

# AQUACULTURE CURRICULUMS AT MAKERERE UNIVERSITY: A PRELIMINARY OVERVIEW<sup>1</sup>

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# **Aquaculture Curriculums at Makerere University: A Preliminary Overview**

## **Introduction**

Aquaculture subsector in Uganda has steadily advances as a means for filling a gap in the supply of food fish gap. There has been a dwindling of supply from captured fisheries, particularly in markets distant from the Ugandan lakes. Previously training and research efforts were concentrated on capture fisheries. However, due to high demand for food fish and subsequent government policy intervention, several the high institution of higher now include aquaculture and fisheries in their curriculums--Makerere University, Nkozi University, and Mukono University.

The degree training in the three colleges at Makerere University offers aquaculture either as full degree or included within a degree as course units. The colleges are: Natural Sciences (CONAS), Agriculture and Environmental Sciences (CAES) and Veterinary Medicine (CVM).

In terms of research on aquaculture, the National Fisheries Research Resource Institute (NaFIRRI) has been designated as the research arm of National Agriculture Organization (NARO). With the financial assistance from the Chinese Government and the African Development Bank, NaFIRRI has been able to rehabilitate its research facilities. NaFIRRI plays an important role in aquaculture subsector. The aforementioned Universities also undertake research on the same

Research and postgraduate work, degrees, diplomas and certificate training are offered by the Zoology Department at the Faculty of Science and the Department of Wildlife at the Veterinary Faculty in Makerere University of Kampala. The Fisheries Training Institute in Entebbe offers opportunities for research, internships, two-year diplomas, as well as certificate training (FAO 2015).

This report provides an overview of Makerere University's undergraduate and graduate aquaculture degree programs, summarizing aquaculture curriculums and courses offered at the undergraduate and graduate level. The report begins with the overview of College of Sciences, followed by the College of Veterinary Medicine, and the College Agricultural and Environmental Sciences

## **Degree Programs**

### **College of Agricultural and Environmental Sciences**

#### **BACHELOR OF SCIENCE IN AGRICULTURE**

The College of Agricultural Sciences and Environment offer a degree in Bachelor of Science in Agriculture. All students enrolled for this degree complete core courses in the first three years of their study and then pick options thereafter. The options available to them are animal science, soil science, crop science, Extension Education and Agricultural Economics. The students who select Animal Science also take a course unit in aquaculture. This extra course unit includes ANS 4104 Fish Farming and FST 4103. The descriptions are as given below.

### **College of Sciences**

#### **BACHELOR OF SCIENCE IN FISHERIES AND AQUACULTURE**

The Bachelor of Science in Fisheries and Aquaculture (BFA) is offered in the CONAS Department of Fisheries and Aquaculture. The curriculum was designed to educate professionals

able to manage aquatic resources on a sustainable basis and to conduct strategic, basic and applied research relevant to fisheries and aquaculture.

The development of Fisheries and Aquaculture program is in line with the University mission of producing skilled manpower for economic development of Uganda. The program addresses capture fisheries, which depends on wild fish stocks, and aquaculture, which is the production of aquatic organisms under controlled conditions. It also covers other disciplines that complement knowledge and skills in capture fisheries and aquaculture.

### **Context**

The program was redesigned to better address current and emerging needs. Some courses merged to remove duplication, content was added and aligned for others to make them more relevant and new courses were introduced, such as ‘Aquaculture Engineering’, ‘Geographic Information Systems and Remote Sensing’, and ‘Project Planning and Management’, among others. The end result is a more concise, relevant but flexible program of study. These changes constitute the first major revision to the BFA program since its inception in the late 1990s. The changes address the following concerns or areas:

- Production of high quality fish products acceptable by international markets.
- Promotion of community conservation in fisheries management to compliment the traditional and less effective legal enforcement.
- Promotion of non-conventional use of aquatic organisms like crocodiles, lake flies, prawns and crabs.
- Advancement of traditional knowledge of gear and fishing craft design, fabrication and maintenance for self-sustenance.
- Production of healthy aquatic organisms.
- Conducting routine operational research to solve problems and fill gaps in fisheries and aquaculture.
- The Fisheries and Aquaculture course provides an upgrading scheme for FTI, National Teachers’ Training College graduates and Diploma holders in Animal Science. The program also provides an avenue for training other aquatic animal resource managers.

The program targets holders of Diplomas in Fisheries Management and Technology, Aquaculture, Animal Husbandry, Environmental Science, Education, Yacht and Boat Building or their equivalent from a recognized college or institution. Individuals with specialized knowledge and skills relevant to fisheries science and aquaculture may be admitted into the program. In addition, the program targets holders of the Uganda Advanced Certificate of Education (or its equivalent) in the relevant subject combination of Biology, Chemistry and Physics. Table1 shows the curriculum courses and schedule.

