

SCHOOL OF AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS & AGRIBUSINESS

1. **PhD in Applied Agricultural Economics and Policy**
2. **PhD in Agricultural Administration**
3. **PhD in Agribusiness**

PHD IN APPLIED AGRICULTURAL ECONOMICS AND POLICY

1. Introduction

The Department of Agricultural Economics & Agribusiness (DAEA) has been involved in the teaching and training of students in the area of agricultural economics, agribusiness and agricultural administration at both the undergraduate and master's levels. The DAEA run a PhD programme in Agricultural Economics. The current PhD programme, *Applied Agricultural Economics and Policy*, is a re-designed of the PhD programme in Agricultural Economics to meet stakeholders in the agricultural sector's need for evidence based policy making. The course of study is designed to be applied in agricultural policy process, including debate of issues, identification of policy options and prioritization, implementation, and monitoring. The overall objective of the *PhD in Applied Agricultural Economics and Policy* is to contribute significantly to the enhancement of the environment for *evidence based policy making* in Sub-Sahara Africa. In order to engender agricultural productivity growth with sustainable environmental management, improve food security, and enhance the role of agriculture in poverty reduction through better integration of farmers to markets, the PhD program will train policy analysts and impart knowledge and skills needed to champion the transformation of agro-food sectors and the rural economies through evidence-based policy making. An added purpose of the programme is to build competencies in conducting policy relevant research on agriculture, food systems and the rural economy including such associated concerns as gender disparities, environment, and natural resource management.

2. Admission Requirements

A relevant Master's degree will be the minimum requirement.

3. Duration of Programme

The period for completion of the PhD is four (4) years for full time and six (6) years for part time.

4. Requirements for Graduation

A total of 75 - 81 credits will be required for graduation.

Course work:	18-24 credits
Seminar I, II, III and IV: 3 credits each:	12 credits
Thesis:	45 credits
Total Credits	75-81 credits

5. Programme Structure

YEAR 1 SEMESTER 1

CORE COURSES:

COURSE CODE	COURSE TITLE	CREDIT
ECON 703*	Advanced Microeconomics	3
ECON 705*	Advanced Macroeconomics	3
AGEC 701	Applied Econometrics	3
AGEC 707	Political Economy of Food Security Policies	3

* Course taken from Department of Economics

ELECTIVES (Students will be required to take 3 - 6 credits per specialization):

Agricultural Marketing and Trade Specialization

COURSE CODE	COURSE TITLE	CREDIT
AGEC 735	RURAL FINANCE	3

Development Economics Specialization

COURSE CODE	COURSE TITLE	CREDIT
AGEC 735	RURAL FINANCE	3

YEAR 1 SEMESTER 2

CORE COURSES:

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702**	Advanced Scientific Writing and Seminar Delivery	3
AGEC 702	Public Policy, Policy Process, Analysis and Negotiation	3

** School of Agriculture required Course

ELECTIVES* (Students will be required to take 3 - 6 credits per specialization):

Resource and Environmental Economics Specialization

COURSE CODE	COURSE TITLE	CREDIT
AGEC 714	Biotechnology Policy	3
AGEC 718	Agricultural Resource Policy	3
AGEC 722	Resource and Environmental Economics	3
AGEC 724	Production Economics	3
AGEC 726	Gender Analyses in Agri-Food Systems	3
AGEC 728	Agricultural Systems Modeling	3

Agricultural Marketing and Trade Specialization

COURSE CODE	COURSE TITLE	CREDIT
AGEC 706	Food Policies	3
AGEC 708	Pricing Commodities and Inputs	3

AGEC 726	Gender Analyses in Agri-Food Systems	3
AGEC 728	Agricultural Systems Modeling	3
AGEC 732	Agricultural Supply Chain Management	3

Development Economics Specialization

COURSE CODE	COURSE TITLE	CREDIT
AGEC 712	Rural Development	3
AGEC 726	Gender Analyses in Agri-Food Systems	3
AGEC 728	Agricultural Systems Modeling	3
AGEC 732	Agricultural Supply Chain Management	3
AGEC 736	Livelihoods and Poverty	3
AGEC 738	Project Analysis and Management	3

* Each year, the elective courses on offer will be advertised

SEMINAR AND THESIS

COURSE CODE	COURSE TITLE	CREDIT
YEAR 2		
AGEC 710	Seminar I	3
AGEC 720	Seminar II	3
AGEC 700	Thesis	-
YEAR 3		
AGEC 730	Seminar III	3
AGEC 700	Thesis	-
YEAR 4		
AGEC 740	Seminar IV	3
AGEC 700	Thesis	45

6. Course Description

AGRC 702: ADVANCED SCIENTIFIC WRITING AND SEMINAR DELIVERY

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

ECON 703: ADVANCED MICROECONOMICS

The main objective of this course is to provide students with a comprehensive understanding of models in advanced Microeconomic Theory so they will be acquainted with the state of the art in microeconomic analyses. At the end, students will be equipped to apply microeconomic concepts and tools to the African environment.

ECON 705: ADVANCED MACROECONOMICS

The course is an advanced treatment of contemporary macroeconomic theory that prepares students to carry out research. Current controversies will be discussed as well as relevance of theoretical and policy issues to the African context. At the end of the course, students are expected to thoroughly understand the structure of a macroeconomic system and its underlying theoretical framework as well as controversies and debates; use methodology and techniques studied in conceptualizing and postulating relevant macroeconomic issues; evaluate macroeconomic policies, and cultivate a critical perspective to current developments in macroeconomics.

AGEC 701: APPLIED ECONOMETRICS

The objective of the course is to provide students with the necessary econometric tools geared towards empirical research in micro-macro econometric techniques and (dynamic) panel data models for policy analyses. There will be hands-on computer-based practicals using economic data in model estimation, diagnostic testing and deriving policy implications. *E-views* and *Stata* will be the main econometric packages used.

AGEC 702: PUBLIC POLICY, POLICY PROCESS, ANALYSIS AND NEGOTIATION

This course is to help students understand the iterative and dynamic nature and power play in the policy process. The various interest groups (stakeholders) who should participate but are excluded or sidelined will be discussed. Student will appreciate the challenges in the process and measures to improve participation and effectiveness.

AGEC 706: FOOD POLICIES

The main objective of this course is to provide basic theoretical knowledge on policy instruments that are generally employed by governments and international organization in the area of food policy, food quality and food safety. This course will focus primarily on the determination and analysis of the collective efforts of governments and international organizations to influence the decision making environment of food producers, food consumers, and food marketing agents in order to achieve social objectives of nutrition, rapid growth in domestic food production and food security.

AGEC 707: POLITICAL ECONOMY OF FOOD SECURITY POLICIES

The course focuses on economic welfare theory and its application to public policy. The interplay of economic agents, institutions and governments power play in regulations, food quality and food safety; agricultural sector problems and policy in the development process; as well as international food policies affecting trade and development are major focus.

AGEC 708: PRICING COMMODITIES AND INPUTS

This course is an applied analysis of input, output and consumer markets. The focus will be to build students understanding and analyses in key areas of theoretical concepts and empirical measurement in the pricing of agricultural commodities and inputs including how subsidies and tariffs influence the demand and supply of agricultural products and inputs.

AGEC 712: RURAL DEVELOPMENT

The course in Rural Development is designed for graduate students to appreciate the role of rural development in achieving total national and international development goals. It explores the

theories of development in general and rural development in particular, and highlights the roles of policy, stakeholders, institutions, and infrastructure in Rural Development. The processes of planning, programming and management for rural development are also presented. Students also shall undertake case studies of government policies as they influence rural development in developing countries.

AGEC 714: BIOTECHNOLOGY POLICY

This course is an exploration of many of the policy issues raised by the biotechnology industry. It is also intended to give students the opportunity to learn more as well as examine the prospects for and implications of the biotechnology revolution. The course includes materials and presentations for non-scientists on background knowledge about the science and technologies involved.

AGEC 718: AGRICULTURAL RESOURCE POLICY

The main objective of this course is to provide an understanding and appreciation of the need for policies to guide the management of resources (mainly irrigation and land) that complement agricultural production for sustainable agricultural development and economic growth. The course focuses on analysis of policies that lead to efficiency, equity and sustainability in the use of land, water and irrigation facilities for agricultural growth and productivity.

AGEC 722: RESOURCE AND ENVIRONMENTAL ECONOMICS

The purpose of this course is to enhance the student's ability to use economic theory to critically analyze natural resource issues and resource management policy. The course will focus on both natural resource and environmental economics. Under natural resource economics the course examines economic models of the use of both renewable and non-renewable resources to analyze issues such as resource conservation, sustainable development, taxation of resource rents, and price determination in resource markets. The environmental economics component will enhance students' understanding of the impact of economic activity on environmental quality and how to design policies to respond to these impacts.

AGEC 724: PRODUCTION ECONOMICS

This course is concerned with issues related to the theory and application of production economics. Discussion of the traditional neo-classical theory of the firm, duality theory, concepts of efficiency and productivity, production response over time and under risk will be considered including other issues and topics related to agricultural production economics. Topics covered are the flexible functional forms, aggregation across inputs and outputs using the theory of separable structures, aggregation over economic optimizing firms, the representation of multi-output technologies, and the analysis and measurement of technical change from both a primal and dual perspective.

AGEC 726: GENDER ANALYSES IN AGRI-FOOD SYSTEMS

The course is designed to offer students the opportunity to recognize the social norms, traditional roles and power structures that influence gender inequalities and contribute to the differential impacts of agriculture and food policies on men and women. It also considers the implications of gender for agro-industrial project development.

AGEC 728: AGRICULTURAL SYSTEMS MODELING

The course is designed to assist students to learn modeling and simulation methods for biological and agricultural systems using a Systems Approach. Students will be introduced to methods for

working with dynamic models including sensitivity analysis, parameter estimation, evaluation, and applications. At the end of this course students are expected to understand the difference between estimation, optimization and simulation and make informed choice of analysis as appropriate. Students will also be able to identify appropriate empirical tool(s) when confronted with particular measurement/ estimation/ hypothesis testing problem(s). Students should be able to understand and apply life cycle assessment for agricultural commodities.

AGEC 732: AGRICULTURAL SUPPLY CHAIN MANAGEMENT

The course is designed to provide students the principles and tools for governance and management of agricultural supply chains, with applications to cases in Africa and elsewhere. The course is provided in a practical environment. The course provides the students with a deeper understanding competitive strategy in Agribusiness, Market access, Transportation and other logistics in agricultural supply chains; the potential role of contracting in supply chains; Food retailing and agricultural development.

AGEC 735: RURAL FINANCE

The objectives of this course include equipping students with skills to assess credit needs of agricultural businesses, the appropriate funding sources and requirements, and financial model to apply to agribusinesses. Students are to have an appreciation of the challenges in agricultural lending in the rural environment, drivers of successfully performing rural financial markets, financial products and lending.

AGEC 736: LIVELIHOODS AND POVERTY

The aim of the course is to provide participants with an understanding of the key concepts of the “Livelihoods” approach, concepts of poverty and wellbeing, poverty measurements and analyses, and the role of agriculture in pro-poor growth strategies. Students will learn the principles and tools of the sustainable livelihoods approach; Its strengths and weaknesses, and how to use the approach in a development-planning context. They will also learn qualitative and quantitative methods of poverty measurement, how to conduct poverty and social impact analysis of agricultural policies and strategies.

AGEC 738: PROJECT ANALYSIS AND MANAGEMENT

The main objective of this course is to provide students with the necessary expertise to assume strategic leadership roles in leading projects through the use of theory and practice. The project analysis and management course is designed to extend their knowledge and equip them with broad research and project analysis and management skills, enabling them to make leadership contributions in financial, economic and social analysis and decision making.

AGEC 710: SEMINAR I

This seminar will involve the presentation of research proposal.

AGEC 720: SEMINAR II

Students will undertake attachment in research and policy institutions to learn from experienced researchers, experts and mentors, the different aspects/components of the research process. The learning experience should help students to strengthen their research proposal and clarify the pathways for a successful completion of the research work. The students will deliver seminar on their experiential research and learning.

AGEC 730: SEMINAR III

This seminar will involve the student's presentation of the progress on the research work, in relation to providing information on data collection, challenges and some preliminary analysis, and findings. This will generate some discussions which will further provide directions for the thesis research.

AGEC 740: SEMINAR IV

This seminar will be the final seminar on the presentation of the research results/findings.

AGEC 700: THESIS

Research report submitted for examination by each student.

PHD IN AGRICULTURAL ADMINISTRATION

1. Introduction

The Department of Agricultural Economics & Agribusiness (DAEA) has been involved in the teaching and training of students in the area of agricultural economics, agribusiness and agricultural administration. The DAEA re-designed her M.Sc. in Agricultural Administration into an M. Phil. programme in 1998 and continued with the one-year Master in Agricultural Administration. The PhD programme in Agricultural Administration is a response to the market demand for higher-level skills in managing and administering complex and integrated agribusinesses and farm enterprises in coordinating sub-disciplines of finance, supply chain management, management and marketing. The objective of the agricultural administration PhD program is to produce scholars who are trained in the latest methods of business, administrative and economic analysis as well as at the forefront of problem solving in agriculture, one of the most important sectors of the Ghanaian and global economy. With this background, graduates of this concentration are expected to assume teaching and research positions at top-ranked research universities. The *PhD in Agricultural Administration* will contribute significantly to the enhancement of the environment for *evidence based policy making* in Ghana, Sub-Sahara Africa and the global economy. The PhD program will train policy analysts and impart knowledge and skills needed to champion the transformation of agro-food sectors and the rural economies through evidence-based policy making in departments of Agricultural and Applied Economics in the Universities and in relevant government Ministries, Departments and Agencies in Ghana, and also the rest of Africa.

2. Admission Requirements

A relevant Master's degree will be the minimum requirement.

3. Duration of Programme

The period for completion of the PhD is four (4) years for full time and six (6) years for part time.

4. Requirements for Graduation

A total of 75 - 81 credits will be required for graduation.

Course work:	18-24 credits
Seminar I, II, III and IV: 3 credits each:	12 credits
Thesis:	45 credits
Total Credits	75-81 credits

5. Program Structure

YEAR 1 SEMESTER 1

CORE COURSES:

COURSE CODE	COURSE TITLE	CREDIT
AGEC 701	Applied Econometrics	3
AGEC 705	Economics for Agribusiness and Agricultural Administration	3
AGEC 709	Political Economy of Agricultural Finance, Credit Policy and Institutions	3

ELECTIVES (Students will be required to take 3 - 6 credits per semester):

COURSE CODE	COURSE TITLE	CREDIT
AGEC 707	Political Economy of Food Security Policies	3
AGEC 735	Rural Finance	3

YEAR 1 SEMESTER 2

CORE COURSES:

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702**	Advanced Scientific Writing and Seminar Delivery	3
AGEC 702	Public Policy, Policy Process, Analysis and Negotiation	3

** School of Agriculture required Course

ELECTIVES* (Students will be required to take 3 - 6 credits per semester):

COURSE CODE	COURSE TITLE	CREDIT
AGEC 706	Food Policies	3
AGEC 708	Pricing Commodities and Inputs	3
AGEC 712	Rural Development	3
AGEC 714	Biotechnology Policy	3
AGEC 716	Cooperatives and Farmer Organizations	3
AGEC 718	Agricultural Resource Policy	3
AGEC 726	Gender Analyses in Agri-Food Systems	3
AGEC 728	Agricultural Systems Modeling	3
AGEC 732	Agricultural Supply Chain Management	3
AGEC 736	Livelihoods and Poverty	3
AGEC 738	Project Analysis and Management	3

* Each year, the elective courses on offer will be advertised

SEMINAR AND THESIS

COURSE CODE	COURSE TITLE	CREDIT
YEAR 2		
AGEC 710	Seminar I	3
AGEC 720	Seminar II	3
AGEC 700	Thesis	-
YEAR 3		
AGEC 730	Seminar III	3
AGEC 700	Thesis	-
YEAR 4		
AGEC 740	Seminar IV	3
AGEC 700	Thesis	45

6. Course Description

AGRC 702 ADVANCED SCIENTIFIC WRITING AND SEMINAR DELIVERY

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

AGEC 701: APPLIED ECONOMETRICS

The objective of the course is to provide students with the necessary econometric tools geared towards empirical research in micro-macro econometric techniques and (dynamic) panel data models for policy analyses. There will be hands-on computer-based practicals using economic data in model estimation, diagnostic testing and deriving policy implications. *E-views* and *Stata* will be the main econometric packages used.

