to be clearly established. The information in this document will be used to develop syllabi for each course and will serve as a foundation for course module development. Each course contains the description from the revised CU catalog, a set of learning outcomes, a set of general questions associated with each learning outcome, and main headings that will found in each module for a particular course.

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Table of Contents

University Requirements	.3
CASD Requirements	.4
Major in <u>Animal Science and Health</u>	.31
Major in <u>Natural Resource Management</u>	.53
Major in <u>Plant and Soil Sciences</u>	.71
Minor in Agricultural Education and Extension	.92
<i>Minor</i> in <u>Agribusiness</u>	.101
Minor in Agricultural Mechanization	.107
Minor in Natural Resource Management	.111

University Requirements

(all majors)

Expected learning outcomes for the courses in this category should already be well established as they are university wide requirements. Learning outcomes for these courses are not presented in this document.

Course title	Credit hours
Principles of Biology (Lab)	4
Principles of Chemistry (Lab)	4
Introduction to Computer Science	3
Introduction to University Studies	2
Fundamentals of Communication I	3
Fundamentals of Communication II	3
Advanced Composition	3
Fundamentals of French I <i>or</i> Fundamentals of Kpelle	3
African History	3
Principles of Mathematics I	3
Principles of Mathematics II	3
Introduction to Psychology	3
Christian Ethics <i>or</i> Comparative Religion	3
	Course title Principles of Biology (Lab) Principles of Chemistry (Lab) Introduction to Computer Science Introduction to University Studies Fundamentals of Communication I Fundamentals of Communication II Advanced Composition Fundamentals of French I or Fundamentals of Kpelle African History Principles of Mathematics I Principles of Mathematics II Introduction to Psychology Christian Ethics or Comparative Religion

Total hours: 40

CASD Requirements

CASD courses that cross departments including independent project study and experience learning*

Course designation	Course title	Credit hours
CASD 101	Introduction to Agriculture and Natural Resource Management	3
CASD 102	Rural Sociology, Gender, and Culture	2
CASD 103	Rural Development, Gender, and Society	3
CASD 104	Introduction to Geology, Soil and Environmental Sciences	3
CASD 201	Population, Food Security, and Sustainable Development	3
CASD 202	Human Nutrition	3
CASD 204	Agricultural Economics	3
CASD 206	Agricultural Physics and Meteorology	3
CASD 301	Entrepreneurship and Microenterprise	3
CASD 302	Gender Relations in Extension	3
CASD 303	Environmental and Social Impact Assessment	3
CASD 304	Information Use and Technology	3
CASD 305	Experimental Design and Statistics	3
CASD 306*	Internship and Field Experience	3
CASD 307	Farm Mechanization and Technology	3
CASD 401*	Research Methods and Proposal Development	3
CASD 402*	Senior Project and Presentation	3

Total hours: 50

CASD 101Introduction to Agriculture and Natural
Resource Management(3 credits)

The objective of this course is to introduce students to the significance of Agriculture and Natural Resources (Forests) to the total national economy. The content will include: Employment creation and contribution to GDP; Linkages between industry, agriculture and natural resources; Current agricultural and natural resource management methods and practices in most developing countries in West Africa; Input distribution systems; Production systems; Marketing systems; Agricultural and natural resource-based consumer products; How to improve the agricultural and natural resources value-chain through agricultural and natural resource business enterprises; Micro-credit/finance in agriculture and natural resource; Small-scale processing; Storage and distribution enterprises; Input acquisition and distribution enterprises; Value creation and addition enterprises.

Learning Outcomes

Students will be able to:

1. Understand basic concepts (including history of, resources needed, and the future of) production agriculture.

Describe important historical developments in production agriculture.

2. Understand factors influencing food security.

Describe the differences between macro and micro nutrients, calories, cholesterol, carbohydrates, proteins, vitamins, and minerals? How is malnutrition classified, and what are the two types? What is the Agriculture-Hunger-Poverty Nexus, and how does it affect residents of Liberia? How does climate change and soil degradation affect food security? Are women and children affected by issues of food security? How?

3. Understand and define the green revolution, and how it affected food production around the world.

What are the major agronomic factors that were part of the green revolution? Are they still being used and developed today? Did Africa benefit from the green revolution?

4. Understand the basic premises of agronomy.

What are some of the constraints to efficient production of agronomic crops? List specific examples of the following types of crops that are grown in Africa: cereals and millets, pulses, oilseeds, feed and forages, fiber crops, sugar and starch crops, drug crops/medicinal plants, and beverages.

- 5. Understand the major segments of the horticulture industry, and the food and ornamental crops that are produced as a result.
- 6. Describe the major areas of study within the discipline of soil science, and why they are important to production agriculture. List the major soil series found in Liberia.

- 7. How does the study of agricultural engineering aid in production agriculture? What are some examples of recent developments?
- 8. Describe the importance of genetics, plant breeding, and biotechnology to production agriculture, and how it has changes during the 21st century.

Who is the father of genetics? Describe the major historical developments in plant breeding. How is biotechnology used to improve plant varieties? What are some human applications to biotechnology?

- 9. Define plant pathology, entomology, and weed science. Understand their roles in reducing yields of agricultural products.
- **10.** Define natural resource management, and give specific examples of natural resources that exist in Liberia.
- **11.** Describe why the production of rubber, oil palm, and trees for forestry are important to the Liberian economy.
- 12. Why is the coastline an important feature for the Liberian economy? Is protection of the soil and natural resources important to Liberia?

Course Module Outline

Section 1: Introduction to Agriculture

- A. Introduction to Agriculture
- B. Food Security
- C. Challenges to Achieving Food Security
- D. Green Revolution
- E. Sustainable Agriculture
- F. Major Branches of Agriculture
- G. Introduction to Agronomy
- H. Introduction to Horticulture
- I. Introduction to Soil Science
- J. Introduction to Agricultural Engineering
- K. Introduction to Genetics
- L. Introduction to Plant Breeding
- M. Introduction to Biotechnology
- N. Introduction to Plant Pathology
- O. Introduction to Entomology
- P. Introduction to Weed Science

Section 2: Introduction to Natural Resource Management

- Q. Definition And Classification of Natural Resources
- R. Major Natural Resources in Liberia
- S. Rubber Production

- T. Oil Palm
- U. Forestry
- V. Coastal Zone
- W. Biodiversity, Wildlife And Fishery
- X. Soil Erosion Management
- Y. Natural Resources Management
- Z. Conservation Movement

CASD 102 Rural Sociology, Gender, and Culture (2 credits)

This course will introduce students to the roles of communities, social life and organization in areas outside the major urban environment and thus in rural areas. Given the population dispersion in Liberia and the importance of stability and economic development in Liberian rural areas, this course will involve the examination of social life, theory, observation in historical and current contexts. Using both qualitative and quantitative data to better understand demographics, resources, and gender, this class will focus on ways to use sociological inquiry to first understand community life and Liberian rural society, and then to apply sociological theory and applied approaches toward the improvement of the quality of rural life. This course will also identify resources for rural development. Students will be introduced to the participatory roles of animators and other stockholders in rural development. The course focuses on rural institutions and rural community development.

Learning Outcomes

Students will be able to:

- 1. Define the types of family and their characteristics.
- 2. List rural institutions and functions.
- 3. Know community welfare structures and neighborhood.
- 4. Understand rural health and religion.
- 5. Analyze agricultural models and programs for gender bias.
- 6. Recognize gendered cultural practice and processes in agriculture in Liberia.
- 7. Understand commonalities between the gender in agriculture situation in Liberia and the rest of the world.
- 8. Be familiar with common international strategies and objectives related to women, agriculture, food and nutrition.
- 9. Recommend policy and research directions to increase gender equality and justice in agriculture.
- 10. Explain how local food systems and public health are linked.

<u>Course Module Outline</u>:

Section 1. Women, Agri-Culture, Food and Nutrition Security, and Gender Justice

- A. Introduction and Course Objectives
- B. Gender Inequality, Injustice, and Hunger
- C. Gender and Agriculture, the formal problem
- D. Gender and Agriculture, the formal solution
- E. Gender and Agricultural Education

Section 2. Human Rights Perspectives; Mainstreaming, Women in Agriculture; Civil Society, and Social Movement Empowerment of Women

- A. Human Rights-based Approach to Food, Nutrition and Gender
- B. Gender mainstreaming
- C. Gender Activism and the Right to Adequate Food and Nutrition

Section 3. Sustainable Local Food Systems

- A. Bridging Nutrition and Agriculture
- B. Designing local food systems for infants and young children
- C. Designing food systems for infants and young children
- D. Review of Maathi with group presentations
- E. Review of Maathi with group presentations

CASD 103 Rural Development, Gender, and Society (3 credits)

This course will introduce students to the basic fundamental principles, concepts and factors that either promote or hinder Rural Development and also the effects, issues, and problems of cultural practices in rural development theory of rural development system of approach to the transformation of rural society/community. This includes evaluation through case studies of various rural development strategies and policies. Experimental design and statistics. Gender, cultural relations and democracy. The relationships of gender equity, human development with social and economic development. Importance of appreciation of cultural diversity as the first step in the promotion of equal opportunities for men and women in agriculture. Gender equity and sustainable livelihoods.

Learning Outcomes

Students will be able to:

- 1. Become familiar with the factors that promote rural development.
- 2. Describe the women's roles as farmers, leaders and environmental stewards.
- 3. Learn to appreciate cultural diversity as a step towards gender equity.
- 4. Identify the link between gender equity and sustainable livelihoods.
- 5. Understand the importance of equal opportunities for men and women as a key aspect of social and economic development.

- A. Introduction and Course Objectives
- **B.** Terminology and Definitions
- C. Components of Rural development
- D. Women and Sustainable development
- E. Gender and agriculture
- F. Cultural diversity and gender equity
- G. Gender equity to foster sustainable livelihoods
- H. The role of women in farming and food security

CASD 104 Introduction to Geology, Soils and (3 credits) Environmental Sciences

The objective of this course is to introduce student to the geology and the origin and formation of soils. Introduction to the mineral, energy and water resources of Liberia. Impacts of geological engineering in sustainable development. Concepts will include chemical and physical properties of soils, fundamentals of soil survey and classification, and interactions of soil colloids and other soil constituents to mineral nutrition. Fundamentals of soil biology, organic matter development and dynamics of nitrogen, phosphorous and sulfur nutrition will be discussed. Soil conservation and improvement, erosion prevention strategies, drainage, tillage and irrigation will be addressed.

Learning Outcomes

Students will be able to:

1. Describe processes involved in soil formation and how variation and intensity of these processes resulted in soil morphology and landscape placement.

Describe processes involved in formation of soils in Liberia.

2. Characterize soil colloids based on percentages of sand, silt and clay; organic matter content; structure; and mineralogy.

Compare the major soil formations using the soil texture pyramid, organic matter, and structural composition.

3. Describe fundamental processes, ramification, and mitigation of soil erosion, compaction, and water infiltration and mobility.

Discuss factors influencing soil erosion, compaction, and water infiltration and methods that improve these phenomena with respect to agriculture and resource management.

- 4. Discuss the role of native elements in soil and soil colloid characteristics on dynamics of soil fertility.
- 5. Discuss the role of soil structure on mineral nutrition in soil.

Course Module Outline:

Section 1: Introduction to Geology

- A. The Nature of Geology
- B. Earth Materials
- C. Igneous Environments
- D. Sedimentary Environments
- E. Deformation and Metamorphism
- F. Weathering
- G. Earthquakes and Earth's Interior

H. Climate, Weather and Their Influences on Geology

Section 2: Introduction to Soil Science

- A. The Importance of Soils
- B. Soil Physical Properties
- C. Soil Formation
- D. Soil Taxonomy
- E. Types of Soil Water
- F. Soil Water Management
- G. Hydrologic Cycle
- H. Soil Chemistry
- I. Soil Acidity and Liming
- J. Soil Organisms
- K. Soil Fertility
- L. Nitrogen and Phosphorus
- M. Potassium, Secondary and Micronutrients
- N. Chemical Fertilizers
- O. Soil Erosion

Section 3: Introduction to Environmental Science

- A. Introduction and Public Views
- B. Population Issues
- C. Non-Renewable Energy Resources
- D. Renewable Energy Resources
- E. Ecology
- F. Biodiversity

CASD 201 Population, Food Security, and Sustainable (3 credits) Development

This course examines the link of the components of sustainable development (social, economic and environment sustainability) with food security. The components of food security, supply, availability and access and utilization of food and the role of gender equity and agricultural productivity will be discussed. Linkage between health, hygiene, education and nutrition in Liberian society will be important topics in the course. The role of economic development and food production systems in sustainable development will be discussed in the context of climate change and the broader scope of international assistance and regional development.

Learning Outcomes

Students will be able to:

- **1.** Use terminology on population, food and nutrition security, and sustainable development with confidence.
- 2. Recognize divergence between approaches to population, food and nutrition security, and sustainable development and begin to develop grounded positions for analysis.
- 3. Identify, organize, and begin to independently evaluate both diverse challenges to sustainable development and food and nutrition security, and, strategies to address these challenges.

Course Module Outline:

Section 1: The Basics: Population, Sustainable Environments and Food and Nutrition Security

- A. Class Introduction: Overview
- B. Critiques on Population and Development Theory and Policy
- C. Understanding the Terminology of Food and Nutrition Security

Section 2. Challenges to Food and Nutrition Security and Development for All

- A. Food and Nutrition Security in Liberia: The Challenges
- B. The Challenges of Conventional vs. Traditional/Local Knowledge
- C. The Challenge of Climate Change
- D. Challenges of (Non-Sustainable) Consumption
- E. Challenges of Land Tenure and Food Security in Liberia

Section 3. Strategies for Food and Nutrition Security and Development For All

- A. Local Food Systems
- B. Local/National Food Systems
- C. Fair Trade
- D. Review and Student Presentations
- E. Review and Student Presentations

CASD 202 Human Nutrition

This course studies the importance of food choices for a healthy and adequate diet to human growth and development. Risks and benefits of foods will be a major component of the course. Nutrients in foods and the body. The science of nutrition, dietary intake, nutritional assessments. The link between diet and health. Planning a healthy diet. Details on digestion, absorption and transport will be discussed in detail. The composition of foods, particularly the foods now consumed in Liberia will be featured along with their nutritional value components (carbohydrates, proteins, amino acids, vitamins, minerals, fats, water). Food safety issues will also be reviewed. Strategies to improve diet and human nutrition at the household and community level will be discussed.

Learning Outcomes

Students will be able to:

- 1. Identify the essential elements required for normal growth and development of humans.
- 2. Gain a basic understanding about the biochemistry of food and learn that food components (i.e. macromolecules) are similar to those that constitute our body.
- 3. Learn about the major systems in the human body with a focus on digestion.
- 4. Learn how malnutrition (under- and over-nutrition and/or simply an unbalanced or inappropriate diet) affects health.
- 5. Identify major diseases associated with improper or inadequate diet. Learn about the major chronic diseases influenced by diet.
- 6. Identify issues that affect food safety such as improper handling, storage and preparation.
- 7. Learn how to identify and plan a balanced diet with the foods consumed in Liberia based on a greater understanding of the operations of household and market in Liberia.

Course Module Outline:

Section 1: Introduction and Course Objectives

A. Terminology and Definitions

Section 2. Biochemistry of Food

- A. Carbohydrates
- B. Fats
- C. Proteins
- D. Water-soluble Vitamins

- E. Fat-soluble Vitamins
- F. Minerals and Water
- G. Energy, Calories and Dietary Guidelines

Section 3. Understanding the digestive system

- A. General overview of the human body anatomy and physiology: focus on anatomy and physiology of the digestive system
- B. Digestion, absorption and transport of nutrients
- C. The cell as the building block of our body: structures and functions

Section 4. Nutrition throughout the lifecycle

- A. Pregnancy, embryonic development and lactation
- B. The growing years
- C. Nutrition and aging

Section 5. Diseases Influenced by Food

- A. Under- and Over-nutrition (Malnutrition and Obesity)
- B. Food infections
- C. Diabetes
- D. Nutrition and Cancer
- E. Healthy Heart
- F. Food Allergies
- G. Alcohol, Tobacco, and harmful drugs
- H. Food- and water-borne illnesses

CASD 204 Agricultural Economics

This course is an introduction to the economics of agricultural and food markets. The goal is to provide the student with an understanding of the basic theoretical tools employed by economists in the analysis of agricultural price determination and discovery. The basics of supply and demand will be reviewed and expanded upon. Types of markets and their structure will be examined as well as the implications they have for participants. Emphasis will be placed on agricultural marketing system in the developing world. The traditional topics of price seasonality, marketing margins, derived demand, and trade will be covered. The role of pricing and risk management institutions, such as commodity futures markets, will be covered. Finally, this course will examine the roll of strategy used in price setting, how market power gets exploited, and what drives the consumer and how to learn more about them.

