INTER-UNIVERSITY COUNCIL FOR EAST AFRICA

BENCHMARKS

FOR

BACHELOR OF SCIENCE IN

AGRICULTURE, HORTICULTURE, ANIMAL SCIENCE, AND FOOD SCIENCE AND TECHNOLOGY

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Acronyms

ABET:	Accreditation Board for Engineering & Technology
ACM:	Association for Computing Machinery
ASIIN:	Accreditation Agency for Engineering, Informatics, Physics and Mathematics
CATS:	Credit Accumulation and Transfer system
CUE:	Commission for University Education (Kenya)
DAAD:	German Academic Exchange Services
DIES :	Dialogue on Innovative Higher Education Strategies
EAC:	East African Community
EAQF:	East African Qualifications Framework
ECTS:	European Credit Transfer System
EQF:	European Qualifications Framework
HEIs:	Higher Education Institutions
HRK:	German Rectors Conference
IEE:	Institute of Electrical and Electronics Engineers
IUCEA:	Inter-University Council for East Africa
IT :	Information Technology
NQF:	National Qualifications Framework
MNC:	Multinational Corporation
NCHE:	National Council for Higher Education
NRAs:	Higher Education National Regulatory Agencies
QA:	Quality Assurance
QAA:	Quality Assurance Agency for Higher Education, UK
TCU:	Tanzanian Commission for Universities

Foreword

The Inter-University Council for East Africa (IUCEA) is a strategic institution of the East African Community (EAC) responsible for the development and coordination of higher education and research in the region. The EAC considers higher education as critical for the attainment of socio-economic development and regional integration. As such, after having been recognized as the surviving institution of the former Community responsible for coordinating the networking of university institutions in the region, IUCEA has assumed a broader role as a building block for the achievement of sustainable socio-economic development and regional integration. In that regard, the mission of IUCEA now focuses on the promotion of strategic and sustainable development of higher education systems and research for supporting East Africa's socio-economic development and regional integration. The IUCEA has set its vision to become a strategic institution of the East African Community responsible for promoting, developing and coordinating human resources development and research in the region.

Hence, in 2006 IUCEA initiated a process aimed at harmonizing regional quality assurance by establishing A common East African quality assurance framework, regional quality assurance office at the IUCEA Secretariat, and setting regional higher education benchmarks quality standards based on internationally recognized frameworks. The process would also prepare a user-friendly quality assurance handbook based on existing national benchmarks and systems, and streamline national and institutional quality assurance systems according to the local perspectives with the aim of promoting international competitiveness of universities in East Africa.

The initiative also focused on capacity building through providing appropriate training on the implementation of the quality assurance system to staff in universities and national commissions and councils for higher education in the Partner States. It is linked to the establishment of a regional qualifications framework. It was anticipated that the regional qualifications framework would facilitate harmonization of education and training systems, and qualifications thereby clearly indicating the programme learning outcomes, the different qualification levels, credit system and recognition of prior learning, among others. Therefore, the framework would easily facilitate mutual recognition of qualifications across the region as envisioned in the EAC Common Market Protocol. All these interventions were aimed at transforming East Africa into a common higher education area, as the ultimate goal of the Community.

In developing the regional quality assurance system in higher education in East Africa, IUCEA in collaboration with the German Academic Exchange Service (DAAD) and the Germany Rectors' Conference (HRK) within the framework of their joint Higher Education Management support programme referred to as "Dialogue on Innovative Higher Education Strategies (DIES)",

started to work on this initiative through a consultative process involving various stakeholders of higher education in the region. The process involved a number of consultative meetings and workshops at country and regional level, aimed at building consensus and mapping out a strategy on how to establish a regional quality assurance framework. This included the development of an operational tool in the form of a Quality Assurance Handbook. The consultative forums were also aimed at ensuring that all performance indicators and quality benchmarks were agreed upon and owned by all end-user institutions. Additionally, IUCEA intended to develop specific subjects benchmarks as part of the tools for harmonization purposed academic programmes taught in higher education institutions in the region in addition to the development of The Handbook *A Roadmap to Quality.* The first benchmarks, formulated were Benchmarks for Bachelor of Business related studies. The second set of benchmarks were for the Bachelor of Computer Science and Bachelor of Information Technology. The current publication contains Benchmarks for the Bachelor of Science in Agriculture, Bachelor of Science in Horticulture, Bachelor of Science in Animal Science and, Bachelor of Science in Food Science and Technology.

On behalf of the IUCEA secretariat, it is my sincere hope and expectation that the higher education fraternity in the region will make use of these benchmarks in all educational processes and world of work to ensure that our programmes are of expected quality.

Prof. Alexandre Lyambabaje **Kampala, November 2017.**

IUCEA, Executive Secretary

Preamble

The benchmarks for Bachelor of Science in Agriculture, Bachelor of Science in Horticulture, Bachelor of Science in Animal Science and, Bachelor of Science in Food Science and Technology contained herein have been developed as one of the set milestones for the development of an East African Quality Assurance System. This constitutes the framework of the East African Common Higher Education Area that was declared by the 18th Summit of the EAC Heads of State on 20th May 2017 in Dar es Salaam, Tanzania. The process of developing these benchmarks commenced after successful completion of developing the "Benchmarks for Business Related Studies" which were printed in June 2013 and the "Bachelor of Computer Science and the Bachelor of Information Technology" printed in March 2015 which are currently in use.

Although the Bachelor of Science in Agriculture, Bachelor of Science in Horticulture, Bachelor of Science in Animal Science and, Bachelor of Science in Food Science and Technology are termed under the umbrella of ''Agriculture programmes'' they do have differences and therefore each one has its own benchmarks. However, based on the traditional programmes, these bachelor programmes are published in one document.

As highlighted in the foreword, the benchmarks are aimed at providing an important process of harmonisation of the Bachelor of Science in Agriculture, Bachelor of Science in Horticulture, Bachelor of Science in Animal Science and, Bachelor of Science in Food Science and Technology and should be beneficial to all the players in the higher education sector. Thus, the main objective of this process is to harmonise the Bachelor programmes in order to provide a baseline for comparability within the region. The benchmarks are to be used as a yardstick or a point of reference, and not as absolute standards.

This document is structured in 6 parts:

- Part 1 presents the background, objectives and the justification for the formulation of the benchmarks. It also articulates the development process of the benchmarks and how they were formulated;
- Part 2 shows the relation between the benchmarks and the Qualification Frameworks, the Curriuclum and the link with Quality Assurance;
- Part 3 presents the benchmarks for Bachelor of Science in Agriculture.;
- Part 4 presents the benchmarks for Bachelor of Science in Horticulture ;
- Part 5 presents the benchmarks for Bachelor of Science in Animal Science;
- Part 6 presents the benchmarks for Bachelor of Science in Food Science and Technology.

Incorporation of Prevention and Control of Aflatoxins and Other Mycotoxins in the Benchmarks

In the course of development of these benchmarks, the 36th Meeting of the EAC Council of Ministers that was held in February 2018 in Kampala Uganda, directed IUCEA to work with Partner States in order to integrate the control and prevention of aflatoxin and other mycotoxins in university syllabi ***(EAC/CM/36/Directive 34***). Thus, IUCEA, convened a meeting of experts in aflatoxins from agricultural universities and national research organisations to incroprate these aspects into the already developed Benchmarks for Agriculture. The Workshop was held during 6th to 8th August 2018, in Kampala Uganda. The experts identified gaps related to the control and prevention of aflatoxins and other mycotinxs in the core and elective courses and their respective learning outcomes of the Benchmarks. Subsequently, additional courses and relevant learning outcomes were incorporated in order to provide guidance to universities and other stakeholders in implementing the Directive of the Council of Ministers.

The proposed courses and learning outcomes are highlighted in this revised document for Benchmarks for B.Sc. Agriculture, B.Sc. Animal Science and B.Sc. Food Sceince and Technology, as presented in Table 3.3, Table 5.4, and Table 6.3, respectively. Appendix I highlights the proposed course outline for prevention and control of Aflatoxins and Other Mycotoxins.

Acknowledgements

I wish to extend my sincere appreciations to several individuals representing various higher education institutions, stakeholders and partners for their invaluable contributions in the development of these benchmarks. I wish to particularly express my gratitude to Prof. Florence Lenga of Jomo Kenyatta University of Agriculture and Technology, Kenya for providing technical facilitation and steering the whole process of developing these benchmarks.

The various individuals representing IUCEA members and some representatives of employers, the list of which is appended to this document are highly appreciated for their contribution. On the same note, their respective institutions are sincerely acknowledged for granting permission to their staff to participate in this process. I wish to extend my sincere appreciation to Dr. Cosam Joseph and Ms. Juru Marie Eglantine of IUCEA for their invaluable contribution and support to this process.

The National Commissions/Councils for Higher Education of the EAC Partner States are highly acknowledged for their instrumental contribution in spearheading and coordinating the processes in the development of these benchmarks in their respective countries. The Staff representing these institutions to this process are sincerely appreciated for their dedications and inputs to this process.

It is my expectation that these benchmarks will contribute significantly as one of the building block of harmonization of education as part of operationalisation of the East African Community Common Higher education Area. Therefore, all stakeholders are encouraged to use them in various intended purposes such as curriculum development and review, assessing graduates' competencies, and comparability, among others.

Prof. Alexandre Lyambabaje, **Kampala, November 2017**

IUCEA, Executive Secretary

PART 1: INTRODUCTION

1.1. Background

One of the mandates of the IUCEA is to maintain high and comparable academic standards in higher education regionally and internationally, with special emphasis on the promotion of Quality Assurance (QA) and Quality Management. In that regard, IUCEA aspires to operate within the expectations of stakeholders to deliver services that enhance and harness QA in the region. In East Africa, the notion of QA in higher education is an issue of great concern among all stakeholders, including policy makers, parents, employers, and students. A number of factors have contributed to this phenomenon. East Africa has experienced rapid expansion of the number and enrollment levels in higher institutions of learning in recent times. This has been triggered by the exponential increase in demand of access to higher education in each of the countries in the region.

As a result, the IUCEA felt the need to ensure that the rapid expansion of higher education in the region did not compromise quality of the very education being delivered. Furthermore, in recent years student mobility within East Africa has increased tremendously, necessitating the need to institute mechanisms for comparability of the quality of education in universities in East Africa. It is important to note that education has become a tradable commodity across borders and hence there have been efforts to institute international safeguards that would ensure maintenance of international quality standards. These efforts are being implemented within regional and international Quality Assurance frameworks. The development of benchmarks therefore became a necessity.

The first formulated regional benchmarks focused on the Bachelor of Business related studies.[1] Based on the experiences with the benchmarks for Business related studies in the region in the framework of the Regional Quality Assurance Initiative, the IUCEA, supported by DAAD (German Academic Exchange Services), took the initiative to develop benchmarks for the Bachelor of Computer Science and the Bachelor of Information Technology offered in the region. Development of benchmarks for Bachelor of Science Agriculture, Bachelor of Science Horticulture, Bachelor of Science Animal Science and, Bachelor of Science Food Science and Technology has taken experience from the benchmarks of the Business related studies and benchmarks for the Bachelor of Computer Science and the Bachelor of Information Technology developed in June 2013 and March 2015 respectively.