AGEC 702: PUBLIC POLICY, POLICY PROCESS, ANALYSIS AND NEGOTIATION

This course is to help students understand the iterative and dynamic nature and power play in the policy process. The various interest groups (stakeholders) who should participate but are excluded or sidelined will be discussed. Student will appreciate the challenges in the process and measures to improve participation and effectiveness.

AGEC 705: ECONOMICS FOR ADMINISTRATION AND AGRIBUSINESS

The course is designed to provide students with the principles and tools of both micro and macro economics to help students develop understanding of the economic environment which agricultural businesses operate at both the private and public levels and how to think strategically within it. The course is provided in a practical environment and the use of case studies are very important part of the course. The course provides the students with a deeper understanding competitive strategy in Agribusiness.

AGEC 706: FOOD POLICIES

The main objective of this course is to provide basic theoretical knowledge on policy instruments that are generally employed by governments and international organization in the area of food policy, food quality and food safety. This course will focus primarily on the determination and analysis of the collective efforts of governments and international organizations to influence the decision making environment of food producers, food consumers, and food marketing agents in order to achieve social objectives of nutrition, rapid growth in domestic food production and food security.

AGEC 707: POLITICAL ECONOMY OF FOOD SECURITY POLICIES

The objective of the course is designed to focus on economic welfare theory and its application to public policy. The interplay of economic agents, institutions and governments power play in regulations, food quality and food safety; agricultural sector problems and policy in the development process; as well as international food policies affecting trade and development are major focus.

AGEC 708: PRICING COMMODITIES AND INPUTS

This course is an applied analysis of input, output and consumer markets. The focus will be to build students understanding and analyses in key areas of theoretical concepts and empirical measurement in the pricing of agricultural commodities and inputs including how subsidies and tariffs influence the demand and supply of agricultural products and inputs.

AGEC 709: POLITICAL ECONOMY OF AGRICULTURAL FINANCE, CREDIT POLICY AND INSTITUTIONS

This course focuses on building students understanding in how political agents and institutions shape agricultural finance, rural credit and in the strengthening of institutions that influence agricultural financing. Case study approach will be adopted in this course.

AGEC 712: RURAL DEVELOPMENT

The course in Rural Development is designed for graduate students to appreciate the role of rural development in achieving total national and international development goals. It explores the theories of development in general and rural development in particular, and highlights the roles of policy, stakeholders, institutions, and infrastructure in Rural Development. The processes of planning, programming and management for rural development are also presented. Students also shall undertake case studies of government policies as they influence rural development in developing countries.

AGEC 714: BIOTECHNOLOGY POLICY

This course is an exploration of many of the policy issues raised by the biotechnology industry. It is also intended to give students the opportunity to learn more as well as examine the prospects for and implications of the biotechnology revolution. The course includes materials and presentations for non-scientists on background knowledge about the science and technologies involved.

AGEC 716: COOPERATIVES AND FARMER ORGANIZATIONS

The course is designed to provide students with the principles and tool for the analysis of the behaviour and practices of cooperatives and farmer based organizations. The course is provided in a practical environment and the use of case studies are very important part of the course. The

course provides the students with a deeper understanding of the formation of cooperatives/farmer-based organization (FBOs) including their functions, developments, growth, group dynamics, and monitoring and evaluation of group programs.

AGEC 718: AGRICULTURAL RESOURCE POLICY

The main objective of this course is to provide an understanding and appreciation of the need for policies to guide the management of resources (mainly irrigation and land) that complement agricultural production for sustainable agricultural development and economic growth. The course focuses on analysis of policies that lead to efficiency, equity and sustainability in the use of land, water and irrigation facilities for agricultural growth and productivity.

AGEC 726: GENDER ANALYSES IN AGRI-FOOD SYSTEMS

The course is designed to offer students the opportunity to recognize the social norms, traditional roles and power structures that influence gender inequalities and contribute to the differential impacts of agriculture and food policies on men and women. It also considers the implications of gender for agro-industrial project development.

AGEC 728: AGRICULTURAL SYSTEMS MODELING

The course is designed to assist students to learn modeling and simulation methods for biological and agricultural systems using a Systems Approach. Students will be introduced to methods for working with dynamic models including sensitivity analysis, parameter estimation, evaluation, and applications. At the end of this course students are expected to understand the difference between estimation, optimization and simulation and make informed choice of analysis as appropriate. Students will also be able to identify appropriate empirical tool(s) when confronted with particular measurement/ estimation/ hypothesis testing problem(s). Students should be able to understand and apply life cycle assessment for agricultural commodities.

AGEC 732: AGRICULTURAL SUPPLY CHAIN MANAGEMENT

The course is designed to provide students the principles and tools for governance and management of agricultural supply chains, with applications to cases in Africa and elsewhere. The course is provided in a practical environment. The course provides the students with a deeper understanding competitive strategy in Agribusiness, Market access, Transportation and other logistics in agricultural supply chains; the potential role of contracting in supply chains; Food retailing and agricultural development.

AGEC 735: RURAL FINANCE

The objectives of this course include equipping students with skills to assess credit needs of agricultural businesses, the appropriate funding sources and requirements, and financial model to apply to agribusinesses. Students are to have an appreciation of the challenges in agricultural lending in the rural environment, drivers of successfully performing rural financial markets, financial products and lending.

AGEC 736: LIVELIHOODS AND POVERTY

The aim of the course is to provide participants with an understanding of the key concepts of the “Livelihoods” approach, concepts of poverty and wellbeing, poverty measurements and analyses, and the role of agriculture in pro-poor growth strategies. Students will learn the principles and tools of the sustainable livelihoods approach; its strengths and weaknesses, and how to use the approach in a development-planning context. They will also learn qualitative and quantitative methods of poverty measurement, how to conduct poverty and social impact analysis of agricultural policies and strategies.

AGEC 738: PROJECT ANALYSIS AND MANAGEMENT

The main objective of this course is to provide students with the necessary expertise to assume strategic leadership roles in leading projects through the use of theory and practice. The project analysis and management course is designed to extend their knowledge and equip them with broad research and project analysis and management skills, enabling them to make leadership contributions in financial, economic and social analysis and decision making.

AGEC 720: SEMINAR II

Students will undertake attachment in research and policy institutions to learn from experienced researchers, experts and mentors, the different aspects/components of the research process. The learning experience should help students to strengthen their research proposal and clarify the pathways for a successful completion of the research work. The students will deliver seminar on their experiential research and learning.

AGEC 730: SEMINAR III

This seminar will involve the student's presentation of the progress on the research work, in relation to providing information on data collection, challenges and some preliminary analysis, and findings. This will generate some discussions which will further provide directions for the thesis research.

AGEC 740: SEMINAR IV

This seminar will be the final seminar on the presentation of the research findings.

AGEC 700: THESIS

Research report submitted for examination by each student.

PHD IN AGRIBUSINESS

1. Introduction

The Department of Agricultural Economics & Agribusiness (DAEA) has been involved in the teaching and training of students in the area of agricultural economics, agribusiness and agricultural administration. Agribusiness as an academic discipline, involves the application of theory and quantitative methods in economics, finance, marketing and management to issues involved in the production, distribution and marketing of food and fiber. In 2002, the DAEA introduced a M. Phil. degree in Agribusiness. DAEA has therefore been offering courses in Agribusiness at both the undergraduate and the post graduate levels. The PhD programme in Agribusiness will complement the M. Phil. in Agribusiness programme in line with the role and functions of the Department to provide trained personnel who meet the nation's demand for high level professional manpower in agricultural sciences, agricultural economics, agricultural administration, agribusiness management, etc. in research, teaching, advisory work and business management. The objective of the program is to produce scholars who are trained in the latest methods of business and economic analysis as well as at the forefront of problem solving in one of the most important sectors of the Ghanaian and global economy, agriculture. The *PhD in Agribusiness* is to contribute significantly to the enhancement of the environment for *evidence based policy making* in Ghana, Sub-Sahara Africa and the global economy. The PhD program will train policy analysts and impart knowledge and skills needed to champion the transformation of agro-food sectors and the rural economies through evidence-based policy making.

2. Admission Requirements

A relevant Master's degree will be the minimum requirement.

3. Duration of Programme

The period for completion of the PhD is four (4) years for full time and six (6) years for part time.

4. Requirements for Graduation

A total of 75 - 81 credits will be required for graduation.

Course work:	18-24 credits
Seminar I, II, III and IV: 3 credits each:	12 credits
Thesis:	45 credits
Total Credits	75-81 credits

5. Program Structure

YEAR 1 SEMESTER 1

CORE COURSES:

COURSE CODE	COURSE TITLE	CREDIT
AGEC 701	Applied Econometrics	3
AGEC 705	Economics for Agribusiness and Agricultural Administration	3
AGEC 711	Agribusiness Management	3

YEAR 1 SEMESTER 1**ELECTIVES (Students will be required to take 3 - 6 credits per semester):**

COURSE CODE	COURSE TITLE	CREDIT
AGEC 709	Political Economy of Agricultural Finance, Credit Policy and Institutions	3
AGEC 735	Rural Finance	3

YEAR 1 SEMESTER 2**CORE COURSES:**

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702**	Advanced Scientific Writing and Seminar Delivery	3
AGEC 702	Public Policy, Policy Process, Analysis and Negotiation	3

** School of Agriculture required Course

ELECTIVES* (Students will be required to take 3 - 6 credits per semester):

COURSE CODE	COURSE TITLE	CREDIT
AGEC 706	Food Policies	3
AGEC 708	Pricing Commodities and Inputs	3
AGEC 712	Rural Development	3
AGEC 714	Biotechnology Policy	3
AGEC 716	Cooperatives and Farmer Organizations	3
AGEC 718	Agricultural Resource Policy	3
AGEC 726	Gender Analyses in Agri-Food Systems	3
AGEC 728	Agricultural Systems Modeling	3
AGEC 732	Agricultural Supply Chain Management	3
AGEC 738	Project Analysis and Management	3

* Each year, the elective courses on offer will be advertised

SEMINAR AND THESIS

COURSE CODE	COURSE TITLE	CREDIT
YEAR 2		
AGEC 710	Seminar I	3
AGEC 720	Seminar II	3
AGEC 700	Thesis	-
YEAR 3		
AGEC 730	Seminar III	3
AGEC 700	Thesis	-
YEAR 4		
AGEC 740	Seminar IV	3
AGEC 700	Thesis	45

6. Course Description

AGRC 702 ADVANCED SCIENTIFIC WRITING AND SEMINAR DELIVERY

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

AGEC 701: APPLIED ECONOMETRICS

The objective of the course is to provide students with the necessary econometric tools geared towards empirical research in micro-macro econometric techniques and (dynamic) panel data models for policy analyses. There will be hands-on computer-based practicals using economic data in model estimation, diagnostic testing and deriving policy implications. *E-views* and *Stata* will be the main econometric packages used.

AGEC 702: PUBLIC POLICY, POLICY PROCESS, ANALYSIS AND NEGOTIATION

This course is to help students understand the iterative and dynamic nature and power play in the policy process. The various interest groups (stakeholders) who should participate but are excluded or sidelined will be discussed. Student will appreciate the challenges in the process and measures to improve participation and effectiveness.

AGEC 705: ECONOMICS FOR ADMINISTRATION AND AGRIBUSINESS

The course is designed to provide students with the principles and tools of both micro and macro economics to help students develop understanding of the economic environment which agricultural businesses operate at both the private and public levels and how to think strategically within it. The course is provided in a practical environment and the use of case studies are very important part of the course. The course provides the students with a deeper understanding competitive strategy in Agribusiness.

AGEC 706: FOOD POLICIES

The main objective of this course is to provide basic theoretical knowledge on policy instruments that are generally employed by governments and international organization in the area of food policy, food quality and food safety. This course will focus primarily on the determination and analysis of the collective efforts of governments and international organizations to influence the decision making environment of food producers, food consumers, and food marketing agents in order to achieve social objectives of nutrition, rapid growth in domestic food production and food security.

AGEC 708: PRICING COMMODITIES AND INPUTS

This course is an applied analysis of input, output and consumer markets. The focus will be to build students understanding and analyses in key areas of theoretical concepts and empirical measurement in the pricing of agricultural commodities and inputs including how subsidies and tariffs influence the demand and supply of agricultural products and inputs.

AGEC 709: POLITICAL ECONOMY OF AGRICULTURAL FINANCE, CREDIT POLICY AND INSTITUTIONS

This course focuses on building students understanding in how political agents and institutions shape agricultural finance, rural credit and in the strengthening of institutions that influence agricultural financing. Case study approach will be adopted in this course.

AGEC 711: AGRIBUSINESS MANAGEMENT

The course objective is to develop the capacity of the student to analyze the environment in which agricultural businesses operate, and to apply management (human resource and supply chain), finance, marketing and economic principles to operations of firms in a sustainable manner. The course is provided in a practical environment and the use of case studies are very important part of the course. The course provides the students with a deeper understanding of agricultural business management principles and policy.

AGEC 712: RURAL DEVELOPMENT

The course in Rural Development is designed for graduate students to appreciate the role of rural development in achieving total national and international development goals. It explores the theories of development in general and rural development in particular, and highlights the roles of policy, stakeholders, institutions, and infrastructure in Rural Development. The processes of planning, programming and management for rural development are also presented. Students also shall undertake case studies of government policies as they influence rural development in developing countries.

AGEC 714: BIOTECHNOLOGY POLICY

This course is an exploration of many of the policy issues raised by the biotechnology industry. It is also intended to give students the opportunity to learn more as well as examine the prospects for and implications of the biotechnology revolution. The course includes materials and presentations for non-scientists on background knowledge about the science and technologies involved.

AGEC 716: COOPERATIVES AND FARMER ORGANIZATIONS

The course is designed to provide students with the principles and tool for the analysis of the behaviour and practices of cooperatives and farmer based organizations. The course is provided in a practical environment and the use of case studies are very important part of the course. The course provides the students with a deeper understanding of the formation of cooperatives/farmer-based organization (FBOs) including their functions, developments, growth, group dynamics, and monitoring and evaluation of group programs.

AGEC 718: AGRICULTURAL RESOURCE POLICY

The main objective of this course is to provide an understanding and appreciation of the need for policies to guide the management of resources (mainly irrigation and land) that complement agricultural production for sustainable agricultural development and economic growth. The course focuses on analysis of policies that lead to efficiency, equity and sustainability in the use of land, water and irrigation facilities for agricultural growth and productivity.

AGEC 726: GENDER ANALYSES IN AGRI-FOOD SYSTEMS

The course is designed to offer students the opportunity to recognize the social norms, traditional roles and power structures that influence gender inequalities and contribute to the differential

impacts of agriculture and food policies on men and women. It also considers the implications of gender for agro-industrial project development.

AGEC 728: AGRICULTURAL SYSTEMS MODELING

The course is designed to assist students to learn modeling and simulation methods for biological and agricultural systems using a Systems Approach. Students will be introduced to methods for working with dynamic models including sensitivity analysis, parameter estimation, evaluation, and applications. At the end of this course students are expected to understand the difference between estimation, optimization and simulation and make informed choice of analysis as appropriate. Students will also be able to identify appropriate empirical tool(s) when confronted with particular measurement/ estimation/ hypothesis testing problem(s). Students should be able to understand and apply life cycle assessment for agricultural commodities.

AGEC 732: AGRICULTURAL SUPPLY CHAIN MANAGEMENT

The course is designed to provide students the principles and tools for governance and management of agricultural supply chains, with applications to cases in Africa and elsewhere. The course is provided in a practical environment. The course provides the students with a deeper understanding competitive strategy in Agribusiness, Market access, Transportation and other logistics in agricultural supply chains; the potential role of contracting in supply chains; Food retailing and agricultural development.

AGEC 735: RURAL FINANCE

The objectives of this course include equipping students with skills to assess credit needs of agricultural businesses, the appropriate funding sources and requirements, and financial model to apply to agribusinesses. Students are to have an appreciation of the challenges in agricultural lending in the rural environment, drivers of successfully performing rural financial markets, financial products and lending.