Learning Outcomes

Students will be able to:

- **1.** Develop an understanding of the Liberian economy form both a microeconomics and macroeconomics perspective.
- 2. Understand and apply the concept of diminishing marginal utility analysis to develop a consumer market demand curve for a product.
- **3.** Conduct price elasticity of demand analysis to interpret the impact of market price changes relating to consumer market demand.
- 4. Identify and apply the economic decision rules relating to the various economic principals of production.
- 5. Conduct price elasticity of supply analysis to interpret the impact of market prices changes relating to producer market supply and production decisions.
- 6. Apply supply and demand analysis for determining the market equilibrium and market equilibrium quantities between consumers and producers in the market place.
- 7. Describe the importance and role of agribusiness to the total Liberian economy and its importance to international trade.

<u>Course Module Outline:</u>

- A. Introduction and Course Objectives
- B. Functions of Capitalistic Economy and the Role of the Marketplace
- C. Role of Agribusiness Sector in the Liberian Economy
- D. Monetary and Fiscal Policies in Liberian Economy
- E. Consumer Behavior and Marginal Utility

- F. Market Demand Analysis and Price Elasticity of Demand
- G. Production Economics: Diminishing Returns Input Basis
- H. Production Economics: Input Analysis Using Resource Substitution
- I. Production Economics: Enterprise Analysis Using Product Substitution
- J. Production Economics: Profit and Production Cost Analysis
- K. Market Price Determination: Supply and Demand Analysis for Market Equilibrium
- L. Market Competition and its Impact on Consumer Prices and Market Efficiency
- M. Impact Market Competition and its Impact on Consumers
- N. Aggregate Demand and Supply Analysis in the Economy

CASD 206 Agricultural Physics and Meteorology (3 credits)

The course introduces students to concepts of applied physics in agriculture and the discipline of meteorology, atmospheric phenomena, weather and climate. Specific topics and concepts will include use of basic meteorological instrumentation, global climatic change and its impact to agriculture. Remote sensing and geographical information system applications in agriculture and natural resource management, and applications of renewable source of energy (e.g. solar radiation) in agriculture will be covered.

Learning Outcomes

Students will be able to:

1. Describe the principles and concepts of and influencing both weather and climate locally, regionally, and globally and factors influencing these phenomena.

Compare and contrast weather and climate and describe their interaction.

2. Describe the impact of climate change on agriculture with a focus on West Africa.

Critique the following theories and predictions associated with climate change and their impact on humans and food production systems and approaches to mitigate impact.

3. Describe energy requirements for current and possible mechanized production including energy sustainability.

Describe the use of each of the following test statistics and formulas used in statistics and the limitations of each.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. General Themes of Applied Physics
- D. Meteorology, Weather, and Climate
- E. Theory and Observations of Climate Change
- F. Crop and Natural Resource Response to Climate
- G. Theory and Practice of Global Information Systems

CASD 301Entrepreneurship and Microenterprise(3 credits)

Theories and principles of administration and management; personnel and office management; entrepreneurship will be discussed in this course. Characteristics of successful entrepreneurship, business ownership structure, legal issues of entrepreneurship, and risk management will be featured. Development of business plans, establishing microenterprises, implementation of a well-developed plan; and monitoring and evaluation of business will be essential components of the course.

Learning Outcomes

Students will be able to:

- 1. Demonstrate their understanding the entrepreneurial process.
- 2. Demonstrate their knowledge of the characteristics of a successful entrepreneur and how they apply to starting and operating one's own business.
- 3. Identify and compare the legal forms of a business.
- 4. Identify the main portions of a Business Plan and be able to write a business plan for a start-up company of their choosing.
- 5. Write financial and non-financial business goals
- 6. Learn and utilize the basic concepts of marketing, financing and Human Resources as they apply to their Business Plan.

- A. Overview and Entrepreneurship
- B. Planning and Research Entrepreneurial Essentials
- C. Planning and Research
- D. Organizational Matter: Management and Legal Structures
- E. Marketing Analysis
- F. Marketing Strategies
- G. Financial Overview
- H. Managing Your Money Financial Planning and Budgets
- I. Developing and Using Cash Flow Projections
- J. Understanding and Using Financial Statements
- K. Sources of Money
- L. Presentation of Business plans

M. Presentation of Business Plans

CASD 302 Gender Relations in Extension

The objective of this course is to introduce gender concepts in agricultural extension and to stress the importance of developing gender sensitive extension and outreach services for sustainable agricultural development for Liberia and Africa. Gender focused extension and outreach options at urban, peri-urban and rural settings are treated in the course. The course highlights the benefits of increased agricultural extension and outreach for women farmers in agriculture as ways of improving agricultural decision-making and output, marketing competencies, post-harvest technologies, communications at the community level, and household based food and nutrition security. The course will introduce concepts of diversity and justice including gender perspective with regards to balancing attention to production for markets and production for household and community food and nutrition security.

Learning Outcomes

Studenta will be able to:

- 1. Define gender and significance in agricultural extension and outreach.
- 2. Understand gender sensitive approaches to agricultural extension and outreach in Liberia.
- **3.** Apply gender sensitive techniques to agricultural extension and outreach under Liberian conditions.

Course Outline:

- A. Course Introduction (Significance, objectives, terminologies, definitions, etc.)
- B. Gender Roles in Liberian and African Agriculture
- C. Conventional Agricultural Extension and Outreach Methods
- D. Gender-Related Limitations of Conventional Ag Extension and Outreach Methods (cultural, religious, literacy, and socio-economic factors)
- E. Gender Sensitive Methods in Ag Extension and Outreach
- F. Application of Gender Sensitive Techniques to Ag Extension and Outreach (some case studies)
- G. Policy Dimensions of Gender Relations in Agricultural Extension
- H. Field Work

CASD 303 Environmental and Social Impact Assessment (3 credits)

This course studies the effects of agricultural productivity (animal and crop production systems), agro-forestry and the industrial commercialization of Liberian natural resources on the environment. The course will provide a primer as to how environmental and social factors need to be monitored, measured and assessed to understand the impact of such activities and then for the development of measures to reduce their impact or footprint. Impacts of these systems on environmental degradation will be discussed.

Learning Outcomes

Students will be able to:

1. Describe the process of program evaluation with special reference to agriculture.

Describe the steps one should follow in planning and conducting an evaluation to determine the impacts of any agricultural development program in Liberia.

2. Plan an evaluation to assess the impacts of an agricultural program.

Explain the use of the logic model in planning an evaluation to determine the outputs, outcomes and impacts of a rural dairy farm development project.

3. Conduct process evaluation for monitoring projects.

Identify appropriate indicators for performance evaluation and describe the significance of program process evaluation in monitoring projects.

4. Develop evaluation tools for collecting data.

Develop an evaluation tool to assess the impact of reforestation program in a district.

5. Conduct impact assessments and writing evaluation reports.

Describe the structure and organization of an evaluation report targeted for the public officials.

6. Critique evaluations for improvement.

Explain the guidelines one should follow when conducting a sound evaluation.

- A. Introduction, course objectives, and definitions of terms
- B. Exploring the concept and the process of Evaluation in the context of agriculture
- C. Planning evaluation with logic models
- D. Process evaluation and monitoring programs
- E. Designing evaluation studies for assessing impacts
- F. Collecting evaluation data

- G. Analyzing and interpretation of data and writing reports
- H. Utilization of evaluation data and meta evaluation

CASD 304 Information Use and Technology

This course teaches students the wide array of information resources available online and offline, analyzing and assessing content appropriate for their personal research and extension work. This course also teaches the effective use of various communication tools using technologies appropriate to various settings: illiterate farmers, community leaders, county decision and policy makers related to the use of sustainable agriculture practices, food security, poverty reduction, gender sensitivity, and market information. This course also teaches students how to effectively work with other professionals such as librarians, health workers, educators (literacy, learning), business professionals, media workers and others. Team work will be emphasized as well as active learning opportunities.

The course is taught using the various delivery methods students themselves will be utilizing in their work after graduation – eLearning modules, Internet methods for communication, text messaging, short videos, and email. Webinars will also be used as a way to interact and communicate with students. Some in-person lectures on how other experts use information and communication in their work will be included.

Learning Outcomes

Students will be able to:

- 1. Identify the difference between scholarly/peer-reviewed research and practical information related to agriculture as well as information that is authoritative, unbiased, and timely.
- 2. Use major resources, both online and offline, to obtain relevant full-text resources and to be able to utilize scholarly resources in their required senior research project.
- **3.** Synthesize scholarly resources themselves in the creation of practical information resources understandable to the general public (farmers and others) and also effectively select and utilize important relevant documents from other West African countries needed for extension work.
- 4. Utilize a variety of delivery methods for providing information to farmers, community leaders, and others for sustainable agriculture practices and market information such as text messaging, mobile devices/tablets, radio, print media, and public speaking and on-site teaching.
- 5. Filter information, use social networking, and keep abreast of new information for continuing education and lifelong learning.

Course Module Outline:

- A. Introduction and Course Objectives
- B. The importance of relevant, appropriate, unbiased information in today's society
- C. Use of major information resources available offline and online including TEEAL, AGORA, and OARE
- D. Effective search strategies to obtain information relevant to their research projects, may involve team work opportunities.
- E. How extension and information workers utilize information in their work to support sustainable agriculture practices and provide market information
- F. Communication skills and work with a variety of users: farmers, community leaders, policy and decision makers, effective presentation methods.
- G. Working effectively with other professionals including librarians, educators, health workers, businesses including team work strategies (may need to include students from other departments).
- H. Internet services and the use of social media
- I. Use of communication technologies texting, mobile devices, radio, public speaking, newspaper articles and the preparation of extension bulletins
- J. Filtering information and the use of e-learning, information services, and webinars for continuing education and lifelong learning.
- K. Class conference with presentations, individual or groups, on research progress towards their senior projects utilizing appropriate presentation tools. Assessment by other students in the class in a board room setting.

Terminology and Definitions

Library/information resources are divided into scholarly (peer-reviewed/refereed) primary research, practical information (government documents, technical reports, extension bulletins, trade journals) and popular information (magazines and newspapers). These resources are used for personal research (scholarly information) and to communicate information via practical and popular media.

ICT or information and communication are technology-based delivery methods to provide sustainable agriculture and market information to end-users from low-technology options such as radio, print, and texting to sophisticated approaches that employ multimedia such as mobile devices including tablets/smartphones, Internet social media, television, and emerging approaches on the horizon.

External information workers include professionals that students will need to communicate and work closely with upon graduation such as librarians, educators, health workers, and business.

CASD 305 Experimental Design and Statistics

(3 credits)

Developing a testable hypothesis and implementing procedures to test hypothesis are essential components of the scientific process. Students in CASD will be exposed to the scientific process and will understand basic process of research including establishing experiments with appropriate controls and replication, recording appropriate data, analyzing data, and making appropriate conclusions from the research project. Students will also be exposed to the importance of written and oral communication of the results from research. This course will serve as a foundation for the student project. Students will have the opportunity to participate in the design of field studies, in the input of data and in statistical analyses. The importance of proper experimental design and statistical analysis in research and the ability to properly interpret the results of any study will be focused.

Learning Outcomes

Students will be able to:

1. Describe the process of constructing a testable hypothesis and developing a set of objectives that can be addressed using the scientific process.

Given the following issue in agriculture, determine if a testable hypothesis is possible and if so, what objectives need to be developed to test this hypothesis?

2. Describe fundamental assumptions and relationships necessary to use a statistical approach to determining treatment effects in biological systems.

Given the following set of observational or experimentally-derived data, describe appropriate assumptions that will ensure data are analyzed properly so that valid conclusions can be derived from statistical analyses.

3. Describe appropriate test statistics, the role of probability, and the limitations of statistical procedures in science.

Describe the use of each of the following test statistics and formulas used in statistics and the limitations of each.

4. Develop appropriate field designs to address testable hypotheses given logistical and resource limitations in biological systems.

Given the following set of treatment factors that need to be compared and the following conditions and resources, develop an experimental design that will be useful in testing the hypothesis and making conclusion over a larger geographical region.

5. Discern the value of data sets with respect to extrapolation beyond confined experiments or observational data.

Given the following data set, indicate the conclusions that can or cannot be made and the factors that limit use of the data set.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. The Experimental Unit
- D. Statistical Assumptions
- E. Fundamentals of Probability
- F. Hypothesis Testing
- G. Designing Experiments
- H. Use of Observational Data and Surveys
- I. Interpreting Data from Controlled Experiments

CASD 306 Internship and Field Experience

(3 credits)

Students will have the choice of working with NGO, government agencies, or business associated with animal or plant systems or natural resource development. This course will expose students to practical applications of their academic program and will provide initial linkages with employment opportunities. Students will also be exposed to professionalism and intangible elements required for successful business and/or support of the agricultural sector of the Liberian economy. This course builds upon the concept and critical importance of service learning for the student's personal and professional development and fosters the connections not only of the student but of the CADS faculty to working toward the improvement of Liberian society.

Learning Outcomes

Students will be able to:

1. Develop a thorough understanding of the role the selected institution plays in the Liberian agricultural sector.

Describe in detail the value and limitations of the institution involved in the internship learning experience.

2. Describe how the internship has influenced the individual's view of the agriculture sector and future career choices.

Describe experiences that have shaped the individual's desire for further study and possible career choice.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Description of Possible Internships Opportunities and Contacts
- D. Structure, Schedule, and Expectations of Interns
- E. Development and Presentation of the Internship Experience

CASD 307 Farm Mechanization and Technology (3 credits)

This course will include characterization and adoption of mechanization and technology used in plant and animal production systems. Economic performance of the total machine systems including machine performance, power performance and operation performance will be discussed. Economic viability of mechanized systems in relation to management decisions for farm machinery and maintenance will be included. Application of new approaches to tillage, seed bed preparation, cultivation, seeding, chemical application, grain harvesting, forage harvesting, farm processing, and materials handling.

Learning Outcomes

Students will be able to:

1. Describe history context of mechanization and technology development in agricultural systems.

Describe the major technological developments during the history of agriculture and how these developments revolutionized animal and crop production.

2. Describe performance, limitations of currently available technology associated with agricultural mechanization and possible advances in these systems.

Given the following set of equipment or machinery, describe their utility, limitations and methods to improve efficiency.

3. Describe the value and risks associated with pesticide and fertilizer delivery in the context of Liberian crop production systems.

What are potential risks and benefits and long term sustainability of delivery and the systems used for pesticides and fertilizers in major Liberian crop production systems?

4. Characterize the role GIS and other precision agricultural tools on the agricultural sector of Liberia.

Describe the possible uses of the following precision agriculture tools for Liberian farmers and the supporting agricultural sector.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. History and Progress in Agricultural Mechanization
- D. Limitations of Mechanization
- E. Energy Requirements in Mechanization
- F. GIS Theory and Application

- G. Pesticide and Fertilizer Delivery Systems
- H. Efficiency or Mechanization Associated with Tillage, stand Establishment, Maintenance, and Harvesting Crops
- I. Construction and Maintenance of Structures Used in Drying, Storing, and Transporting Crops

CASD 401 Research Methods and Proposal Development (3 credits)

With assistance from an appropriate advisor/mentor, students will develop a research hypothesis and prepare a plan of action to test the hypothesis. Each student will prepare a proposal based on appropriate justification and experimental procedures. Students will implement the project during this time. The goal of this course is to help students develop critical thinking skills and to provide experience in having a student work through developing a concept to a full proposal. This course provides opportunities in the agricultural sector that foster sustainable development in Liberia. The student farm will be an essential component of this course and the companion course CASD 403.

Learning Outcomes

Students will be able to:

1. Identify one important issue associated with agricultural and develop a testable hypothesis to address this issue.

Describe the reasons why the issue is important to the agriculture sector of Liberia and explain what can be tested to bring additional clarification to the issue and a possible solution.

2. Develop a set of objects and appropriate experimental procedure to test the hypothesis.

Describe in detail the objectives of the experiment and the experimental approach used to address the set of objectives.

3. Describe potential outcomes and pitfalls associated with the proposal and the experimental procedure.

Describe pitfall that could occur once the experiment is established that could limit addressing desired outcomes.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Conducting a Quality Literature Review
- D. Developing a Proposal Outline
- E. Examples of Effective and Ineffective Proposals
- F. Identifying Weaknesses and Potential Pitfalls
- G. Presenting Proposals to Funding Institutions

CASD 402 Senior Project and Presentation

This course involves the completion of research outlined in CASD 401 and will require analyses of data and preparation of a written documentation of results and application of those results to end users. The student will also present the research findings to their peers and academic advisor and other faculty members. The information will also be presented to agribusiness, NGO and government when appropriate.