1.2. Objectives of the formulated benchmarks

The objectives of the formulated benchmarks are to:

[1] IUCEA *Benchmarks for Bachelor of Business related studies*, June 2013

- Act as a guide and tool for the HEIs in designing the curriculum for Bachelor of Science Agriculture, Bachelor of Science Horticulture, Bachelor of Science Animal Science and, Bachelor of Science Food Science and Technology
- Enable the National Commissions and Councils for higher education to assess the quality of the Bachelor of Science in Agriculture, Bachelor of Science in Horticulture, Bachelor of Science in Animal Science and, Bachelor of Science in Food Science and Technology programmes;
- Promote harmonization of the specific programmes in the region;
- Support staff and student mobility;
- Enhance the regionalization of the labor market, which is one of the aims of the East African Community (EAC); and
- Guide the labour market in judging the quality of the graduates.

It should be noted that the document focuses on benchmarking in terms of the output rather than the process. This means focusing more on expected learning outcomes rather than the details of the content of the programmes. The outcomes and/or competencies approach was chosen because of the need to harmonize the programmes. The process of ensuring commensurate content, pedagogy and assessment for the achievement of the learning outcomes is left to the Higher Education Institutions (HEIs) and to individual National Commissions and Councils for Higher Education.

1.3. Justification

Following its revitalization and subsequent ratification of the Protocol in 2002, IUCEA initiated a reform process aimed at re-positioning itself in order to address its expanded mandate within the Community. Such reforms became necessary after the enactment of the IUCEA Act in 2009. The reforms prompted the need to establish an appropriate environment for harmonization of higher education systems, so as to promote the EAC regional integration agenda as envisioned in the Common Market Protocol. Among the important steps towards harmonization of higher education in the region was the setting up of benchmarks for various academic programmes.

Three key areas were identified and given prority due to their social and economic importance in the region. These were agriculture due to its contribution to food security and industrial development, engineering for infrastructure development, and medicine due to its contribution to health and social development of the region. This document concentrates on the benchmarks of agriculture programmes. Within the field of agriculture, there are various degree programmes taught across the region with large variations in content. This presented a challenge in allowing student mobility and credit transfer within the region. In order to address these challenges, the idea of formulating benchmarks in agricultural disciplines became imminent.

Agriculture is the driving force of the economies of the East African region. It is the source of food and foreign exchange of the region and the major supplier of raw materials for agro-based industries. In addition, it is the main source of income and employment for the majority of the population. Most parts of the region have fairly fertile soils and suitable climatic conditions that favour agricultural production. Graduates of this programme will take up positions in agro-based and allied industries, agricultural research centres, higher institutions of learning, self-employment, and non-governmental organisations.

1.4. The development process

The development of the benchmarks for Bachelor of Science Agriculture, Bachelor of Science Horticulture, Bachelor of Science Animal Science and, Bachelor of Science Food Science and Technology underwent a number of interactive processes that included data collection, analysis, and documentation on, the basis of which a consultative fora bringing together multiple stakeholders in a preparatory meeting and round table sessions to deliberate on the content of the benchmarks as follows:

- *The first preparatory meeting (Nairobi, 15th to 17th March 2017).*
  IUCEA organised a preparatory meeting in Nairobi to prepare the 1st session for the benchmarking process in Agriculture, Engineering and Medicine programmes in East Africa. It was decided that Agriculture, Engineering and Medicine should be the focus of the subject benchmark exercise. After extended deliberations involving stakeholders from academic insitutions, professional bodies, employers, and national Commissions and Councils amongst others, it was decided that benchmarks for Agriculture programmes should focus on traditional programmes. Consequently, professionals in the Agriculture programme deliberated to focus on four traditional degree programmes namely Bachelor of Science Agriculture, Bachelor of Science Horticulture, Bachelor of Science Animal Science and, Bachelor of Science Food Science and Technology.
- *The second meeting (Kampala, 10th to 12th July 2017)*
  The second meeting developed a set of benchmarks in the field of Agriculture, Horticulture, Animal Science and Food Science and Technology in line with the National Qualification Frameworks that could lead to harmonization of the programmes in the region. The output of the second meeting was a draft document with programme goal, objectives and expected learning outcomes for Agriculture, Horticulture, Animal Science and Food Science and Technology.
- *The third meeting (Kampala, 27th to 29th November 2017)*
  The third meeting developed a benchmark document with programme content areas and their brief description, differentiation between core courses and supporting courses, the role of research project and field attachment.

The discussions about the benchmarks were based on:

- Bachelor of Science in Agriculture, Horticulture, Animal Science, and Food Science and Technology in the East African Universities: Sokoine University of Agriculture (Tanzania); Jomo Kenyatta University of Agriculture and Technology, University of Nairobi, Egerton University, Moi University (Kenya); Makerere University (Uganda); University of Rwanda (Rwanda); and university of Burundi (Burundi).

1.5. Stakeholders involvement

Special efforts were made to involve key stakeholders including higher education experts, professional bodies, employers and industry. Therefore, participants were drawn from Agriculture, Horticulture, Animal Science and Food Science and Technology, departments of HEIs, Higher Education National Commissions and Councils, professional bodies, employers and industry representatives from all the EAC Partner States. International experts were brought on board as resource persons to provide an overview of the global initiatives in the harmonization of standards in university education.

During the preparatory meeting, the professional bodies and employers clarified what they expected from graduates in Agriculture, Horticulture, Animal Science and Food Science and Technology. Also through questionnaires, employers provided input for the discussions. During the 1st and 2nd round table, representatives of the professional bodies and labour market contributed to the discussions.

PART 2: THE USE OF BENCHMARKS

2.1. The Benchmarks and the Qualifications Framework

As earlier mentioned, this document is not meant to replace the initiatives of the EAC Partner States and institutions, but rather to provide a regional benchmark with regard to the learning outcomes. Therefore, care has been taken to ensure that the benchmarks are in line with the various National Qualification Frameworks. Globally, in the last 10 years, there have been developments in which various countries have either formulated or are formulating National Qualifications Framework(NQF). Such National Qualifications Frameworks may be regarded as the policy framework that defines all qualifications recognized nationally in post-compulsory education and training within a country. In the same spirit, the East African countries are working on National Qualification Frameworks. The NQF of Tanzania[2] defines National Qualifications Framework (NQF) as *"a national instrument for the development and classification of qualifications according to a set of criteria for levels of learning and skills achieved."*

The East African Qualifications Framework[3] defines Qualifications Framework as *"an instrument for the development and classification of qualifications according to a set of criteria for levels of learning and skills and competences achieved.*"

Looking at the NQFs in Europe and the European Qualifications Framework, and other NQFs in other parts of the world, it is clear that there are efforts to describe the different levels of education. Concerning Higher Education, 3 levels are described namely: Bachelors, Masters and Doctorate. For the purpose of this document, only Bachelors and Masters Degrees will be discussed. In all NQF's the levels of Bachelors and Masters Degrees are described. The level number may differ. In the European Qualification framework, it is level 6 and 7; in the EAQF it is level 8 and 9. However, the level descriptors are more or less the same:

- *Bachelor's Degree (level 8)*
  The holder of the qualification will be able to apply knowledge, skills and understanding in a wide and unpredictable variety of contexts with substantial personal responsibility for the work of others and responsibility for the allocation of resources, policy, planning, execution and evaluation.
- *Master's Degree (level 9)*
  The holder of the qualification will be able to display mastery of a complex and specialized area of knowledge and skills, employing knowledge and understanding to conduct research or advanced technical or professional activity, able to work autonomously and in complex and unpredictable situations.

[2] *The Tanzanian Commission for universities, National Qualification framework, final draft March, 2010*
[3] IUCEA, *The East African Qualifications Framework,* draft August, 2014

The description of both the Bachelors and the Masters Degree levels is very general. Clearly, in order to be operationalised, each level has to be filled in and elaborated with statements of expected learning outcomes formulated by the discipline. In most of the NQF's, the level descriptors are elaborated in *generic* learning outcomes. However, each programme/discipline has to translate the *generic* learning outcomes into specific course units within *specific* subjects. For example, one of the generic learning outcomes is ability to identify, pose and solve problems. This might become applied research concepts and techniques to solve computing problems or to solve emerging challenges in modern IT environment.

2.2. The benchmarks and curriculum design

One of the purposes of formulating benchmarks is to support the HEIs to design or redesign the curriculum. It is clear that the National Commissions and Councils in the five East African countries will apply their own criteria in the assessment of the curricula. The benchmarks are needed because learning outcomes guarantee:

- Comparable quality levels of the graduates;
- Comparable chances for the graduates in the labour market;
- Labour market understands the competencies that CS and IT graduates possesses;
- Increased national and international mobility of students; and
- Increased national and international mobility of lecturers.

2.2.1. Programme objectives

The Bachelor of Science degrees in Agriculture, Horticulture, Animal Science, and Food Science and Technology should be designed in such a way that they address the concerns of different stakeholders. This should be reflected in the programme objectives. These objectives can be grouped into three categories:

- Academic ability
- Employability
- Personal development

The survey of the Bachelor programmes in Agriculture, Horticulture, Animal Science, and Food Science and Technology showed that the universities in general had formulated programme objectives, but not learning outcomes. What had not been put in place was the translation of the programme-oriented objectives into student-oriented learning outcomes: what the student is expected to learn through this programme.

2.2.2. Formulating the Expected Learning Outcomes

The first step in designing or redesigning a programme is the formulation of the learning outcomes. The purpose of the learning outcomes is to describe clearly what the student is expected to demonstrate after completing the whole programme, a module or a course. HEIs are

expected to compare their formulated learning outcomes with the benchmarks and see what is missing or what should be rephrased. For each learning outcome, one should describe how the outcome would be measured and assessed.

It is worth noting that benchmarks are based on the formulated learning outcomes. According to literature on benchmarking and learning outcomes, there are many different definitions of learning outcomes or competences. In the European Qualification Framework (EQF)[4]*Learning outcomes* are defined as: statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence. *Competence,* according to the EQF, is the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. According to IUCEA[5] learning outcomes are viewed as what a learner is expected to know and understand, and be able to do or demonstrate, on completion of a learning process within a recognized qualifications framework.

In the discussion about learning outcomes, the problem is the concept of *Competencies.*Although the notion *Competency* is used regularly, it is unclear what competences are. In all the definitions there is a hint to knowledge, applying knowledge and skills. Furthermore, there is talk about abilities and attitudes. A graduate exhibiting competencies at a working place will have partly acquired the competencies as outcomes of his/her study. It should be noted that some of the competencies are acquired through non formal and informal experiences and others are inborn. This means that not all competencies are taught at the universities. The Learning Outcomes form only a part of the compencies a graduate will show in his/her job.

As mentioned before, a learning outcome is a statement of the knowledge, skills and attitudes students should have acquired at the end of each course (module, unit) and programme. It has been observed that although universities are engaged in the practice of defining objectives and measuring outcomes in one form or another, many do not approach the process of formulating Learning Outcomes in a uniform way. It is important to note that focusing on and defining learning outcomes would create an opportunity to:

- Enhance students' learning and mobility;
- Provide guidance to instructors;
- Identify and overcome barriers to effective teaching;
- Facilitate collaboration among HEIs in the region and beyond;
- Improve students' learning, retention and completion;
- Produce quality graduates; and
- Increase students´ chances for employability.