AGEC 738: PROJECT ANALYSIS AND MANAGEMENT

The main objective of this course is to provide students with the necessary expertise to assume strategic leadership roles in leading projects through the use of theory and practice. The project analysis and management course is designed to extend their knowledge and equip them with broad research and project analysis and management skills, enabling them to make leadership contributions in financial, economic and social analysis and decision making.

AGEC 710: SEMINAR I

This seminar will involve the presentation of research proposal.

AGEC 720: SEMINAR II

Students will undertake attachment in research and policy institutions to learn from experienced researchers, experts and mentors, the different aspects/components of the research process. The learning experience should help students to strengthen their research proposal and clarify the pathways for a successful completion of the research work. The students will deliver seminar on their experiential research and learning.

AGEC 730: SEMINAR III

This seminar will involve the student's presentation of the progress on the research work, in relation to providing information on data collection, challenges and some preliminary analysis,

and findings. This will generate some discussions which will further provide directions for the thesis research.

AGEC 740: SEMINAR IV

This seminar will be the final seminar on the presentation of the research findings.

AGEC 700: THESIS

Research report submitted for examination by each student.

DEPARTMENT OF AGRICULTURAL EXTENSION

PHD IN AGRICULTURAL EXTENSION

1.0 Programme Aim

The PhD in Agricultural Extension program is designed for people whose career aspirations are in the areas of teaching, research and extension in institutions of higher learning, research organizations and also top managerial positions in development organizations. The program seeks to provide such people with in-depth understanding of the theoretical considerations and their practical and policy implications for extension delivery.

2.0 Programme Objectives

1. To produce PhD holders with very good understanding of the theory and practice of extension and development work for top management jobs in development organizations..
2. To develop PhD holders who will undertake teaching, research and extension work in research and academic institutes.
3. To produce graduates who are competent to respond to dynamic challenges in extension and development work.

3. Admission Requirements

Two main categories of students will be expected to enroll for our PhD programme.

- i) Candidates applying with first degree ; and,
- ii) Candidates applying with Masters degrees.

3.1. Candidates applying with a first degree.

- i. Candidates with a good first degree may apply into an MPhil or PhD programme.
- ii. The PhD applicant will be given conditional admission letters by the School of Graduate Studies.
- iii. They shall take prescribed courses (Level 600 courses) in the first year.
- iv. On completion of the Level 600 courses, candidates will be assessed, and may progress into MPhil or PhD depending on performance;
- v. Candidates who progress into MPhil will undertake their thesis research and on successful completion, will be awarded an MPhil degree.
- vi. Candidates who progress into PhD will be admitted into the PhD programme, they shall take Level 700 courses in Year 2 and continue to fulfill the requirements for the award of PhD degree.
- vii. Candidates who are unable to meet the criteria for a research degree may be offered the option to do an MA/MSc. Dissertation.

3.2 Candidates applying with a Master’s degree (e.g.MA/MSc/MPh/MBA/MPhil)

- i. Student with a Masters degree may apply into a PhD programme.
- ii. Such students will be given conditional admission letters by the School of Graduate Studies.
- iii. They shall take prescribed courses (Level 700 courses) in Year 1 as well as “make-up courses”, as necessary, in Years 1 & 2.
- iv. Candidates will be assessed on successful completion of the prescribed courses, and may progress to the PhD depending on performance.
- v. Candidates who qualify to progress to PhD will be admitted to the PhD programme.
- vi. Candidates who are unable to meet the criteria may be offered the option to do an MPhil in which case, they shall proceed to do an MPhil thesis research.

4. Duration of Program

The duration for PhD. Agricultural Extension programme is four (4) years for full time students and six (6) years for part-time students.

5. Requirements for Graduation

Course work:	18-24 credits
Seminar (4)	12 credits
Thesis:	45 credits
Total credits	75-81 credits

6. Structure of Programme

Year 1

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDITS
AGEX 701	Theoretical Foundations of Extension and Development work	3
AGEX 705	Research Methods for Development work	3
Semester 1: Elective course (maximum of 3 credits)		
AGEX 703	Planning, Monitoring and Evaluation (M&E) of Rural Development Program	3
AGEX 707	Communication and Extension Methods for Innovation	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDITS
AGEX 702	Statistics for Development Studies	3

AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
Semester 2: Elective course (maximum of 3 credits)		
AGEX 704	Organizational Management for Development Workers	3
AGEX 714	Development Sociology	3

Year 2 Internship/Experiential Learning Program

Year 2-4

COURSE CODE	COURSE TITLE	CREDITS
AGEX 710	Seminar 1	3
AGEX 720	Seminar 2	3
AGEX 730	Seminar 3	3
AGEX 740	Seminar 4	3
AGEX 700	Thesis	45

7. Description of Courses

AGEX 701 Theoretical Foundations of Extension and Development work

The traditional view on agricultural development is often linear, and ignores the complexities of smallholder constraints. The course challenges this outlook and introduces the innovation system / system innovation approaches to agricultural development. It aims to equip the students with the theoretical underpinnings and concepts for understanding the complexity of smallholder livelihoods. These include the concept of innovation embodying hardware, orgware and software. Institutional, socio-organisational and technological change, multi-level framework for identifying opportunities, challenges and entry points of change. The implications of these concepts and approaches for facilitating innovation for enhancing sustainability of smallholder livelihoods will be explored.

AGEX 702 Statistics for Development

The goal of the course is that students develop the skills to be able to collect, organize, analyze, and interpret social research data. Topics include regression and multivariate data analysis; logistic regression, multivariate analysis of variance, repeated measures analysis of variance; advanced topics in quantitative methods; classification and clustering, causal inference. Multiple regression and correlation for analyzing data in the behavioral, social, and innovation sciences; ANOVA, ANCOVA, and path analysis. Use of SPSS, SAS, EXCEL, EPI-Info statistical

software packages for statistical data analysis. Real data sets from the National Statistical Surveys, Departmental projects and research, baseline and evaluation research studies will be used for practice.

AGRC 702 Advanced Scientific Writing and Seminar Delivery

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

AGEX 703 Planning, Monitoring and Evaluation (M&E) of Developing Programmes

This course aims at equipping students with in-depth knowledge in the theories and practice of programme planning, monitoring and evaluation. Students will be taught; strategies for designing programmes using impact pathway, and participatory impact pathway analysis. Planning and growth of organizations. Theory of planned behavior, change theory, reliability, validity and sensitivity in programme monitoring and evaluation, methodological constraints and challenges in programme evaluation. Conventional uses of evaluation results; persuasive utilization, direct utilization, and conceptual utilization. Paradigms within programme monitoring and evaluation; positivist, interpretive, and critical-emancipatory paradigms for in-depth understanding of programme evaluation.

AGEX 704 Organizational Management for Development Workers

Students will be guided to acquire in-depth knowledge in, and theoretical understanding of, contemporary issues affecting the management, growth, and sustainability of organizations. These include; the role of corporate social responsibilities in managing organizations, cooperate social responsibilities and legitimacy of organizations, knowledge systems and management in organizations, managerial traits in knowledge economy, hard and soft theories of change and sustainability of organizations, team dynamics, group dynamics, managing careers, succession plan and leadership, decision making process, governance process, structural growth problems, economies of scale of entrepreneurial organizations, institutionalized conflict resolution, and alternative dispute resolution in organizations,

AGEX 705 Research Methods for Development Work

This course introduces advanced study of social science research methods. The course examines the relationship between theory and research methodological issues, such as objectivity, the logic of argument, reliability and validity. Concepts, constructs, and variables; measurement of constructs, conceptualization, operationalization, sample size estimation and confidence intervals. Improving internal and external validity. Theoretical and empirical planes of research; positivism, post-positivism. Worldviews; epistemological stances, paradigms, pragmatism, Mixed methods research, methodological implications of combining qualitative and quantitative methods. Alternate research designs. Systems and networks in social research; social network

analysis, structure and dynamics of networks. Social research ethics. Proficiency and publishing in social research

AGEX 707 Communication and Extension Methods

This course will deepen understanding in the theories and concepts related to agricultural and development communication in both applied and theoretical settings. Specific areas of study include past and emerging theoretical paradigms in the development communication discourse such as cognitive dissonance theory, interpretative and interaction theories, system theory, network theory and computer mediated communication theory. Practical implications of different communication modes and approaches for successful agricultural development programs, the emergence and suitability of new media and ICT in extension from economic, cultural and technological perspectives, communication competencies for social change and development practitioners, and current debates in the field of development communication research.

AGEX 614: Development Sociology

This course will provide students with the theoretical and methodological background in the processes and practices of social transformation. These include sociological theories of development, new institutionalism, social networks, social identity, social and cultural capital, cognitive theories of culture, and resource mobilization. Students will also be taught the nature of rural sociology and cultural anthropology, cultural change and development work, theoretical insights on relevance of social structure of rural societies, social institutions and needs of rural communities. The overarching methodological principles such as positivism, and anti-positivism used to conduct sociological research in broadly the same manner as natural science will be discussed.

8. Seminars

AGEX 710: Seminar 1

Proposal presentation.

Students will present a seminar on their research proposal. The proposal will cover the concern area, problem statement, research questions and objectives. Students will also be required to provide information on their proposed methodology, data analysis and nature of results and discussions.

AGEX 720: Seminar 2

Internship report and preparation for field work.

Students will present a seminar on the report from their internship. This will include the theoretical foundations underpinning the projects that they engaged in, lessons learnt from the field work and the relevance of the internship to the PhD research work.

AGEX 730: Seminar 3.

Progress report on data analysis and thesis preparation.

Students will present a seminar on the experiences in their field data collection, strategies for data analysis, and presentation of statistical packages being used for data analysis. Students will be required to provide information on the schedule of their thesis and the strategies they are adopting to complete their thesis for submission.

AGEX 740: Seminar 4.

Presentation of findings.

Students will give a seminar on the findings of the data analysis, discussions and conclusions derived from the discussions of the results. Students should provide clear explanations concerning the specific activities to be undertaken to submit their thesis.

10. Details of Year 2 Experiential Program

The activities of the second year of the PhD program are directed towards guiding students to apply theory to practice by participating in projects that will require them to apply theoretical understanding of contemporary issues to analyze data and writing reports on them. Candidates will also be guided to acquire specific techniques and expertise in research work. These include the development of methodologies to be used in the PhD research. The various activities will help them to be well-grounded in various research activities.

Seminar and Conference Participation

Candidates will be required to participate in departmental seminars, as well as the conferences and workshops organised by development organizations, research institutions and credible national and regional associations. By engaging in these activities, students will interact with experienced practitioners who can serve as mentors and collaborators. The candidate will be required to write and present papers at these conferences in collaboration with senior members in the Department.

Participation in Research Projects.

In addition to the activities outlined above, candidate will be engaged in on-going projects in the Department and also projects that other research institutions, ministries, and development partners are undertaking with support from researchers in our department. This includes the following.

A. The Public-Private Partnership Cocoa Extension Project. (Dr. Francis Baah)

This project is based on the understanding that the public cocoa extension service does not have all the needed resources to cover all cocoa communities with the required goods and services to attain increased productivity that the nation needs. Some private individuals and organizations have competitive advantage over the public cocoa extension service providers and can make meaningful impact on cocoa extension delivery. The project seeks to identify, register, and give accreditation to all private cocoa extension service providers for efficient and effective extension delivery. The project also seeks to establish joint technical working committee comprising public and private cocoa extension providers. Candidates who participate in this project will collect data on prospective private cocoa extension service providers related to their expertise, coverage and comparative advantages. Candidates will also collect data on accreditation schemes of service providers involved in commodities such as cocoa, shae nut and oil palm to be used to determine the most appropriate scheme for COCOBOD. This project will help students to read on the theoretical foundations of public-private partnership and accreditation of service providers. Students will write reports on their activities and submit to the department.

B. Capacity Development of Cocoa Extension Staff. (Dr. Francis Oppong)

In order to operate professionally and competently in the delivery of extension service to farmers, this project has been initiated to train all cocoa extension staff and also give them the needed resources by the appropriate service providers to enable the staff deliver their services efficiently. This project will also take care of new technologies and other improvements in the cocoa industry. The goal of the project is to have extension staff that are highly qualified, well trained and motivated, and well equipped to meet the emerging needs and challenges in cocoa extension. Candidates who participate in this project will undertake thorough literature search to obtain theories that underpin staff development programmes of commodity specialized extension approaches. They will collect and analyse data on the requisite skills, and resources needed by extension staff operating in an ICT era among the different categories of Ghanaian cocoa farmers. Candidates will write reports on their activities and submit to the department.

C. Ministry of Fisheries and Aquaculture Development (MOFAD) Staff development Programme

This programme is being implemented by the Department of Agricultural Extension in collaboration with the Ministry of Fisheries and Aquaculture Development. The programme seeks to achieve the following; undertake a participatory organisational self-assessment of training needs of MOFAD, appraise the full Fisheries Value Chain performance gaps, determine key performance gaps of knowledge, attitudes, skills (KAS) to be filled by appropriate training, designing training modules, manuals and schedules for relevant training, facilitating the training in phases, and preparation of a schedule of Monitoring and Evaluation to ensure that the benefits of the training are sustained. Candidates who participate in this project will conduct literature search on the theoretical foundation underpinning participatory self assessment and key

performance gaps. Candidates will collect data on current key performance gaps prevailing in the fisheries and aquaculture sector and investigate into the gaps that could be addressed with local resources. Students will write reports on their activities and submit to the department

11. Collaborations

The Department of Agricultural Extension has collaborated with some universities in Africa and outside Africa for the development, running and assessment of our PhD programme. The universities are;

1. Wageningen University

Knowledge, Technology and Innovation Group

2. Universite d'Abomey-Calavi, Cotonou, Benin

3. University of Reading

International and Rural Development Department.

4. Federal University of Agriculture (FUNAB)

Abeokuta, Nigeria

5. Department of Agricultural Economics and Agribusiness

University of Ghana, Legon

DEPARTMENT OF ANIMAL SCIENCE

PHD PROGRAMME IN ANIMAL SCIENCE

1. INTRODUCTION

The Department of Animal Science was established in 1961 and has since evolved to become one of the five fully fledged units under the School of Agriculture. The Department ensures an enabling environment for its research, training and outreach work in order to attract, recruit and maintain highly qualified animal scientists. The vision of the Department is to build a centre of excellence that trains livestock scientists and animal agriculture and husbandry development managers with thorough knowledge and skill in Animal Production, to enhance animal productivity and improve the capacity in meeting the demands of the growing market for quality meat and other products, as well as execute mission-oriented and demand-driven research for knowledge acquisition while maintaining dynamic outreach programmes for the development of Ghana's agriculture.

The main areas of specialization for the PhD programme in the Department are Animal Breeding and Genetics, Animal Nutrition, Animal Physiology, Microbiology and Immunology, Meat Science and Technology, and Range and Forage Science.

2. ADMISSION REQUIREMENTS

Students with relevant Master's degree may apply into a PhD programme.

3. DURATION OF PROGRAMME

The duration for completion of the Doctor of Philosophy degree shall normally be four (4) years for full-time students and six (6) years for part-time students.

4. REQUIREMENTS FOR GRADUATION

To graduate, students must pass all core courses. In all cases, the University of Ghana Regulations in the Handbook for Graduate Studies shall apply. Students must obtain a total of 75-81 credits as indicated in the breakdown below.