Learning Outcomes

Students will be able to:

1. Record appropriate empirical data and analyze data in a manner that allows conclusions to be drawn from those data based on the research proposal developed in CASD 401.

Employ appropriate statistical procedures to data sets and make appropriate conclusions about the treatment factors compared in the experiment.

2. Present conclusions and application of the results in written and oral formats to appropriate audiences including possible experiments that would build on results.

Prepare a written report outlining the justification for the experiment, the hypotheses and associated objectives, a complete set of experiment procedures, analyses of data and discussion of results, and a larger discussion of results in the context of what is already know or speculated about the issue in question. In addition to a written document, results will be presented orally and will be scrutinized by peers, academic advisors, and individuals in the agricultural sector with knowledge of the issue.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Developing Protocols and Procedures
- D. Collecting Pertinent Data to Effectively Test the Hypothesis
- E. Analyzing and Interpreting Data
- F. Preparing Effective Reports and Presentations

Animal Science and Health

Course designation	Course title	Credit hours
ASH 201	Introduction to Animal Production and Health	3
ASH 202	Animal Anatomy and Physiology	2
ASH 204	Animal Nutrition and Growth	3
ASH 301	Animal Genetics and Breeding	3
ASH 302	Ruminant Production	3
ASH 303	Animal Reproduction and Lactation	3
ASH 304	Swine and Poultry Production	3
ASH 306	Aquaculture and Fisheries	3
ASH 401	Animal Health and Diseases	3
ASH 402	Extension and Food Safety	3
ASH 403	Animal Products and Technology	3
ASH 404	Non-Traditional Animal Production	3

Total Hours: 35

ASH 201 Introduction to Animal Production and (3 credits) Health

Animal Science is the study of the biology and management of domestic animal species. Animal health is a growing field that serves not only the agricultural community but also our human society. This introductory course provides foundational knowledge pertaining to the variety of livestock species, animal behavior, basic livestock and aquaculture production systems, introductory concepts in animal health and disease, and an introduction to animal products and processing.

Learning Outcomes

Students will be able to:

1. Discuss issues related to food security in developing and developed nations; current patterns of regional and global food production; patterns food production in the future; and, the impact of agriculture on human heath

Define food security; describe methods used for food production in developed vs. developing countries; discuss the relationship between diet and health in both people and animals.

2. Describe animal, poultry and aquaculture breeds and their end products including meat, milk, fiber and by-products.

List all common animal and aquaculture breeds used in livestock and aquaculture production; identify end products for livestock agriculture and aquaculture; discuss nutrient value of various end products; identify grading systems used to assess meat and fiber production; discuss basic processing methods for animals, poultry and fish.

3. Describe key aspects of the basic physiological processes of reproduction, nutrition, and breeding & genetics needed for producing livestock, poultry and fish

3a. Reproduction: Identify gross anatomy of the reproductive system; describe key hormones that regulate reproduction; discuss technologies used in managing reproduction;

3b. Nutrition: Identify gross anatomy of digestive system; identify basic nutrient groups; discuss nutrient requirement for growth, maintenance, reproduction and lactation. Identify feed additives and their use. Describe basic steps used for ration formulation.

3c. Breeding and Genetics: Discuss concepts of heritability, dominant & recessive traits, selection, and use of cross-breeding. Identify other basic breeding/mating systems.

4. Describe basic concepts related to herd health in livestock, poultry and aquaculture production.

Describe the basic physical examination of animals for health assessment; discuss basic concepts regarding disease processes, healing and vaccination; discuss diseases commonly encountered in the production of various livestock species.

5. Describe how regional and national programs can affect animal production, marketing, end-product quality and product availability.

Describe the responsibilities and functions of production cooperatives; marketing cooperatives; production improvement federations; compare and contrast horizontal vs. vertical integration of agricultural production systems.

- A. Introduction to The Animal Sciences, Food Security and Systems of Animal Production
- B. Livestock Breeds, Their End Products and Their Contributions to Human Society
- C. Basics of Animal Reproduction
- D. Basics of Animal Nutrition
- E. Basics of Animal Breeding And Genetics
- F. Introduction to Animal Health And Disease
- G. Introduction to Herd Health And Concepts Of Public Health
- H. Introduction to the Animal Industries, Cooperatives, Federations and Production Integration
ASH 202 Animal Anatomy and Physiology

Understanding fundamental concepts of anatomy and physiology of livestock, poultry and fish is necessary for understanding the organization and functions of the animal body systems and their impact on animal productivity, health and well-being. A solid understanding of animal body systems is also necessary to support development of management methods that can maximize productivity while also maintaining animal health, well-being and environmentally sound production.

Learning Outcomes

Students will be able to:

1. Discuss basic organization of life forms and the relationship between structure and function within an organism.

Identify components of a cell; list physiological functions related to specific cellular structures; identify analogous structures and physiological functions present in complex organisms; define homeostasis.

2. Identify gross and fine anatomical structures of livestock, poultry and fish species commonly used in agriculture production.

Identify skeletal structures of cattle, sheep, goats, swine, chickens, and fish; identify organs within each of these species; identify histological (fine anatomical) structure associated with major organ systems of the body.

3. Identify the major physiological systems of the body and discuss their function in maintaining homeostasis in livestock, poultry and fish.

List all major body systems; identify major functions of each body system; describe the tissue and organ components that contribute to the functioning of each major body system; discuss how each of these components perform their function to maintain homeostasis within that body system; discuss the effects of perturbation of homeostasis on the function of individual body systems as well as on the integrated functioning of the entire body.

- A. Anatomy and Physiology of Cells and Tissues
- B. Body Structure, Concepts of Homeostasis, Concepts of Endocrine Control
- C. Musculoskeletal System
- D. Circulatory System
- E. Nervous System
- F. Respiratory System

- G. Gastrointestinal System
- H. Urinary System
- I. Reproductive System
- J. Special Senses
- K. Response to Stress

ASH 204 Animal Nutrition and Growth

Basic concepts in nutrition of livestock, poultry and fish will be discussed in this course. Topics will include anatomy and physiology of the digestive tract, nutrients and their metabolism, digestion, absorption, animal growth and development, introduction to feedstuffs, feeds and feeding, ration formulation and nutrient requirements.

Learning Outcomes

Students will be able to:

1. Define terms important in the area of animal nutrition.

Learn specific terms including various feedstuffs, nutrients, parts of gastrointestinal tract, digestive enzymes, hormones, and terms related to general animal growth and production.

2. Classify and characterize feedstuffs and apply to feeding of animals.

Classify feedstuffs by their use; learn characteristics of various feedstuffs; learn the use of each feedstuff in animal feed; learn anti-nutritional compounds found in various feedstuffs; learn how feedstuffs are mixed to a complete feed.

3. Classify nutrients and explain their functions.

List six major classes of nutrients; learn roles of various nutrients in cellular metabolism; explain how absorbed nutrients in each class function in the body for growth and maintenance of body tissue, provision of energy, and regulation of body processes.

4. Explain functions of gastrointestinal tract and compare differences among animal species.

Learn characteristics and functions of each part of gastrointestinal tract; learn how gastrointestinal tracts are different between ruminant animals (cows, sheep, and goats) and simple stomach animals (pigs and chickens); identify where feed are digested and absorbed; identify where microbial fermentation occurs.

5. Explain how feedstuffs are digested and absorbed to an animal body.

Explain functions of various digestive enzymes; explain process of carbohydrate digestion and absorption; explain process of protein digestion and absorption; explain process of lipid digestion and absorption.

6. Give examples of the application of nutrition principles to feeding practices for domestic animals.

Learn how feed are formulated and fed to different animal species.

- A. Introduction, Terms and Definitions in Animal Nutrition
- B. Feedstuffs

- C. Gastrointestinal Tract
- D. Water
- E. Energy Partition
- F. Carbohydrates
- G. Lipids
- H. Proteins
- I. Minerals and Vitamins
- J. Mycotoxins and Antinutritional Compounds
- K. Animal Feeding

ASH 301 Animal Genetics and Breeding

Understanding basic principles of inheritance in animals of agricultural and aquaculture significance is important for the long-term improvement of livestock and aquaculture production. In addition, understanding of genetic transmission and its effects on the usefulness of animals, the application of basic principles of animal improvement through genetic selection, the use of mating systems and the application of biotechnology are keys to improving the performance of livestock and other animals used in agricultural production.

Learning Outcomes

Students will be able to:

1. Discuss physical location of genes within a cell, the processes of mitosis and meiosis, the basic structure of a gene and how gene expression results in cell, tissue and organismal changes.

Define the terms gene, DNA, chromosomes, RNA, protein, diploid, and haploid. Identify components of a gene; describe the steps of mitosis and meiosis; describe the process of gene expression, protein production and tissue changes due to gene expression.

2. Discuss Mendelian inheritance, allelic frequency, and concepts of gene segregation, recombination, dominance, co-dominance, inbreeding, crossbreeding and mutation on traits important to agriculture.

Identify differences between homozygous and heterozygous; calculate expected gene frequencies for simple inheritance; identify methods for changing gene frequency in a population; define heritability; identify ranges in heritability for various production traits; discuss how mutation affects genetic inheritance and trait expression; define heterosis; describe mating systems that can affect heterosis.

3. Discuss the estimation of breeding values as well as factors that affect their accuracy and use in selection systems.

Define breeding value, EPD, PTA and genetic progress; define correlative response to selection; list major factors affecting use of a selection system such as EPD; discuss the status of EPD development for the major livestock species.

4. Discuss the application of genetic engineering, marker-assisted selection, and selection indexes on genetic progress for livestock and aquaculture production.

Define genetic engineering; describe basic genetic engineering technologies; discuss how use of genetic engineering can affect animal end-products and performance; describe marker-assisted selection; contrast the use of selection index vs. individual markers for animal selection.

5. Describe how data are obtained for genetic evaluation in the beef, dairy, swine, poultry and aquaculture industries. Be able to evaluate and select animals based on performance testing programs, sire summaries and genetic selection programs.

Define DHIA, NSIF and NPPC; describe how each are used in industry management; define sire summary; describe how summary data is obtained; describe a performance test and the types of data that are produced; discuss how performance data are used for animal selection; identify the pros and cons of using summary and test data for animal selection.

- A. Genes and Principles of Inheritance
- B. Gene Expression, Sex-linked Inheritance
- C. Qualitative vs. Quantitative Traits, Population Genetics
- D. Heritability, Heterosis, Genetic Correlations
- E. Breeding Value, Expected Progeny Difference (EPD)
- F. Mating systems, Performance Information, Genetic Evaluation
- G. Genetic Improvement Programs, Use of Genomic Evaluation for Genetic Progress

ASH 302 Ruminant Production

Managing livestock operations for meat and milk production is a key part of animal agriculture. This course will discuss the management principles associated with meat (beef, sheep and goat) and dairy (cattle and goat) production. The course will integrate information on nutrition, genetics, reproduction and health with production systems, operations management, record keeping systems, product marketing, business practices, and decision-making processes as applied to beef cattle, dairy cattle, sheep, meat goat and dairy goat operations.

Learning Outcomes

Students will be able to:

1. Identify breeds and breed characteristics of beef cattle, dairy cattle, sheep, meat goats and dairy goats. Be familiar with optimal form to function (body conformations) for each species. Recognize dentition and methods for age estimation of animals.

List livestock breeds; identify good vs. poor conformation of livestock; determine age of animal by oral examination (photo, diagram or live).

2. Describe basic management practices for successful farm operations including disinfection, quarantine, isolation and carcass disposal. Be able to detail facilities needs for meat-based ruminant livestock operations and for dairy-based operations. Be able to detail pasture/forage management practices needed for a meat-based or dairy-based operation.

List steps for introducing animals onto a farm; detail farm facilities needed for establishing an operation; identify both useful and dangerous forages for livestock production; identify optimal practices used for pasture development and maintenance.

3. Describe general management and feeding practices for juveniles, adolescent, pregnant, lactating and dry female animals; be able to describe general management and feeding practices for growing and maintaining male animals.

Describe basics of feeding various classes of animals in a meat-based and dairy-based operation.

4. Describe reproductive management and health management practices for female and male animals of various ages (juveniles, adolescent, pregnant, lactating, dry and adult) within a meat-based or dairy-based ruminant livestock operation.

Identify reproductive management strategies that can be used to reduce labor inputs while maximizing herd fertility and production. List the components of a good herd health program for meat-based and dairy-based livestock operations. Discuss production-related diseases that can affect the output of a livestock operation.

5. Describe proper milking, milk handling and milk storage procedures for large and small dairy operators. Detail factors that can influence milk production and milk quality.

Identify factors that affect milk let down; trace milk pathway from site of production to site of on-farm storage for a large dairy operation; identify factors that affect milk volume and quality; discuss end-product options for dairy producers.

6. Delineate an annual management timeline for the successful operation of beef cattle, dairy cattle, meat goat, dairy goat and sheep production operations.

Create a production wheel, timeline or other format with key action items identified for each the various ruminant livestock production operations.

7. Use production records for assessment of a livestock operation. Be able to detail various marketing strategies used for meat-based or dairy-based livestock operations. Be able to utilize accounting balance sheets to detail economic inputs and outputs to determine the financial viability of a ruminant livestock operation.

Complete a production, marketing and financial analysis for a livestock operation; develop a business plan for a meat-based or dairy-based ruminant livestock operation .

- A. Introduction to Production Ruminants: Breeds, Conformation, Assessments
- B. Beef Cattle Production Management
- C. Meat Goat and Sheep Production Management
- D. Dairy Cattle Production Management
- E. Dairy Goat Production Management
- F. Herd Health Management Practices for Ruminants
- G. Tools for Maintaining Production Records for Operations Management

ASH 303 Animal Reproduction and Lactation

(3 credits)

Understanding basic concepts of reproduction of livestock, poultry and fish is necessary for utilization of reproductive management techniques and the application of reproductive technologies to increase animal productivity and ensure food security. Reproductive concepts including endocrine control of reproduction, anatomy and physiology of the male and female reproductive tract, mammary anatomy and physiology, milk and egg production, breeding cycles and seasonality will be addressed.

Learning Outcomes

Students will be able to:

1. Identify and describe functions of the macroscopic and microscopic parts of the reproductive and mammary systems of the male and female of livestock, poultry and fish species.

List parts of the male and female reproductive tract of cattle, sheep, goats, pigs, chickens and fish; describe the stages of follicular development in livestock, poultry and fish; describe the production of male and female gametes in livestock, poultry and fish; list parts of the mammary gland and describe their function; list parts of the egg and discuss how it is formed; discuss the process of fertilization in livestock, poultry and fishes.

2. Discuss relationships among cells, tissues, glands, hormones and organs involved in reproduction and lactation and explain the main biological mechanisms involved in each of these processes.

Define endocrine hormone; feed-back loops; identify the hormones produced by the hypothalamus, pituitary, gonads, uterus and placenta and describe their role in control of reproductive processes; define puberty and discuss the hormones involved in its control; discuss the endocrine regulation of the estrus cycle, gametogenesis and pregnancy; describe development of the embryo and fetus; describe the stages of normal parturition; describe the process of oviposition; discuss the endocrine control of lactation.

3. Describe husbandry skills appropriate for management of livestock to achieve acceptable reproductive performance and economical production of milk in a domesticated setting.

Identify endocrine hormones used in the management of reproduction and lactation; define estrus synchronization and ovulation synchronization; describe methods used to achieve estrus or ovulation synchronization; discuss the effects of growth promotants on puberty and lactation; discuss the relationship between sperm production and daughter fertility; describe management procedures that can improve fertility following parturition.

4. Explain how reproduction and lactation are influenced by environmental and genetic factors.

Discuss the effects of nutrition on reproductive performance; identify livestock, poultry and aquaculture species with seasonal reproductive patterns; identify genetic factors that are responsible for major changes in reproductive production; describe man-made environmental factors that can affect reproductive performance.

- A. Introduction to Endocrine Control of Reproduction
- B. Comparative Reproductive Anatomy and Physiology of the Female
- C. Comparative Reproductive Anatomy and Physiology of the Male
- D. Puberty
- E. Estrous Cycles, Ovulation, Spawning, Fertilization
- F. Breeding Management of the Male and Female
- G. Pregnancy and Parturition
- H. Lactation and Postpartum Reproductive Management
- I. Egg Production and Layer Management

ASH 304 Swine and Poultry Production

The course is aimed at helping students to understand the management principles associated with swine and poultry production. Emphasis will be placed on interactions of physiology, health, equipment, nutrition, reproduction and genetics applied to the nursery (starting), growing, finishing, farrowing and breeding phases of swine production and to the broiler and egg layer segments of poultry production. Incorporation of waste management practices and alternatives, development of marketing strategies and economic evaluation of management practices as applied to swine and poultry operations in developed and developing countries.