[4]*The European Qualification Framework for Life Long Learning, European Commission 2008*
[5] IUCEA, *The East African Qualifications Framework,* draft August, 2014

In this document, the following definition for Learning Outcomes is used :

***Learning outcomes*: statements of the knowledge, skills and attitude that a learner is able to demonstrate on completion of a learning process.**

Learning Outcomes can be separated in three domains

- Cognitive learning (Knowledge)
- Psychomotor learning (Skills)
- Affective learning (Attitude),

In the taxonomy of Bloom, the teaching and learning hierarchy is important for the correct and consistent building of the knowledge side of the Learning Outcomes.The cognitive domain comprises six levels starting with the easiest level *remembering* and ending in the top with *creating as* the most complex level of the taxonomy. (see figure 1). In formulating Expected Learning Outcomes one has to formulate actions, starting at the lowest level of the taxonomy. See, for examples, figure 2.

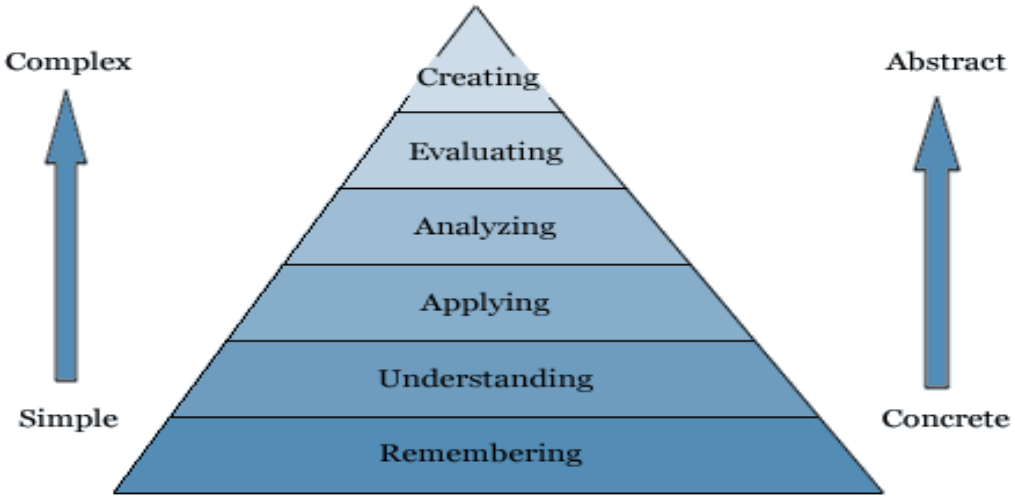

Fig 1: Revised Taxonomy of Bloom (Anderson and Krathwohl 2001)[6]

[6]*Krathwohl, D.R., Bloom, B.S. and Masia, B.B. Taxonomy of Educational Objectives: Handbook II. The Affective Domain.N.Y., David McKay Company, Inc. 1964. In: Van der Klip Cees: Profession based education and training,A Teachers guide, Draft 2015*

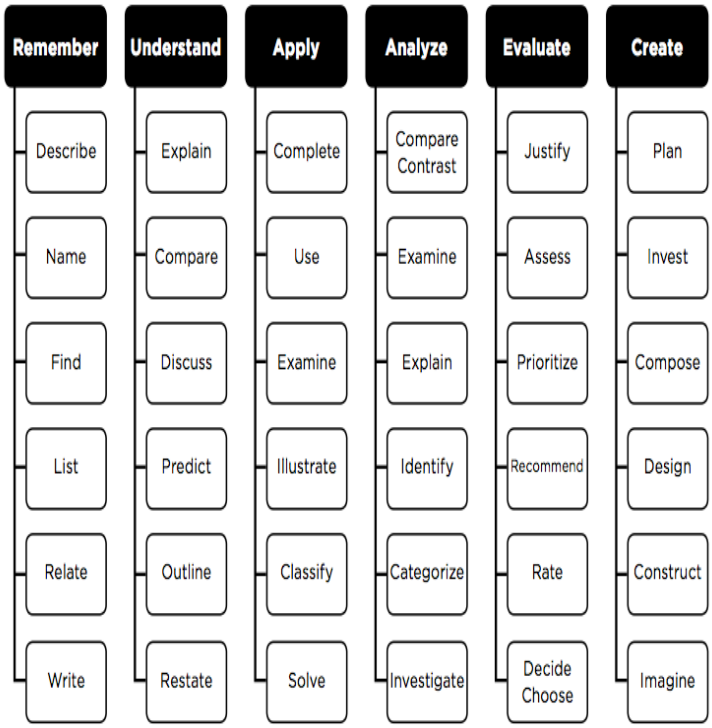

Fig.2 Action words for the cognitive domain (Anderson and Krathwohl 2001)

Learning outcomes can be divided into:

- *Knowledge*
  Knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. Knowledge is described as theoretical and/or factual;
- *Skills*
  Skills mean the ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are categorized as:
  - *Cognitive skills* (involving the use of logical, intuitive and creative thinking);
  - *practical skills* (involving manual dexterity and the use of methods, materials, tools and instruments);
  - *interpersonal skills* (the way of communication, cooperation, etc).

  Attitude
  Attitude means a settled way of thinking or feeling about something. Four major components of attitude are: affective (emotions or feelings), Cognitive (belief or opinions held consciously), Conative (inclination for action), Evaluative (positive or negative response to stimuli).

Figure 3 shows the relationships between knowledge, skills and attitude. The model is also used

to categorize the learning outcomes for Computer Science and Information Technology.

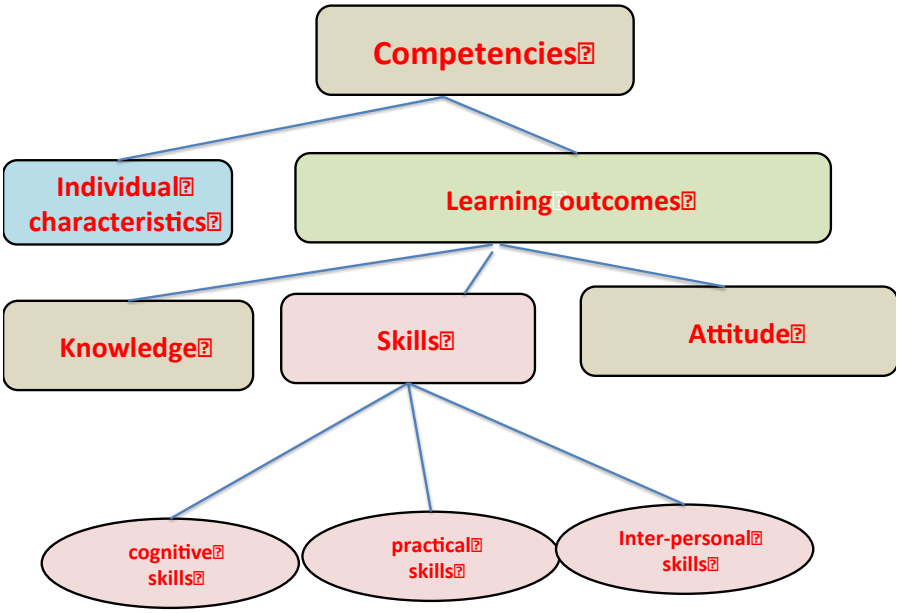

Figure 3: Categorisation of Learning Outcomes

In formulating learning outcomes, a distinction has to be made between *generic* learning outcomes and *subject specific* learning outcomes. *Generic learning outcomes* are those outcomes expected from all academic trained graduates. Examples of generic learning outcomes are: problem solving, communication skills, and ability to cooperate. A key characteristic of a *generic learning outcome* is that you have to practicise it in a specific field. *Subject specific* learning outcomes are those that are typical to that discipline.

2.2.3. Translating learning outcomes into the programme

The next step in the process after the formulation of learning outcomes is to identify what courses[7] are needed to achieve the learning outcomes. A distinction has to be made between the core subjects and the supporting subjects. Establish what is already present in the programme (may be with another name) and what subjects should be added.

To check if the planned courses cover the learning outcomes, it is important to develop a curriculum alignment matrix, an example as shown in Table 1. For each course the specific learning outcomes have to be formulated andone must check how far this course contributes to the achievement of the programme learning outcomes.

[7]In this context Course also means modules and units

Table 2.1: Curriculum alignment matrix

Bachelor programme of Computer Science					
Learning outcomes	*Course 1*	*Course 2*	*Course 3*	*Course 4*	*Course 5*
Communication skills	X		x		
Critical thinking		X		x	x
Problem solving					x
Cooperate/working together	X				
Etc					

2.2.4. Course description

In this document, the learning outcomes both for the basic programme and the major areas of specialisation in Computer Science and Information Technology are provided. Higher education institutions will have to develop the courses, starting with the formulation of the learning outcomes for that specific course. For each course, a clear description should be available. (An example can be found in appendix 1). An essential part of the programme is to assess how far the student has achieved the learning outcomes. Therefore, it is necessary for the HEIs to decide how each learning outcome will be assessed.

2.3. The benchmarks and quality assurance

It is envisaged that the benchmarks will play a significant role in quality assurance of their respective programmes. Although each National Commission or Council applies its own criteria in assessing the quality of programmes, the benchmarks can play a significant role in harmonization of quality assessment and quality assurance at the region level. It is therefore expected that the National Commssions and Councils will ideally align their standards with these benchmarks. The benchmarks also offer external assessment teams a frame of reference in assessing the quality of a programme. For the HEI, the benchmarks offer a good instrument for evaluating the quality of their own programmes.

2.4 . Implementation of the Benchmarks

The implementation of these benchmarks is the responsibility of HEIs and the oversight responsibility is that of the National Commissions and Councils. The choice to follow either a modular or a course unit system is at the discretion of the university. IUCEA will provide the overall coordination and evaluation of the process.

2.5. Review of the Benchmarks

These benchmarks will be subject to review after every five-year period to take care of emerging trends in the environment.

PART 3: BENCHMARKS FOR BACHELOR OF SCIENCE IN AGRICULTURE

3.1 Description of BSc Agriculture

Agriculture in this context is the science and art of growing crops and rearing animals to produce materials needed by human beings. It is a science and an art because knowledge from both disciplines is required in order to optimally utilize the soil, plant and animal resources in the production processes. It is moulded from disciplines that include zoology, botany, soil science, agronomy, mathematics, physics, sociology, geography and economics. The discipline of agriculture consists of five main divisions, namely crop science, animal science, soil science, agricultural engineering, agricultural economics and food science. Crop science deals with all activities involved in the production of crops, and also include the study of plant life. Animal science deals with all activities involved in the rearing of livestock, and also include the study of animal life. Soil science is concerned with the origin of soil, how it interacts with crops and animals, and how it can be kept productive as long as possible. Agricultural engineering is concerned with the production and use of tools, machines, structures, and related processes of post-harvest handling in agriculture. Agricultural and applied economics deals with economic principles of production such as marketing, farm management and agricultural policy.

Agriculture is the driving force of the economies of the East African region. It is the source of food and foreign exchange of the region and the major supplier of raw materials for agro-based industries. In addition, it is the main source of income and employment for the majority of the population. Most parts of the region have fairly fertile soils and suitable climatic conditions that favour agricultural production. Graduates of this programme will take up positions in agro-based and allied industries, agricultural research centres, higher institutions of learning, self-employment, and non-governmental organisations.

3.2 Programme Goal

The goal of BSc Agriculture is to develop intellectual capacity of scientists and equip them with knowledge, practical skills and attitudes to positively influence sustainable agricultural development, nature conservation and judicious utilisation of environmental resources.