Coursework: 18-24 credits

Seminar (I – IV): 12 credits

Thesis: 45 credits

Total Credits: 75-81

5. STRUCTURE OF PROGRAMME

YEAR 1 (Coursework)

ANIMAL BREEDING AND GENETICS

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 703	Applied Genomics for Sustainable Livestock Breeding	3

Semester 1: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 705	Molecular Genetic Techniques	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 702	Biodiversity and Animal Genetic Resource (AnGR) Conservation	3

Semester 2: Elective Courses (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 704	Special Topics in Quantitative Genetics	3
ANIM 706	Advances in Molecular Animal Genetics	3

***Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture or Faculty of Science may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.**

ANIMAL NUTRITION

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 707	Concepts and Developments in Animal Nutrition	3

Semester 1: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 709	Nutrition and Health Interaction	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 712	Protein Metabolism	3

Semester 2: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 708	Nutrition and Gastrointestinal Health	3

***Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture or Faculty of Science may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.**

ANIMAL PHYSIOLOGY

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 711	Special Topics in Reproduction	3

Semester 1: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 705	Molecular Genetic Techniques	3
ANIM 713	Advances in Endocrinology	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 714	Advances in Reproductive Physiology	3

Semester 2: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 604	Endocrinology and Reproductive Physiology	4

***Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture or Faculty of Science may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.**

MICROBIOLOGY AND IMMUNOLOGY

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 715	Mechanism of Diseases	3

Semester 1: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 705	Molecular Genetic Techniques	3
ANIM 717	Current Trends in Animal Microbiology	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 716	Advanced Immunobiology	3

Semester 2: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 718	Advanced Reading in Immunobiology	3

*Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture, Faculty of Science or College of Health Sciences may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.

MEAT SCIENCE AND TECHNOLOGY

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 719	Muscle Biology	3

Semester 1: Elective Courses (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 705	Molecular Genetic Techniques	3
ANIM 721	Meat Handling and Public Health	3

* Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture or Faculty of Science may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 718	Meat Biochemistry and Physiology	3

Semester 2: Elective Courses (Students will be required to take 3-6 credits per semester)

Students may take electives from the School of Agriculture or Faculty of Science in consultation with the Graduate Students' Advisor and/or Supervisory Committee.

RANGE AND FORAGE SCIENCE

Semester 1: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
ANIM 701	Advanced Research Methodology	3
ANIM 723	Advanced Range Ecology	3

Semester 1: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
ANIM 725	Integrated Range Management	3

Semester 2: Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
ANIM 724	Geographic Information Systems in Range Survey	3

Semester 2: Elective (Students will be required to take 3-6 credits per semester)*

COURSE CODE	COURSE TITLE	CREDIT
SOIL 617	Agricultural Systems Simulation and Modeling	3

***Additional electives of up to a maximum of 6 credits at the MPhil Level and not more than 3 credits from Levels 300 or 400 from the School of Agriculture or Faculty of Science may be selected in consultation with the Graduate Students' Advisor and/or Supervisory Committee.**

YEAR 2

COURSE CODE	COURSE TITLE	CREDIT
ANIM 710	Seminar I – Research Proposal	3
ANIM 720	Seminar II – Experiential Research and Learning (Attachment)	3

YEAR 3 & 4

COURSE CODE	COURSE TITLE	CREDIT
ANIM 730	Seminar III – Progress of Work	3
ANIM 740	Seminar IV – Research Results	3
ANIM 700	Thesis	45

6. DESCRIPTION OF COURSES**AGRC 702: ADVANCED SCIENTIFIC WRITING AND SEMINAR DELIVERY**

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

ANIM 701: ADVANCED RESEARCH METHODOLOGY

This course will emphasize advanced research methods beginning with a review of elementary matrix algebra for a proper understanding of the linear models in some of the complex equations students may encounter. The course will cover topics such as Covariance and other methods for adjusting continuous data, Polynomial regression, Residual analysis, transformations and weighted Least Squares Analysis, Response Surface Experimentation, Principal Components

Analysis, Factor Analysis with Rotation- varimax and oblique, Discriminant Analysis and Design and conduct of On-Farm Trials. The course will be laboratory based using computer software applications.

ANIM 702: BIODIVERSITY AND ANIMAL GENETIC RESOURCE (ANGR) CONSERVATION

The Biodiversity and Animal Genetic Resource course examines diversity in the livestock sector, current status of AnGR and the Global Plan of Action on AnGR. Topics include agricultural biodiversity, livestock diversity, uses and values of AnGR, flows of AnGR and impacts of gene flow on diversity, threats to livestock genetic diversity, phenotypic and molecular characterisation of AnGR, breeding strategies for sustainable management of AnGR, conservation of AnGR, ownership of AnGR and case studies. Development of a project based on the Global Plan of Action on AnGR will be part of the course.

ANIM 703: APPLIED GENOMICS FOR SUSTAINABLE LIVESTOCK BREEDING

The Applied Genomics for Sustainable Livestock Breeding course examines the principles of genomic selection, gene mapping and quantitative trait loci (QTL) in the selection of various livestock species. Topics include an overview of genomics and proteomics, structural genomics, gene mapping, molecular markers, sequencing, genome expression, functional genomics, application of genomics and proteomics in Animal Science. Utilisation of appropriate software to demonstrate the efficiency of genomic selection will be part of the course.

ANIM 704: SPECIAL TOPICS IN QUANTITATIVE GENETICS

The Special Topics in Quantitative Genetics Course examines estimation of genetic parameters of traits of economic importance as tools for establishing sustainable breeding programmes. Topics will include advanced training in mathematical aspects of quantitative and population genetics theory as applied to animal breeding, linear models, advanced mixed model methodology for genetic evaluation of livestock, genotype by environment interaction, design and evaluation of breeding programmes and measurement of genetic progress. The course will be aided by use of appropriate statistical software.

ANIM 705: MOLECULAR GENETIC TECHNIQUES

This course will be laboratory-based with the objective of equipping students with the theory and hands-on experience of molecular laboratory techniques currently used in molecular biology. The student will acquire the knowledge, skills and techniques required to obtain samples for DNA extraction, quantitation, purification and analysis. These include recombinant DNA techniques and various methods of genome analysis.

ANIM 706: ADVANCES IN MOLECULAR ANIMAL GENETICS

The main objective of this course is to keep students abreast with cutting-edge research in the rapidly evolving field of molecular genetics by reviewing current peer-reviewed journal articles. This will also help them appreciate the style of writing and the varied formats required by various journals. The course will involve presentations by students on recent journal articles published in the field of Molecular Animal Genetics followed by a discussion involving both students and faculty. Students will be guided to select their project topics and put together their project proposals at the end of the course.

ANIM 707: CONCEPTS, TRENDS AND DEVELOPMENTS IN ANIMAL NUTRITION

Each student and Instructor will select a current nutritional topic from a list that will be provided at the beginning of the course, conduct a literature search applicable to the topic, provide copies of this literature to everyone in the class, and lead the discussion on the topic during the designated class period. Each student is expected to write an 8-12 page paper summarizing the current knowledge about the topic and develop a power-point presentation using it to present the highlights of the their paper. The focus of the paper and presentation will be on the application of nutrition principles relative to the topic.

ANIM 708: NUTRITION AND GASTROINTESTINAL HEALTH

This course discusses the peculiar nature of both the monogastric and ruminant gastro-intestinal tract and how this, together with the type of diet that is fed can have an effect on overall health and well being of the animal. Topics to be covered will include fibre and its effects on the monogastric animal, health benefits of certain types of fibres, effects of diet on overall digestive and assimilative capacity of the gastro-intestinal tract, concentrates in ruminant nutrition and its effects on rumen microbial balance, and immune function. Completion of an in-depth research and presentation, both power-point and hard copy on a particular area of nutrition and gastro-intestinal health will be an integral part of this course.

ANIM 709: NUTRITION AND HEALTH INTERACTION

The course will primarily look at the effect of nutrition on disease and vice versa, and the connection between feeding and digestive abnormalities. Topics to be taught include energy and protein deficiencies and excesses, mineral and vitamin deficiencies and excesses, and gastrointestinal health and tissue metabolism. Ways of tailoring nutritional regimens to address individual disease or stress situation will be emphasized under the general area of therapeutic nutrition. Completion of an in-depth research and presentation, both power-point and hard copy on a particular area of nutrition and health interaction will be an integral part of this course.

ANIM 710: SEMINAR I – RESEARCH PROPOSAL

Students will be expected to present a good original research idea in the form of a written research proposal in their chosen discipline and formally defend the proposal before the Graduate Committee, academic staff in the discipline and Supervisory Committee. The proposed research work must be relevant to the research interest of the department, meaningful, viable, feasible and capable of being completed on time. Also, there must be an expert in the proposal area within the department, cognate department or external partner university to supervise the thesis research.

ANIM 711: SPECIAL TOPICS IN REPRODUCTION

The special topics in reproduction course examines the influence of nutrition on reproductive performance, the process of ovarian follicular development and function, the influence of animal behavior in successful mating and survival of the young, and the role of immune function in the reproductive tract for good health and for maintaining a high rate of fecundity. Topics include Nutrition-reproduction interactions in livestock, folliculogenesis, egg maturation and ovulation, immunology of reproduction, pharmacotoxicologic factors and reproduction, and reproductive behavior.

ANIM 712: PROTEIN METABOLISM

This course examines the metabolism of amino acids from the cellular level through to the multisystem operation of the whole organism. Topics to be covered include synthesis of amino acids and measurements of rumen protein degradation, thermogenic response to protein intake, nitrogen detoxification pathways, protein-energy relationships, protein and amino acid imbalances, deficiencies and toxicities, inborn errors of metabolism, protein intake recommendations for maintenance, growth, pregnancy, and lactation, protein and amino acid nutrition in disease. An in-depth research and presentation, on a particular area of protein metabolism will be an integral part of this course.

ANIM 713: ADVANCES IN ENDOCRINOLOGY

The advances in endocrinology course examines the components of the endocrine system in relation to their functions, the roles played by hormones and growth factors in reproduction and food intake, and evaluates the techniques involved in the measurements of hormones associated with reproduction. Topics include crosstalk between gastrointestinal neurons and the brain control of food intake, hormone receptors and signal transduction, endocrine integration of energy and electrolyte balance, blood metabolites, metabolic hormones, and growth factors regulating reproduction, and hormone assays in reproduction.

ANIM 714: ADVANCES IN REPRODUCTIVE PHYSIOLOGY

The advances in reproductive physiology course examines the structure and functions of the male and female reproductive system, the regulation of the reproductive cycle by environmental, genetic, physiologic, hormonal and behavioral factors, and technologies developed to improve reproductive success. Topics include functional anatomy of reproduction, physiology of reproduction, reproductive cycles, energy balance and fertility, reproductive failure, and assisted reproductive technology.

ANIM 715: MECHANISM OF DISEASES

Interactions between pathogens and host (human or animal) result in various disease conditions. This course will cover recent knowledge of the principles of infectious disease, including pathogenesis, virulence factors of pathogens and host resistance mechanisms. Immunogenetic influences in disease occurrence will be highlighted. The course will enable students to understand details of the causation process of diseases caused by bacteria, viruses, prions and fungi.

ANIM 716: ADVANCED IMMUNOBIOLOGY

Advanced Immunobiology covers immunologic reactions as they apply to protective immune responses against microbial pathogens. The objective is to provide comprehensive and up-to-date overview of immunology, both at the conceptual and practical levels, demonstrate the importance of immunology to humans and animals at both the clinical and basic science levels, specifically highlighting the recent developments that have been made in the field and the relevance to infectious disease control and management in humans and livestock. Topics will focus on understanding how the immune system evolves to recognize molecules from pathogenic organisms, cellular interactions and controls that allow development of robust adaptive immune responses to microbial infections, immunodiagnostic techniques, mechanisms of antigenic variation and consequences for vaccine development.

ANIM 717: CURRENT TRENDS IN ANIMAL MICROBIOLOGY

This course will provide insight into current understanding of the nature of the aetiology of common infectious diseases of livestock and poultry in the tropical parts of the world. Emphasis will be placed on zoonotic infections and factors that promote animal-man transmissions. Current laboratory diagnostic techniques of the causative organisms and their control will also be covered. This course will emphasize the “One Health” principle of infectious disease control.

ANIM 718: ADVANCED READING IN IMMUNOBIOLOGY

The primary objective of the course is to help the students obtain and use information on immune mechanisms involved in infectious diseases for design of research projects. This objective would be facilitated by assigning library resources (peer-reviewed scientific articles in the field) to complete weekly assignments which are discussed during the class meeting times and finally by development of research proposal. The course covers immunologic reactions as they apply to protective immune responses against microbial pathogens. In addition to the focus on host mediated immune control of infections centered essentially on mechanisms of humoral and cell-mediated reactions, the course places strong emphasis on development of scientific hypothesis.

ANIM 719: MUSCLE BIOLOGY

This course seeks to equip students with an in-depth understanding of the structure, composition and function of muscle and the important role it plays in meat production. Topics include normal and abnormal muscle growth and development; Muscle development, function, genetics; Muscle abnormalities, repair and programmed cell death; Disease conditions - impact on muscle proteins and meat production.

ANIM 720: SEMINAR II – EXPERIENTIAL RESEARCH AND LEARNING

Students will undergo an internship to experience hands-on training and acquire skills relevant to their chosen areas of specialization. This internship may take any of several forms including industrial attachment, placement on ongoing research projects within the Department, development of thesis proposals, acquiring specific techniques and expertise, development of experimental protocols to be used in the PhD research, participation in colloquia, conferences or seminars, and visiting collaborating universities to participate in selected programmes and/or research. Students are expected to produce a report and present a seminar based on what they have done during the year at the end of their attachment.

ANIM 721: MEAT HANDLING AND PUBLIC HEALTH

This course emphasizes the importance of meat quality and its impact on consumers and public health. Topics include Animal behaviour and handling; Good slaughter practices; Meat microbiology, Carcass evaluation, classification grading, quality and sensory characteristics; Meat merchandising; HACCP; Meat preservation and safety; Meat-borne diseases and impact on consumer health.

ANIM 722: MEAT BIOCHEMISTRY AND PHYSIOLOGY

The objective of this course is to help students understand the biochemistry and physiology of muscle as a meat entity so that they will better appreciate the mechanisms at play during the conversion of muscle to meat. Topics will include muscle proteins and proteases, fats and lipids, carbohydrates, inorganic components – function and effect on post-mortem physiology and meat quality.

ANIM 723: ADVANCED RANGE ECOLOGY

The objective of this course is to fully understand how interacting biotic and abiotic factors influence range composition, condition and productivity. The course content will include: the analysis of applied ecological principles, range resource and ecosystem function; species diversity and richness, critical issues on proper range use, crop-livestock integration, climatic drivers on range health and condition and wildlife and range utilization; advanced range research techniques.

ANIM 724: GEOGRAPHIC INFORMATION SYSTEMS IN RANGE SURVEY

The objective of this course is to employ Geo-information and earth observation techniques in the evaluation and monitoring of rangelands. The course provides students with knowledge and skills needed in ecological survey of rangelands, hyperspectral and hypertemporal advanced modeling techniques in determining range condition and productivity, interpolations using spatial statistics, comparison of trend surfaces and various krigging methods for range analysis. Students will be given data for the analysis of spatial patterns.

ANIM 725: INTEGRATED RANGE MANAGEMENT

The objective of this course is to integrate foreknowledge and experience in forage production and forage utilization by livestock in decision making, analysis and planning for sustainable range management. Topics will include; innovations in livestock production systems, morphology and physiology of forage plants, criteria for selection of forage species, establishment of pasture with predetermined production objectives, pasture seed production, management of cultivated pastures in relation to the animal and plant, techniques in the restoration of degraded rangelands, range management after drought conditions, policy interventions for sustainable rangeland production.

ANIM 730: SEMINAR III – PROGRESS OF WORK

In this seminar, students are expected to present progress report of their research work comprising their introduction, relevant review of the literature, materials and methods and any preliminary results obtained.

ANIM 740: SEMINAR IV – RESEARCH RESULTS

In this seminar, students are expected to present the results of their research work, discuss the results in the light of available literature and draw relevant conclusions based on their research objectives.

7. DETAILS OF EXPERIENTIAL LEARNING - YEAR 2

The activities of the second year PhD programmes are geared towards guiding students to put theory into practice by engaging in projects that will require them to apply the theories and skills they have acquired into analyzing data and writing reports on them. Students will also be guided to acquire specific techniques and expertise in research work. These include the development of methodologies to be used in PhD research. The various activities will help them to be well-grounded in various research activities.