Learning Outcomes

Students will be able to:

1. Describe the biology of pigs and poultry.

Learn domestication of swine and key poultry species; identify different breeds of pigs and poultry; learn comparative anatomy and physiology of pigs, chicken, and duck; learn basic behavior of pigs and poultry for handling in production; learn major diseases relative to the production of pigs and poultry.

2. Describe how to feed and manage pigs and poultry.

Learn feeding principles including nutrient requirements and phase feeding; learn management principles associated with swine and poultry production; learn feed formulation; learn major equipment used in swine and poultry production.

3. Describe how to manage swine and poultry farms.

Learn management of nursery pigs, finishing pigs, and sows; learn hatchery management; learn housing and ventilation; learn vaccine program.

4. Know current biotechnological practices used in swine and poultry production.

Learn feed additives including probiotics, prebiotics, antibiotics, feed acidifiers, crystalline amino acids, feed enzymes, etc.; learn feed processing technology including grinding, mixing, pelleting, extrusion, etc.

- A. Basic Pig Biology
- B. Behavior and Handling of Swine and Poultry
- C. Reproductive Physiology of Swine and Poultry
- D. Genetics and Selection of Swine and Poultry
- E. Nutrition of Swine and Poultry
- F. Diseases in Swine and Poultry

G. Production Management of Swine and Poultry Farms

ASH 306 Aquaculture and Fisheries

This course introduces students to the management principles associated with aquaculture and fishery production. Biological and general principles of aquaculture and fisheries management, species involved, techniques employed, and problems encountered will be discussed.

Learning Outcomes

Students will be able to:

1. Describe the purpose of aquaculture and explain its role in agriculture and world food supply.

What is aquaculture? What proportion of the world food supply is provides through aquacultural production or fisheries harvest?

2. Identify major species that are used in the captive aquaculture industry. Differentiate between the types of aquaculture systems used for production.

List most common species used for aquacultural production; identify most common species of fish harvested from oceanic fisheries for human consumption. Describe types of aquaculturists and aquaculture systems. Differentiate between captive fisheries and blended fisheries.

3. Discuss the life cycles of major aquaculture species and discuss issues in genetics, reproduction, nutrition and environment as they relate to harvest of fish from aquaculture production systems or fisheries management.

Describe the stages of the life cycle for generalized aquaculture management. Describe the key issues encountered when establishing production systems for fish, prawns and crustaceans.

4. Discuss a basic production cycle for a farm-raised aquaculture species.

Choose an aquaculture species and describe the basic steps of the production of that species from mating through harvest and marketing. Identify key issues affecting production efficiency for that species.

5. Discuss the major issues that influence the success of any aquaculture production operation.

Identify factors that affect production efficiency in an aquaculture operation or fisheries harvest operation. List issues that have the greatest effects on success.

- A. Overview of the Aquaculture Industry
- B. Life Cycles of Major Aquaculture Species
- C. Types of Aquaculture Systems including combined Agriculture/Aquaculture Systems

- D. Production Systems for Catfish, Tilapia, Freshwater Prawns
- E. Production Systems for Salmon, Mollusks
- F. Principles of Fisheries Management

ASH 401 Animal Health and Diseases

The objective of this course is to provide basic health concepts and disease processes. This course focuses on external and internal parasites of livestock and fishes, as well as key diseases affecting livestock production and aquaculture, public health and zoonotic diseases

Learning Outcomes

Students will be able to:

1. List the body's defense mechanisms.

Learn terminology in pathology and immunology; define the function of the immune system and its relationship to the development of disease; define the concepts of passive and active immunity; describe the general concepts of inflammation and wound healing.

2. List and describe the common diseases of domestic animals.

Categorize common diseases of livestock and fishes; discuss the causes of infectious and noninfectious disease; learn diseases in the digestive, reproductive, respiratory, and urinary systems.

- **3.** List and describe the parasitic protozoa, helminthes, and arthropods in livestock and fishes.
- 4. Describe form, function, life cycle, and pathogenesis of major parasites in livestock and fishes.
- 5. Demonstrate the proper care and administration of drugs.
- 6. Explain factors influencing diseases; learn environmental control of infectious diseases; learn types of vaccines used.

- A. History of Animal Health
- B. Disease Categories
- C. Reaction to Infection
- D. Major Diseases of the Respiratory System
- E. Major Diseases of the Digestive System
- F. Major Diseases of the Urinary System
- G. Major Diseases of the Respiratory System
- H. Disease Prevention
- I. Definitions and Categories of Parasites
- J. Pathogenesis of Parasites

K. Vaccination and Immunization

ASH 402 Extension and Food Safety

The objective of this course is to teach extension principles to transfer expertise to farmers in food safety and quality of animal products. This course will include topics related to appropriate sanitation and handling to obtain safe livestock-based products entering the food chain to generate a safe and secure food supply for consumers.

Learning Outcomes

Students will be able to:

1. Understand the Hazard Analysis Critical Control Points System (HACCP) and how they apply to food processing environment.

Describe each step for developing and implementing a HACCP plan for processing meat, poultry, eggs, seafood, and dairy products; learn risk analysis and hazard analysis in food safety.

2. List regulatory requirements for meat, poultry, eggs, seafood, and dairy processing operations.

Explain sanitary standards in producing, importing, and exporting meat, poultry, eggs, seafood, and dairy products of food; learn how to develop, implement and maintain a sanitation plan based on sanitation standard operating procedures.

3. Describe the importance of food sanitation and good manufacturing practices and apply them to specific food processing systems.

List concepts and background of good manufacturing practices (GMP) in food production; learn how and why GMPs were developed; discussion of hygienic practices, requirements for sanitation programs, and modern sanitation practices in food processing facilities.

4. Demonstrate an introduction to microbiological food safety hazards.

Describe prominent microbial foodborne safety hazards and their control; learn pathogenesis and transmission of specific pathogens in meat, eggs, and dairy products.

<u>Course Module Outline</u>:

- A. Importance of Food Safety
- B. Current Regulations in Meat, Poultry, Eggs, Seafood, and Dairy Processing Operations
- C. Introduction to Hazard Analysis and Critical Control Points
- D. Sanitation Standard Operating Procedures in Food Safety Control
- E. Good Manufacturing Practices
- F. Food Sanitation
- G. Microbial Foodborne Hazards

ASH 403 Animal Products and Technology

Basic concepts in the principles of conformation and quality of animal carcasses and products including milk and eggs. This course focuses on livestock and carcass evaluation, meat and dairy products processing, egg products, animal by-products, and value-added product technologies.

Learning Outcomes

Students will be able to:

1. Describe the basic concepts and terminology in meat, dairy, and egg product processing.

List historical view of production, trade, and consumption of meat, dairy, and egg products; learn terminology related to the processing of meat, dairy products, and egg products; learn the importance of food safety and HACCP plan; learn various products derived from meat, dairy, and eggs; identify the wholesale and retail cuts of meat.

2. Illustrate the basis of muscle biology, lactation physiology, and egg formation.

Define structure and function of muscle; learn mechanism of muscle contraction; learn muscle composition; understand the basics of carcass and muscle tissue breakdown; learn conversion of muscle to meat; learn mammary gland structure and milk synthesis; learn process of egg formation.

3. Determine yield and quality grades of beef, pork, chicken, and lamb.

Describe nutritional composition and value of meat and compare among animals; learn carcass grading; identify factors influencing quality and palatability of meat, dairy products, and egg products.

4. Explain various dairy and egg products by comparing their respective nutritive components

Identify various products and composition of the products made from milk; prioritize the steps necessary in producing various dairy products.

5. Review the packing process of beef, pork, chicken, and lamb

Understand the steps in meat processing; understand identification and fabrication of meat; learn tools and equipment used in meat processing; learn the use of by-products from meat processing.

6. Understand and identify the specific processing technologies used for milk, eggs, and their related products

Understand the steps in processing of dairy and egg products; learn tools and equipment used in processing of dairy and egg products.

<u>Course Module Outline</u>:

- A. Food Safety and Meat
- B. Muscle Biology
- C. Slaughter and Dressing of Livestock, Meat Processing and Packing
- D. Preservation Methods (canning, salting, smoking)
- E. Procurement and Processing of Milk and Dairy Products
- F. Process of Egg Formation
- G. Egg Processing

ASH 404 Non-Traditional Animal Production (3 c

While traditional livestock and aquaculture production systems form the majority of animal systems, productions systems that include animals such as rabbits and other game or bush animals will be included in this course. Integrated systems that include interactions of multiple animals will also be a component of this course.

Learning Outcomes

Students will be able to:

1. Describe the place of rabbits and other non-traditional animals in society and agriculture.

List types of non-traditional species used for agriculture. Describe the roles that these species also play in the larger human society.

2. Identify major rabbit breeds and describe products derived from them.

List most common species of rabbit used for agricultural production; identify other nonagricultural products or uses for rabbit species. Identify other non-traditional animal species that are used for agriculture or economic gain by human society.

3. Discuss the basics of managing rabbits to maximize reproductive efficiency. Identify the major methods for feeding rabbits and issues associated with maintaining proper rabbit nutrition. Discuss basic husbandry issues related to rabbit production.

List major and minor considerations when preparing housing for rabbit production and reproduction. Discuss key aspects of buck management, pregnant doe management and kindling management. Identify key aspects to consider when develop diets for rabbits.

4. Describe the basic groups of rodents and exotic fowl and their roles in agriculture and society. Identify the major rodent and fowl species used for food production; identify distinctive external physical characteristics and unique internal physiological characteristics.

Differentiate between major rodent and exotic fowl types and list uses of each of these types of animals in an agricultural context. Describe behaviors relative to age, reproduction and social interactions. Identify key aspects of feeding, reproductive management and health issues.

5. Discuss integrated systems for raising traditional and non-traditional animal species in an agricultural context.

Identify factors affecting species integration for agricultural production; describe how 2 species can be used in an agricultural operation to maximize production efficiency.

- A. Breeds, Physical Characteristics and Key Physiologic Aspects of Non-Traditional Animal Species Used for Agricultural Production
- B. Rabbit Production Management
- C. Grasscutter (Groundhog) Production Management
- D. Guinea Fowl Production Management
- E. Integrating Traditional and Non-Traditional Agricultural Species in Production Operations

Natural Resource Management

Course designation	Course title	Credit hours
NRM 201	Introduction to Agro-Forestry	3
NRM 202	Natural Resource Economics	3
NRM 204	Natural Resources Management Extension	3
NRM 206	Ecosystems and Biodiversity	3
NRM 208	Water Resource Management and Hydrology	3
NRM 301	Principles of Community Development	3
NRM 302	Ecology, Land Use, and Environmental Quality	3
NRM 304	Climate Change Impact on Natural Resources	3
NRM 306	Forest Ecology and Management	3
NRM 401	Urbanization and Sustainable Development	3
NRM 402	Natural Resource Use and Public Policy	3
NRM 403	Regional Development	3
NRM 405	Land Rights, Natural Resources, and Benefit Distribution	3
NRM 407	Non-Timber Forest Products	3
NRM 409	Project Development and Implementation	3

Total Hours: 45

NRM 201 Introduction to Agro-Forestry

3 credits

This course introduces students to the concepts of the systems, practices, and technologies of agroforestry, including its origin and evolution, structure and function, and its dynamics and manipulation; the ecology of agroforestry systems and in the possibilities and limitations of application of agroforestry systems. Specific topics covered include an overview and the identification of multipurpose trees, shrubs, products and services available and their interactions; pests, diseases and weed management in these systems; socio-economic issues in agroforestry; diagnosis and design of agroforestry systems; and the utilization and enhancement of local knowledge in agroforestry. The course also embraces an ecological understanding of the basis for sound agroforestry and plantation management.

Learning outcomes

Student will be able to:

- 1. Describe the agroforestry systems suitable for the Liberia context.
- 2. Understand the social, economic and environmental benefits of agroforestry.
- **3.** Develop an ecological understanding of the basis for sound agroforestry as well as plantation management.
- 4. Define the importance of agroforestry practice to natural resource management.
- 5. Identify indigenous and introduced species suitable for agroforestry systems.
- 6. Gain insight into the ecology of agroforestry systems and in the possibilities and limitations of application of agroforestry systems.
- 7. Acquire skill and techniques involved in field observation.
- 8. Perform simple field practical/field laboratory in agroforestry and considering the understanding of the feasibility of s a land use practice.
- 9. Describe considerations that determine feasibility of agroforestry to the land user.
- **10.** Identify multipurpose trees and shrubs in an ecosystem, collect, interpret and analyze the data.

Course module outline

- A. Definition, origin, evolution of Agroforestry.
- B. Classification of agro-forestry systems, practices and technologies
- C. Selected examples of agroforests, plantation crops and gardens.
- D. Local knowledge and domestication of valuable species
- E. Multipurpose trees and shrubs
- F. Other agroforestry systems and practices (integration of livestock, fodder and silvopastoral systems, agroforestry for reclamation of soils and landscape restoration)

- G. Pests, diseases and weed management in Agro-forestry
- H. Economic considerations (economic and financial analyses, valuation of benefits)
- I. Identify and collect data on multipurpose trees and shrubs and ecosystems; interpret and analyze the data collected.

NRM 202 Natural Resource Economics

This course introduces students to economic issues specific to the use and management of natural resources. It explores the economic principles for the efficient allocation of resources over time. Topics covered include the economic classification of natural resources; scarcity, growth and sustainability; ownership, access systems and rent dissipation; and principles of optimal depletion and use. Policies and mechanisms to foster greater economic efficiency in economic systems dependent on natural resources will be examined. Key social and demographic factors will be evaluated in the context of the demand for environmental assets and amenities. Course objective includes familiarizing students with the applications of economic principles to public and private management of natural resources and the environment; to understand the economic justification for collective action in allocating, managing, and protecting the environment; and to develop the analytical skills and concepts that will enable the student to critically evaluate private actions and public policy influencing environmental and natural resource management.

Learning Outcomes:

Students will be able to:

- **1.** Apply core economic theory and economic reasoning to explain different kinds of market failure in the fields of environment, climate and nature resources.
- 2. Clarify the concept flow and stock pollutants and which principles apply for optimal handling of these.
- 3. Estimate some of the economic benefits and costs of natural resources;
- 4. Explain optimal extraction of non-renewable and renewable resources.
- 5. Elucidate climate measures, climate problems, and how to handle them.
- 6. Demonstrate their understanding of efficient resource allocations and how they can be applied in managing specific natural resources;
- 7. Demonstrate understanding of verbal, graphical, mathematical and econometric representation of economic ideas and analysis, including the relationship between them.
- 8. Discuss and analyze government policy.
- 9. Work with abstract concepts and in a context of generality.
- **10. Reason logically and work numerical problems analytically.**
- 11. Prioritize the context in which a problem is to be addressed.
- **12.** Identify the appropriate techniques to solve natural resource problems.
- 13. Justify conclusions through economic arguments with appropriate manner.
- 14. Apply relevant mathematical, statistical and graphical techniques in an appropriate manner.
- 15. Communicate effectively and clearly in written and oral formats.

16. Analyze and solve complex problems precisely.

- A. Characteristics and classification of natural resources.
- B. Property rights, externalities and sustainability
- C. The concept of values and valuations: Non market valuation methods: CVM, TCM other methods.
- D. Benefit-Cost analysis: Procedure, Issues, limitations and alternatives.
- E. Allocation of renewable and non-renewable resources (forests, water, land, etc.) under various market structures: management strategies for major natural resources.
- F. Social welfare function, Pollution control and policies
- G. Environmental justice and sustainable development
- H. Ecological Economics
- I. Poverty, Population and Natural Resources
- J. Natural Resources and Conflicts in Africa
- K. Global Issues: Climate change and their problems
- L. Government programs for conservation and development of natural resources.
- M. Class Wrap-up

NRM 204 Natural Resource Management Extension 3 Credits

This 3-credit course introduces the student to the applications of the principles and practice of agricultural extension to natural resource management with emphasis on Liberian and African agriculture. By the end of the course the student should be able to understand the elements of agricultural extension and their relevance to the optimization of natural resources in agricultural ecosystems. The student will be able to compare various options in agricultural extension practices and understand the process of determining the appropriate option for various natural resource management circumstances in Liberia and elsewhere in Africa. In particular, the student will learn the extension principles and practices that are applicable in forest, wildlife, fisheries, water and soil resource management under Liberian and African conditions. Through in-class and out-door teaching, class discussions, homework assignments, class quizzes and exams the student is taught the principles and practice of Natural Resource Management Extension

Learning Outcomes

Students will be able to:

- 1. Describe principles and practices of agricultural extension.
- 2. Apply agricultural extension principles and practices to natural resource management in Liberian and African agriculture.
- **3.** Develop simple and appropriate agricultural extension methods for forest, wildlife, fisheries, water, and soil resource management in Liberia.