3.3. Programme Objectives

The BSc Agriculture programme addresses the concerns of different stakeholders. This can be achieved by focusing on the following categorised programme objectives:

3.3.1. Academic Ability

The programme objectives under this category are to equip learners with:

- Ability to articulate issues dealing with agricultural systems and resource management;
- Working knowledge in crop and animal production;

- Basic sciences linked to or having to do with agriculture;
- Knowledge and scientific skills to enable proper performance
- Leadership skills to assist farmers and other stakeholders
- Practical knowledge of modern agriculture, and be able to incorporate current modern technology and engineering in agriculture
- Sufficient knowledge to handle economic and agribusiness principles along the product value chain.
- Ability to adapt and adopt emerging/evolving agricultural technologies;
- Knowledge and skills for developing effective ways to deal agricultural challenges;
- Ability to undertake research and to pursue higher levels of learning.
- Ability to conduct consultancies and outreach activities

3.3.2. Employability

The programme objectives under this category are to equip learners with:

- Up-to-date agricultural skills for the industry;
- Problem-solving skills for agricultural related tasks;
- Analytical skills to understand impacts of agriculture on individuals, organizations and society;
- Ability to integrate theory and practice to work effectively and efficiently in organizations;
- Knowledge and skills that enable creativity, innovativeness and entrepreneurship in the field of agriculture.

3.3.3 Personal development

The programme objectives under this category are to:

- Prepare learners for life-long learning and research;
- Empower students to progress in their personal career; impart professional ethics to the learner; equip the learner with skills and attitude to work in multicultural and global environments;
- Equip the learner with knowledge and skills to work as a team in the agricultural field;
- Enable the learner to develop skills to perform effectively in technical and non-technical environments.

3.4 Expected Learning Outcomes (ELOs)

To harmonise the BSc Agriculture programme and to make it more coherent and consistent for East Africa, the following student-oriented learning outcomes have been formulated to be used as benchmarks. The purpose of ELOs is to describe clearly what the student is expected to demonstrate after completing the whole programme, a module or a course. It is a statement of the knowledge, skills and attitudes students should have acquired at the end of a programme. In the taxonomy of Bloom, knowledge is the body of facts, principles, theories and practices that is related to a field of work or study; skills is the ability to apply knowledge and use know-how to

complete tasks and solve problems; while altitude is a settled way of thinking or feeling about something.

The formulated ELOs are the threshold: all graduates of the BSc Agriculture programme must achieve them. The higher institutions of learning may consider adding Learning Outcomes as and when necessary in line with their mission and vision or other identified need(s). Table 3.1 outlines the expected learning outcomes for a BSc Agriculture programme.

Table 3.1: Expected learning outcomes for BSc Agriculture programme

Domain	Expected learning outcomes
Knowledge (*Cognitive learning*)	***The graduate should be able to:*** 1. Demonstrate knowledge of agricultural production systems 2. Clearly show adequate knowledge of sciences related to agriculture 3. Demonstrate knowledge to articulate issues dealing with crop and animal production and resource management 4. Demonstrate knowledge to handle issues from production to marketing at all levels of the food value chain
Skills (*Psychomotor learning)*	
Cognitive skills	***The graduate should be able to:*** 5. Exhibit scientific skills to deal with crop and animal management 6. Demonstrate competence to handle issues from production to marketing at all levels of the food value chain
Practical skills	***The graduate should be able to:*** 7. Demonstrate skills to handle issues from production to marketing at all levels of the food value chain 8. Demonstrate ability to work in an agricultural production system
Inter-personal skills	***The graduate should be able to:*** 9. Communicate effectively with farmers and professional colleagues 10. Exhibit leadership skills in agriculture 11. Demonstrate ability to work in research and extension systems 12. Act professionally and ethically in the work environment 13. Be an effective team player
Attitude *(Affective learning)*	***The graduate should demonstrate:*** 14. Self-confidence and ability to adapt to new situations 15. Professionalism in the field of agriculture

3.5 Core and Supporting Courses of BSc Agriculture

A list of core and supporting courses in the programme of BSc Agriculture, are presented in Table 3.2. The subject areas include 54 courses that are segregated into clusters that reflect basic courses such as introductory statistics and ICT. The Table also reflects professional courses in soils and water, agronomics, animal production, marketing, and research methods, while others reflect current trends in agriculturesuch as urban agriculture and biotechnology. A list of core and supporting subject areas for the BSc Agriculture programme is presented in Table 3.2.

Table 3.2: List of Core and supporting subject areas for BSc Agriculture programme

Core subject areas	Supporting subject areas
1. Soil Genesis and Physics	1. Introductory Statistics
2. Soil Chemistry	2. ICT
3. Soil Fertility and Fertilizer Use	3. Communication Skills
4. Soil Microbiology	4. Dryland Farming
5. Agro-climatology	5. Agro-forestry
6. Agricultural Biotechnology	6. Organic Farming
7. Plant Pathology	7. Urban Agriculture
8. Entomology and Nematology	8. Organizational Management and Leadership
9. Weed Science and Management	9. Entrepreneurship Skills
10. Soil and Water Conservation	10. Fundamentals of Econometrics
11. Irrigation and Drainage	11. Agriculture and Food security
12. Soil Survey and Classification	12. Sociology and Development
13. Land Evaluation and Land Use Planning	13. Development Concepts And Social Ethics
14. Agricultural Power and Machinery	
15. Agricultural Structures	
16. Principles of Crop Production	
17. Principles and practices of Horticulture	
18. Agronomy of Annual Crops	
19. Agronomy of Perennial Crops	
20. Pastures and Fodder Crops	
21. Plant Physiology	
22. Biochemistry	
23. Molecular Biology	
24. Genetics and Cytogenetics	
25. Plant Breeding	
26. Principles of Animal Production	
27. Animal Breeding	
28. Animal Health Management	
29. Animal Physiology	
30. Principles of Animal Nutrition	
31. Post-Harvest Physiology and Technologies	
32. Principles of Macro-economics	
33. Principles of Micro-Economics	
34. Farm Management	
35. Agribusiness Management	

36. Agricultural Marketing 37. Agricultural Extension Education 38. Agricultural policy 39. Project Planning and Management 40. Research Methodology 41. Research Project 42. Field Attachment	

Table 3.3: Courses for mainstreaming Aflatoxins in BSc. Agriculture

Course	Aspects to include in the curriculum	Expected Learning Outcomes[8]
1. Soil Microbiology	• Introduction to soil borne fungi with special focus on mycotoxin-producing fungi	Students able to isolate and identify mycotoxin producing fungi
2. Plant Pathology	• Introduced to symptoms caused by mycotoxin-producing fungi; importance of mycotoxins; management of fungi	1. Students able to identify symptoms in crops 2. Students able to isolate and identify mycotoxin producing fungi 3. Students describe mycotoxin-producing fungi management options
3. Principles of Crop Production	• Introduce good agricultural practices (GAPs) for management of fungal diseases with special focus on mycotoxin-producing fungi.	Students to demonstrate competence in GAPs for management of mycotoxin-producing fungi
4. Agronomy of Annual Crops	• GAPs specific to annual crops w.r.t. management of fungal diseases especially management of	Students demonstrate skills in soil and crop disease management especially management of mycotoxin-producing fungi for improved crop quality.

[8] The numbering of the existing outcomes is as indicated in Tables 3.3, 5.3 and 6.3 of the benchmark document

	mycotoxin-producing fungi	
5. Agronomy of Perennial Crops	• GAPs specific to perennial crops with respect to management of fungal diseases especially management of mycotoxin-producing fungi. Special consideration is given to occurrence of fungal pathogens due to perenniability of the crops.	Students demonstrate skills in soil and crop disease management especially management of mycotoxin-producing fungi for improved crop quality.
6. Pastures and Fodder Crops	• Silage preparation and storage of fodder products; introduce issues on mycotoxin-producing fungi and fodder quality	Students are able to apply strategies to minimise and manage the mycotoxin-producing fungi
7. Biochemistry	• Introduce students to the different types of mycotoxins and analysis techniques;	1. Students able to differentiate different mycotoxins 2. Students demonstrate basic knowledge on mycotoxin analysis techniques
8. Molecular Biology	• Introduce the application of molecular techniques for inclusion in crop resistance against	Students demonstrate basic knowledge in application of molecular techniques in crop improvement

	mycotoxin-producing fungi	
9. Principles of Animal Nutrition	• Introduce the effects of mycotoxins on nutrition and health of animals (livestock, poultry, pigs, etc)	1. Students demonstrate basic knowledge on mycotoxins and their sources in animal nutrition 2. Students demonstrate knowledge on the effects of mycotoxins on animal health and quality of animal products.
10. Post-Harvest Physiology and Technologies	• Introduce good postharvest handling, storage and processing practices (GPP); bio deterioration factors and emerging appropriate technologies for the management of mycotoxin-producing fungi and mycotoxins.	1. Students demonstrate knowledge of GPP 2. Students demonstrate knowledge of the effects of bio-deterioration factors. 3. Students demonstrate knowledge of appropriate technologies for management of mycotoxins and mycotoxin-producing fungi.
11. Agricultural Extension Education	• Introduce proper communication to relevant stakeholder groups on importance of mycotoxins on health and trade and available management options	1. Students demonstrate ability to effectively communicate on the importance of mycotoxins in society 2. Students demonstrate ability to effectively communicate on the effect of mycotoxins on trade 3. Students demonstrate ability to effectively communicate on available mycotoxin management options.
12. Organic Farming	• Introduce good agricultural practices (GAPs) in organic farming; hygiene and safety of	1. Students to demonstrate knowledge in GAPs in organic farming 2. Students demonstrate competence in hygienic and safe use of organic products. 3. Students clearly show adequate knowledge in the management of

	organic products; and options for managing fungal diseases with special focus on mycotoxin-producing fungi;	fungal diseases especially mycotoxin-producing fungi.
13. Urban Agriculture	• Introduce GAPs in urban agriculture with respect to mnagement of fungal diseases especially management of mycotoxin-producing fungi.	Students demonstrate skills in soil and crop disease management especially management of mycotoxin-producing fungi for improved crop quality.

3.6 Translating learning outcomes into BSc Agriculture programme

This involved the development of a curriculum alignment matrix for the programme to check if the planned courses in Table 3.2 cover the learning outcomes suggested in Table 3.1. For each course, the specific learning outcome was formulated and indicated by a 'tick'. The extent to which a given course contributed to the achievement of the learning outcomes could be assessed (or checked) through the number of 'ticks' observed for it in the matrix. The curriculum alignment matrix for BSc Agriculture is presented in Table 3.4 below.