7.1 Seminar/Conference Participation

Students will be required to participate in departmental seminars, the College of Basic and Applied Sciences Colloquium series, as well as conferences and workshops organized by credible national, regional and international associations such as the Ghana Society of Animal Production (GSAP), the Ghana Animal Science Association (GASA), the Ghana Science Association (GSA), the All African Society of Animal Production (AASAP), the American Society of Animal Science (ASAS) and the American Dairy Science Association. By engaging in these activities, students will come into contact with experienced practitioners in Animal Science who can serve as mentors/collaborators. The students will be mandated to write and present papers at these conferences individually, in teams or in collaboration with senior members in the Department.

7.2 Participation in Research Projects

In addition to the general activities outlined above, students will be engaged in on-going projects in the Department. This includes the following;

A: Feed the Future Innovation Lab for Genomics to Improve Poultry Project (PI: Dr. B.B. Kayang)

This is a USAID funded project undertaken in partnership with the University of California, Davis, Iowa State University, Sokoine University of Agriculture, Tanzania, and the University of Delaware. The project seeks to develop Newcastle disease-resistant and heat-tolerant chickens for smallholder farmers in Africa. The students who will be attached to this project will have the opportunity to be engaged in a wide range of procedures including husbandry practices such as rearing of breeders, hatching of eggs from breeders, rearing of chicks; virus replication and challenge experiments; collection and processing of biological samples such as blood and tears; laboratory analysis such as ELISA, DNA and RNA extraction, real-time RT-PCR, sequencing; genotyping on low-density and high-density SNP panels; and data manipulation and statistical analyses using the relevant software. Thus, this project will help students to acquire skills in virology, immunology, genomics and bioinformatics. Students will write papers or reports on their activities.

B: The Anaplasmosis Vaccine Project (PI: Dr. Futse)

This is an ongoing project that is focused on enhancing the health and productivity of livestock. Students who participate in this work will be directly involved in collecting ticks and blood from field grazing cattle and preparing these materials for laboratory analysis. The primary short-term impact will be to help students develop expertise in on-field collection of samples for biomedical study while establishing working relationships with the livestock farmers. In the laboratory, students will be trained in molecular techniques including genomic DNA extraction, molecular identification of pathogen strains, cloning and sequencing to verify the identity of infectious organisms in both the ticks and cattle. This training will improve the adaptive capacity of participating students through developing and implementing diagnostic assays for a doctoral research and future epidemiologic surveys for prevalence of infectious diseases of livestock. Students will submit written reports of their activities and results.

C: Innate stimulation as a Multi-pathogen Vaccine (PI: Dr. Futse)

This project seeks to stimulate the innate immune response in young cattle to mitigate disease severity and high mortality in crossbred cattle, thus providing an alternative approach to developing vaccine for each of multiple pathogens. Students will be trained in protein expression

and purification for subsequent use in the development of immunological and diagnostic assays for infectious diseases such as ELISA, Western blots. In addition, this training will provide the opportunity to doctoral students to acquire the experience required to develop procedures for identifying antigens, formulating vaccines and vaccination of cattle. Students will submit a written report of their activities and results.

D: The Sorghum Barley Brewers Spent Grain (SBBSG) Project (P.I: Dr. Thomas Nortey)

This is an on-going project and involves evaluating the suitability of the above brewery by-product as feed for poultry and pigs, and determining the actual availabilities of key nutrients within this by-product to poultry (layers and broilers) and pigs. The students who participate in this project will be involved in laboratory analyses of feed, digesta and fecal samples, dietary formulations to meet specific physiological and metabolic needs, and the use of the SAS statistical package to analyze data. This project will help students to acquire techniques for humane and effective force-feeding of birds, assay for nutrients (proteins, amino acids, ether extract, fibre etc), least-cost feed formulation, and the use of the SAS statistical package in analyzing data. Students will write papers or reports on their activities.

E: The Pig Weaner diet Project (P.I: Dr. Thomas Nortey)

Intestinal integrity (morphology and microbial colony) is fundamental very early in the life of the weaner pig if it is to attain market weight in a timely fashion and free from disease. Specialized transition diets are therefore needed to set the pig on the path to achieving this goal. There is research currently underway to test various dietary effects on weaner intestinal integrity, including villi height and crypt dept (two key indicators of intestinal health). These require special techniques and there is collaboration with the Electron Microscopy and Histology Department of the Noguchi Memorial Institute. The students who participate in this project will be involved in the laboratory analyses of feed, digesta and fecal samples, diet formulation to meet specific physiological and metabolic needs of weaner pigs, sectioning and preserving specific areas of the GIT, and the use of Electron Microscopy to identify and read segments of the GIT. Students will write papers or reports on their activities.

F: Characterization of Bovine lipogenic Genes and their Correlation with Marbling of the *Longissimus dorsii*. (PI: Dr. Ohene-Adjei)

Marbling is a prime characteristic in beef that goes a long way to determine the value of a carcass on international markets. This project seeks to investigate the genetic diversity and expression levels of genes that control deposition of intramuscular fat in cross-bred and local breeds of cattle. Students who participate in this project will be involved in bioinformatics analysis, gene expression analysis and manipulation of sequence information. Additionally carcass evaluation information will be used to correlate bioinformatics data. They will present seminars and write short manuscripts for publication.

G: Characterisation and Breeding for a docile Grasscutter in Ghana (Prof. B.K. Ahunu)

This is an on-going project which seeks to characterise the grasscutter at the molecular level and also develop suitable handling procedures for this specie. This will involve family trees based on pedigree information and tissue analysis. A large body of data is being generated and students who participate in this project will gain experience in the collection of data with respect to body

measurements, tissue sampling, molecular analysis and genotyping. In addition they will learn how to manipulate large data sets and the use of various statistical packages for data analysis. Students will write papers or reports on their activities.

8. COLLABORATION

The Department is collaborating with a number of institutions including the following:

- Wildlife Research Centre, Kyoto University (an MOU is in place for joint research and academic cooperation allowing for exchange of students and researchers).
- Graduate School of Life and Environmental Sciences, Kyoto Prefectural University (an MOU is in place for joint research and academic cooperation allowing for exchange of students and researchers).
- University of Western Australia, Australia (an MOU is in place for joint research and academic cooperation allowing for exchange of students and researchers).
- University of California, Davis, USA (A Cooperative Agreement for research is in place allowing for student lab/research training).
- University of Illinois at Urbana-Champaign (partnerships with faculty exist and we are working towards establishing an MOU for student and faculty exchange and joint supervision of students).
- University of Manitoba, Canada (we have partnerships with faculty and are working towards establishing an MOU for student and faculty exchange and joint supervision of students).
- Washington State University, USA (we have partnerships with faculty and are working towards establishing an MOU for student lab/research training and joint supervision).
- International Livestock Research Institute, Kenya (partnerships with faculty exist and we are working towards establishing an MOU for student lab/research training and joint supervision).

9. ACTIVITIES IN YEAR 3

Students will be required to present a seminar in each semester of Year 3 outlining the progress of their research work and any challenges that they are encountering. The first semester seminar shall include their introduction, relevant review of the literature, and materials and methods, while the second semester shall be based on preliminary research results obtained. Both seminars shall be graded by the Supervisory Committee and the Departmental Graduate Committee and the average mark used as the grade for Seminar III.

10. ACTIVITIES IN YEAR 4

In Year 4, students will be expected to present an update of results of their research work in the first semester and by the middle of the second semester they shall present the final results of their research work, discuss their results in the light of available literature and draw relevant conclusions based on their research objectives. Both seminars shall be graded by the Supervisory Committee and the Departmental Graduate Committee and the average mark used as the grade for Seminar IV. Theses shall be submitted by the end of the second semester of Year 4.

DEPARTMENT OF CROP SCIENCE

DOCTOR OF PHILOSOPHY (PHD) CROP SCIENCE

1. Introduction:

The Department of Crop Science is one of the five units under the School of Agriculture. The Department provides an enabling environment that attracts and maintains high caliber Crop Scientists who train quality graduates and develop strategies for sustainable production of crops through the strengthening of both basic and applied research, teaching and extension. Research areas within the department include the: Development of crops with high water-use efficiency, high yields, early maturing, and high consumer acceptability; Development of environmentally compatible strategies for the efficient management of pests and diseases of agricultural crops both on the field and after harvest; development of cropping systems for food and industrial crops, that increase profitability while reducing undesirable environmental impacts and improving food safety.

2. Admission Requirements:

A relevant Master's degree.

3. Duration of programme [Doctor of Philosophy Degree (PhD)]:

The duration for completion of the Doctor of Philosophy degree shall be four years for full-time students and six years for part-time students.

4. Graduation Requirements:

Course Work: 18 -24 credits

Seminars (4): 12 Credits

Thesis: 45 credits

Total Credits: 75-81

5. Programme Structure:

YEAR 1

PHD AGRONOMY

Semester 1: Core Courses

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 701	Advanced Experimental Design and Analysis	3
CROP 703	Plant Cell and Tissue Culture	3

Semester 1: Electives (Minimum of 1 Elective)

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 711	Chemical Control of Plant Pests	3
CROP 717	Advanced Plantation and Fruit Tree Crops	3

Semester 2: Core Courses

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
CROP 716	Pest Risk Analysis	3

Semester 2: Electives (Minimum of 1 Elective)

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 706	Climate Change and Sustainable Agricultural Productivity in the Tropics	3
CROP 704	Laboratory Instrumentation	3

*** Additional electives of up to a maximum of 3 credits at the M. Phil Level from Faculty of Science or School of Agriculture may be selected in consultation with the Graduate Students' Advisor or Supervisory Committee.**

PHD PLANT PATHOLOGY

Semester 1: Core Courses

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 701	Advanced Experimental Design and Analysis	3
CROP 711	Chemical Control of Plant Pests	3

Semester 1: Electives (Maximum of 1 Elective)

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 705	Methods in Plant Pathology	3
CROP 707	Advanced Plant Virology and Viral Diseases	3
CROP 709	Advanced Bacteriology and Bacterial Diseases	3
CROP 713	Breeding for Disease Resistance in Crop Plants	3

Semester 2: Core Courses

Course Codes	Course Title	Credits
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
CROP 708	Advanced Plant Mycology and Fungal Diseases	3

Semester 2: Electives (Maximum of 1 Elective)

Course Codes	Course Title	Credits
CROP 712	Advanced Plant Nematology and Nematode Diseases	3
CROP 714	Epidemiology of Plant Diseases	3
CROP 716	Pest Risk Analysis	3

PHD GENETICS AND PLANT BREEDING**Semester 1: Core Courses**

Course Codes	Course Title	Credits
CROP 701	Advanced Experimental Design and Analysis	3
CROP 715	Quantitative Genetics and Crop Improvement	3

Semester 1: Electives (Minimum of 1 Elective)

Course Codes	Course Title	Credits
CROP 713	Breeding for Disease Resistance in Crop Plants	3
CROP 703	Plant Cell and Tissue Culture	3

Semester 2: Core Courses

Course Codes	Course Title	Credits
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
CROP 702	Advances in the Breeding of Tropical Crops	3
CROP 718	Molecular Genetics and Biotechnology in Plant Breeding	3

Semester 2: Electives (Maximum of 1 Elective)

Course Codes	Course Title	Credits
CROP 706	Climate Change and Sustainable Agricultural Productivity in the Tropics	3
CROP 704	Laboratory Instrumentation	3

PhD POSTHARVEST TECHNOLOGY

Semester 1: Core Courses

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 701	Advanced Experimental Design and Analysis	3
POHT 701	Postharvest Food Safety	3

Semester 1: Electives (Minimum of 1 Elective)

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
POHT 703	Plant Microbes	3

***Additional electives of up to a maximum of 3 credits at the M. Phil Level from Faculty of Science or School of Agriculture may be selected in consultation with the Graduate Students' Advisor or Supervisory Committee.**

Semester 2: Core Courses

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
POHT 702	Advanced Postharvest Physiology of Perishable Crops	3

Semester 2: Electives (Minimum of 1 Elective)

<i>Course Codes</i>	<i>Course Title</i>	<i>Credits</i>
CROP 704	Laboratory Instrumentation	3
CROP 716	Risk Analysis	3

Seminars and Thesis

Year	Course Codes	Course Title	Credits
2	CROP 710	Seminar 1	3
	CROP 720	Seminar 2	3
3	CROP 730	Seminar 3	3
4	CROP 740	Seminar 4	3
	CROP 700	Thesis	45

6. Course Descriptions and Reading Lists:

AGRC 702: Advanced Scientific Writing and Seminar Delivery

3 Credits

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint). Part two of the course is skewed towards research planning and design. Student will present a seminar and write a term paper which will both be graded.

CROP 701: Advanced Experimental Design and Analysis

3 Credits

This course is designed to increase practical knowledge and skills in experimental design and analysis for typical biological and agricultural experiments. Emphasis will be on appropriate choice of experimental design, statistical software and interpretation of results to address research questions. Topics include: experimental designs-rational and layout; analysis of variance and covariance; applied linear statistical models; simple, multiple logistic, probit and Poisson regression. Repeated measures and related designs; response surface methodology; multivariate analysis-principal component, cluster discriminant and Canonical Variate Analysis (CVA). Long-term and multi-location experiment, Biplot and GGE analysis.

CROP 702: Advances in the Breeding of Tropical Food Crops

3 Credits

The course is designed for students with a good background in concepts and methodologies in Plant Breeding. It will cover current breeding methods for key crops within the major groups of tropical food crops namely:

- i. Cereals: Maize, Rice, Sorghum
- ii. Roots and Tuber Crops: Yams, Cassava, Sweet potato
- iii. Legumes: Cowpea, soybeans, Bambara groundnut
- iv. Vegetables: Peppers, Garden eggs, Tomatoes

Each topic will be presented by an expert who is actively involved in breeding of the crop.

CROP 703: Plant Cell and Tissue Culture

3 Credits

This course seeks to enhance students' ability to utilize plant cell and tissue culture techniques for the in-vitro propagation of agricultural crops as an alternative for the multiplication of

planting materials for plant propagation and conservation. Topics will include the design, establishment and maintenance of callus cultures, choice of explants, preparation and sterilization, embryogenesis, culture manipulation, cryopreservation and storage of germplasm.

CROP 704: Laboratory Instrumentation

3 Credits

This course seeks to equip students with techniques in laboratory instrumentation and their use thereof. Topics will include understanding of the principles of microscopy (especially, electron microscopy); photometry; use of refractometry; leaf area measurements, plant and soil nutrient analyses, photosynthetic instrumentation; use of penetrometers and chromatography including HPLC. Biotechnology methods (use of thermocyclers, spectrophotometers, trans-illuminators and gel electro phoresis) will be discussed.

CROP 705: Methods in Plant Pathology

3 Credits

The course provides advanced theoretical and practical knowledge in methods in plant pathology such as: Setting up plant pathology laboratory; Techniques in isolation of bacteria and fungi, extraction of nematodes and purification of viruses; advanced microscope techniques including electron microscopy for identification of pathogens; Plant disease diagnostics based on symptoms, pathogen morphology, diagnostic keys and taxonomy; Molecular Plant disease diagnostics; PCR characterization of microorganisms; Methods used for studying Induced Resistance.

CROP 706: Climate Change and Sustainable Agricultural Productivity in the Tropics

3 Credits

This course seeks to educate students on cropping systems, crop distribution and production patterns and biodiversity conservation in the tropics in response to effects of climate change. Sustainability concepts and perspectives, Agricultural evolution, history, resources and functions diverse agricultural systems and practices and their relative sustainability will be discussed. Cropping system patterns and food production systems as practical methods of mitigating climate change will be studied.

CROP 707: Advanced Plant Virology and Viral Diseases

3 Credits

The course designed for students with adequate background knowledge in Plant Virology/Viral Diseases/Molecular Biology. Topics will include: Viruses as causal agents of plant disease and as tools for manipulating plants; structures of virus particles; mechanisms of transmission, replication, and spread in the plant; cytology and molecular biology in susceptible and resistant reactions to virus infection; virus disease control.

CROP 708: Advanced Plant Mycology and Fungal Diseases**3 Credits**

The course is designed for students with background knowledge in Plant Mycology. Topics will include: How plant pathology developed worldwide and in Ghana; Phytopathogenic worldwide fungi; Modern techniques and theories on classification of fungi, species concepts, sexual compatibility and vegetative compatibility; Advanced treatment of molecular biology and genetics of filamentous fungi and yeasts. Laboratories work will emphasize various approaches to fungal identification.