- A. Introduction
- B. Objectives
- C. Principles and Practice of Agricultural Extension
- D. Definition of Agricultural Extension
- E. Socio-Economic Significance of Agricultural Extension
- F. Historical Perspectives of Agricultural Extension (1 lecture)
- G. 21st Century Agricultural Extension
- H. Applications of Agricultural Extension to Natural Resource Management
- I. Description of Liberia's Natural Resources
- J. Application of Agricultural Extension Principles and Practice to Soil Management, Water Management, Forest Resources Management, Wildlife Management and Fisheries Management

NRM 208 Water Resource Management and Hydrology (3 credits)

Course will cover the principles and practices of watershed management and hydrology, including the management of forests, rangelands, and other areas, for the protection, maintenance, and improvement of water resource values. Course will cover hydrological and biological methods used to manage watersheds and assess watershed health. Ecology, management, and basic aspects of wetland ecosystems including the issues surrounding the utilization of wetlands and problems of wetlands management and use will be examined.

Learning Outcomes

Students will be able to:

- 1. Define the principles and practices of water resource management and hydrology.
- 2. Describe the various components of watershed management.
- 3. Recognize the biological and hydrological methods use in managing watershed.
- 4. Identify the challenges confronting watershed management.
- 5. Identify appropriate approach to water resource management and hydrology.
- 6. Apply the skill in solving problems facing water resource management and hydrology.

- A. Principles and practices of water resource management and hydrology.
- B. Water as a source of life
- C. Components of watershed management
- D. Management of forest, rangelands and other areas
- E. Protection, maintenance and improvement of water resource values.
- F. Water Crises in Africa
- G. Hydrological and biological methods of managing watersheds and assess watershed health.
- H. Ecology management and basic aspects of wetland ecosystems.
- I. Utilization and problems of wetlands management.

NRM 301 Principles of Community Development (3 credits)

This course discusses the processes involved in active and sustainable communities based on social justice, equality and mutual respect. Theories and practices of community development. Social dynamics and human ecology will be linked with strategies of community and individual empowerment through skill development and capacity building to overcome poverty, generate economic opportunities and preserve the environment. Approaches to community development will be examined in the context of Liberian society.

Learning outcomes

Students will be able to:

- 1. Describe basic community development concepts and definitions.
- 2. Elucidate the importance of people working together to solve problems and improve their communities.
- **3.** Identify the problems that hinder the development of communities in Sub-Saharan Africa, the West African Region and Liberia.
- 4. Identify the elements and approaches to community development.
- 5. Describe the importance of key approaches to community development in the Liberian context: community capacity, economic development, sustainable development and participatory approaches.
- 6. Explain the importance of collective decisions about the use of resources as a key component of community development .
- 7. Identify the process and products of community development.

- A. Introduction and course objectives
- B. Concepts and definition of community, development and community development
- C. Development problems in Sub-Saharan Africa
- D. Approaches and strategies to community development
- E. Community capacity building
- F. Community economic development
- G. Participatory approaches of community development
- H. Products and processes of community development
- I. Sustainable development

NRM 302Ecology, Land Use, and Environmental
Quality(3 credits)

This course studies the ecological processes involved in the evolution and re-creation of a natural community including the challenges of ecological sustainability of the land use and management. The importance of sustaining ecological systems to preserve and support ecosystem services, cultural and aesthetic values, recreation, and sustainable extractive uses of the land. Habitat characteristics, life histories, reproductive ecology, biological invasions and ecological transformations, mutualism, societal laws, attitudes toward restoration and approaches to ecological restoration will be explored.

Learning Outcomes

Students will be able to:

- 1. Identify the main processes that have shaped natural ecosystems .
- 2. Describe main ecosystem functions.
- 3. Define the main services of the Liberian ecosystem and their importance.
- 4. Describe ecosystem conservation as a key activity to preserve important ecosystem services, and to realize ecosystems are the basis for economic development.
- 5. Describe the importance of land use and management to preserve ecosystems and their services.
- 6. Explain how ecosystem processes can be used to manage lands for more sustainable and efficient production systems.
- 7. Identify the components of environmental quality.
- 8. List the approaches to ecological restoration of degraded habitats.

- A. Introduction and Course Objectives
- B. Ecosystem services
- C. Land cover and use in Liberia
- D. Land use and ecosystem processes
- E. Land use and agriculture in Liberia
- F. Impacts of Land Use in Liberia
- G. Habitat fragmentation and succession
- H. Components of environmental quality
- I. Energy flow changes from natural ecosystems and managed systems

- J. Land use and ecosystem conservation
- K. Managing successions for increased ecosystem and socio-economic productivity

NRM 304 Climate Change Impact on Natural Resources (3 credits)

This course will cover the history and impact of climate change on natural resources. Other topics to be discussed include: Analysis of the major global climate changes based on principles of ecosystems ecology; carbon, nutrient, and pollution cycling mechanisms and budgets; the methods used to study these phenomena. Climate change will also be explored in relationship to agro-forestry, tropical diseases, food production, food security, environmental impact of agricultural and industrial systems and how such changes can impact the biological and social underpinnings of conservation.

Learning Outcomes

Students will be able to:

- 1. Diagram the global climatic system.
- 2. Evaluate the factors affecting climate.
- **3.** Describe how climate changes in geological times has contribute to our current knowledge in climate change.
- 4. Explain the negative consequences of climate change.
- 5. Evaluate how climate change will affect agricultural and industrial systems.
- 6. Describe potential impacts of climate change on the management of natural resources.
- 7. Predict climate change effects on the social, economic and environmental components of sustainability.

- A. Introduction
- B. Course Objectives
- C. Climate, a dynamic Earth system
- D. Energy balance across the globe
- E. The causes of climate change. Greenhouses gases. Carbon cycle in the earth. Other factors
- F. Climate system and continued greenhouse gases build up
- G. Potential consequences of climate change on agriculture and natural resources
- H. Effects on sea level, local and global food supply
- I. Potential effects on tropical diseases
- J. Climate change effects on forest, soils, wildlife, water

NRM 306 Forest Ecology and Management

(3 credits)

This course is design to cover ecology as applied to the management of natural resource ecosystems including biological diversity and conservation biology in natural resource ecology. The course will cover studies on the plant life histories, populations, communities, and plant animal interactions (pollination, dispersal, herbivory) and evolutionary basis for plant ecological traits will be included. The students will be taught basic principles of forest, fish, and wildlife management, which are components of the forest ecosystem. It will also cover history, ecology, economics, and policy. Students will be introduced to the fundamentals of measuring and quantifying natural resources including cruising and scaling timber, quantifying wildlife and fisheries habitat, measuring and estimating forage production for wildlife and livestock, and sampling wildlife populations. The course will also introduce basic statistical concepts and their applications in resource management. Nomenclature, identification, ranges, and habitats of important native and naturalized trees of Liberia will be examined. Shrubs, vines and Non-Timber Forest Species, important as wildlife food and cover will be discussed.

Learning Outcomes

Students will be able to:

- 1. Describe ecology and associated sub topics as related to natural resource use and management.
- 2. Identify constituent of biodiversity and understand interrelationship between ecosystem and biodiversity.
- **3.** Carry out field observation on measuring and collection of data on forage and wildlife populations.
- 4. Apply basic statistical concepts in natural resource management .
- 5. Identify important naturalized trees of Liberia and forest species of food to wildlife.
- 6. Acquire skill and technique involved in fieled observation.
- 7. Collect data on the important naturalized trees of Liberia.
- 8. Interpret and analyze the data collected using basic statistical concepts in natural resource management.

<u>Course Module Outline</u>:

- A. Introduction
- B. Course Objectives
- C. Ecology as applied to the management of natural resource ecosystem
- D. Fundamentals of measuring and quantifying natural resources
- E. Methods of measuring and estimating forage production and sampling wildlife populations.

- F. Impacts of forests on watershed
- G. Importance of forests in Liberia
- H. Basic statistical concepts and their applications in resource management
- I. Ranges and habitats of important naturalised trees of Liberia and important forest species of food to wildlife.

NRM 401Urbanization and Sustainable Development(3 credits)

This course explores the process of urbanization that is playing a dominant role in the modern world and the impact the changing landscape has on the environment and sustainable development. Other aspects of this course will include (i) advantages, challenges and opportunities of urbanization; (ii) the link between urbanization and economic prosperity, social development and environmental sustainability; (iii) sustainable development, urbanization and the relationship with rural development; (iv) the relationship between society and nature; and (v) plant biology and the preservation and management of trees in urban environments.

Learning Outcomes

Students will be able to:

- 1. Describe the process of urbanization and list how cities were formed.
- 2. Identify and compare urbanization trends that contributed to the growth of cities and metropolises.
- 3. Explain factors driving migration from rural areas to urban areas.
- 4. Discuss the models of urban growth.
- 5. Describe the social, economic and environmental impacts of urbanization (urban and suburban).
- 6. Identify the consequences of urbanization on Liberian natural resources.
- 7. Describe policies to deal with urban challenges in Liberia and the region.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Urbanization and urban growth
- E. Urbanism and urban dynamics
- F. Definition and measurement of urbanization
- G. Global, regional and local urbanization trends
- H. Consequences of urbanization
- I. Urbanization effects on social and economic development
- J. Urban growth and the use and conservation of natural resources
- K. Urban and regional planning

L. Urbanization policies
NRM 402Natural Resource Use and Public Policy(3 credits)

This course provides an overview to the national rules and regulations governing the use, extraction and commercialization of natural resources of Liberia. The course will compare public policies from other African countries and international treaties.

Learning Outcomes

Students will be able to:

- **1.** Describe and list rules and regulation governing the use of natural resources from the U.S., European countries and other developing countries.
- 2. Explain how Liberian law, policies and regulations affect the extraction and commercialization of natural resources.
- **3.** List the consequences of forest loss and habitat loss using examples from West Africa.
- 4. Describe the role of Liberian government institutions and ministries in regulating natural resource use.
- 5. Propose policies that protect Liberian natural resources in a context of social and economic growth.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Natural Resources use and Development in Liberia constraints and prospects
- E. Natural resources rules and regulation in the U.S. and Europe
- F. Natural Resource Industries in West Africa and Liberia
- G. National Resources Law in West Africa and Liberia
- H. Government institutions impacting Natural Resources
- I. Primary objectives and powers of the Forestry Development Authority (FDA).
- J. Regulations controlling trade
- K. Permits and taxes for local and export markets.
- L. The roles of Ministry of Trade & Commerce and Customs and Ministry of Agriculture
- M. The future of Liberian Natural Resources

NRM 403 Regional Development

This course introduces students to regional development in several ways. First, as a process within the context of the development of Liberia and West Africa. Second, as a vehicle for constructive change; and third, as a process with unintended consequences to the natural resources and communities living in the forests. The course will provide an opportunity to foster ideas and discussion about environmental and scientific impacts that are associated with regional development in the context of natural resources. Case studies examining specific regional development initiatives will be examined. Students will be introduced and exposed to the world of the nongovernmental agencies, international donors and others in research, advocacy relative to the protection, preservation and conservation of the natural resources; and to those invested in the commercialization of natural resources for regional development.

Learning Outcomes

Students will be able to:

- 1. Explain the drivers of the development of the West African region.
- 2. Explain key issues in the West African region including; poverty reduction, the role of state, and policy formulation.
- 3. Identify the policies leading to a constructive change in Sub-Saharan Africa.
- 4. List critical elements (ethnicity, nationalism) for both national and regional building.
- 5. Identify nongovernmental agencies, international donors and others dealing with social, economic development and preservation of the environment in Liberia and the region.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Causes of regional disparities
- E. Nation Building and Modernization
- F. Perspectives on West African Development
- G. Democratization, Good Governance and Sustainable Development
- H. The role of non-governmental organization and donors on local and regional development
- I. Local and regional development in a context of preservation of Liberian natural resources

- J. Regional cooperation and integration
- K. Regional planning and policies

NRM 405 Land Rights, Natural Resources, and Benefit (3 credits) Distribution

Development, content and implementation of public land and natural resource policies emphasizing forest, range, wildlife, and wild land recreation. This course will also review and examine Liberian law that focuses on land rights, inheritance, benefit distribution and natural resources.

Learning Outcomes

Students will be able to:

- 1. Identify patterns of land use in Liberia.
- 2. Describe the history of land and property rights in Liberia.
- 3. Outline current legislation of Liberian land rights.
- 4. Explain Liberian legislation in regards to forests (National Forestry Reform Law), community forests, wildlife (Wildlife Law) and other protected areas.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Land use in Liberia
- E. Land use and conflicts in Africa and Liberia
- F. Gender equity: access to and tenure of land ownership
- G. Liberian Law, Land and Property Rights in Liberia
- H. Community rights to land and renewable natural resources
- I. Natural resource management and revenue distribution

NRM 407 Non-Timber Forest Products

The forests occupy a massive land mass in Liberia and yet few have studied the non-timber species (flora and fauna) that provide and hold aesthetic, ecological, environmental and economic value. This course will provide an overview and inventory of Non-Timber Forest Species (NTFS) in Liberia and West Africa. Quantitative analysis and understanding of the ecology, management, and conservation of game and non-game wildlife (terrestrial and aquatic). Population dynamics, harvesting, habitat requirements and fragmentation, conservation genetics, and managing of protected areas all will be explored as case studies focusing on botanicals, spices and medicinal plants from the forests. Using the World Health Organizational Guide to Good Agricultural and Collection Practices, students will be exposed to strategies to sustainably collect and extract high value plant products from the forests while ensuring the protection of the indigenous plant and associated ecosystem. The use of NTFS as a vehicle to provide income generating activities will be explored.

Learning Outcomes

Students will be able to:

- 1. State the importance of forests as rich reservoirs of valuable resources, not just timber, but also as non- timber (forest) products.
- 2. Identify rules and regulations for the successful commercialization of NTFP in Liberia.
- **3.** Describe the diversity of Non-timber forest products and their importance to meet Liberian people needs without destroying the forest resource.
- 4. Explain the importance of conserving forest resources and NTFP by studying concepts of sustainable systems of collection and harvest in forest management.
- 5. Demonstrate techniques to identify plant species from which NTFP derived and how to grow these plants in forest gardens, arboreta and nurseries.
- 6. Describe the uses and importance of NTFP to meet daily needs of Liberian forest dwellers.
- 7. Identify suitable non-timber forest species for domestication and incorporation into agroforestry setting.
- 8. Observe how the varied NTFP of animal, plant and fungous origin are collected and processed and used.
- 9. Highlight the importance of development of NTFP enterprises as one of the activity that integrates the three "C's" of forestry (Commercial, community and conservation).
- **10.** Describe the local importance and uses of NTFP within a community management of the resource for generating income.

- **11.** Apply concepts of value chain to learn opportunities to upgrade the NTFP value chains.
- 12. Define factors affecting the establishment of successful NTFP Small and Medium Forest Enterprises.
- 13. Describe local, regional and international markets of the NTFP.

- A. Introduction
- B. Course Objectives
- C. NTFP definitions and classification
- D. Traditional botanical Knowledge. Uses of NTFP as an interaction of people with forest.
- E. Main groups of NTFP in Liberia: Benefits of their uses (income, nutrition, medicine construction materials).
- F. Challenges and opportunities of the NTFP industry in West Africa and Liberia. National Resources Law. Government institutions impacting NTFP industry.
- G. The Convention on Biological Diversity. Issues with intellectual property rights. Equitable sharing of benefits from use of genetic resources.
- H. Identification of NTFP species. Vegetative and Reproductive Morphology.
- I. Main Liberian NTFP of animal, plant and fungal origin and their uses.
- J. Value chain concept approach to the production of NTFP.
- K. Agroforestry systems for production of NTFP. Application of traditional botanical knowledge in agroforestry. Domestication of Liberian non-timber forest species, species selection and multiplication.
- L. Technologies for production of NTFP of plant, fungal and animal origin (honey, snails, mushrooms, medicinal plants, ornamental plants, native fruits and nuts).
- M. Opportunities for restoration of forest ecosystem using NTFP species. Integration of NTFP into the local rural economy.
- N. Local, urban, national, regional and international markets of NTFP.
- O. Factors affecting marketing of NTFP. Market information systems. The trade environment of NTFP. Trends in International Trade. Value chain analysis.
- P. Strategies for development of successful enterprises. Problems faced by small/medium forest enterprises. Building entrepreneurial and management skills.