Table 3.4: Curriculum alignment matrix for BSc Agriculture Programme

S/no	Course Title (See Table 3.2)	Expected Learning Outcomes (See table 3.1)														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1.	Introductory Statistics		√			√										
2.	ICT			√	√	√				√						√
3.	Communication Skills	√	√	√	√					√	√	√			√	√
4.	Soil Genesis and Physics	√	√	√		√		√								
5.	Soil Chemistry	√	√	√		√		√								
6.	Soil Fertility and Fertilizer Use	√	√	√		√		√								
7.	Soil Microbiology	√	√	√		√		√								
8.	Agro-climatology	√	√	√	√		√	√	√							
9.	Agricultural Biotechnology	√	√	√	√	√										
10.	Plant Pathology	√	√	√		√		√	√							
11.	Entomology and Nematology	√	√	√	√											
12.	Weed Science & Management	√	√	√		√		√								

13.	Soil and Water Conservation	√	√	√		√		√	√							
14.	Irrigation and Drainage		√			√		√								
15.	Soil Survey and Classification	√	√	√		√		√								
16.	Land Evaluation and Land Use Planning	√	√	√	√	√		√								
17.	Agricultural Power and Machinery	√	√	√		√		√								
18.	Agricultural Structures	√	√	√	√	√		√								
19.	Principles of Crop Production	√	√	√	√	√	√	√	√							
20.	Principles and Practices of Horticulture	√	√	√	√	√	√	√	√							
21.	Agronomy of Annual Crops	√	√	√	√			√	√							
22.	Agronomy of Perennial Crops	√	√	√	√			√	√							
23.	Pastures and Fodder Crops		√			√		√								
24.	Plant Physiology	√	√	√		√		√								
25.	Molecular Biology		√			√										
26.	Genetics and Cytogenetics		√			√										
27.	Plant Breeding		√			√										
28.	Dryland Farming	√	√	√	√	√	√	√								
29.	Agro-forestry	√	√	√	√	√	√	√	√							
30.	Organic Farming	√	√	√	√	√	√	√	√							
31.	Urban Agriculture	√	√	√	√	√	√	√	√							
32.	Principles of Animal Production	√	√	√	√	√	√	√	√							
33.	Animal Breeding	√	√	√	√			√	√							
34.	Animal Health Management	√	√	√	√			√	√							
35.	Animal Physiology	√	√	√	√											
36.	Principles of Animal Nutrition	√	√	√		√		√	√							
37.	Post-Harvest Technologies	√	√	√	√	√	√	√	√							
38.	Principles of Macro-economics	√	√	√	√	√	√	√								
39.	Principles of Micro-Economics	√	√	√	√	√	√	√								
40.	Farm Management	√	√	√	√	√	√	√		√	√		√	√		
41.	Agribusiness Management	√	√	√	√	√	√	√								
42.	Agricultural Marketing	√	√	√	√		√									
43.	Agricultural Extension Education	√	√	√	√		√			√	√	√	√	√	√	√
44.	Agricultural policy	√	√	√	√		√									
45.	Organizational Management and Leadership				√		√		√	√	√	√	√	√	√	√
46.	Entrepreneurship Skills				√		√	√		√						
47.	Fundamentals of Econometrics	√	√	√	√	√	√	√								
48.	Agriculture and Food security	√	√	√	√		√									
49.	Sociology and Development	√		√			√			√		√	√	√		√
50.	Development Concepts And Social Ethics			√					√	√	√	√	√	√	√	√
51.	Project Planning and Management	√	√	√		√	√	√								
52.	Research Methodology	√	√	√	√	√	√	√	√							
53.	Research Project	√	√	√	√	√	√	√	√	√		√	√	√		
54.	Field Attachment	√	√	√	√	√	√	√	√	√		√	√	√		

3.7 Role of Field Attachment and Research Project

3.7.1 Field Attachment

Field attachment is intended to expose a student pursuing BSc Agriculture to real-world experience and potential employment opportunities. The attachment should be compulsory and last for not less than eight weeks. Field attachment exposes the student to the practical and daily operations of crop and animal production chains. The student is placed in private and government farming enterprise or institution to relate what was learnt in the classroom with actual field situations.

The student is assessed by an immediate supervisor at the attachment place and at least one university academic staff who visits the student during that period. The academic staff is also able to understand challenges and opportunities in the field, which can be used to formulate possible research projects to assist the society and review of the curriculum. The organisation where the student is attached is also able to beneficiary interact with the university community. The student is expected to fill-in all daily activities in a log-book. At the end of the attachment period, a report documenting the experience acquired by the student is submitted. Such a report, including the log-book and the two field assessments, are used to grade the student.

3.7.2 Research Project

Research project is intended to give a student an opportunity to apply knowledge acquired in class to solve a research problem. The student should formulate a research proposal prior to the final year and implement it during their final year of study under supervision of an academic staff. The project involves identification of the problem, setting up of objectives, literature review, experimental design, data collection and analyses, and report writing. At the end of the programme, a student shall submit a final project report, make an oral presentation to demonstrate knowledge and understanding in the study area.

PART 4: BENCHMARKS FOR BACHELOR OF SCIENCE IN HORTICULTURE

4.1 Description of Horticulture

Horticulture is an art and science of growing vegetables (olericulture), fruits (pomology), ornamental plants (floriculture), spices and aromatic plants. It also encompasses utilization of plants in beautification and landscape designs for their aesthetic values. Degree programme in horticulture is designed to develop the knowledge and skills required to integrate the challenges of food security, sustainable production, preservation of biodiversity, climate change and human well-being.

Graduates with horticulture degrees have a thorough understanding of plant manipulation and production methods and of the underpinning scientific, economic and business principles. They are able to identify technological and economic problems encountered in current production systems, evaluate new techniques and, where appropriate, apply them to commercial practice. Graduates may go on to manage horticultural enterprises and related businesses, operate in

international trade and production systems, manage amenity landscapes or be involved in closely related public and commercial research and advisory work.

4.2 Programme Goal

To prepare competent graduates that are able to integrate horticultural components in farming systems; to understand farmers' circumstances and provide technical solutions compatible with the available resources; conversant with different types of horticultural industries, from the small holder farmer and cooperative level to large scale corporate production, as well as from field/greenhouse production to market and export aspects. The graduate should also master planning, organization, management and administrative tasks related to horticultural production.

4.3 Programme Objectives

The Bachelor of Science Horticulture degree programme is designed to address the concerns of different stakeholders in the horticulture industry. This can be achieved by focusing on the following grouped programme objectives:

4.3.1 Academic Ability

The programme objectives under this category are to equip learners with:

- Knowledge and skills on the significance of ornamentals, fruits and vegetables in the family and national economy
- Practical skills on raising production and value addition, improving marketing of horticultural crops and products on both small and large-scale farms.
- Skills to develop and offer learning processes that enable progression to higher level studies

4.3.2 Employability

The programme objectives under this category are to:

- Prepare learners to meet the requirements for employability in the horticultural sector labour market
- Equip learners with managerial and appropriate technical skills and practices in a horticultural business
- Equip learners with knowledge and skills that enable creativity, innovativeness and entrepreneurship in the field of horticulture

4.3.3 Personal Development

The programme objectives under this category are to:

- Empower learners in their personal career development
- Prepare learners for life-long learning, research and entrepreneurship
- Equip learners with skills and attitudes to work as a team in multicultural, gender-sensitive and global environments

- Impart learners with professional ethics to be respectful of consumers' rights and the same time conserve the environment

4.4 Expected Learning Outcomes (ELOs)

Learning Outcomes are statements that describe the knowledge and attitudes that learners should have after successfully completing a learning experience or programme. Harmonization of the Bachelor of Science Horticulture programme in the East African region is required for coherence and consistency. The formulated ELOs are thresholds that all the Bachelor of Science Horticulture graduates are expected to achieve. In addition, individual universities are also expected to develop their own ELOs to reflect specific content to meet local horticultural needs. The following learning outcomes have been formulated to be used as benchmarks (Table 4.1).

Table 4.1: Attributes and Expected Learning Outcomes for a Bachelor of Science in Horticulture

Attributes	Expected Learning Outcomes
Knowledge	The graduate should be able to:
	1. Demonstrate knowledge to handle issues from the production, marketing at all levels of the value chain in the horticultural sector
	2. Demonstrate knowledge on issues dealing with horticultural specialties: floriculture, pomology, olericulture, spices, urban horticulture, and landscape design
	3. Demonstrate familiarity with current theory in the field of horticulture and the ability to integrate theory with practical skills
	4. Demonstrate knowledge of current innovations and appropriate technologies in horticulture
	5. Demonstrate knowledge and understanding of how global emerging issues including climate change, energy use, water availability, and/or food safety impact sustainability of horticultural systems locally, nationally, and globally
	6. Demonstrate knowledge for economic importance of plants in managed ecosystems and the impact of horticultural crops in food systems
	7. Demonstrate knowledge in economic and business principles on issues dealing with horticultural specialties
Skills	
Cognitive skills	The graduate should be able to:
	8. Analyze horticultural problems from various domains,
	9. Use multiple sources, including current and older literature, to find, evaluate, organize, and manage information related to horticultural systems
Practical skills	The graduate should be able to:
	10. Coordinate and supervise the development of a horticulture business
	11. Design appropriate solutions for horticultural problems and implement the solution to agreed standards.
	12. Demonstrate competence with laboratory and/or field-based technologies used in modern horticulture

	13. Apply concepts of horticulture science to select, manage, and improve plants and their products
	14. Exhibit scientific skills to deal with horticultural systems and management
Interpersonal skills	The graduate should be able to:
	15. Communicate effectively with various audiences using oral, written, and visual presentation skills, and contemporary networking/social media technologies
	16. Demonstrate the ability to transfer knowledge and technology to other stakeholders
	17. Demonstrate ability to influence policies in the horticultural sector
Attitude	The graduate should be able to:
	18. Demonstrate the ability to work ethically and professionally as an individual or within a team
	19. Develop thoughtful, clear, and consistent perspectives on ethical and moral issues related to horticulture
	20. Demonstrate the ability to exploit available resources for self learning and learn from experience

4.5 Translating the learning outcomes into Bachelor of Science Horticulture courses

In this section, the Bachelor of Science Horticulture programme is translated into core and supporting courses (Table 4.2).

- *Core Courses*

  These are essential courses offering a thorough foundation of horticulture. They constitute the backbone of the horticulture discipline and are mandatory for every student.

- *Supporting Courses*

  These are courses for backing up the core courses. They enable a learner to understand the core courses. Those courses are also compulsory for all students.

Table 4.2: A list of core and supporting courses for Bachelor of Science Horticulture

No	Core Courses	No	Supporting Courses
1	Principles and practices of horticulture	1	Communication skills
2	Agricultural botany	2	Information technology
3	Agricultural microbiology	3	Statistics
4	Plant physiology	4	Extension methods
5	Agricultural entomology	5	Horticultural Policies and Legislations
6	Plant propagation and nursery management	6	Entrepreneurship
7	Genetics	7	Biometrics
8	Plant pathology		
9	Agribusiness management		
10	Weed science and management		
11	Integrated Pest Management		
12	Fundamentals of soil science		

13	Irrigation and drainage		
14	Farm power and machinery		
15	Horticultural structures		
16	Principles of vegetable production		
17	Principles of fruit production		
18	Spices and aromatic crops		
19	Ornamental crops		
20	Vegetable crop production		
21	Fruit crop production		
22	Postharvest physiology and Technologies		
23	Landscape design and management		
24	Plant breeding		
25	Plant biotechnology		
26	Plant nutrition and management		
27	Horticultural mechanization		
28	Agro-meteorology		
29	Field attachment		
30	Research methods		
31	Research project		

Table 4.3: Curriculum alignment matrix for Bachelor of Science in Horticulture

Bachelor of Science in Horticulture Programme																					
	Courses	**Learning Outcomes**																			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	Core courses																				
1	Principles and practices of horticulture	v	V	V																	
2	Agricultural botany		V	V																	
3	Agricultural microbiology		V	V																	
4	Plant physiology		V	V																	
5	Agricultural entomology		V	v		v															
6	Plant propagation and nursery management	v	V	v	V							V	v	v	v						
7	Genetics		V	v																	
8	Plant pathology		V	v		v															
9	Agribusiness management	v					v	v			v										
10	Weed science and management	v	V			v															
11	Integrated Pest Management	v	V	v		v						V	v	v					v	v	
12	Fundamentals of soil science	v	V																		
13	Irrigation and drainage	v	V		V				v			v	v		v						
14	Farm power and machinery	v	V		V				v			v	v		v						
15	Horticultural structures	v	V		V	v			v			v	v		v						
16	Principles of vegetable production	V	v	v																	
17	Principles of fruit production	V	V	v																	
18	Spices and aromatic crops	V	V	v	V	v					v	v	v	v	v						