CROP 709: Advanced Bacteriology and Bacterial Diseases**3 Credits**

Bacteria structure and pathogenicity, Criteria and methods for classifications of bacteria, Methods for bacteria identification, typing and detection, Epidemiology and ecology of plant pathogenic bacteria, how bacteria genetically engineer plants: The crown gall story, Advanced diagnostic methods for bacterial diseases of plants, Bacterial diseases of plants in Ghana, New and emerging bacterial diseases of plants, Control of bacterial diseases of plants.

CROP 711: Chemical Control of Plant Pests**3 Credits**

The course will equip students with techniques to practice safe and effective application of pesticides for plant pest control. Topics will include: the National pesticide regulatory program (Ghana) - registration, enforcement); Types of pesticides approved for Ghana; Pesticide properties, storage and sale of pesticides, disposal and decontamination of pesticides; types of spraying equipment; Types and selection of nozzles; Calibration of sprayers and calculations involved in the application of pesticides; Safety in the use of pesticides.

CROP 712: Advanced Plant Nematology and Nematode Diseases**3 Credits**

The course seeks to increase knowledge in plant nematology and nematode diseases with respect to morphology, life cycle and survival mechanisms, population dynamics and symptomatology. Topics will include: Advanced methods for extraction and identification of nematodes (including molecular methods); Behaviour of plant parasitic nematodes; Research methods for their study in laboratory, greenhouse and field.

CROP 713: Breeding for Disease Resistance in Crop Plants**3 Credits**

The course will equip students with techniques to improve the resistance of plants to disease. Topics will include: Types of plant resistance to diseases; how to obtain resistance varieties including breeding for resistance; Justification for resistance; Problems associated with

resistance including variations in pathogen; How plants defend themselves (mechanisms of resistance); genetics of plant disease resistance.

CROP 714: Epidemiology of Plant Diseases

3 Credits

The course provides advanced theoretical and practical knowledge of techniques in the study of plant disease epidemics including measuring and monitoring plant disease and plant host epidemics; Disease Progress Concepts of monocyclic and polycyclic epidemics; Advanced topics in disease progress over time; Disease Progress in space: concepts for dispersal and spread; types of spread; models for disease gradients; analysis and comparison of gradients; control implications; Spatial patterns of epidemics: concepts of dispersion and aggregation, and scale of aggregation; statistical distributions of disease incidence; analysis of spatial patterns and interpretation of results; sampling for incidence; models for crop losses.

CROP 715: Quantitative Genetics and Crop Improvement

3 Credits

The course seeks to provide students with in-depth knowledge of quantitative genetic theory to enable them evaluate relevant literature in the field and also be equipped to design, execute, analyze and interpret results of experiments involving quantitative traits in crop breeding programmes. The topics include: genetic structure of plant populations; genetic values and means; generation mean analysis; covariance among relevant and heritable estimates. Response to artificial selection, multi-trait selection and correlated response. Mating designs, combining ability and heterosis. Genotype x environment interactions. Quantitative trait loci analysis and marker assisted selection.

CROP 716: Risk Analyses

3 Credits

The course equips students with theory and practical concepts of risk analyses including: the role of economics in risk analysis; Risk Assessment concepts and methodologies; Data sources; Global Pest and Disease Database, Offshore Pest Information System: Agricultural Quarantine Inspection Monitoring and Activity System, Global Pest and Disease Database, Offshore Pest Information System, Risk Management and Risk Communication, Food Safety, Environmental Risk Analysis. The structured approach comprising the three distinct but closely linked components of risk analysis (risk assessment, risk management and risk communication) as defined by the Codex Alimentarius Commission will be discussed. Emphasis will be placed in subject area specialties to satisfy various components of the course. Risk Analysis and Trade; Quantitative Modeling and Risk Analysis; Sanitary Phytosanitary (SPS) agreement and application of Risk Assessment; Case Studies on SPS issues; SPS Dispute Settlements (WTO).

CROP 717: Advanced Plantation and Fruit Tree Crops

The course will treat in depth the physiology, ecology, agronomy and post-harvest of major plantation and fruit crops in Ghana and the West African Sub-Region. emphasis will be on cocoa, coffee, cashew, oil palm, rubber, papaya, plantain, banana, avocado, citrus, mango, custer apple, pineapple. the content will include post-harvest production, utilization and marketing potential, propagation methods, production systems and their management, major diseases and pests and of the selected crops.

Seminar session discussing opportunities and challenges of tree and fruit tree production in the West African Sub-Region and in depth comparative study of production systems of major plantation and fruit crops in West Africa and South-East Asia will be held.

CROP 718: Molecular Genetics and Biotechnology in Plant Breeding **3 Credits**

This course emphasizes the applications of molecular biology and biotechnology in plant breeding programmes. Topics will include molecular cell biology, protein structure and function, nucleic acids structure and function. Mechanisms of genetic change: Gene manipulation, structural and ploidy changes in chromosomes, Recombination, transposable elements. Organization and composition of plant genomes, comparative genomes of plants, plant gene isolation, gene mapping. Molecular markers in plant breeding, Applications of tissue culture in plant breeding.

POHT 701: Postharvest Food Safety **3 Credits**

The course discusses current issues and developments associated with post-harvest food safety. Emphasis on biological/microbiological, chemical, and physical food safety hazards and strategies to reduce or control these hazards. Topics will include discussions on the hazards in foods, good manufacturing practices, good agricultural practices, The Hazard Analysis Critical Control Point (HACCP) concept and the application of current technologies in reducing risks. Case studies and class projects will be used to demonstrate and apply the key principles discussed. Regulations governing food safety and consumer perceptions will be addressed.

POHT 702: Advanced Postharvest Physiology of Perishable Crops **3 Credits**

Physiological effects of controlled temperatures and supplemental environments or treatments on horticultural crops; Overview of physiological processes related to maturation and senescence of plant products and their responses to postharvest stresses. Targeted approaches and technologies to maintain product quality and limit postharvest disorders; in-depth review of the biochemical processes involved in crop deterioration

POHT 703: Plant Microbes**3 Credits**

The course is designed to provide in-depth practical knowledge on pathogens affecting both perishable and durable agricultural crops. The etiology, epidemiology and characterization of plant pathogens (bacteria, fungi nematodes and viruses), the biochemical and molecular plant-pathogen interactions with particular emphasis on plant defense responses, concepts of pathogenicity and virulence, detection and identification of plant pathogens and of mycotoxins by traditional and molecular methods, application of the biological knowledge of pathogens in disease control, climate change and plant health will be studied.

CROP 710: Seminar 1**3 Credits**

Seminar 1 will cover the PhD Research Proposal. The research topic, research outline, justification and objectives methodology, data to be collected and types of analysis as well as plan of work as well as budget will be reviewed following a formal presentation by the student to the supervisory committee and other members of the department. This will be graded.

CROP 720: Seminar 2**3 Credits**

Seminar 2 will cover the period of attachment at a requisite organization for a minimum of three months. A formal report endorsed by the organizational supervisor will be submitted by the student after which a seminar will be presented, both of which will be graded.

CROP 730: Seminar 3**3 Credits**

Seminar 3 will cover the progress of work. A formal report will be submitted by the student after a presentation, both of which will be graded.

CROP 740: Seminar 4**3 Credits**

Seminar 4 will look at research results and discussions in line with the set objectives. A presentation of results/findings and contribution of research to knowledge will be assessed and graded.

The thesis will be a write-up of research conducted by student under supervision. Student will be expected to provide two progress reports prior to the submission of the thesis. The thesis will be assessed and graded by both internal and external assessors.

Year Two: Experiential Learning

The second year of the PhD programme is geared towards practical training for students in preparation towards the conduction of their research. The Year II is hoped to provide students with a series of activities that would positively influence their PhD programmes in the University of Ghana and prepare them adequately for the corporate world and academia.

The proposed experiential learning period in the Department should be for a minimum of six (6) months and a maximum of eight (8) months to allow students ample time to start their research projects.

Details of Departmental projects to which student will be attached

- **Development of Appropriate Strategies for the Management of Rosette Disease of Groundnuts in the Volta Region** (Prof. S. K. Offei and Dr. E.W. Cornelius)

The project aims at screening existing elite groundnut genotypes (from Ghana and IITA) for resistance to the disease in the Volta Region and to support the selected varieties with appropriate cultural practices and disease management strategies in an IPM regime and to develop fact sheet and training video to educate farmers and extension agents on the use of the technology developed.

Methodologies to acquire under this project include: Focus group discussion with Agricultural Extension Agents (AEA's) and farmers; Design, pretesting and administration of semi-structured questionnaires to farmers; Design and use of disease assessment key to measure disease incidence and severity. Varietal screening of groundnut germ plasm for resistance to all the three GRD agents using viruliferous aphids technique (Olorunjuet *al.*, 1992). Diagnostic assays such as TAS-ELISA or PCR to confirm the presence or lack of GRD agents; Use of cultural practices for managing plant disease; Design and printing of Fact sheets and production of training video recording to educate farmers, as well as for technology transfer. Organization and implementation of farmer field school. Data collection and analysis using Analysis of variance (ANOVA) and least significant difference (LSD) to separate mean.

- **Development of Media Based Growth Troughs and Plastic Containers for Vegetable Production In Periurban/Urban Areas to Alleviate Urban Poverty** (Prof. K. F Kumaga, Dr. E.W. Cornelius and Dr. (Mrs.) C. Amoatey).

The objective of the project is to train four low-income vegetable farmer groups in skills for the production of high quality vegetables using environmentally friendly, low cost high intensity media – based system (Dr. E.W. Cornelius).

Methodologies to acquire under this project include: Growing vegetables to maturity in environmentally friendly substrate derived from cocoa peat and a mixture of 40% sawdust + 40% rice husk + 20% poultry manure; Preparation of nutrient solution; Determination of frequency and rate of application of nutrient solutions from inorganic fertilizers and organic sources on growth and yield of different vegetables; Economic analysis on the systems of production.

- **Field Evaluation of a New Fertilizer Package (TM Agricultural, TM Germination and BEST Foliar Fertilizer) for Production of Pineapple** (Dr. E.W. Cornelius)

The project aims to evaluate fertilizer efficacy for TM agricultural, TM germination and BEST Foliar fertilizer on pineapple at Koranco Farms near Nsawam in the Eastern Region of Ghana.

Methodologies to acquire under this project include: Soil sampling and analysis for pH (H₂O, KCl/CaCl), Soil organic Carbon, Total Nitrogen, Available P and Exchanging bases (Ca, K, Na, Mg) and Exchangeable acidity. Data collection (agronomic, field and postharvest) and data analysis using ANOVA and LSD to separate mean.

- **Management of *Prosterphanustruncatus* (Horn.) on Stored Maize Using *Beauvariabassiana* (Bals.)** (Dr. E. W. Cornelius, Dr. V. Y Eziah and Dr. K. O. Fening)

The objective of the project is to evaluate the infectivity of *Beauvariabassiana* to *Prosterphanustruncates* and *Teretriusnigrescens*.

Methodologies to acquire under this project include: Determination of spore count in conidia/g and cfu/g; Infecting insects with fungal spores to determine mycosis; Determination of dose response of *Prosterphanustruncate* to *B.bassiana*.

- **Etiology and Management of a Leaf Curl and Yellowing Disease of Tomato and Pepper in the Volta Region of Ghana** (Prof. S. K. Offei and Dr. E.W. Cornelius).

The objectives of the project are to: Assess the perception of farmers about the disease and catalogue their interventions; Determine the incidence and severity of the disease in farmers'; Identify and characterize begomoviruses associated with leaf curl and yellowing disease syndrome using degenerate and specific markers in polymerase chain reactions (PCR) and Evaluate some tomato cultivars bred for resistance to leaf curl diseases of tomato.

Methodologies to acquire under this project include: Focus group discussion with Agricultural Extension Agents (AEA's) and farmers; Design, pretesting and administration of semi-structured questionnaires to farmers; Design and use of disease assessment key to measure disease incidence and severity. Varietal screening of tomato germ plasm for resistance to disease.; Use of cultural practices for managing plant disease; Design and printing of Fact sheets and production of training video recording to educate farmers, as well as for technology transfer. Organization and

- **Efficacy of VSC Nematicide and Organic Amendments as Treatments for Control of Nematodes in Tomato, Okra, Pepper, and Pineapple Fields.** (Dr. S.T. Nyaku)

The Objective is to determine the efficacy of VSC and various organic amendments to serve as control of nematodes in tomato, okra, pepper, and pineapple fields.

This project will determine the best nematicidal and organic amendments that farmers and other crop producers could apply to their fields to effectively control plant parasitic nematodes.

- **Grafting as a means to control *Meloidogyne* infestation in Tomato Genotypes.** (Dr. J. N. Amissah and Dr. S.T. Nyaku)

Objectives:

- Determine the compatibility of widely grown tomato cultivars grafted onto *Solanum* rootstocks using splice and top-wedge grafting techniques
- Assess the response of grafted tomato genotypes to *Meloidogyne* infestation and plant yield
- Develop a grafting manual with protocols and timelines.

This project will produce compatible tomato scions and eggplant rootstocks for tomato production, further, resistant *Meloidogyne* grafts will be identified, and a grafting manual with protocols and specific timelines developed.

Experiential learning by PhD students

Students attached to this project will:

- Understand host-parasite relationships and population dynamics
- Confidently isolate, and identify various types of nematodes from soil samples
- Classify nematodes using their morphology and molecular techniques
- Effectively conduct grafting on tomato and eggplants.

Research is developing domestication protocols for the cultivation of medicinal plant species, (currently working on *Cryptolepis sanguinolenta* and *Croton membranaceus*), on the verge of extinction. The two species *Cryptolepis sanguinolenta* and *Croton membranaceus* are used in the treatment of malaria and prostate cancer and related problems respectively. The research also seeks to assess molecular diversity and the effectiveness of bioactive compounds in both species.

A PhD student assigned to this project will help with:

- Designing experiments and field data collection
- Carrying out chemical analysis [using the HPLC technique]
- Training farmers to cultivate medicinal plants

Other activities will include;

- Hands-on practical training in the use of scientific equipment (collaborations with Food Research Institute (CSIR), Ghana Standards Authority, Physics Department and Noguchi Memorial Institute for Medical Research (NMIMR)).
- Teaching demonstration using Sandwich Diploma programme.
- Participation in UG Doctoral School.
- Participation in conferences (Ghana Science Association (GSA), Ghana Institute of Horticulturists (GhIH))
- Development of PhD research area and proposal
- Seminar presentation and report on Experiential Learning (Seminar I).

Collaborating Departments/Institutions/Organizations will include:

- Agricultural Research Centres (SIREC, FOHCREC. LIPREC)
- Related Departments within the University of Ghana (Biotechnology Centre, WACCI, Botany, Nutrition and Food Science)

- Partner Public Universities in Ghana with expertise lacking in UG
- Research Organizations (CSIR- Institutes ; GAEC-BNARI, RAMSRI; NMIMR)
- Forestry Commission
- Ministry of Food and Agriculture
- Aarhus University
- University of Copenhagen
- Technical University of Denmark
- African, Caribbean and Pacific Group of States (ACP)
- International Crop Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Institute of Tropical Agriculture (IITA)
- Asian Vegetable Research and Development Centre (AVRDC)
- CIRAD (France)

DEPARTMENT OF FAMILY AND CONSUMER SCIENCES

PH.D IN FAMILY AND CONSUMER SCIENCES

Introduction

The Department of Family and Consumer Sciences, formerly Home Science Department, was established as an academic unit by the University of Ghana in 1965. The BSc programme started in 1966 with eight female science students and three Senior Members. The graduate programme (MPhil) in Home Science started in the 1990/91 academic year.

From its small beginnings, the Department of Family and Consumer Sciences has revolutionized the concept of Home Economics Education in Ghana from the narrow perspective of cooking, sewing and general housecraft. It now has an enviable broader curriculum of teaching and research that embraces programmes in consumerism and livelihood issues, gender and environment as well as contemporary and emerging issues of the family and human development. In its entirety, the Department of Family and Consumer Sciences programme at Legon is about the only one that offers both undergraduate and graduate training in Ghana. It is necessary to maintain this lead and to take advantage of the opportunities that are open for the training of faculty and staff of other emerging universities and colleges which are now pursuing similar programmes. Furthermore, because the programme provides strong interdisciplinary training in all aspects of contemporary family and consumer issues, Family and Consumer Sciences graduates are increasingly in very high demand by both Government and NGO's that are engaged in livelihood issues. The job market is also increasingly requiring postgraduate training in specialized areas in family and consumer sciences. The Department of Family and Consumer Sciences has both the capacity and capability to pursue a vigorous post-graduate training programme.