### **Curriculum objectives**

The overall objective of the program is to produce well-trained and skilled persons understanding the dynamics of aquatic ecosystems. Graduates of this program should be able to sustainably utilize aquatic resources for the present and future generations. The Bachelor of Science in Fisheries and Aquaculture addresses the following:

- Production of well-trained and skilled personnel for utilization and conservation of fisheries resources.

- Enhancement of conservation of Uganda's ichthyic-fauna diversity.
- Promotion and appreciation of the role and value of Uganda's aquatic resources.
- Production of personnel to spearhead Aquaculture Development in Uganda.

**BACHELOR OF SCIENCE IN FISHERIES AND AQUACULTURE**

**Introduction**

The development of fisheries and aquaculture programme is in line with the University mission of producing skilled manpower for economic development of Uganda. The programme addresses capture fisheries which depends on wild fish stocks and aquaculture which is the production of aquatic organisms under controlled conditions.

**Objectives**

The overall objective of the programme is to produce well trained and skilled persons understanding the dynamics of aquatic ecosystems. Graduates of this programme should be able to sustainably utilize aquatic resources for the present and future generations.

**Programme Structure**

The Bachelor of Science in Fisheries and Aquaculture programme will involve lectures, practicals, field training, tutorials, seminars, field visits and a project to be written and submitted for examination in the second semester of third year

**Programme Structure**

Year I: Semester I		
Course Code	Course	CU
BFA 1101	Introduction to Fisheries Science	3
BFA 1102	Basic Fish Biology	5
BFA 1103	Limnology	5
BFA 1104	Basic Aquatic Ecology	3
BFA 1105	Evolution & Classification	3
BFA 1106	Introduction to Computer and Information Science	
MAK 1101	Information Technology	4
Semester II		
BFA 1201	Population Genetics	4
BFA 1206	Population Genetics	4
BFA 1202	Introduction to Functional Anatomy	3
BFA 1203	Environment Chemistry	3
BFA 1204	Basic Parasitology	3
BFA 1205	Aquatic Microbiology	4
Year II: Semester I		
BFA 2101	Cell & Molecular Biology	4

BFA 2102	Aquaculture Systems	3
BFA 2104	Common fish diseases	5
BFA 2105	Diagnostics of Fish Diseases	4
Semester II		
BFA 2201	Biostatistics	4
BFA 2202	Research Methods & Communication Skills	2
BFA 2203	Biomathematics & Fisheries Stock Assessment	5
BFA 2204	Aquatic Resource Management	5
BFA 2205	Fisheries Socio-Economic	3
BCB 2204	Ecological & Environmental Techniques	4
BCB 2205	Advanced Computer Applications	3
BCB 2207	Internship	3
Recess Term		
BFA 2206	Field Study Project	5
Year III: Semester I		
BFA 3101	Fisheries & Aquaculture Extension	3
BFA 3102	Fish Marketing & Transportation	3
BFA 3103	Aquatic Environmental Health	3
BFA 3104	Pond Sitting Construction & Management	3
BFA 3105	Design & Construction of Fishing Gears	3
Electives		
BFA 3106	Fish Processing Technology & Quality Assurance	3
BFA 3107	Fish Breeding & Applied Endocrinology	4
Semester II		
BFA 3201	Larval Food Production & Hatchery Management	3
BFA 3202	Utilization & Integration of Non-Conventional Aquatic Res.	3
BFA 3203	**Cichlid Culture	3
BFA 3204	Environmental Protection & Impact Assessment	
Electives		
BFA 3205	Feed Formulation and Analysis	4
BFA 3206	Culture of Cyprinids & African Catfishes	4

Figure 1 B. S. Degree [Makerere University](#)

## MASTERS OF SCIENCE DEGREE PROGRAMME IN ZOOLOGY

The College of Science offers a two-year program in either Entomology or Fisheries and aquatic Science or Parasitology or Wild life Ecology and Management. The objectives of the degree program are to provide advance training in applied zoology and to facilitate the acquisition of practical skills and techniques for scientific inquiry, research and evaluation. Students choose specializations in Fisheries and Aquatic Sciences, Entomology, Parasitology, or Wildlife Ecology and Man agent