19	Ornamental crops	V	V	v	V	v					v	v	v	v	v						
20	Vegetable crop production		V	v	V	v					v	v	v	v	v						
21	Fruit crop production		V	v	V	v					v	v	v	v	v						
22	Postharvest physiology and management	V	V	v	V	v			v		v	v	v		v						
23	Landscape design and management		V		V				v												
24	Plant breeding		V		V	v								v							
25	Plant biotechnology		V		V	v								v							
26	Plant nutrition and management		v									v	v	v	v						
27	Horticultural mechanization		v		V								v								
28	Agro-meteorology		v			v															
	Support courses																				
29	Communication skills									V						v	v				
30	Information technology				V	v															v
31	Statistics						v	v	v	V											
32	Research methods								v			v			v						
33	Research project								v			v			v						
34	Extension methods															v	v		v	v	
35	Horticultural Policies and Legislations																	v	v	v	
36	Field attachment											v	v		v						
37	Entrepreneurship							v			v										
38	Biometrics								V			v			v						

Table 4.4. Explanation of the numbers in Table 4.3

1. Demonstrate knowledge to handle issues from the production, marketing at all levels of the value chain in the horticultural sector
2. Demonstrate knowledge on issues dealing with horticultural specialties: floriculture, pomology, olericulture, spices, urban horticulture, and landscape design
3. Demonstrate familiarity with current theory in the field of horticulture and the ability to integrate theory with practical skills
4. Demonstrate knowledge of current innovations and appropriate technologies in horticulture
5. Demonstrate knowledge and understanding of how global emerging issues including climate change, energy use, water availability, and/or food safety impact sustainability of horticultural systems locally, nationally, and globally
6. Demonstrate knowledge for economic importance of plants in managed ecosystems and the impact of horticultural crops in food systems
7. Demonstrate knowledge in economic and business principles on issues dealing with horticultural specialties
8. Analyze horticultural problems from various domains,
9. Use multiple sources, including current and older literature, to find, evaluate, organize, and manage information related to horticultural systems
10. Coordinate and supervise the development of a horticulture business
11. Design appropriate solutions for horticultural problems and implement the solution to agreed standards.
12. Demonstrate competence with laboratory and/or field-based technologies used in modern horticulture
13. Apply concepts of horticulture science to select, manage, and improve plants and their products
14. Exhibit scientific skills to deal with horticultural systems and management
15. Communicate effectively with various audiences using oral, written, and visual presentation skills, and contemporary networking/social media technologies
16. Demonstrate the ability to transfer knowledge and technology to other stakeholders
17. Demonstrate ability to influence policies in the horticultural sector
18. Demonstrate the ability to work ethically and professionally as an individual or within a team
19. Develop thoughtful, clear, and consistent perspectives on ethical and moral issues related to horticulture
20. Demonstrate the ability to exploit available resources for self learning and learn from experience

4.6 Role of Field attachment and Research Project

4.6.1 Field attachment

The purpose of the course is to equip the learners with:

- Knowledge, skills and attitudes that will enable them to link class activities with job market expectations
- Skills to enable them to apply the principles learnt in class to the real world situations,
- Skills to enable them to address the challenges faced with in the work place

- Knowledge enabling them to understand horticultural institutional organizational setup and their applications.

This is attained by students being attached to agricultural /horticultural farms, industries and institutions where they will gain relevant experience in production, processing and marketing of horticultural crops/products.

At the end of the attachment period, the learner should submit a report which will be graded on Pass or Fail basis. In addition, the supervisor in the horticultural firm submits an evaluation report. The evaluation may include but not limited to, attitude towards work, work initiative, quality of work, adaptability, dependability, cooperation, attendance and professionalism.

4.6.2 Research Project

The purpose is to equip the learners with the skills in designing a scientific study, implementing it, collecting and analyzing the data to help solve a practical problem in horticulture. It involves development of proposal relevant to problem identification and or finding solutions related to horticultural issues. The project can be conducted as laboratory activity, field experiment, or survey. The project is conducted under the close supervision and consultation with qualified academic staff. The assessment involves evaluation of the proposal, on-site evaluation, and final project report. The work is done by students on individual basis.

PART 5: BENCHMARKS FOR BACHELOR OF SCIENCE IN ANIMAL SCIENCE

5.1. Description of BSc Animal Science

Animal sciences deal with the study of domestic animals, researching the structure, development, way of life and their relationship with the environment. The focus of the animal sciences discipline is to offer knowledge about breeding, growth, improvement and utilization of domestic animals. Animal sciences study improvement methods that ensure proper nutrition feeding, breeding, conservation and preservation of livestock.

The animal sciences discipline integrates theories and concepts from biology, chemistry, agriculture and veterinary medicine. Courses include topics on domestic animal biology, animal genetics, immunology in animal health and disease, animals in biomedical research, production systems for improvement and value addition of the livestock products and by products.

Graduates in animal sciences programme are able to combine and analyze knowledge from biochemistry, anatomy and genetics with concepts from economics, management, and marketing. They will also develop skills on how to design, organize and manage animal farms and animal production processes in all species of domestic animals. Animal scientists will learn computer skills as they have to analyze data and make use of statistical techniques.

5.2. Programme goal

The goal of B.Sc. Animal Science programme is to build capacity for enhanced and sustainable development of the animal industry in the East African region. It enables the learner appreciate animal science as a business and an investment profession where farmers and agro-industrialists make profits to improve their quality of life among the diversified communities. In addition, graduates will be given an opportunity to broaden and deepen their knowledge in body system functions, humane and sustainable management of livestock and its environment, feeds and feed management, animal genetic resource and technologies for improving the efficiency of livestock production. Graduates may seek employment in the food and feed industries, in academic teaching and research, and in governmental and nongovernmental agencies.

5.3. Programme objectives

The B.Sc. Animal science programme is designed in such a way that it addresses the concerns of the various stakeholders. This is reflected in the programme objectives. The objectives have been grouped in the following categories:

5.3.1 Academic Ability

The graduate should be able to:

- Understand basic sciences linked to or having to do with Animal Science
- Have knowledge on animal production, animal health management, and public health

- Understand economic and business principles in animal production
- Have practical knowledge on livestock production systems, resource management and current technology
- Have sufficient knowledge to handle economic and agribusiness principles along the product value chain
- Have practical and scientific skills enabling proper performance
- Be equipped with communication and leadership skills to assist farmers and other stakeholders

5.3.2. Employability

Graduates from the programmes will be able to:

- Support research activities in livestock and related research institutions and laboratories in government and private sector
- Support the private sector businesses such as animal feed industry and farms
- Support agricultural programmes in tertiary institutions and universities
- Provide extension services through government and non-governmental organizations that support the livestock sector
- Initiate business and consultancy along the various livestock value chains
- Knowledge of Animal Science in Agricultural development
- Ability to use scientific principles to develop solutions for the optimization of farm animal production systems;
- Ability to analyze problems associated with production and marketing of animal products
- Knowledge of biological and social systems to enable them design suitable solutions encountered in animal farming systems.

5.3.3. Personal development

The programme is intended to:

- Prepare learners for lifelong practice in the field of animal science
- Empower learners to develop and guide farm business planning, enterprise selection and combination for financially viable agribusinesses
- Be able to intellectually participate in public discussions in matters of crop-animal-water-atmosphere interactions;
- Guide the learner in policy formulation related to domestic animal production and the entire value chain;
- Enable the learner to mobilize communities for agricultural development projects
- Equip with skills to conduct independent scientific investigations in Animal science and production.

5.4. Expected learning outcomes (ELOs)

To harmonize the bachelors programme in animal science to make it coherent and consistent for the East Africa, the following learning outcome have been formulated to be used as benchmarks. The formulated ELOs are the minimal threshold the graduates of the bachelors programme in animal sciences must achieve. Table 5.1 outlines the expected learning outcomes for Bachelor of science animal sciences.

Table 5.1: Expected learning outcomes for BSc. Animal Science

Domain	Expected learning outcomes
Knowledge	*The graduate should be able to:* 1. Demonstrate knowledge and an understanding of sciences related to animal production 2. Demonstrate knowledge of economic principles in livestock production systems 3. Demonstrate knowledge of business principles in livestock production systems 4. Demonstrate knowledge on livestock production systems 5. Demonstrate knowledge on livestock products value chain
Skills	
Cognitive	*The graduate should be able to:* 6. Apply acquired skills to various aspects of livestock production systems 7. Organize value addition for livestock products
Practical	*The graduate should be able to:* 8. Apply acquired knowledge on existing technology in livestock resource management 9. Apply acquired knowledge on existing technology in feed resource management 10. Manage, preserve and process animal products 11. Carry out basic husbandry operations 12. Institute measures for prevention and control of animal diseases 13. Design and implement solution for specific livestock production problems 14. Deploy appropriate tools and technology for animal products value addition
Interpersonal	*The graduate should be able to:* 15. Communicate effectively and exhibit leadership skills in animal science 16. Act professionally and ethically in the work environment 17. Demonstrate self-confidence and ability to adapt to new situations
Attitude	*The graduate should demonstrate:* 18. Open mindedness 19. Commitment to life-long learning, self and professional development

5.5. Translating the learning outcomes into the programme

5.5.1. Core course

These are the essential courses which are the fundamental foundation on which the learners will build their careers (table 5.2). They are mandatory for every student (table 5.2).

5.5.2. Supporting courses

These are courses which are essential to enable the learner to understand the core courses as well as assuring their application of the modern technological development in the field of animal sciences (table 5.3).

5.5.3. Elective courses

After core and supportive courses the following elective courses could enhance competences of a graduate in Animal Science. The emphasis given to these courses may vary among Universities in East Africa (table 5.3).

Table 5.2. Core courses of Bachelor of Science in animal science

Core courses	
1. Introduction to Animal Production and Health	1. Farm managements and accounts
2. Basic Anatomy and Physiology of Farm animals	2. Animal feeds and feeding
3. Basic Animal Genetics	3. Beef Cattle Management
4. Chemistry	4. Small Ruminant Management
5. Biochemistry	5. Pig Production
6. Introductory soil science	6. Poultry production
7. Botany	7. Dairy Cattle Management
8. Zoology	8. Aquaculture
9. Ecology	9. Apiculture
10. Farm power and machinery	10. Rabbit production
11. Agro-Meteorology	11. Camel and equine production
12. Parasitology and Entomology	12. Non-conventional animals production
13. General Microbiology	13. Animal welfare and ethics
14. Basic Farm Animal Skills	14. Animal Products and processing
15. Animal Nutrition	15. Climate and livestock production
16. Pasture management	16. Research methodology
17. Range management	17. Research project
18. Farm structures	18. Field/ Industrial attachment
19. Animal diseases	19. Reproductive Physiology and Assisted reproductive techniques
20. Principles of Animal Breeding	20. Animal growth and development

21. Biometrics	21. Livestock production economics

Table 5.3. Supportive and elective courses Bachelor of Science in animal science

Supportive courses	Elective courses
1. Basic Mathematics	11. Introductory Sociology
2. Introductory statistics	12. Geoscience and land use planning
3. Computer applications	13. Organic production systems
4. Development studies	14. Management of Livestock Wastes
5. Introduction to Agricultural Economics	15. Principles of Administration & Management
6. Gender in Agriculture Development	16. Agroforestry
7. Agricultural Extension	17. Programme development and evaluation
8. Agribusiness and Entrepreneurship Development	18. Agricultural Marketing Management
9. Livestock Policies and Legislations	
10. Communication skills	

Table 5.4: Courses and Learning Outcomes for Mainstreaming Aflatoxins into BSc. Animal Science

Course	Aspects to include in the curriculum	Expected learning outcomes
1. Biochemistry	Introduce students to different types of mycotoxins and analysis techniques;	Learners demonstrate basic knowledge on mycotoxins associated with animal feeds and analysis techniques.
2. General Microbiology	Introduction to fungi with special focus on mycotoxin-producing fungi	Student should demonstrate knowledge, principles and concepts related to quality and safety of animal feeds and animal products.
3. Animal Nutrition	Introduce the effects of mycotoxins on nutrition and health of animals (livestock, poultry, pigs, etc)	Learners demonstrate knowledge of mycotoxins in animal health and nutrition.
4. Pasture management	Introduce effects of mycotoxins on quality of feed resources. Preparation and storage of silage and fodder, as well as feed resources prone to mycotoxin contamination.	Learners demonstrate knowledge on strategies to ensure quality and safety of feed resources. .