There are currently different major areas of study with structured outreach programmes run by the Department up to the MPhil level. The Doctor of Philosophy in Family and Consumer Sciences is designed to provide highest level of scholarship to students in the different areas of the subject matter. The Areas of Specialization are a) Food Utilization and Community Nutrition, b) Textiles and Clothing and c) Child and Family Studies.

Admission Requirements

A relevant master's degree in Family and Consumer Sciences/Home Science/Home Economics or any related field from an accredited institution.

Duration of Programme

Full-time students will be required to complete their program in four years and Part-time students in six years.

Requirements for graduation

Course Work:	18 – 24 credits
Seminars (4):	12 credits
Thesis:	45 credits
Total	75 – 81 credits

Structure of Programme

Food Utilization and Community Nutrition Option

Year 1, Semester 1:

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
FCOS 701	Advanced Research Methodology	3
FCOS 703	Advanced Food Product Development	3
FCOS 705	Advanced Community Nutrition	3

Electives (Students will be required to take 3 credits)

COURSE CODE	COURSE TITLE	CREDIT
FCOS 707	Food Packaging Principles and Applications	3
NUTN 701	Advanced Nutritional Epidemiology	3
FCOS 711	Food Habits, Food Environments and Nutrition	3
NUTN 750	Technology in Nutrition Research	3

Year 1, Semester 2:

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3

FCOS 704	Innovations in Food Product Development	3
FCOS 706	Household Food Insecurity and Family Nutrition	3

Electives (Students will be required to take 3 credits)

FCOS 702	Regulation of Food Safety and Composition	3
FCOS 708	Functional Foods, Nutraceuticals, and Dietary Supplements	3
FCOS 712	Development and Evaluation of Community Nutrition Interventions	3
FCOS 714	Nutrition, Lifestyle and Chronic Non-communicable Diseases	3

Textiles and Clothing Option

Year 1, Semester 1:

Core Courses

FCOS 701	Advanced Research Methodology	3
FCOS 713	Apparel Technology Management	3
FCOS 715	Textile Quality and Process Control	3

Electives (Students will be required to take 3 credits)

FCOS 717	Global Textile and Apparel Business Dynamics	3
FCOS 719	Textiles Labour and Safety Management	3

Year 1, Semester 2:**Core Courses**

FCOS 716:	Textile Brand Management and Marketing	3
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3

Electives (Students will be required to take 3-6 credits)

FCOS 718	Management of Textile Product Development	3
FCOS 722	Advanced Computer-Aided-Design for Fashion	3

Child and Family Studies Option**Year 1, Semester 1:****Core Courses**

FCOS 701	Advanced Research Methodology	3
FCOS 721	Early Childhood Development and Education	3

Electives (Students will be required to take 3-6 credits)

FCOS 723	Human Development and Social Policy	3
FCOS 725	Human Biology, Health and Society	3

Year 1, Semester 2:

Core Courses

FCOS 726	Child and Adolescent Development	3
FCOS 728	Family, Law and Public Policy	3
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3

Electives (Students will be required to take 3 credits)

FCOS 732	The Aging Process: Gerontology	3
FCOS 736	Comparative Human Development	3

Year 2

FCOS 710	Seminar I	3
FCOS 720	Seminar II	3

Year 3

FCOS 730	Seminar III	3
----------	-------------	---

Year 4

FCOS 740	Seminar IV	3
FCOS 700	Thesis	45

COURSE DESCRIPTION

FCOS 701: Advanced Research Methodology

This course is an advanced study of research methods to increase graduate students' knowledge and skills in both quantitative and qualitative research techniques. Approaches to collecting and managing qualitative data and quantitative data using a variety of statistical packages will be highlighted. Topics will include examination of the relationship between theory and research methodological issues, mixed method research, alternate research design, advanced issues in planning sample sizes, parametric and non parametric tests, regression and multivariate data

analysis, logistic regression, repeated measures and related designs, causal inferences, use of SPSS, STATA, QUALTRICS statistical packages for data analysis.

AGRC 702: Advanced Scientific Writing and Seminar Delivery

This course will prepare students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Seminar: seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

FCOS 702: Regulation of Food Safety and Composition

The food industry is producing new foods in response to consumer demand and lifestyle changes. New crops are being developed, so too are functional foods aimed at disease prevention and health claims for foods. The goal of this course is to provide students with an understanding of how these developments are regulated to ensure a safe food supply. Topics will include food laws and regulations, WTO and Codex Standards, emergency prevention system for food safety, public education and communication.

FCOS 703: Advanced Food Product Development

The course will provide students with in depth knowledge on issues related to food product development. Topics that outline the product development process from the development of a concept; identification of a target market; product formulation to the development of a prototype; product life cycle, line extensions, brand extensions, marketing new products and consumer research will be discussed.

FCOS 704: Innovations in Food Product Development

This is an independent study where students will use the principles of product development and food packaging to develop a concept for an innovative new food product and then develop a prototype of their products. Students will also develop a marketing plan for their products and present a seminar outlining the development process, target market and marketing plan for their products.

FCOS 705: Advanced Community Nutrition

The course aims to promote an advanced level of knowledge on community nutrition. Emphasis will be placed on the integration of food, nutrition, health and diet-related disorders from the perspectives of policy, programmes and research; up-dates on current issues affecting food intake, nutritional status, morbidity and mortality related to nutrition. Students will acquire competency in critique of publications, manuscript preparation and seminar presentations. The course will include critique of scientific publications and reports in community nutrition.

FCOS 706: Household Food Insecurity and Family Nutrition

The course aims to provide students with knowledge on the relationship between hunger, food insecurity and family nutritional status. Topics to be covered include definition and measurement of hunger; causes and consequences of hunger and food insecurity on family nutrition; measurement of the cost, availability and accessibility of food in communities; evaluation of the strengths and limitations of emergency food programs; food and nutrition assistance and the community food security movement.

FCOS 707: Food Packaging, Principles and Applications

The course provides an understanding of the application of the principles of packaging to food products. Specific topics include manufacturing of food packaging materials such as polymers, paper, glass and aluminum; food spoilage and shelf life studies; Aseptic, Modified Atmosphere, Active and Intelligent Packaging Technologies; Food Packaging Innovations; Packaging for meats and horticultural products and Migration between packaging and food.

FCOS 708: Functional Foods, Nutraceuticals and Dietary Supplements

This course prepares students to be grounded in issues related to functional foods, nutraceuticals and dietary supplements and their health benefits. Topics on assessing scientific evidence on international regulations, commercialization, quality control, safety and ethical issues of functional foods, nutraceuticals and dietary supplements in health promotion and disease prevention will be discussed. Students will also learn more on nutraceuticals present in foods.

FCOS 711: Food Habits, Food Environments and Nutrition

Food environment plays a role in what (and how much) we choose to consume. Our food environment can be broken into two different parts. First, the atmosphere, distractions, and social interactions we encounter when actually eating, and second, how food is portioned and presented to us. Together, these elements contribute to influencing the amount of food we eat at a given time. Students will explore the relationship between diet/food choices and health; reasons why people eat what people eat; examine how the environments in homes, schools, market places and communities affect what they eat. They will also explore the effects of food marketing and labeling on food choice and programs geared toward reducing the epidemic of diet-related diseases.

FCOS 712: Development and Evaluation of Community Nutrition Interventions

This course covers nutritional interventions and assessment of their impacts. Topics to be covered include general factors in designing programs, forming partnership, personnel management, planning, program goals and objectives, implementation and evaluation of nutrition interventions. Emphasis will be placed on the development and determination of effectiveness of community nutrition interventions for vulnerable groups.

FCOS 713: Apparel Technology Management

The course provides indepth knowledge on technology in the textile and apparel production process such as technological developments in the sewing rooms, pattern design and grading, and production systems. It will also provide a menu driven, interactive, self-paced learning environment for students to examine the role of textile complex in manufacturing and supplying of products-on-demand to meet the quality and performance of the global customer. Analysis of the textile supply chain with retail demand to understand constraints on manufacturing capacities will be emphasized by using texts, graphics, photos and videos to describe and illustrate the current technology used in the industries.

FCOS 714: Nutrition, Lifestyle and Chronic Non-communicable Diseases

Unhealthy lifestyles are the main cause of many non-communicable diseases like hypertension, diabetes and cancers. A healthy lifestyle is therefore key to quality life. This course covers the

relationship between nutrition, lifestyles and prevalence of non-communicable chronic diseases. Nutritional policies and interventions for prevention of non-communicable chronic diseases will also be discussed.

FCOS 715: Textile Quality and Process Control

The course examines quality control and improvement methods for textile processes such as fiber selection, yarn production, fabric manufacturing, wet processing and apparel manufacturing and also for textile products such as dyestuffs and chemicals used in dyeing, printing and finishing. Topics include quality systems, statistical control chart procedures, process capabilities, acceptance sampling plans, textiles process and product designs, on-line and off-line control systems and specific quality factors governing textile products and processes and their variabilities. The course would utilize the ISO 2825 regulation which is also known as the International Standard Procedure in Quality Control Inspection.

FCOS 716: Textile Brand Management and Marketing

The course provides an understanding of the global textile brand management and marketing environments, global markets, and marketing programs and organizations. Specific topics look at considerations in the understanding, crafting and evaluating brand strategies which include the economic, social, political/legal, and cultural environments; global textile market opportunities and challenges; global textile and apparel marketing strategies, and creation and management of global textile and apparel brands. The course will also emphasise theories, models and other analytic tools to make better branding decisions.

FCOS 717: Global Textile and Apparel Business Dynamics

The course provides an in depth knowledge on the economic, competitive, and technological and market dynamics of the international textile and apparel industries. Special attention is given to the role of the industry as a leader in industrial movements, the history of global trade developments, followed by an overview of the special trade problems that emerged for the textile and apparel sectors. Variations of trade theories and developmental theories that are relevant to the textiles and apparel sectors are also presented. Topics include trends in demand and output, the dynamic forces shaping and transforming the industry internationally. Patterns of change at the global, regional, and national and company level will be reviewed.

FCOS 718: Management of Textile Product Development

The course focuses on an integrated approach to new product design, development and marketing of textile products. The integrated approach will cover innovation strategy, and opportunity identification; the design process for textile products; market launch and the management innovation. Trends, diverse end-uses of textiles, textile product development, design prototypes, strategy, production analysis and recommendations will be discussed. Other areas of the course include the major industry practices of licensing, private label and specification buying, offshore production, CAD/CAM use of factors, and chargebacks, industry trends such as brand extensions, globalization and industry cooperation, quick response movement and the mass customization theory and their effects on the product development chain and finally, the new SIC/NAICS codes and how manufacturers and retailers can use them.

FCOS 719: Textiles Labour and Safety Management

This course examines labor and safety management in the textile and apparel industry, with particular emphasis directed toward application of the international and local Occupational Safety and Health Act. The course will cover safety management system, safety equipment, occupational hygiene, principles of ergonomics, and labour issues aimed at promoting health, safety and good industrial practices in the workplace. Special attention will be given to toxic and hazardous substances in the processing and dyeing of textile materials, respiratory questionnaire, spirometry prediction table for normal males and females, health and safety standards interpretations and hazard recognition.

FCOS 721: Early Childhood Development and Education

This aim of this course is to prepare students to be well grounded in theories of child development, learning and curriculum to enable them construct their professional practices. The course focuses on child-centered and culturally sensitive approaches and emphasizes the need for multiple methods of instruction to accommodate a broad range of learners. It also focuses on collaboration with families and other professionals, policy-makers and other service providers and offers students opportunity to participate in laboratory and field work.

FCOS722: Advanced Computer-Aided-Design for Fashion

This course is about the application and use of industry design software for apparel and other sewn products so that the skill sets will provide higher foundation of fashion design while understanding and incorporating all the aspect of digital production out flow. Topics include advanced computerized pattern design, apparel product data management. U4ia visual design software, 3D to 2D pattern generation software, Gerber Accumark or Lectra pattern design programs, Adobe Illustrator and Photoshop, and other programs used by the industry to create, market and/or visualize products will be taught. Peripheral equipment essential to the design and visualization process will be included.

FCOS 723: Human Development and Social Policy

The course focuses on human developmental process across the life span and explores how human development is influenced by family and community. It also focuses on theories of individual development; family and group dynamics, drawing on disciplines of Psychology, Sociology, and other Social Sciences. Topics include public decision-making, social services in developing countries, gender studies and communication studies to provide opportunity to students to combine theory with practice and to develop skills to address current social issues pragmatic throughout the life span.

FCOS 725: Human Biology, Health and Society

This course focuses on issues not only relating to biological and physical aspect of illness but also the social, psychological, economical, cultural and political dimensions. It also focuses on changes in the management of health problems in Ghana. In the context of the changing environment, it assists students to view human health issues from a broad and multi-disciplinary perspective. Students are equipped to use perspectives from both biological sciences and social sciences to examine health issues.

FCOS 726: Child and Adolescent Development

This course provides an advanced level knowledge and understanding on issues in the area of child studies and adolescent development. The course emphasizes risk and resilience, multi-cultural issues, disabilities, mental health, prevention and intervention. The focus is on applying theory and research to practice as they relate to human development. The course is designed to prepare students for positions as researchers, teachers or leaders in early childhood education, human development and related fields.

FCOS 728: Family, Law and Public Policy

This course aims at the theoretical and substantive issues that relate to the development and implementation of family policies, implications of political culture and family legislation for the well-being of children and their families. The course also explores challenges, stresses, and crises experienced by individuals and families; protective factors and resilience; coping strategies; prevention and intervention. It highlights concepts and techniques in human services and how policy addresses issues of human services in Ghana.

FCOS 732: The Aging Process: Gerontology

This course will focus on the physiological, psychological, and social changes that impact the aging population. Topics will include theories of aging, myths and stereotypes about aging; identification of biological and psychological changes which occur in the normal aging process; common diseases in the aging process; services, including alternatives to institutionalization, available to seniors through government, non-profit, and for-profit organizations as well as issues relating to caregiving, social security and health.

FCOS 736: Comparative Human Development

This course relies on knowledge from psychology, sociology and methodological theories across the Social Science disciplines to examine issues of central concern to socio-cultural and mental practices. It highlights issues including gender, sexuality, race and age and also focuses on issues on likeness and differences in the field of human development. It explores the socio-cultural, psychological and biological processes of human beings and how that change over time as well as practices and policies that may promote human developmental expectations.

NUTN 701: Advanced Nutritional Epidemiology

This course will provide an understanding between the relation between diet and long-term health and disease. Topics to be covered will include: epidemiologic study designs; Causation in epidemiologic investigation and research; issues on analysis and presentation of dietary data; Nutrition monitoring and surveillance; Vitamin A and lung cancer; Dietary fat and breast cancer, diet and coronary heart disease, folic acid and neural tube defect.

NUTN 750: Technology in Nutrition Research

This hands-on course has two components; a theoretical sections and a practical section. The different software used in analyzing nutrition survey data, such as dietary, anthropometry and clinical will be reviewed. Hand on practices of software, such as Access, Epi-info, The Food Processor, and WHO Anthro 2006 will be undertaken. Instrumentation, principles and calibration of equipment will be covered. Students will be given secondary dataset to analyze using software for nutrition data analyses. Also basic knowledge and skills regarding the design,

implementation, analysis, and interpretation of research in the field of nutrition as well as policy with respect to nutrition research technology will be covered.

FCOS 710: Seminar 1

The candidate will be required to make a presentation on his/her research proposal. This will be in year two.

FCOS 720: Seminar 1I

The candidate will be required to make a presentation on his/her experiences and lessons learned from an attachment to a research, industrial establishment or any appropriate organization or project. The attachment should last for a minimum of six months in year two.

FCOS 730 Seminar III

The candidate will be required to make a presentation on the progress of his/her research work in year three.