NRM 409Project Development and Implementation(3 credits)

This course will expose students to a series of case studies involving natural resources. Students will learn how to develop and hypothesis, design experiments to test the hypothesis and arrive to valid conclusions and write a report. Students will be introduced and trained in conducting quality and quantitative interviews. Students will be exposed to internal/external sources of funding, and grant writing and application process. Student will learn to; a) generate inventory of Liberian plants, b) develop germplasm banks and vegetative propagate important Liberian plants, and c) development of mitigation plans.

Learning Outcomes

Students will be able to:

- 1. List the methodology of science with a focus on the natural resources.
- 2. Identify a research problem affecting Liberian natural resources.
- 3. Identify the components of experimental designs
- 4. Conduct qualitative and quantitative interviews.
- 5. Process scientific results and display them according to the convention of biology writing.
- 6. Conduct simply statistical analysis.
- 7. Write research reports with the structure of a research publication.
- 8. Identify main sources of internal and external funding and scholarships.

- A. Introduction
- B. Course Objectives
- C. Research methodology
- D. Experimental design
- E. Statistical analyses for the natural resource management area
- F. Technical and report writing
- G. Oral and poster presentation
- H. Internal and External sources of funding
- I. Writing successful grant proposals

Plant and Soil Sciences

Course designation	Course title	Credit hours
PSS 202	Principles of Crop Production I	3
PSS 204	Crop and Soil Management Extension	3
PSS 301	Principles of Crop Production II	3
PSS 302	Horticultural Crop Production and Management	3
PSS 304	Fertility Management and Plant Nutrition	3
PSS 306	Soil-Crop Management Systems	3
PSS 401	Principles of Pest Management I:Disease and Weeds	3
PSS 402	Principles of Pest Management II: Insects and Vertebrate Pests	3
PSS 403	Plantation Crop Production and Management	3
PSS 404	Staple Crop Production and Management	3
PSS 405	Plant Genetics and Breeding	3
PSS 407	Post-Harvest Handling and Processing	3

Total Hours: 38

PSS 202 Principles of Crop Production I

This course introduces students to basic anatomical and physiological processes associated with plant growth, development, and reproduction. This course is foundational in understanding more complicated topics associated with crop production systems. In addition to classification of crops, topics will also include discussions of the role of climate and weather on crop growth and development and approaches to minimizing and avoiding crop stress.

Learning Outcomes:

Students will be able to:

1. Identify key anatomical structures of major crops grown in Liberia including roots, stems and leaves, and both flowers and asexual reproductive structures.

Label the following plant structures for rice, maize, cow pea, cassava, rubber, eggplant, groundnut, sugarcane, banana, plantain, oil palm, sweet potato, coffee, cocoa, mango, pineapple, eddoes and other important crops.

2. Characterize the role of anatomical structures in plant growth, development and reproduction.

Describe the role of each of the following morphological features associated with plant growth, development, and reproduction.

3. Describe in detail the anatomical features of crop seed, the physiological function of each feature, the role of dormancy in crop seeds, and factors that influence germination of seed and crop stand establishment.

Identify the anatomical parts of seed for the major crops in Liberia and the role of these features in germination and stand establishment.

4. Describe abiotic and biotic stresses that can affect plant growth, development, and reproduction.

Describe how abiotic stresses such extremes in water, temperature, and fertility and biotic stresses such as weeds, diseases, insects and parasitic nematodes can affect crops and the stages in which specific crops are most vulnerable to these stresses.

5. Describe yield components of crops and factors that influence their optimization.

For the following major crops, describe the ultimate value of the crop, the nutritive contribution to humans and livestock, and components of the crop that can be manipulated for a positive outcome.

- A. Introduction
- B. Course Objectives

- C. Terminology and Definitions
- D. Characterization of Crops by Geography, Use, and Nutritional Value
- E. Anatomy and Morphology of Crops
- F. Physiological Processes Involved in Crops
- G. Plant-Water Relations
- H. Mineral Uptake
- I. Physiology of Seeds and Asexual Reproduction
- J. Biotic and Abiotic Stresses Influencing Crops

PSS 204 Crop & Soil Management Extension

Providing essential information on managing crop and soil systems is important in developing new enterprises and increasing efficiency and economy of scale of traditional agricultural production systems. This course will include key concepts associated with managing production systems and extending information to end users including farmers and allied industry, NGO, INGD, and government agencies.

Learning Outcomes:

Students will be able to:

1. Conduct needs assessments with stakeholders.

Describe identification of stakeholders; describe how to conduct a needs assessment with stakeholders and prioritize needs; describe the advantages of having extension advisory groups comprised with stakeholders.

2. Set realistic goals and write S.M.A.R.T. (Specific, Measurable, Achievable, Results Focused, Time-Bound) objectives for extension programs.

Describe qualities of SMART objectives and write clear program objectives.

3. Develop effective extension programs and activities.

Describe steps for planning effective extension events and programs; Develop educational programs for achieving extension objectives; Describe how to develop instructional materials for experiential learning.

4. Explain the theory of adoption and diffusion.

Describe characteristics of innovators and early adopters; describe the theory of adoption and diffusion and its application in transferring technology to users.

5. Describe different extension program delivery strategies.

Describe planning and conducting demonstrations; describe how to market extension programs to target audiences; Compare advantages and disadvantages of various extension delivery methods.

6. Review extension programs for improvement and accountability.

Describe the role of evaluating extension programs for improvement and accountability.

7. Demonstrate the use of Social Media for maintaining contact with farmers – including, Facebook, Skype, Facetime, WhatsUp, Twitter.

- A. Introduction, Course Objectives, and Definitions of Terms
- B. Understanding Crop and Soil Management Needs of Target Audiences

- C. Setting Goals and SMART Objectives for Crop and Soil Management Extension Programs
- D. Development of Crop and Soil Management Extension Events and Programs
- E. Theory of Adoption and Diffusion of Technology
- F. Crop and Soil Management Extension Program Delivery Strategies
- G. Evaluation and Follow-Up of Extension Programs

PSS 301 Principles of Crop Production II

Students will learn basic practices associated with establishment, protection, maintenance, and harvest of major crops grown in Liberia including rice, rubber, maize, cassava, and other staple and cash crops vital to the Liberian economy. General principles of harvesting, post-harvest handling, marketing and storage of crop plants will be discussed.

Learning Outcomes:

Students will be able to:

1. Describe the role of crop canopy establishment in optimization of resources for each of the major crops grown in Liberia.

Describe the most effective plant configuration and population per unit area that promotes optimum yield for major crops such as; rice, maize, legumes, cassava, eddoes, oil palm, banana, plantain, cocoa, coffee, rubber, pineapple, sugarcane, etc in Liberia.

2. Describe the relationship of heat unit accumulation, photoperiod, and water stress for each major crop in Liberia and how these crops respond given planting date, fertility inputs, and geographical location in Liberia.

Describe how heat unit accumulation, photoperiod, and moisture stress can impact crop growth, development and reproduction and techniques that can be used to minimize risk and maintain yield and quality.

3. Describe the advantages and disadvantages on crop rotation, monoculture, and intercropping and techniques to optimize production in each system.

Describe crops and crop communities respond to biotic and abiotic factors when considering crop rotation, monoculture production and intercropping.

4. Describe techniques used in handling and storage of seed and vegetative reproductive structures important for sustainability of crop production systems in Liberia.

Describe the positive and negative features or handling and storing seed and vegetative reproductive structures on stand establishment for subsequent plantings.

5. Define the major essential elements necessary for proper form and function of major crops in Liberia.

List the following nutritional elements relative to amount needed by major crops in Liberia (defined as micronutrient or macronutrient) and how each element affects plant growth, development, and reproduction.

- 6. Describe the difference between C3/C4 plants
- 7. List the Center of Origin for the major crops grown in Liberia, and define how that is important to crop management.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Optimizing Resources Through Crop Canopies
- D. The Role of Temperature and Water on Crop Growth, Development, and Reproduction
- E. Crop Rotation, Monoculture, and Intercropping
- F. Mineral Nutrition in Crops
- G. Protecting Genetic Resources

Improved diets are a function of diversity of food available, especially vegetable and fruits. Students will learn about the major horticultural crops, their associated production and pest management systems that protect yield and quality.

Learning Outcomes:

Students will be able to:

1. Define the nutritive value of major horticultural crops in Liberia and their role in human health.

List the major horticultural crops (vegetables, herbs, fruits and nuts), their nutritive value and economic potential in Liberia.

2. Describe the major production systems associated with horticultural crops including fertility requirements, panting configurations and populations per unit area, and harvesting techniques.

Describe in detail the major production systems and their management for horticultural crops in Liberia.

3. Describe aspects of harvest, storage and marketing of horticultural crops in Liberia.

Compare techniques and labor required to harvest, store and market major horticultural crops in Liberia.

- 4. Describe and identify a variety of Ornamental Trees, Flowers, and Grasses that grow in Liberia.
- 5. Describe and demonstrate the use and application of various propagation methods and use of growth hormones.
- 6. Demonstrate the basic types of training and pruning or ornamental and horticultural crop plants.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Characterization of Major Horticultural Crops and Their Production Systems
- D. Harvesting, Storing, and Marketing Horticultural Crops
- E. Agronomic Practices and Pruining
- F. Plant Growth Regulators

PSS 304 Fertility Management and Plant Nutrition (3 credits)

Improving soil fertility and understanding the relationship of soil fertility with crop growth and development are essential in optimizing crop yield and protecting soil resources. Students will learn essential elements and interactions of these elements and how they influence yield. Students will also learn how to calculate rates for soil amendments and the potential impact of fertility practices on the environment. This course will expose students to deficiency symptoms observed in key crops grown in Liberian and methods to correct nutrient deficiencies observed in these crops.

Learning Outcomes:

Students will be able to:

1. Describe the relationship between soil organic matter and texture relative to nutrient adsorption, soil mobility, and availability for plant uptake.

List all essential elements required for normal plant growth, development and reproduction and the charge associated with each element and its role in soil mobility.

2. List all essential elements for plants and their role in the process of plant growth, development, and reproduction.

List all essential elements and the physiological and/or anatomical function in plants and the critical level of these nutrients required to optimize crop yield in Liberia.

3. Describe the process of preparing and applying green manure, animal/poultry waste, composting and synthetic fertilizers in production systems.

Compare and contrast positive and negative attributes of all major fertilizer sources used in crop production.

4. Describe the role of soil pH on nutrient availability and overall plant health.

Describe the role of soil pH in nutrient availability for plant uptake and the soil properties that influence soil pH.

5. Recognize nutrient deficiency and toxicity symptoms of all essential elements.

Identify each of the following pant deficiencies and/or toxicities from the images provided and indicate if these elements are highly mobile, somewhat mobile or immobile in soil and plants.

6. Determine the concentration of essential elements and forms of elements found in all available fertilizer and lime sources and calculate the rate of fertilizer product needed to deliver the required rate of elements.

Given the following information associated with these fertilizers and lime sources, calculate the rate of fertilizer per unit area required to deliver the critical level of soil fertility.

7. Describe the implications of cropping sequence and tillage system on soil fertility needed for all major crops.

Provide an average value of nutrient removal by the following crops in terms of harvested component and the impact on subsequent crops in the rotation.

8. Describe the nitrogen cycle and biological nitrogen fixation in detail.

Given the following schematic, identify the correct phase of nitrogen and the factors influencing movement of nitrogen through the cycle and the process of nitrogen fixation.

9. Describe the role of chemical fertilizer use in Liberia.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Elements Essential for Crop Growth
- D. The Nitrogen Cycle and Biological Nitrogen Fixation
- E. Sources and Delivery of Fertilizers
- F. Nutrient Availability and Soil pH
- G. Determining and Addressing Nutrient Deficiencies and Toxicities
- H. Relationship of Tillage and Crop Sequence on Fertility

PSS 306 Soil-Crop Management Systems

Understanding interactions of production and pest management practices in the context of a farming enterprise will be essential for sustainable crop production in Liberia. Students will learn how to develop and successfully implement a farm plan that includes protection of soil resources, incorporation of improved genetics, developing effective rotation systems, implementing irrigation systems, creating a diversified farming system, and understanding the economic impact of overall crop production and managerial expertise.

Learning Outcomes:

Students will be able to:

1. Describe the interaction of genetics and environment and the role of management in optimizing this interaction at the whole farm level.

Describe environmental factors that can influence crop production and how genetic resources can be effectively managed to ensure a sustainable crop production system.

2. Develop a comprehensive long-term plan for a rotation system at the whole farm level and explain risks associated with system in terms of both agronomy and economics.

Given the following set of crops, land area and access to markets, develop a rotation scheme that minimizes risk and optimizes farm income.

3. Describe potential environmental impacts of diversified farming systems in both the short and long term.

Given the following set of crops, land area, access to markets, soil characteristics and geography, describe the potential environmental ramifications of the following crop production systems and long-term sustainability of each production system and provide suitable alternatives to those systems posing significant risk.

4. Describe the production of warm season and cool season crops like cabbage, collard, mustard and lettuce in Liberia.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Managing the Genetic by Environment by Business Interaction
- D. Benefits and Challenges of Risk Management Through Enterprise Diversity
- E. Developing a Sustainable Cropping System

PSS 401 Principles of Pest Management I: Diseases (3 credits) and Weeds

Disease and weeds can reduce yield and quality dramatically in all crop production systems. Managing these pests requires an understanding of interactions of pests with crop production systems. Students will learn key elements in pest management including identification of weeds and diseases, recognizing relationships between pest damage, pest populations, and yield and quality loss assessments; fundamental concepts associated with the biology and development of pests; and development and implementation of approaches and techniques designed to avoid or suppress pests and their impact on crop production.

Learning Outcomes:

Students will be able to:

1. Identify economically important pathogens and their life cycles, environmental conditions influencing development of epidemics, and their impact on major agronomic and horticultural crops in Liberia.

Given the following crops, describe the major diseases that cause economic loss and under what environmental conditions farmers would expect yield loss.

2. Identify economically important weeds and their life cycles, locations and landscapes where they are present, factors influencing their pernicious nature, their impact on major agronomic and horticultural crops in Liberia and rank their economic impact across crops.

Given the following crops, describe the major weeds that cause economic loss and under what production systems farmers would expect yield loss.

3. Describe the role of integrated pest management principles in minimizing economic loss from weeds and diseases in Liberia.

Define theory and components of integrated pest management, the rationale behind economic thresholds for diseases and weeds, and challenges and risks of production systems when considering integrated pest management.

4. Describe processes that enable pathogens and weeds to adjust to management forces imposed on the major cropping systems in Liberia.

Given the following production systems, explain how the following disease complex and weed diversity may respond to pest management practices and the underlying principles behind their response.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Terminology and Definitions

- C. Biology and Impact of Pathogens and Disease
- D. Biology and Impact of Weeds
- E. Principles of Integrated Pest Management Associated with Disease and Insects
- F. Social, Economic, and Environmental Impact of Pest Management Strategies

PSS 402 Principles of Pest Management II: Insects and (3 credits) Vertebrate Pests

Insects and vertebrate pests such as rodents and birds can reduce yield and quality dramatically in all crop production systems. Managing these pests requires an understanding of interactions of pests with crop production systems. Students will learn key elements in pest management including identification of insects and nematodes, recognizing relationships between pest damage, pest populations, and yield and quality loss assessments; fundamental concepts associated with the biology and development of pests; and development and implementation of approaches and techniques designed to avoid or suppress pests and their impact on crop production.

Learning Outcomes:

Students will be able to:

1. Identify economically important insects and describetheir life cycles, environmental conditions influencing development and population increase, and their impact on major agronomic and horticultural crops in Liberia.

Given the following crops, describe the major insects that cause economic loss and under what conditions farmers would expect yield and storage loss.

2. Identify economically important vertebrate pests and describe their life cycles, locations and landscapes where they are present, their impact on major agronomic and horticultural crops in Liberia.

Given the following crops, describe the major vertebrate pests that cause economic loss and under what environmental conditions farmers would expect yield and storage loss.

3. Describe the role of integrated pest management principles in minimizing economic loss from insects and vertebrates in Liberia.

Define theory and components of integrated pest management, the rationale behind economic thresholds for insects, and challenges and risks of production systems with and without sound integrated pest management strategies.

4. Describe the process enable insect and vertebrate pests to adjust to management forces imposed on the major cropping systems in Liberia.