5. Animal feeds and feeding	Introduce quality feed formulation to reduce mycotoxin contamination.	1. Learners demonstrate knowledge on animal feeds and feeding standards 2. Learners demonstrate knowledge of effects of quality and safety of feeds on animal health and nutrition.
6. Pig Production	Introduce quality feed formulation to reduce the effects of mycotoxin on pigs	Learners demonstrate knowledge of quality and safety of livestock feeds and feeding resources.
7. Poultry Production	Introduce quality feed formulation to reduce the effects of mycotoxins on poultry	Learners demonstrate knowledge of quality and safety of livestock feeds and feeding resources.
8. Dairy Cattle Management	Introduce quality feed formulation to reduce the effects of mycotoxins on dairy cattle	Learners demonstrate knowledge of quality and safety of livestock feeds and feeding resources.
9. Basic Aquaculture	Introduce quality feed formulation to reduce the effects of mycotoxins on fish.	Learners demonstrate knowledge of quality and safety for feeds and feeding resources.
10. Rabbit production	Introduce quality feed formulation to reduce the effects of mycotoxins on rabbits	Learners demonstrate knowledge of quality and safety for feeds and feeding resources.
11. Animal Products and processing	Monitoring and assessment of mycotoxin levels in animal products	1. Learners demonstrate knowledge of quality and safety requirements for animal products. **2.** Learners are able to monitor and assess hazards in animal products.

Table 5.5: Expected learning outcomes and the curriculum alignment matrix for BSc. Animal Science

Course		Expected Learning outcomes																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Introduction to Animal Production and Health	X																		
2	Anatomy and Physiology of Farm animals	X																		
3	Principles Animal Genetics	X							X											
4	Chemistry	X																		
5	Biochemistry	X						X												
6	Introductory soil science	X																		
7	Botany	X																		
8	Zoology	X																		
9	Ecology	X			X															
10	Farm power and machinery	X								X										
11	Agro-Meteorology	X								X										
12	Parasitology and Entomology	X											X							
13	General Microbiology	X						X			X		X							
14	Farm Animal Practical Skills						X													
15	Animal Nutrition	X								X										
16	Pasture management									X										
17	Range management									X										
18	Farm structures						X						X							
19	Animal diseases											X	X							
20	Principles of Animal Breeding								X											
21	Reproductive Physiology and Assisted reproductive techniques	X							X											
22	Biometrics	X					X							X						
23	Animal growth and development	X					X	X	X											
24	Livestock production economics		X	X		X	X	X												
25	Farm managements and accounts		X	X		X	X	X												
26	Animal feeds and feeding	X								X		X		X						
27	Beef Cattle Management	X		X	X	X	X		X	X		X								
28	Small Ruminant Management	X		X	X	X	X		X	X		X								
29	Pig Production	X		X	X	X	X		X	X		X								
30	Poultry production	X		X	X	X	X		X	X		X								

31	Dairy cattle Management	X		X	X	X	X		X	X		X								
32	Basic Aquaculture	X		X				X		X	X				X					
33	Apiculture	X		X		X		X			X		X		X					
34	Rabbit production	X		X	X	X	X		X	X		X								
35	Camel and equidae Management	X		X	X	X	X		X	X		X								
36	Non-conventional Livestock farming			X		X		X			X	X								
37	Animal welfare and ethics	X															X			
38	Animal Products and processing	X				X		X			X				X					
39	Climate and livestock production	X			X		X		X	X			X					X		
40	Research methodology	X					X							X		X				
41	Research project	X					X							X		X				X
42	Field/ Industrial attachment	X					X					X		X		X	X	X	X	X
43	Basic Mathematics	X																		
44	Introductory statistics	X												X						
45	Computer applications	X												X		X				
46	Development studies	X														X	X	X		X
47	Introduction to Agricultural Economics	X	X	X	X	X														
48	Gender in Agriculture Development																X		X	
49	Agricultural Extension															X	X	X	X	X
50	Agribusiness and Entrepreneurship Development	X	X	X		X		X						X		X	X	X	X	X
51	Livestock Policies and Legislations				X												X	X		
52	Communication skills															X	X	X	X	X
																X	X			

Explanation of the numbers in Table 5.5

1. Demonstrate knowledge and an understanding of sciences related to animal production
2. Demonstrate knowledge of economic principles in livestock production systems
3. Demonstrate knowledge of business principles in livestock production systems
4. Demonstrate knowledge on livestock production systems
5. Demonstrate knowledge on livestock products value chain
6. Apply acquired skills to various aspects of livestock production systems
7. Organize value addition for livestock products
8. Apply acquired knowledge on existing technology in livestock resource management
9. Apply acquired knowledge on existing technology in feed resource management
10. Manage, preserve and process livestock products
11. Carry out basic husbandry operations
12. Institute measures for prevention and control of animal diseases
13. Design and implement solution for specific livestock production problems
14. Deploy appropriate tools and technology for livestock products value addition
15. Communicate effectively and exhibit leadership skills in animal science
16. Act professionally and ethically in the work environment
17. Demonstrate self-confidence and ability to adapt to new situations
18. Open mindedness
19. Commitment to life-long learning, self and professional development

5.6. Field attachment and Research Project

5.6.1. Field attachment

Field attachment is intended to expose students pursuing BSc Animal Science to real-world experience and potential employment opportunities. The attachment should be compulsory and last for not less than eight weeks. During this time, students link their learning with the real-world experience. This provides them with exposure to the practical and daily operations of animal production systems. Students are placed in private industries and government institutions so that they can relate what they have learnt in the classroom with actual field situations. While in the field the supervisors evaluate them on their altitude to work, skills application, cooperation in the work place and attendance .At the end of the attachment a report documenting the experience acquired by the student is submitted and graded.

5.6.2. Research Project

Research project is intended to have students apply knowledge acquired in class to analyze a research problem, design and manage a research project, collect and analyze data and write a scientific report under supervision of an academic staff. It involves development of a proposal relevant to problem identification and/ or finding solutions related to livestock issues. It is

mandatory and the work is done by students on individual basis. The assessment entails grading of the proposal, oral presentation and final report.

PART 6: BENCHMARKS FOR BACHELOR OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY

6.1 Description of Food Science and Technology

Food Science and Technology degree programme is designed to empower learners with an understanding of food materials, nutritional quality, biological, chemical and physical characteristics of foods and the impact of food storage and processing. The program emphasizes on development of skills and competences in management of food and environmental safety concerns. The learners should have competences to handle issues of value addition of produce and postharvest quality management from the farm to the folk. The graduates from the program must be equipped with creativity and innovation skills in tackling food security and health issues related to foods. The graduates of Food Science and Technology must be able to take up positions as trainers and consultants in institutions of learning for capacity building proficiency in food industry and operations and management. The program must be able to produce professionals in food science and technology with competences to solve food and nutrition related problems through research, and translate them into business opportunities as entrepreneurs.

6.2. Program Goal

The goal of this program is to equip the Food Science and Technology graduate with knowledge and skills to create, innovate, and apply Food Science and Technology discipline to hold leadership position in the industry, academia and government in problem solving through research and entrepreneurial initiatives to make tangible impact on the health of people's diet. The goal specifically entails the following:

Fundamental concepts and specific skills in Food Science and Technology: . To possess comprehensive knowledge in Food chemistry concerned with the analytical, biochemical, chemical, physical, nutritional, and toxicological aspects of food and its ingredients; Food microbiology and food safety; Food processing dealing with application of scientific, engineering, and economic principles to food processes and food processing equipment; Food technology involving the application of modern scientific and engineering principles in the preservation and distribution of food; Food sensory analysis concerned with the attributes of food that makes it a success in the market.

Food science and Technology specific skills: the ability to use critical knowledge and understanding of the theoretical and practical aspects of nutrition based food science and technology and their relationship to human health

Inculcate cognitive, analytical and application oriented skills and competencies in tackling food related problems.

Produce graduates who as practitioners should have competencies and capabilities of food scientists, researchers able to nurture entrepreneurial initiatives.

6.3. Program objectives

The degree program in Food Science and Technology should address the concerns of different stakeholders and actors in food value chain.

6.3.1. Academic ability

- Develop effective communication skills to write technical reports, read and interpret data's
- Equip graduates with ability to integrate knowledge, skills and competencies with theoretical and experiential learning
- Develop higher cognitive skills to apply: scientific method to food science problems; quantitative reasoning skills to food science data; critical thinking and analytical evaluation to contemporary food science information and literature; food science to solve related problems
- Equip graduates with knowledge to undertake research, consultancy and training pertaining to food science and technology
- Prepare learners to undertake research and further advanced levels of knowledge through postgraduate studies

6.3.2 Employability

- To equip learners with excellent communication skills to express and sell ideas
- To utilize managerial and entrepreneurial skills in the field of Food Science and Technology
- To equip learners with experiential skills and prepare a workforce with the required job specified skills needed by the food industry to be competent personnel's or entrepreneurs.

6.3.3 Personal Development

- Prepare for lifelong learning by appreciating the evolving information, knowledge and technology in Food Science and Technology to think independently and solve problems to equip oneself and participate in research and consultancy activities
- To impart knowledge to uphold and cherish professional ethics in food science and technology
- To foster community learning by enhancing positive learning in multicultural setup to value time management by utilizing results based management (RBM) approach
- To adopt the use of computers in the field of Food Science and Technology

6.4: Expected learning outcomes

In order to harmonize the program of Food Science and Technology and make it more consistent and coherent in the EAC, the following learning outcomes (ELOs) have been identified as found in Table 6.1. The ELOs are the minimum thresholds that the graduates of food science and technology in EAC must achieve. Besides, the graduates must also achieve the ELOs for the supportive, experiential courses and internships, and any other courses recommended by respective senates of higher education institutions in the EAC region.