FCOS 740: Seminar IV

The candidate will be required to make a presentation on the findings of his/her research in year four.

FCOS 700: Thesis

The PhD thesis will be based on a supervised individual research investigation in any of the field of Family and Consumer Sciences. The thesis will be submitted at the end of year four.

DEPARTMENT OF SOIL SCIENCE

PHD SOIL SCIENCE

INTRODUCTION

The Department of Soil Science is mounting courses to satisfy the requirements of the restructured PhD programmes of the University of Ghana. The courses are intended to give students contemporary and world class knowledge in all the areas of specialization. The courses will also give students the opportunity to clearly appreciate the role of soil science in mitigating and managing agricultural and environmental problems. The Department of Soil Science offers courses in the following areas of specialization:

Soil Fertility

Soil Chemistry

Pedology and Landscape Process

Soil Physics and Conservation

Soil Microbiology and Biochemistry

Environmental Soil Science

ADMISSION REQUIREMENTS

Candidates with relevant master's degree may be considered for admission.

DURATION OF PROGRAMME

Full-time students shall complete the PhD programme in four years and Part-time students in six years.

REQUIREMENTS FOR GRADUATION

Course Work:	18 – 24 credits
Seminar I, Seminar II, Seminar III & Seminar IV	: 12 credits
Thesis:	45 credits
Total:	75 – 81credits

STRUCTURE OF PROGRAMME

YEAR 1

(SOIL CHEMISTRY)

Semester 1

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3
SOIL 703	Advanced Environmental Soil Chemistry	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 705	Environmental Soil Microbiology and Biochemistry	3

Semester 2

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3

Elective Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 706	Advanced Soil Fertility	3
SOIL 714	Environmental Risk Assessment	3

(Students shall offer a total of 6 to 12 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

(SOIL FERTILITY)

Semester 1
Core Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3

Elective Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 703	Advanced Environmental Soil Chemistry	3
SOIL 705	Environmental Soil Microbiology and Biochemistry	3

Semester 2
Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3
SOIL 706	Advanced Soil Fertility	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 708	Model Application for Agricultural Decision Making	3

(Students shall offer a total of 6 to 12 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

(PEDOLOGY AND LANDSCAPE PROCESSES)

Semester 1

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3
SOIL 707	Forensic Soil Science	3

Electives Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 703	Advanced Environmental Soil Chemistry	3

Semester 2

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3

Elective Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 712	Paleopedology	3
SOIL 714	Environmental Risk Assessment	3

(Students shall offer a total of 6 to 12 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

(SOIL PHYSICS AND CONSERVATION)

Semester 1

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3
SOIL 713	Biomathematics	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 706	Advanced Soil Fertility	3

Semester 2

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3
SOIL 704	Advanced Soil Physics	3

Elective Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 708	Model Applications for Agricultural Decision Making	3
SOIL 714	Environmental Risk Assessment	3

(Students shall offer a total of 3 to 9 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

(SOIL BIOCHEMISTRY AND MICROBIOLOGY)

Semester 1

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3
SOIL 705	Environmental Soil Microbiology and Biochemistry	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 707	Forensic Soil Science	3

Semester 2

Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 706	Advanced Soil Fertility	3

(Students shall offer a total of 6 to 12 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

(ENVIRONMENTAL SOIL SCIENCE)

Semester 1
Core Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 701	Soils of the Tropics	3
SOIL 703	Advanced Environmental Soil Chemistry	3

Elective Courses

COURSE CODE	COURSE TITLE	CREDIT
SOIL 707	Forensic Soil Science	3
SOIL 713	Biomathematics	3

Semester 2
Core Courses

COURSE CODE	COURSE TITLE	CREDIT
AGRC 702	Advanced Scientific Writing and Seminar Delivery	3
SOIL 702	Advanced Research Methods	3
SOIL 714	Environmental Risk Assessment	3

Elective Course

COURSE CODE	COURSE TITLE	CREDIT
SOIL 708	Model Application for Agricultural Decision Making	3

(Students shall offer a total of 3 to 9 credits of electives. They may offer the above electives **and/or** other Level 700 or Level 600 courses upon consultation with the Departmental Graduate Committee).

YEAR 2

COURSE CODE	COURSE TITLE	CREDIT
SOIL 710	Seminar I	3
SOIL 720	Seminar 2	3

YEAR 3

COURSE CODE	COURSE TITLE	CREDIT
SOIL 730	Seminar 3	3

YEAR 4

COURSE CODE	COURSE TITLE	CREDIT
SOIL 740	Seminar 4	3
SOIL 700	Thesis	45

Total Number of Credits**75 - 81****DESCRIPTION OF COURSES*****AGRC 702******ADVANCED SCIENTIFIC WRITING AND SEMINAR DELIVERY***

This course will strengthen the ability of students for scientific presentations at seminars and conferences as well as improve their computing literacy skills in data analysis and presentation. Topics to be covered will include; seminar presentation, data display; paper writing for conferences, journals, book and book chapter; summary and abstracts, short notes, speech writing styles, grant proposal writing, research management; computing skills: data management tools (EXCEL, ACCESS), project planning tools (MSPROJECT) and communication tools (PowerPoint).

SOIL 701**SOILS OF THE TROPICS**

This course builds on students' appreciation of the peculiar features and properties of tropical soils and how they differ from those of the temperate zone. This course will also focus on management of the challenges of these soils. Topics to be covered will include; Characteristics of tropical environment: temperature, rainfall, vegetation, biotic and abiotic factors; Geology of the tropics; dominant factors controlling soil formation in the tropics, overview of properties of soils in the tropics: physical, chemical, mineralogical, biological; productivity and management: productivity indices, distribution and classification of soils of the tropics.

SOIL 702**ADVANCED RESEARCH METHODS**

This course takes research methods to higher quantitative levels in order to strengthen the analytical knowledge of students. Topics to be covered will include; Experimental design, correlation and regression analysis, use of orthogonal polynomials in regression analysis, functional analysis of variance or method of orthogonal coefficient, mean separation, confounding, transforming, curve fitting techniques, multivariate analysis (factor analysis, principal component analysis), statistical models, probability distributions and density functions, geo-statistics: variography, auto-correlation, spatial distribution and extrapolation methods (kriging) computer use in statistical analysis (MINITAB), programming with R.

SOIL 703**ADVANCED ENVIRONMENTAL SOIL CHEMISTRY**

This course builds on the knowledge of students for explaining processes and mechanisms of reactions in soils and the environment. Topics to be covered will include; Organic pollutants in soil; The nature of physical and chemical adsorption, Trace and toxic elements in soil, Properties of individual elements important in soil, Quantitative Description of Cation Exchange, Cation Exchange Selectivity, Exchange Isotherms and Preferences; Kinetics of Soil Chemical Reactions; Application of Chemical Kinetics to Heterogeneous Surfaces; Time scales of soil chemical reactions; Fate, effect and transport of organic pollutants in terrestrial and aquatic environments.

SOIL 704**ADVANCED SOIL PHYSICS**

This course builds on the theoretical background to the description of water, solute and heat transfer and fluxes in soils. Soil water: water and soil in equilibrium, structure of water forces and energy; Movement of water in soils: saturated water flow: Darcy's Law and Laplace equation, fundamental concept of unsaturated flow, differential equations of unsaturated flow and their solutions, diffusivity, infiltration, Philip's solution for horizontal and vertical infiltration: Onsager's relation and coupled flow processes; Solute movement in soils; Fick's

Law and the differential equation of gaseous diffusion, transient state diffusion of oxygen in soils; Soil temperature: Fourier's Heat flow law, determination of heat flux in soils, thermal conductivity in soil, simulation heat, water and solute transport in soils.

SOIL 705 ENVIRONMENTAL SOIL MICROBIOLOGY AND BIOCHEMISTRY

This course strengthens the theoretical knowledge of students in soil environmental biochemistry and microbiology. Topics will include; Pesticides and persistent organic pollutants-characteristics, monitoring and management in the soil. Heavy metals and application of bioremediation in their cleanup from soils. Petroleum-soil environmental impact, microbial degradation and its management, Management of polluted soils, multidisciplinary approach, Metabolism of lipids, nucleotides, amino acids and hydrocarbons. Population growth in batch and continuous culture, Stationary phase physiology and starvation survival, Protein secretion in bacteria, Enzyme-humus complex in soils-nature of immobilization and stability of enzymes. Analysis of soil microbial community using microarrays, Antigen-antibody interactions, Molecular biology/genetic engineering, microbial ecology.

SOIL 706 ADVANCED SOIL FERTILITY

This course will provide students with in-depth knowledge in soil fertility management. Topics to be covered will include; functions of micro and macro mineral nutrients, nutrient availability in soils; Integrated soil-plant nutrient management; Soil-root interface (rhizosphere) as related to mineral nutrition; Nutrient potentials, intensity, capacity and rate of nutrient availability and uptake; Adaptation of plants to soil chemical conditions, natural vegetation, high-input versus low-input approach, acid mineral soils, waterlogged and flooded soils, saline soils.

SOIL 707 FORENSIC SOIL SCIENCE

This is a contemporary application of Soil Science in crime investigation. Various, pedological, soil chemistry, mineralogical and microbiological principles are applied to unravel events of the past. Topics to be covered will include; absolute and relative dating, principles and laws used in dating of geological materials, radiometric dating, concepts of forensic soil science; soil, sediment and dust materials; phytoliths, palynology and other biological materials; The role of soil organisms in terrestrial decomposition, Specimen preparation and microscopic analyses; Taphonomy, biostratinomy and diagenesis; Principles of instrumental analyses (SEM-EDX, XRD, TEM, IR, etc.); Database and evaluation; Case-studies from across the world, and reports of original research.

SOIL 708**MODEL APPLICATION FOR AGRICULTURAL DECISION MAKING**

This course will provide application and hands-on training of the theoretical concepts of modelling and introduce concepts of decision science. Topics will include; Decision science: introduction to decision science; first and second order stochastic dominance, yield and income functions, introduction to linear programming, multi-objective methods in environmental analysis, farming systems simulation and representative pathways to development, Trade-Off-Analysis.

SOIL 712**PALEOPEDOLOGY**

This course gives students an insight into the properties of soils of old as they were influenced by climate, geology and organisms. The topics will include; review of pedogenic factors and their interactions, soil forming processes, models of soil formation, geological time scale, features of fossil and relict soils, changes in paleosols after burial, life on land, the Pleistocene and quaternary studies, the Holocene and the rise to dominance of man, human activities and climate change.

SOIL 713**BIOMATHEMATICS**

This course will give students a good grasp of mathematics necessary for quantitative analysis of environmental and bio-physical phenomena. Topics to be covered include; Calculus: ordinary and partial differential equations, resolution of equations into partial fractions, analytical solutions; solutions, numerical methods: difference equations, solution methods, Euler and Runge Kutta methods, modeling concepts and use of models to examine biological and ecological systems (e.g. competing species); modeling concepts, matrix algebra: inverse and solution methods, eigenvectors and eigenvalues, solution of a system of linear equations; probability distributions concepts, Markov chains, Monte Carlo sampling methods.

SOIL 714**ENVIRONMENTAL RISK ASSESSMENT**

This course is designed to provide an in-depth understanding of the principles of environmental toxicology and the processes by which chemicals adversely affect living organisms in their habitats. Topics to be covered include; Ecotoxicity assessments of organic contaminants in soil and aquatic environments. Principles of toxicology; fate, persistence and transport of organic chemicals in aquatic and terrestrial environments; biodegradation and bioaccumulation of organic chemicals, the use of Quantitative Structural Activity Relationship (QSAR) models/software for estimating ecotoxicological data (EPIWEB, DECO Toolbox, ACD PhysChem Suite), Criteria for aquatic hazard assessment, classification and communication.

SOIL 700: Thesis

SOIL 710: Seminar I

This seminar will be given in the second year. The presentation will be on project proposal.

SOIL 720: Seminar II

This seminar will be given in the second semester of the second year. The presentation will be a report on experiential research and learning.

SOIL 730: Seminar III

This seminar will be given in the third year. The presentation will show progress of work.

SOIL 740: Seminar IV

This seminar will be given in the fourth (final) year. This will be a presentation of findings.

Details of Experiential Learning

Students will be attached to on-going international collaborative projects in which the Department is involved for a period of six to ten months to acquire hands-on skills in instrumentation, laboratory analyses, data analyses and interpretation and project management. Such projects include:

1. Green Cohesive Agricultural Resource Management (WEBSOC).

This is a collaborative research project involving four universities in Denmark and two universities in Ghana, University Cape-Coast and University of Ghana. The project is being sponsored by DANIDA.

The objectives of the project are to:

- a) Investigate the use of biochar for improving soil chemical and physical properties of highly weathered tropical soils
- b) Assess the use of biochar in maize production in some soils in Ghana
- c) Prepare wood-gas for households in Ghana to lessen the pressure on firewood and charcoal.

Student Attachment

On this project, a student will have the opportunity to go to Aarhus University in Denmark to do soil analysis and data interpretation for six months.

2. Integrated Soil Fertility Management for Food Security: Matching Capacities in Anglophone West African National HEIs with Local Needs (CAPACITY4FOOD)

This is a collaborative capacity building project involving University of Alicante in Spain, and five West African Universities namely University of Ghana, University of Dschang in Cameroon, University of the Gambia, Federal University of Technology, Nigeria and the University of Sierra Leone. The project is being sponsored by EDULINK.

The general objective of the project is to foster capacity building and regional integration in the field of Integrated Soil Fertility Management (ISFM). The specific objectives are to:

- a) Set up Regional Network of Centres of Excellence for Food Security in West African Universities
- b) Develop target activities at the local level with the view to increase sustainable food production.

Student Attachment

Students attached to this project in their experiential year will have the opportunity to have hands-on training in needs analysis, capacity building for stakeholders, networking, and project management.

3. African Urban Agriculture: Environmental, Social and Economic Challenges and Prospects in Small and Intermediate Sized Urban Centres in Ghana and Kenya

This is a collaborative project being executed by the Department of Soil Science and ISSER of the University of Ghana, Lund University and the Swedish University of Agricultural Sciences, Sweden and the University of Nairobi, Kenya. The project is being sponsored by the Swedish Government.

The objectives of the project are to:

- a) Identify how urban agriculture influences household food security and welfare in the context of rising food prices.
- b) Determine whether differences based on socio-economic status and gender can be found in patterns of urban agriculture in terms of i) urban agriculture based primarily on self-provisioning and ii) urban agriculture as source of income diversification and entrepreneurship
- c) Study technology use and marketing strategies of households who pursue urban agriculture as a method of income diversification.
- d) Analyse the health related consequences of urban agriculture for the cultivators themselves and their households on one hand and for the buyers of agricultural products cultivated in urban settings on the other hand. The analysis will focus on heavy metal load, food safety concerns as well as the wider health implications regarding contamination of water sources in the areas surrounding fields used for urban agriculture
- e) Analyse the regulatory framework that exists to uphold food safety standards, so as to assess how policies capable of encouraging dynamic, equitable and environmentally sustainable urban agriculture can be designed.

Student Attachment

The project will train two PhD students from Ghana and Kenya. In each country, one student will be trained in the social sciences and the other in the natural sciences.

In Ghana, the natural science student is already enrolled on PhD Soil Science programme in University of Ghana. He is presently in the second semester of the First Year. In the second year, he will be attached to the Swedish University of Agricultural Sciences in Malmo for course work and training in laboratory techniques and instrumentation.

2.4 African-German Partnership to Enhance Resource Use Efficiency and Improve Food Security in Urban and Peri-Urban Agriculture of West African Cities (URBANFOOD^{PLUS}).

This is an on-going collaborative research project involving universities in Ghana, Burkina-Faso, Mali, Cameroon, Nigeria and Germany. The project involves research into urban and peri-urban vegetable cultivation in these countries. The project is being sponsored by the German Federal Ministries of Education and Research (BMBF) and Economic Cooperation and Development (BMZ) together with PTJ and GIZ.

Student Attachment

The project will train MPhil and PhD students from Ghana.

Report and Seminar: Students will present reports on their experiential learning to the Departmental Graduate Studies Committee through their Major Supervisors and also present seminars on the experiential learning experience within six weeks of the end of the Second Semester of Year 2.