Given the following production systems, explain how the following insect and vertebrate complex may respond to pest management practices and the underlying principles behind their response.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Terminology and Definitions

- C. Biology and Impact of Insects
- D. Biology and Impact of Vertebrate Pests
- E. Principles of Integrated Pest Management Associated with Insects and Vertebrates
- H. Social, Economic, and Environmental Impact of Pest Management Strategies

PSS 403 Plantation Crop Production and Management (3 credits)

Rubber and other crops that generate income but are not considered staple crops can generate significant economic income for communities. Students will learn production and pest management practices associated with these large-scale crops including infrastructure, transportation, marketing and postharvest handling.

Learning Outcomes:

Students will be able to:

- 1. Identify major plantation crops in Liberia, including rubber, oil palm, coffee, cocoa, citrus, banana, plantain, pineapple, and coconut.
- 2. Describe the growth cycles of major crops and pests and other agronomic factors that limit production.
- 3. Outline the processing, storage and harvest of plantation crops.
- 4. Design a product budget and marketing plan for plantation crops.
- 5. Describe the post-harvest and handling of plantation crops.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Overview of Plantation Crops
- D. Production Constraints to Plantation Crops in Liberia
- E. Fertility Programs in Plantation Crops
- F. Pests and Their Management in Plantation Crops
- G. Harvest of Plantation Crops
- H. Budget and Economic Considerations for Plantation Crops
- I. Plantation Crops in the Broader Context of Sustainability in the Liberian Region.

PSS 404Staple Crop Production and Management(3 credits)

This course will cover production methods, harvesting and postharvest handling to increase production of staple crops such as rice, corn, cassava, and legumes, essential in daily caloric and nutrient input for Liberians. The course is focused on increasing yields and quality through improved genetic materials and high quality germplasm, improved production technologies, proper harvest and postharvest handling.

Learning Outcomes:

Students will be able to:

- 1. Identify major staple crops in Liberia
- 2. Describe the growth cycles of major crops and pests and other agronomic factors that limit production.
- 3. Outline the processing, storage, harvest and post-harvest handling of staple crops.
- 4. Design a product budget and marketing plan for staple crops.
- 5. Describe staple crop production techniques and storage.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Overview of Staple Crops
- D. Production Constraints to Staple Crops in Liberia
- E. Fertility Programs in Staple Crops
- F. Pests and Their Management in Staple Crops
- G. Harvest of Staple Crops
- H. Budget and Economic Considerations for Staple Crops
- I. Staple Crops in the Broader Context of Sustainability in the Liberian Region.

PSS 405 Plant Genetics and Breeding

Incorporation of improved genetics is essential in increasing crop yield and efficiency of production either through the inherent ability of crops or through ability to resist biotic and abiotic stress. Students will learn the role of crop improvement through cultivar and hybrid development and methodologies designed to determine performance of promising plant material of major crops in Liberia. Students will be exposed to the techniques and issues associated with genetically modified (GM) crops in the context of agriculture in Liberia. Students will also be introduced to the importance of germplasm collection, maintenance and evaluation and the ways in which varieties and advanced genetic lines are comparatively evaluated for possible introduction and commercialization.

Learning Outcomes:

Students will be able to:

1. Describe the fundamentals of genetics in predicting outcome of progeny and how this knowledge can be used in improving genetic resources for crop production systems.

Describe the advances in understanding of genetics including the findings of Mendel's phenotypic observations of heritability of genetic traits, the discovery of DNA and its ramification to breeding programs, and process and controversy associated with genetic engineering of crops.

2. Describe the process of from the initial cross of two plants to the release of a variety and practices needed to maintain cultivar purity.

Describe in detail the entire process of identifying appropriate parents, crossing these parents, developing varieties, and maintaining variety integrity distinction once a variety is released publically.

3. Identify the center of origin for the major crops grown in Liberia and describe the value of this knowledge.

List the center of origin for the following crops frequently grown in Liberia and describe how this knowledge can be used in breeding programs.

4. Compare sources of germplasm that can be used in Liberia.

Describe sources of germplasm that can be used in the both the near and long term in Liberia.

5. Describe a variety of plant breeding methods and techniques used for crops grown in Liberia.

<u>Course Module Outline</u>:

A. Introduction and Course Objectives

- B. Terminology and Definitions
- C. The Concept of Crop center of Origin
- D. Genotype and Phenotype Expression
- E. Sexual and Asexual Propagation of Crops
- F. Developing a Successful Crop Breeding Program
- G. Sources of Germplasm
- H. Genetically Engineered Crops
- I. Appropriate Techniques Used in Variety Development

PSS 407 Post-Harvest Handling and Processing (3 credits)

Ability to deliver quality products to the market will influence economic value. Students will learn factors that affect loss of yield and quality after harvest during the handling, storage, and transportation steps in the agricultural production and delivery system and practices that can minimize loss in these areas. Handling of fresh products for processing (control of enzymatic and non- enzymatic changes), grading, sorting, cleaning, peeling, sampling and size reduction will be discussed. Appropriate processing of fruits and vegetables including canning, dehydration processes including freeze-drying, spray-drying and sun-drying will be included in the course as well as chemical, physical and physiological changes in cereals and tubers during storage and handling and methods of preservation. Low-cost systems of affordable cooling and storage of fresh produce will be reviewed. Principles of packaging, characteristics of packaging materials, packaging requirements for fresh and processed foods for local, regional, and international markets will be component of the course.

Learning Outcomes:

Students will be able to:

1. Describe major losses in quantity and quality of the major agronomic, plantation and horticultural crops grown in Liberia.

Given the following list of crops grown in Liberia, identify the overall impact of these losses on the Liberian agricultural sector.

2. Describe proper temperature and moisture regimes that promote medium and long term storage of major crops in Liberia and techniques to minimize loss in storage.

Define specific conditions that affect integrity of stored agricultural products and practices mitigating losses including feasibility under limited resources.

3. Identify pests common to storage products, including mycotoxins, which adversely affect value of products and present risks to human health.

List the major pests associated with storage of the following crops and possible strategies to minimize occurrence and damage and risk to consumers.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Minimizing Loss in the Field
- D. Minimizing Loss During Transportation and Storing
- E. Quality Control
- **F.** Value Chain Enhancement

Minor in Agricultural Education and Extension

Course designation	Course title	Credit hours
AEE 301	Educational Psychology and Extension	3
AEE 303	Extension Methods	3
AEE 402	Public Policy and Agricultural Extension	3
AEE 404	Leadership Impact in Agricultural Extension	3

Total Credits: 12

AEE 301 Educational Psychology and Extension (3 d

(3 credits)

This course focuses on theories of learning, development and motivation applied to Agricultural Extension and Outreach. It examines theories that explain how the clientele in agriculture adopts new technologies, considering the social, moral, and emotional dimensions. It highlights case studies of socio-economic impact of successes and failures in agricultural extension. The course also explores methods of identifying how the clientele in agriculture develops and learns; how one clientele is different from every other clientele; and how the theory and practice of extension and outreach come together to inform the delivery of sound agricultural extension and outreach programs.

<u>Key subjects</u>: Concepts of psychology; personality development; concept of intelligence; concept of measurement in psychology; extension teaching & learning and motivation; classification and description of extension methods. Agricultural clientele psychology, extension agent-clientele relations, socio-economic barriers to agricultural technology transfer.

Learning Outcomes:

Student will be able to:

1. Describe major learning theories and educational psychology in extension education.

Describe and compare different learning theories; describe implications of learning theories for extension; describe the significance of understanding the motivation for learning.

2. Describe and apply theories of adult education.

Describe theories of adult education; compare the difference and similarities of andragogy and pedagogy; apply adult education theories in extension program development.

3. Describe learning styles of different individuals and demonstrate teachable moments.

Describe different learning styles and application of diverse instructional strategies to compatible with different learning styles; analyze conditions for teachable moments and apply in instructional delivery.

4. Identify learning needs of target clients for extension program development.

Describe learning motivation of target client groups; describe various methods used to identify learning needs of extension clientele; translate learning needs into instructional objectives; develop effective lesson plans compatible with social and cultural background of target client groups.

5. Apply learning and motivation theories to develop instructional materials.

Apply learning theories and motivational theories to develop lesson plans; compare and contrast social, cultural, and economic factors impacting change of target client groups; develop extension strategies to facilitate sustainable changes.

6. Compare and apply various instructional strategies.

Describe different instructional strategies; compare advantages and weaknesses of various instructional strategies.

7. Develop quality extension programs based on sound learning theories

Describe how to apply learning theories for designing instructional materials; develop effective instructional materials; teach effectively using various instructional materials.

- A. Introduction, Course Objectives, and Definitions of Terms
- B. Understanding and Application of Learning Theories and Educational Psychology in Extension Education Context
- C. Theory and Application of Adult Education
- D. Learning Styles and Teachable Moments
- E. Understanding Clients and Their Learning Needs
- F. Development of Instructional Materials
- G. Advantages and Disadvantages of Various Instructional Strategies
- H. Characteristics of Effective Extension Education Programs

AEE 303 Extension Methods

This course examines the basic principles of cooperative extension. It defines diffusion and adoption; processes of diffusion and adoption; adopter categories and diffusion curves. It describes the organization of governmental and non-governmental extension services in Liberia; explains the roles and qualities of different categories of extension personnel; compares selected extension methods and techniques. It also deals with the meaning and elements of communication process; methods and strategies in extension; education and entertainment education in social change; extension learning & teaching situations and experiences; preparation and use of communication development models; news gathering techniques; mechanisms and techniques of writing agricultural news for the media; news evaluation and copy editing, organization of twilight, town hall and other community meetings. The course also covers the principles & practices of using audio-visual equipment such as projectors, digital and video cameras; tape recorders, public address system, cartoon and graphics; information and communication technologies.

Key subject: Cooperative Extension: Principles and Practices.

Learning Outcomes:

Student will be able to:

1. Describe and compare different extension systems.

Describe and compare strengths and weaknesses of different extension systems; describe implications for improving the extension system in Liberia.

2. Describe the characteristics of strong extension systems and Review current situation of governmental and nongovernmental extension systems in Liberia.

Describe the characteristics of strong extension systems; analyze the current situation of extension system in Liberia; propose changes to improve the current situation of extension system in Liberia.

3. Describe extension advisory groups and their role in extension.

Describe the role of extension advisory groups; demonstrate the role of extension advisory groups; describe strategies to recruit community leaders for advisory groups; Analyze advisory groups for the representation of diverse clients.

4. Describe essential linkages needed for extension to function effectively.

Analyze current situation of linkages Liberia extension has with research, industry, businesses, farmers, and community; propose needed improvements to establish strong extension linkages.

5. Describe roles, needed skills, and responsibilities of various extension personal.

Analyze various job responsibilities of extension in Liberia; describe needed skills to perform those jobs.

6. Compare strengths and weaknesses of various extension strategies and methods.

Compare and contrast various extension methods and strategies; develop extension methods to educate target client groups.

7. Describe in detail the theory of adoption and diffusion and its application in extension.

Describe the theory of adoption, adopter categories, and diffusion curve; explain the application of theory of diffusion in extension program delivery.

8. Describe application of various mass communication methods in extension.

Describe and compare various extension communication methods; demonstrate the application of various communication methods in extension setting.

9. Review extension methods and communication strategies for improvements.

Analyze extension methods and strategies for suggesting necessary improvements.

- A. Introduction, Course Objectives, and Definitions of Terms
- B. Different Extension Systems
- C. Characteristics of Strong Extension Systems
- D. Review of Governmental and Nongovernmental Extension in Liberia
- E. Establishment of Extension Advisory Groups and Conducting Community Forums
- F. Building Linkages with Research, Clients, Industry, and Community
- G. Understanding the Role and Responsibilities of Extension Personnel
- H. Effective Extension Programming Strategies and Methods
- I. Theory of Adoption and Diffusion of Technology
- J. Use of Effective Communication Methods in Extension
- K. Review of Extension Programs and Strategies for Improvement

AEE 402 Public Policy and Agricultural Extension (3 credits)

This is senior level course which purpose is to clarify to the student the relationship between public policy and agricultural development and the role of agricultural extension. It discusses government policies that directly or indirectly impact agricultural development in Liberia. Public policy on urban, peri-urban and rural development in relation to agricultural practices are discussed. The challenges of development in Liberia and how a good agricultural extension program may minimize such challenges are considered. Strategic options for implementing effective agricultural extension methods in a given public policy scenario are explored. Students also debate how to influence public policy for the advancement of effective agricultural extension.

Key subjects: Public Policy, Agricultural Development, Cooperative Extension.

Learning Outcomes:

Student will be able to:

1. Describe the role of extension in agricultural development.

Explain the role of extension and agricultural development; describe how the agricultural development policy frame work can impact the role of extension.

2. Review and analyze the current agricultural development policies in Liberia.

Critically review the current agricultural development and trade policies of Liberia; describe positive and negative effects of current policies in extension programming.

3. Analyze agricultural development challenges and issues in Liberia.

Analyze agricultural development challenges and issues in public policy context; propose policy alternatives to meet challenges and address issues.

4. Describe the focus of Extension programming in current context of Liberian Agricultural Development Policy and propose changes needed to support agricultural development policies of Liberia.

Analyze the current situation of extension programming and propose needed changes to support agricultural development policies of Liberia.

5. Describe needed advocacy for public policy reforms.

Describe the role of advocacy in public policy reforms; demonstrate public policy advocacy for reforming policies to build strong extension systems.

- A. Introduction, Course Objectives, and Definitions Of Terms
- B. Role of Extension in Agricultural Development

- C. Review and Analysis of Current Agricultural Development Policies in Liberia
- D. Analyzing Agricultural Development Challenges and Issues in Liberia
- E. Changes Needed to Align the Role of Extension for Supporting Agricultural Development Policies of Liberia
- F. Development, Implementation, and Evaluation of Extension Programs in the Current Context of Liberian Agricultural Development Policy
- G. Advocacy for Policy Reforms to Build Strong Public Extension

AEE 404 Leadership Impact in Agricultural Extension (3 credits)

This is a senior level course which focuses on the impact of strong leadership in successful cooperative agricultural extension. It teaches the student the basic principles of effective leadership in cooperative extension, the relationship between leadership qualities and success in agricultural development at individual, group and community levels. The student is taught how to identify, evaluate and train leaders for agricultural development at the community level; it distinguishes between professional/technical and local leaders, explains the patron-client relationships and value systems. It discusses the principles and procedures for community level. As tools for strong leadership, the course teaches the student elements of the planning process, principles & concepts of program planning; steps in planning; concept of monitoring and evaluation; and evaluation approaches. As additional tools for strong leadership qualities, the course also teaches the concept, theories, principles and guidelines of administration; organization and supervision of agricultural extension services in Liberia; staff recruitment, selection, placement and supervision; and assessment of extension work accomplishments.

Key subjects: Leadership Qualities, Organizational Ability, Community Knowledge, Effective Planning, Administration.

Learning Outcomes:

Student will be able to:

1. Describe and contrast different leadership theories and apply those in extension context.

Compare and contrast different leadership theories; describe application of leadership theories in extension context for building community partnerships.

2. Describe contingency and situational leadership theories and their application in extension.

Discuss the application of contingency and situational leadership theories for building strong extension organization.

3. Describe leader-follower link and motivation; Apply motivation concepts to lead others, organize community groups.

Analyze the motivational factors of leaders and followers; describe the linkage between leaders and followers; apply the leader-follower linkages for building extension partnerships with businesses, industry and community.

4. Describe the internal and external contextual factors of extension impacting leadership roles in organization.

Analyze and describe the internal and external contextual factors impact leadership tasks of extension.

5. Describe ethical dimensions of leadership and analyze leadership qualities.

What are the ethical dimensions of leadership? Analyze leadership qualities with reference to their application in extension for building a strong organization.

6. Demonstrate leadership skills essential for working in extension. Describe the role of leadership in extension organization.

What are the leadership skills essential for someone to be effective in extension? Provide examples for the situations one will have to use these leadership skills in an extension organization; describe the role of leadership in extension at different levels of the organization.