Table 1. Fisheries and Aquatic Sciences

Course	Title	LH	PH	Credits
ZFA 7201	Fish handling, processing and marketing	15	30	2
ZFA 7202	Wetland ecology and management	15	30	2
ZFA 7203	Fish nutrition and feed technology	30	30	3
ZFA 7204	Advanced fish population dynamical	30	30	3
ZFA 7205	Aquaculture production systems	30	30	3
ZOO 7208	Seminars	30	30	2
	Total	0	60	15

### College of Veterinary Medicine & Animal Resources & Biosecurity

#### MASTER OF SCIENCE IN WILDLIFE HEALTH AND MANAGEMENT

The College of Veterinary Medicine, Animal Resources & Bio-security plans to offer a two-year program that features course work in aquaculture. The program description notes that as the wild animal populations continues to dwindle, the human population growth has taken the reverse pattern of exponential growth putting pressure on the natural resources in order to meet growing human needs. Exploitation has resulted in the disruption of the ecological systems bringing:

- Excessive stress on the habitats and the animals
- Increased disease incidence among wild animals
- Emerging zoonotic diseases involving aquatic animals
- Accumulation of pollutants in the environment
- Invasion of alien and exotic species into human and wildlife habitats.

To achieve most management objectives, there was need to enhance the existing capacity of Uganda Wildlife Authority (UWA) and other stakeholders in wildlife including veterinary extension staff, animal handlers, tourism sector, private sector, wildlife managers, researchers and ecologists. From previous wildlife policy workshops, UWA gave the mandate for both research, training of the Wild Animal Health professionals and managers to the Makerere University, School of Veterinary Medicine. It was against this background that a postgraduate Diploma in Wildlife Health and management in 1998 was developed, which was upgraded to a Master in Wildlife Health and Management in 2001.

## **DIPLOMA IN FISH PRODUCTION, VALUE ADDITION, AND ENTREPRENEURSHIP**

In cooperation with the Africa Institute of Strategic Services and Development (AFRISA), the college offers a skills certificate and skills diploma in fish production value addition and entrepreneurship.

### **Objectives**

- Drive transformative skills, knowledge, technology, innovation, SMEs (Small-Medium Enterprises) and services into the meat industry
- Through industry partnerships, continuously improve production, health, employment, community well-being and economic growth.
- Produce graduates with the skills in fish farm planning, pond design and construction, fish fry and fingerling production, fish feed formulation and feeding, table fish production, fish products processing, value addition, product packaging, and ornamental fish production
- Contribute to the development and transformation of the underutilized fish production sector.
- Produce skilled graduates who are job creators in fish and related enterprises.

### **Courses Offered with Aquaculture in the Title**

The following courses are offered as part of the undergraduate and graduate programs in aquaculture at Makerere University

## **FISH FARMING**

### **Description**

ANS 4104 provides an overview of the fish sub-sector in Uganda. Constraints to improved production and the potential for improvement. Other topics include: record keeping, production systems, planning for fish, objectives and elements of success in fish farming, Pond design and construction, stocking a fish pond, feeds and feeding of fish, as well as management of fish in a pond. Fish health, hygiene, and marketing also are considered.

### **Objectives**

- Enable the students to acquire basic knowledge and broad understanding of fish farming.
- Gain an overview of the aquaculture industry in Uganda, its importance and constraints to improved production.
- Gain practical understanding of specific fish species.
- Understand fundamental principles applied to improve production of fish.
- Gain practical understanding of the husbandry practices used in the production of fish through farm visits.

## **MEAT, POULTRY AND FISH TECHNOLOGY**

### **Description**

FST 4103 addresses the structure and composition of various food animal carcasses: beef, pork, poultry and fish. Lectures address: slaughtering and butchering techniques, post-mortem meat handling, and storage and processing of meat products: dried, smoked, and salted products and sausages. Poultry processing and cooling techniques include: poultry meat products, egg processing and preservation, fish structure and composition in relation to preservation and processing, as well as icing, freezing and cold storage. Topics also include: drying and smoking salt fish products, preparation of fish protein concentrates, and disposal of waste products of meat, fish and poultry processing.

## **Objectives**

- Describe the structure of and composition of meat
- Outline the post-harvest changes that occur in animal flesh after slaughter
- Describe major meat quality attributes, their measurement and processes used to ensure quality
- Describe the processes that should be followed to obtain quality meat from animals
- Develop skills in processing and preservation of meat, fish and poultry production

## **FISH PRODUCTION**

The course ANS 6108 provides an overview of fish production in Uganda: Populations, diversity, production systems, opportunities and constraints.