- A. Introduction, Course Objectives, and Definitions of Terms
- B. Leadership Theories: Transformational, Instrumental, and Transactional Leadership
- C. Contingency and Situational Theories of Leadership Applicable to Extension
- D. Theories of Motivation and Link Between Leadership and Follower Motivation
- E. Understanding Leadership as a Function of Contextual Factors of Extension Organization
- F. Ethical Dimensions and Qualities of Leadership
- G. Leadership Development
- H. The Role of Leadership in Extension
Minor in Agribusiness

Course designation	Course title	Credit hours
AGB 301	Farm Production and Management	3
AGB 303	Agricultural Finance	3
AGB 402	<u>Value Chain Analysis in Commercial</u> <u>Agriculture</u>	3
AGB 404	Economics of Agricultural Sustainability	3

Total Hours: 12

AGB 301 Farm Production and Management

(3 credits)

The purpose of this course is to develop an understanding of the various business management decisions involved in the organization and operation of a farm firm for continuous profit and production cost efficiency. Each farm, like any other agribusiness firm, is a complex business. Most farms are organized as sole proprietorships or as family businesses, like many other small businesses, but farmers must understand a broader array of management activities including, managing biological productive processes, evaluating and adopting new technology, devising and carrying out marketing strategies, arranging financing, dealing with personnel, and using communication technology to their advantage. The rapid pace of new institutional developments and of evolving government programs, of changing market environments brought about by more open and competitive markets, and of new technology place, the modern producer is under constant pressure to adapt and change.

Learning Outcomes:

Student will be able to:

- 1. Describe the role of the manager and decision-maker on farms.
- 2. Use decision-making tools such as records, budgeting, breakeven analysis, and capital investment useful to the manager in planning and controlling the farm.
- **3.** Analyze factors which affect the decision-making process and the profitability of a farm or ranch business.
- 4. Use spreadsheets as agricultural decision-making aids.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Farm Management in the 21st Century
- C. Management and Decision Making
- D. Acquiring & Organizing Management Information
- E. The Balance Sheet & Its Analysis
- F. The Income Statement & Its Analysis
- G. Farm Business Analysis
- H. Enterprise Budgeting
- I. Partial Budgeting
- J. Whole-Farm Planning
- K. Cash Flow Budgeting

- L. Farm Business Organization
- M. Managing Risk & Uncertainty
- N. Managing Income Taxes
- O. Enterprise Analysis
- P. Land Control & Use
- Q. Human Resource Management
- **R.** Machinery Management

AGB 303 Agricultural Finance

(3 credits)

The objective of this course is to present principles and procedures in managing financial and credit resources. Financial analysis of agricultural businesses such as liquidity, capital structure, and growth of agricultural firms, risk and return, capital budgeting methods, analysis of land investments, leasing, and costs of credit, financial intermediation and major financial institutions for agriculture, credit scoring, loan pricing, and asset-liability management techniques by financial intermediaries will be covered. Specific learning outcomes for students taking this course include: be able to construct a set of integrated financial statements for an agricultural business, be able to analyze financial condition and performance using financial criteria and measures, be able to evaluate and analyze financial information for management and credit decisions, understand the interrelationship between business and financial risk and demonstrate how risk management tools can be used to manage risk.

Learning Outcomes:

Student will be able to:

- 1. Construct a set of integrated financial statements for an agricultural business.
- 2. Analyze financial condition and performance using financial criteria and measures.
- 3. Evaluate and analyze financial information for management and credit decisions.
- 4. Define the interrelationship between business and financial risk and demonstrate how risk management tools can be used to manage risk.
- 5. Apply financial analysis concepts to agribusiness management and credit management decisions.
- 6. Demonstrate how risk management tools may be used to manage a business's overall risk position.

- A. Introduction to Agricultural Finance
- B. A Look at Current Farm Financial Conditions
- C. An Introduction to Competitive Strategy and the Structure of Agricultural Credit Markets
- D. Financial Analysis, Planning and Control Farm Businesses
- E. Capital Structure, Liquidity and Risk Management
- F. Agribusiness Finance
- G. Capital Budgeting and Long-Term Decision Making
- H. Risk Management
- **I.** Class Presentations

AGB 402Value Chain Analysis in Commercial
Agriculture(3 credits)

The objective of the course is to help students understand value chain concepts and competitiveness and be able to assess risks and identify strategic opportunities to strengthen value chains, recognize how cohesive value chains can be used to reduce risks and facilitate access to finance and learn how to apply value chain financial products to meet the needs of various actors in the value chain. The students will learn about the mapping these commodity value chains to demystify and quantify the associated risks and costs. The result of this should facilitate the introduction of focused, viable and sustainable agriculture finance products within institutions that stretch beyond the bounds of production finance.

ABG 404Economics of Agricultural Sustainability(3 credits)

This course introduces students to theories and principles of the economics of sustainability. Primary course objectives are to provide students with basic understanding of the economic theory that can be used in decision making and to provide a good understanding of microeconomic agricultural sustainability issues. Several topics are covered including agricultural intensification, population growth, market efficiency, agricultural policy, trade and consumer awareness.

Minor in Agricultural Mechanization

Course designation	Course title	Credit hours
AGM 301	Farm Structures and Environmental Control	3
AGM 303	Farm Machinery and Power	3
AGM 401	Irrigation Technologies	3

Total Hours: 9

AGM 301 Farm Structures and Environmental Control (3 credits)

Environmental and structural requirements of farm structures; planning of plant and livestock houses; water supply and waste disposal (biogas as a means of utilizing waste). Specifications and selection of farm building materials. Environmental control for plants and livestock. Farm planning and layout. Use of psychrometric charts.

Learning Outcomes:

Student will be able to:

1. Diagram appropriate farm structures and describe the purpose, limitations, construction materials and costs of building and maintenance of these structures.

For each of the following structures, indicate the number of units required for construction and estimate expense of construction and maintenance.

2. Describe the impact of farm structures on the surrounding environment and how water and waste materials will be handled to minimize environmental impact and optimize recycling of renewable products.

Given the following overall farm systems, how will the following farm structures be arranged to allow maximum efficiency and capturing of renewable fertilizer sources.

3. Describe sources and limitations of energy supply with a focus on developing sustainable operations in a total farming outlay.

For each of the following farm structures, provide the energy consumption during use.

<u>Course Module Outline</u>:

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Comparison of farming Structures and Materials
- D. Water and Waste Management
- E. Energy Use and Sustainability

AGM 303 Farm Machinery and Power

The objective of this course is to introduce students to farm machinery and power in the animal and plant sciences. Successful implementation of farm mechanization. Machinery in crop production, operation, repair and maintenance. Selection of machines and machine systems in conservation agriculture. Horticultural equipment. Machinery in the animal sciences. Alternative sources of energy for the farms under Liberian conditions. Advantages, disadvantages and implementation of solar, wind, hydroelectric, biomass (biogas) energy systems.

Learning Outcomes:

Student will be able to:

1. Describe farm machinery and implements and their role in farming operations and how use can improve efficiency.

Label each of the implements and machinery and describe their value in farming systems.

2. Describe limitations to machinery adoption in Liberia and approaches to address these perceived limitations.

What are the major hurdles to adoption of implements and farm machinery in Liberia and how can those obstacles be addressed effectively.

3. Describe procedures and protocols that minimize risk and hazards to operators of machinery and others in the active working zone.

Describe the risks to operators of each of the following pieces of machinery.

4. Describe the role of renewable energy in sustaining farm machinery use.

For each of the following pieces of machinery, describe the current energy source and its efficiency and pose alternatives to the current system with respect to increased sustainability.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Description of Farm Implements and Machinery in Crop Systems
- D. Description of Farm Implements and Machinery in Animal Systems
- E. Efficiency of Machinery in the Liberian Context
- F. Sustainability and Maintenance of Farm Equipment and Machinery

AGM 401 Irrigation Technologies

The objective of this course is to highlight the interrelation of irrigation and conservation agriculture. Hydrological cycle, soil/plant relationships, infiltration and evapotranspiration. Requirements of Liberian main crops, estimation of leaching and run-off. The assessment of irrigation and drainage. Irrigation technologies under Liberian conditions. Design, layouts and management of drainage systems. Assessment of erosion and control strategies, the use of crops and vegetation. Practices and policies in soil preservation and improvement.

Learning Outcomes:

Student will be able to:

1. Define the relationship between water use in crops and critical periods of water demand.

For each of the following crops, define the most critical time when water stress impacts yield and quality and the amount of water supplied through irrigation needed to alleviate water stress.

2. Describe irrigation systems and their potential in Liberian cropping systems.

Contrast positives and negatives of the following irrigation systems in Liberian crop production.

3. Describe the impact of irrigation on the surrounding ecosystem.

Describe the consequences of overuse of irrigation on crop fields and the surrounding ecosystem.

- A. Introduction and Course Objectives
- B. Terminology and Definitions
- C. Critical Periods of Water Demand in Crops
- D. Irrigation Systems: Limitations and Value
- E. Physics of Water Movement in Soil and Irrigation Systems
- F. Environmental Impact and Sustainability of Irrigation Systems

Minor in Natural Resource Management

Course designation	Course title	Credit hours
NRM 306	Forest Ecology and Management	3
NRM 401	Urbanization and Sustainable Development	3
NRM 405	Land Rights, Natural Resources, and Benefit Distribution	3
NRM 407	Non-Timber Forest Products	3

Total Hours: 12

NRM 306 Forest Ecology and Management

(3 credits)

This course is design to cover ecology as applied to the management of natural resource ecosystems including biological diversity and conservation biology in natural resource ecology. The course will cover studies on the plant life histories, populations, communities, and plant animal interactions (pollination, dispersal, herbivory) and evolutionary basis for plant ecological traits will be included. The students will be taught basic principles of forest, fish, and wildlife management, which are components of the forest ecosystem. It will also cover history, ecology, economics, and policy. Students will be introduced to the fundamentals of measuring and quantifying natural resources including cruising and scaling timber, quantifying wildlife and fisheries habitat, measuring and estimating forage production for wildlife and livestock, and sampling wildlife populations. The course will also introduce basic statistical concepts and their applications in resource management. Nomenclature, identification, ranges, and habitats of important native and naturalized trees of Liberia will be examined. Shrubs, vines and Non-Timber Forest Species, important as wildlife food and cover will be discussed.

Learning Outcomes

Students will be able to:

- 1. Define ecology and associated sub tropics as related to natural resource use and management.
- 2. Identify constituent of biodiversity and understand interrelationship between ecosystem and biodiversity.
- **3.** Carry out field observations, including measuring and collection of data on forage and wildlife populations.
- 4. Apply basic statistical concepts in natural resource management.
- 5. Identify important naturalized trees of Liberia and forest species of food to wildlife.
- 6. Acquire skill and technique involve in field observation.
- 7. Collect data on the identified important naturalized trees of Liberia.
- 8. Interpret and analyze the data collected using basic statistical concepts in natural resource management.

<u>Course Module Outline</u>:

- A. Introduction
- B. Course Objectives
- C. Ecology as applied to the management of natural resource ecosystem
- D. Fundamentals of measuring and quantifying natural resources

- E. Methods of measuring and estimating forage production and sampling wildlife populations.
- F. Impacts of forests on watershed
- G. Importance of forests in Liberia
- H. Basic statistical concepts and their applications in resource management
- I. Ranges and habitats of important naturalised trees of Liberia and important forest species of food to wildlife.

NRM 401 Urbanization and Sustainable Development (3 credits)

This course explores the process of urbanization that is playing a dominant role in the modern world and the impact the changing landscape has on the environment and sustainable development. Other aspects of this course will include (i) advantages, challenges and opportunities of urbanization; (ii) the link between urbanization and economic prosperity, social development and environmental sustainability; (iii) sustainable development, urbanization and the relationship with rural development; (iv) the relationship between society and nature; and (v) plant biology and the preservation and management of trees in urban environments.

Learning Outcomes

Students will be able to:

- 1. Describe the process of urbanization and explain how cities were formed.
- 2. Identify and compare urbanization trends that contributed to the growth of cities and metropolises.
- 3. Explain factors driving migration from rural areas to urban areas.
- 4. Discuss the models of urban growth.
- 5. Describe the social, economic and environmental impacts of urbanization (urban and suburban).
- 6. Identify the consequences of urbanization on Liberian natural resources.
- 7. Describe policies to deal with urban challenges in Liberia and the region.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Urbanization and urban growth
- E. Urbanism and urban dynamics
- F. Definition and measurement of urbanization
- G. Global, regional and local urbanization trends
- H. Consequences of urbanization
- I. Urbanization effects on social and economic development
- J. Urban growth and the use and conservation of natural resources
- K. Urban and regional planning

L. Urbanization policies

NRM 405Land Rights, Natural Resources, and Benefit(3 credits)Distribution

Development, content and implementation of public land and natural resource policies emphasizing forest, range, wildlife, and wild land recreation. This course will also review and examine Liberian law that focuses on land rights, inheritance, benefit distribution and natural resources.

Learning Outcomes

Students will be able to:

- 1. Identify patterns of land use in Liberia.
- 2. Explain the history of land and property rights in Liberia.
- 3. Outline current legislation of Liberian land rights.
- 4. Discuss Liberian legislation in regards to forests (National Forestry Reform Law), community forests, wildlife (Wildlife Law) and protected areas.

- A. Introduction
- B. Course Objectives
- C. Terminology and Definitions
- D. Land use in Liberia
- E. Land use and conflicts in Africa and Liberia
- F. Gender equity: access to and tenure of land ownership
- G. Liberian Law, Land and Property Rights in Liberia
- H. Community rights to land and renewable natural resources
- I. Natural resource management and revenue distribution

NRM 407 Non-Timber Forest Products

The forests occupy a massive land mass in Liberia and yet few have studied the non-timber species (flora and fauna) that provide and hold aesthetic, ecological, environmental and economic value. This course will provide an overview and inventory of Non-Timber Forest Species (NTFS) in Liberia and West Africa. Quantitative analysis and understanding of the ecology, management, and conservation of game and non-game wildlife (terrestrial and aquatic). Population dynamics, harvesting, habitat requirements and fragmentation, conservation genetics, and managing of protected areas all will be explored as case studies focusing on botanicals, spices and medicinal plants from the forests. Using the World Health Organizational Guide to Good Agricultural and Collection Practices, students will be exposed to strategies to sustainably collect and extract high value plant products from the forests while ensuring the protection of the indigenous plant and associated ecosystem. The use of NTFS as a vehicle to provide income generating activities will be explored.

Learning Outcomes

Students will be able to:

- **1.** State the importance of forests as rich reservoirs of valuable resources, not just timber, but also as non- timber (forest) products.
- 2. Identify rules and regulations for the successful commercialization of NTFP in Liberia.
- **3.** Explain the diversity of Non-timber forest products and their importance to meet Liberian people needs without destroying the forest resource.
- 4. Explain the importance of conserving forest resources and NTFP by studying concepts of sustainable systems of collection and harvest in forest management
- 5. Learn techniques to identify plant species from which NTFP derived and how to grow these plants in forest gardens, arboreta and nurseries.
- 6. Describe the uses and importance of NTFP to meet daily needs of Liberian forest dwellers.
- 7. Identify suitable non-timber forest species for domestication and incorporation into agroforestry setting.
- 8. Describe how the varied NTFP of animal, plant and fungous origin are collected and processed and used.
- 9. Highlight the importance of development of NTFP enterprises as one of the activity that integrates the three "C's" of forestry (Commercial, community and conservation).
- **10.** Describe the local importance and uses of NTFP within a community management of the resource for generating income.

- **11.** Apply concepts of value chain to learn opportunities to upgrade the NTFP value chains.
- **12.** Emphasize factors affecting the establishment of successful NTFP Small and Medium Forest Enterprises.
- 13. Describe local, regional and international markets of the NTFP.

- A. Introduction
- B. Course Objectives
- C. NTFP definitions and classification
- D. Traditional botanical Knowledge. Uses of NTFP as an interaction of people with forest.
- E. Main groups of NTFP in Liberia: Benefits of their uses (income, nutrition, medicine construction materials).
- F. Challenges and opportunities of the NTFP industry in West Africa and Liberia. National Resources Law. Government institutions impacting NTFP industry.
- G. The Convention on Biological Diversity. Issues with intellectual property rights. Equitable sharing of benefits from use of genetic resources.
- H. Identification of NTFP species. Vegetative and Reproductive Morphology.
- I. Main Liberian NTFP of animal, plant and fungal origin and their uses.
- J. Value chain concept approach to the production of NTFP.
- K. Agroforestry systems for production of NTFP. Application of traditional botanical knowledge in agroforestry. Domestication of Liberian non-timber forest species, species selection and multiplication.
- L. Technologies for production of NTFP of plant, fungal and animal origin (honey, snails, mushrooms, medicinal plants, ornamental plants, native fruits and nuts).
- M. Opportunities for restoration of forest ecosystem using NTFP species. Integration of NTFP into the local rural economy.
- N. Local, urban, national, regional and international markets of NTFP.
- O. Factors affecting marketing of NTFP. Market information systems. The trade environment of NTFP. Trends in International Trade. Value chain analysis.
- P. Strategies for development of successful enterprises. Problems faced by small/medium forest enterprises. Building entrepreneurial and management skills.