### **Description**

Topics include: Fish breeding and reproduction, aquatic ecology and pond productivity, fish stock management, hatchery techniques, larval food production, and harvesting techniques. Feed resources and feeding topics addressed are: Natural feeds and commercial feeds, and feeding techniques. Fishpond and water management lectures address: pond design, construction, and integrated fish production techniques. Water purification and treatment of fish farm effluent. Other topics include fish health and disease control, as well as fish processing, quality control and marketing. The course endeavors to impart skills that include: pond construction and maintenance, water quality control, fish stocking, larval production, hatchery techniques, feeding, assessment of health status and disease control. The course also discusses harvesting, farm level processing and preservation

## **FISH BIOLOGY AND AQUACULTURE**

The College of Natural Sciences, School of Biological Sciences, Department of Biology offers a three-credit course that introduces principles of fish biology. It is a pre-requisite to understanding and practicing aquaculture of the fishes of East Africa. This course concentrates primarily on fish species with worldwide commercial importance. Lectures cover a broad range of topics including fish physiology, behavior, nutrition, genetics, water quality, health and disease, reproductive techniques, economic, political and legal issues, and various types of culture systems technologies. Students analyze many of the contemporary challenges facing the aquaculture industry, through task exercises. These effort endeavor to develop interdisciplinary knowledge, lateral thinking, creative problem solving, thus bridging science and technology to enable issues management. Although the subject matter is focused on aquaculture, the pedagogical outcomes for students include improved critical analysis and problem solving skills.

### **Description**

The catalog course description reads as follows: Fish feeding habits and behavior, breeding and reproduction of fishes of East Africa, development in fishes, age growth and mortality, fish population structures, fish nutrition, recruitment, prediction of fisheries control measures, fishing gears, post-harvest fish handling and losses control measures, type of fisheries in Uganda, fisheries and man, over fishing and conservation

## **Objectives**

- Articulate the importance of fisheries science and aquaculture in the national economy
- Articulate the fundamental principles involved in the farming of aquatic organisms
- Apply knowledge of fish biology to the handling and conservation of fish and in the raising fishes at commercial level and resolution of basic problems in aquaculture practice

## **AQUACULTURE SYSTEMS**

The College of Natural Sciences, School of Biological Sciences, Department of Biology offers the Semester I course BFA2102 Aquaculture Systems for four credits.

### **Description**

To equip students with knowledge of a variety of available aquaculture systems in various countries. The course introduces students to the culture systems available to be adopted by fish farmers

### **Objectives**

- Identify and describe various aquaculture systems at smallholder level.
- Design, construct and maintain some of the common aquaculture systems.
- Apply the knowledge of the various aquaculture systems of raising fishes at commercial level.

## **FISHERIES & AQUACULTURE EXTENSION**

The course BFA 3101 is offered for three credits on an annual basis.

### **Description**

To equip students with the latest extension approaches used in Fisheries and aquaculture.

### **Objectives**

- Outline the fundamental principles of extension used in rural development and show how they can be applied to aquaculture.
- Identify problems in an aquaculture production setting and develop a strategy to address the problems so identified.

## **AQUACULTURE ENGINEERING**

The course BFA 3109 is offered for three credits on an annual basis.

### **Description**

The course covers the fundamentals of the types, design, operation and maintenance of aquaculture equipment and facilities. It aims to build competence in routine trouble-shooting, operation and maintenance of aquaculture facilities.

### **Objectives**

- Make technical evaluation of existing aquaculture facilities
- Discuss with and advise construction experts (technicians) the requirements for the aquaculture facilities
- Construct and maintain simple aquaculture facilities

## **ENVIRONMENTAL HEALTH IN AQUACULTURE**

As part of the Master of Science in Wildlife Health and Management in the College of Veterinary Medicine, Animal Resources & Bio-security, School of Veterinary Medicine and Animal, Department of Wildlife and Animal Resources Management, WHM 7211 is a two-credit course offered in Semester 2 as part of the first year of study.

## **Description**

Water quality, water and waste water management, impact of exotic fishes and aquatic plants, impact of environmental factors on health and productivity of aquatic organisms, public health issues, introduction to fish health and diseases.

## **Objectives**

- Acquire knowledge of the influence of environmental factors on aquaculture systems.
- Acquire skills in environmental pollutants evaluation
- Acquire skills in fish health diagnostics

## **Learning outcomes**

- Identify and describe how environmental factors do influence aquaculture
- Design aquaculture plans based on consideration of environmental health
- Offer environmental health advice to aquaculture farmers

## **NUTRITION AND FEEDING TECHNOLOGY IN AQUACULTURE**

As part of the Master of Science in Wildlife Health and Management in the College of Veterinary Medicine, Animal Resources & Bio-security, School of Veterinary Medicine and Animal Health, Department of Wildlife and Animal Resources Management, WHM 7211 provides a two-credit. It is offered in Semester 2 as part of the first year of study. WHM 7212 is a two-credit course offered in Semester 2 as part of the first year of study.

## **Objectives**

- Acquire knowledge of the nutrient requirements for adequate nutrition of selected aquaculture species
- Acquire skills in aquaculture feed formulation
- Acquire skills in aquaculture feed evaluation and feeding techniques

## **Learning outcomes**

- Describe the nutrient requirements for different growth stages of aquaculture species
- Formulate feeds using locally available materials
- Offer nutrition and feeding technical advice to aquaculture farmers

## **AQUACULTURE PRODUCTION SYSTEMS AND TECHNOLOGY**

As part of the Master of Science in Wildlife Health and Management in the College of Veterinary Medicine, Animal Resources & Bio-security, School of Veterinary Medicine and Animal Health, Department of Wildlife and Animal Resources Management, WHM 7210 lists a two-credit course. It is offered in Semester 2 as part of the first year of study. WHM 7212 is a two-credit course offered in Semester 2 as part of the first year of study.

## **Description**

Evolution and status of Aquaculture, principles and prospects, production systems (ponds, tanks, cages); level of management (extensive, semi-intensive, intensive, integrated); reproduction and breeding (broodstock management, breeding technologies, larvae and fry management, applied reproductive physiology).

## Objectives

- Acquire knowledge of the composition of aquatic production system.
- Acquire skills in relevant technologies for aquaculture production

## Learning outcomes

- Describe the components of various aquaculture production systems
- Design and implement aquaculture systems
- Offer technological skills applicable in aquaculture systems

## Conclusion

Makerere University features a broad range of courses in aquaculture and aquatic biology but the functional locations of the curriculums may be said to make the whole less than the sum of the parts. The undergraduate curriculum is centered in the College of Science and the Master of Science degree is under consideration. In the College Veterinary Medicine Animal Resources and Biosecurity, courses addressing aquaculture are undertaken at Bachelor's level. In addition, diploma and certificate courses are offered at the African Institute of Strategic Services and Development (AFRISA). This is housed within the College of Agricultural and Environmental Sciences, where the course units on aquaculture are offered.

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### **Appendix 1. The STRECAFISH Partnership**

Two RUFORUM member universities have received a grant of **390,000 euros** from the Austrian Partnership Programme in Higher Education and Research for Development (APPPEAR) to implement a higher education academic partnership for enhancing capacity in research and training in fisheries and aquaculture. The two universities, [Makerere University](#) and the [University of Eldoret](#), work with other partner organizations including the University of Natural Resources and Life Sciences in Vienna and the Ethiopian Institute of Agricultural Research to implement a three-year project titled “**Strengthen regional capacity in research and training in fisheries and aquaculture for improved food security and livelihoods in Eastern Africa (STRECAFISH)**”.

Through the project, academic staff and graduate students are equipped with knowledge and skills in developing and implementing innovations to address key constraints in the fisheries and aquaculture sector. The partnership engages over 20 academic staff and researchers, and train three PhD and six master’s students from Ethiopia, Kenya and Uganda.

STRECAFISH is coordinated by Makerere University, under the leadership of Dr. Peter Akoll of the College of Natural Sciences, together with focal persons [1] in the partner organizations. RUFORUM engages as an associate partner to backstop multi-stakeholder innovation platforms as well as provide opportunities for linking and disseminating project outputs to the wider RUFORUM Network, which spans 22 countries in sub-Saharan Africa. This project complements several other RUFORUM supported initiatives that have effectively engaged academic and non-academic stakeholders in the fisheries and aquaculture sector, resulting in improved productivity and enhanced incomes and livelihoods.

[1] Focal persons for the STRECAFISH Project are: Makerere University – Dr. Peter Akoll, ([pakoll@cns.mak.ac.ug](mailto:pakoll@cns.mak.ac.ug)); University of Eldoret – Prof. Boaz Kaunda ([b\\_kaunda@yahoo.com](mailto:b_kaunda@yahoo.com)); University of Natural Resources & Life Sciences, BOKU – Drexler Silke ([silke.drexler@boku.ac.at](mailto:silke.drexler@boku.ac.at)) and the Ethiopian Institute of Agricultural Research, EIAR– Dr. Adamneh Dagne Admassie ([adamnehdet@gmail.com](mailto:adamnehdet@gmail.com)); RUFORUM – Dr. Paul Nampala, [p.nampala@ruforum.org](mailto:p.nampala@ruforum.org)).