Table 6.1 Expected Learning outcome of Bachelor of Science in Food Science and Technology program

Category	*Outcomes*
Knowledge	*The graduate should be able to:* 1. Provide knowledge and understanding of higher level courses in terms of the principles and fundamentals 2. Provide knowledge understanding, an ability in written and oral communication 3. Demonstrate knowledge of sciences related to food science and technology 4. Demonstrate and understand the principles, current practices and skills in food processing techniques and impact on product quality 5. Demonstrate knowledge, understanding of concepts principles, theories and skills related to food safety concerns and environmental issues 6. Demonstrate competence, skills and knowledge in food storage and processing 7. Demonstrate knowledge, understanding and skills on value addition of produce, postharvest quality management and processing 8. Demonstrate knowledge, understanding of business principles, economics and entrepreneurship skills in food businesses 9. Demonstrate competence in creative thinking, innovation and adaption skills of appropriate technologies in food science and technology 10. Exhibit and commit to the highest standards of professional integrity and ethical values 11. Demonstrate competence, skills and knowledge to handle issues from production, marketing and at all levels of the value

	chain in the food sector 12. Demonstrate ability to work on research and extension systems within the food industry
Skills	
Cognitive skills	*The graduate should be able to:* 13. Model, design and plan the flow of work in a food plant and develop food processing engineering system 14. To apply unit operations in food processing industry and implement Quality Management Systems (GHP, GMP, HACCP and ISO) 15. Capable of conceptualizing a research problem and proposal development
Practical skills	*The graduate should be able to:* 16. Apply and incorporate the principles of Food Science in practical real-world problem solving 17. Apply statistical tools in research, and production system in food sector 18. Demonstrate competence, knowledge and understanding in executing / implementing research projects, data processing and dissemination of outcomes
Interpersonal skills	*The graduate should be able to:* 19. Demonstrate motivation to continuous self-learning, commitment to highest standards of professional integrity and ethical values, team work qualities and ability to interact with individuals from diverse cultures.
Attitudes	*The graduate should be able to:* 20. Exhibit awareness and understanding of professional ethics and food quality standards in Food Science and Technology 21. Embrace creativity and innovativeness in developing food solutions for EAC problems 22. Demonstrate knowledge and understanding on ways to communicate effectively and display leadership skills

6.5: Translation of learning outcomes into courses

The learning out comes (ELOs) have to be aligned and translated in terms of corresponding core courses divided into Common, Pre-requisites, Basic (foundational), Applied and Professional courses.

6.5.1 Common courses are those which are recommended to be taken by learners in all degree programs in institutions of higher learning with the aim of influencing behavior and perception change as well as addressing weaknesses that would help learners benefit from the degree programs. Examples: Communication Skills

6.5.2 Pre-requisite courses are those that provide learners with general aspects and elements of a related course offered at higher level, with the aim of enabling learners to comprehensively understand the higher level course. Examples: Introduction to Food Science & Technology, Biochemistry, General Microbiology

6.5.3 Basic courses are also referred to supporting courses without which a learner would find it difficult to understand the core courses; and relate to but not exclusively to fields that constitute food science and Technology, namely Chemistry, Microbiology, Engineering, Nutrition and Economics.

6.5.4 Applied courses in Food Science and Technology are those whose principles and application in foods are taught with respect to their impact on food properties/characteristics and functionalities. Examples: Food biotechnology, Food Enzymology, Food sanitation and Hygiene etc.,

6.5.5 Professional courses are those which address processes for modification and differentiation of food commodities for purposes of adding value in their functionalities, safety, access to and performance in markets. Examples include: Cereals and pulses Science and Technology, Dairy Science and Technology, Meat Science and Technology etc.

Table 6.2. List of Core and Supportive courses in Food Science and Technology Degree

Core courses	Supportive courses
1. Introduction to food science 2. Food Chemistry and Toxicology 3. Unit operations in food processing 4. Principles of food engineering	1. Organic Chemistry 2. In-Organic Chemistry 3. Biochemistry 4. Basic mathematics
5. Food Biochemistry	5. Applied mathematics
6. Food Microbiology and protection	6. Crop physiology 7. Animal physiology
7. Food Enzymology	8. General Microbiology 9. Nutritional biochemistry and physiology
8. Food biotechnology	10. Introduction to micro and macroeconomics
9. Principles of Human Nutrition 10. Food Nutrition, Policy, Law and legislation	11. Communication skills 12. Introduction to agricultural economics
11. Principles of food processing and preservation	13. Introduction to computers and information systems
12. Food engineering systems	
13. Food economics	
14. Entrepreneurship and innovation	
15. Industrial Economics	
16. Food processing and nutritional quality	
17. Food and nutrition security	
18. Research design and methodology	
19. Computer sciences and application	
20. Post-harvest physiology and technology	
21. Industrial waste and environmental management	
22. Food hygiene, safety and sanitation	
23. Food fermentation and biotechnology	
24. Food quality assurance	
25. Material properties and structures in food applications	
26. Food packaging	
27. Food product development and sensory evaluation	
28. Food Analysis and Instrumentation	
29. Food formulation and Functional foods	
30. Food physical chemistry	
31. Cereals and pulses Science and Technology	
32. Dairy Science and Technology	

33. Meat Science and Technology	
34. Root and tuber crops Science and Technology	
35. Tea and coffee Science and Technology	
36. Spices and aromatic crop technologies	
37. Technology of Alcoholic beverages	
38. Measurement and control engineering	
39. Fats and oils Science and Technology	
40. Sugar technology	
41. Industrial attachment and or Internship	
42. Research projects	

Table 6.3: Courses and Learning Outcomes for mainstreaming Aflatoxins into B.Sc. Food Science and Technology

Course	**Aspects to include in the curriculum**	**Learning outcome (s)**
1. Introduction to Food Science	• Introduce students to mycotoxins as one of the chemical hazards in food	Provide knowledge and understanding of higher level courses in terms of the principles and fundamentals
2. Food Chemistry and Toxicology	• Foods prone to mycotoxins • Standards for mycotoxins • Structure/chemistry of the common mycotoxins • Mechanism &Toxicity of the common mycotoxins • Risks associated with mycotoxins	Demonstrate knowledge and understanding of the mechanisms of toxicity and risk assessment of food hazards
3. Food Microbiology and protection	• Mycotogenic molds • Isolation and Identification of mycotogenic molds	Demonstrate knowledge and skills to isolate and identify major microorganisms of safety concern in foods
4. Food biotechnology	• Application of biotechnology tools in detection mycotoxin	Students have the ability to integrate biotechnology principles and concepts in the analysis of hazards in foods

	analysis	
5. Food Nutrition, Policy, Law & legislation	• Effects of mycotoxins on nutrition and health • Mycotoxin legislation and regulation • Standards for mycotoxins	Demonstrate ability to link food safety to nutrition & health; policy, legislation and law
6. Food and nutrition security	Effect of mycotoxins on food security	Demonstrate ability to explain the effect of mycotoxins on food security
7. Post-harvest physiology and technology	Factors promoting contamination of food with mycotoxigenic molds and mycotoxins Post-harvest technologies involved in management of mycotoxins in food	No new outcome added. Issues related to the added aspects are well taken care of under outcomes 4, 5, 6 and 7.
8. Food Analysis and Instrumentation	Analytical methods for mycotoxins	Demonstrate knowledge and skills for analyzing food components and contaminants.
9. Food quality assurance	• Application of HACCP in the management of mycotoxins	To apply unit operations in food processing industry and implement Quality Management Systems (GHP, GMP, HACCP and ISO)
10. Cereals and pulses Science and Technology	Processing technologies for reducing mycotoxins in cereal and pulse products	No new outcome added, issues on mycotoxins well covered in outcomes 4, 5,6 & 7
11. Dairy Science and Technology	• Contamination of animal feeds with mycotoxins • Occurrence of mycotoxins in animal products	No new outcome added. Issues of mycotoxins well covered in outcomes 4,5,7,8,11,12,14,16 and 20
12. Tea and coffee Science and Technology	• Mycotoxins associated with tea and coffee • Strategies to manage mycotoxins in coffee and tea	No new outcome Issues on aspects of mycotoxins well covered in outcomes 4,5,6,7
18. Spices and aromatic crop technologies	• Mycotoxins associated with spices and aromatic crops • Strategies to manage	No new outcome Issues on aspects of mycotoxins well covered in outcomes 4,5,6,7

	mycotoxins in spices and aromatic crops	
13. Fats and oils Science and Technology	• Mycotoxins associated with fats and oils • Strategies to manage mycotoxins in fats and oils	No new outcome Issues on aspects of mycotoxins well covered in outcomes 4,5,6,7

6.6 The learning outcomes and the curriculum alignment matrix

The following table 6.4 provides the curriculum alignment matrix for the Expected Learning outcomes for the Bachelor of Food Science and Technology. For each core subject the contribution of the Expected Learning outcomes are provided.

Table 6.4: Curriculum alignment matrix for Bachelor of Food Science and Technology program

	Core courses	**Expected learning outcomes of a Food Scientist / Food technologist as a:**																					
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1	Organic Chemistry (B)	x		X	x																		
2	In-Organic Chemistry (B)	x		X	x																		
3	Biochemistry (B)	x		X	x																		
4	Basic mathematics (B)	x		X	x																		
5	Applied mathematics (A)	x		X	x																		
6	Basic physics (B)	x		X	x																		
7	General Microbiology (B)	x		X	x																		
8	Introduction to food science (B)	x																					
9	Nutritional biochemistry and physiology (B)			X	x	x																	
10	Introduction to micro and macro economics (B)	x																					
11	Introduction to agricultural economics (B)	x																					
12	Introduction to computers and information systems (B)	x																					
13	Communication skills (B)		x																				
14	Food Chemistry and Toxicology(A)			X	x	x	x	x															
15	Food Analysis and Instrumentation (P)					x	x			x		x	x										
16	Food physical chemistry (P)					x	x			x		x	x										

17	Food Biochemistry (A)			X	x	x	x	x															
18	Food Microbiology and protection (A)			X	x	x	x	x															
19	Food Enzymology (A)			X	x	x	x	x															
20	Food biotechnology (A)			X	x	x	x	x															
21	Principles of food engineering (B)			X	x	x																	
22	Principles of food processing and preservation (A)			X	x	x	x	x															
23	Unit operations in food processing (B)			X	x	x															X		
24	Food engineering systems (A)			X	x	x	x	x															
25	Food economics (A)					x	x			x		x	x										
26	Entrepreneurship and innovation (A)								x	x	x		x	x	x								
27	Industrial Economics (A)							x	x			x	x	x									
28	Principles of human nutrition (B)			X	x	x																	
29	Food processing and nutritional quality (A)			X	x	x	x	x															
30	Food and nutrition security (A)			X	x	x	x	x															
31	Biostatistics (B)			X	x	x																	
32	Research design and methodology (A)									x			x			x	x	x	x		x	x	x
33	Computer sciences and application (A)			X	x	x	x	x															
34	Cereals and pulses Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
35	Dairy Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	

36	Meat Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
37	Industrial waste and environmental management (A)				x	x	x	x	x														
38	Food hygiene, safety and sanitation (A)				x	x	x	x	x														
39	Food fermentation and biotechnology (A)				x	x	x	x	x														
40	Food quality assurance (A)				x	x	x	x	x														
41	Food plant layout, design and maintenance (p)												x		x	x	x	`			x		
42	Food packaging (A)				x	x	x	x	x														
43	Food product development and sensory evaluation (A&P)				x	x	x	x	x												x	x	x
44	Post-harvest physiology and technology (A)				x	x	x	x	x														
46	Food formulation and Functional foods (AP)				x	x	x	x	x												x	x	x
47	Fruits and vegetables Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
48	Root and tuber crops Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
49	Tea and coffee Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
50	Spices and aromatic crop technologies (P)				x	x	x	x	x	x		x	x		x		x				x	x	
51	Food Nutrition, Policy, Law and legislation (A)														x		x			x	x		
53	Introduction to molecular genetics (B)			X	x	x																	
54	Technology of Alcoholic beverages (P)				x	x	x	x	x	x		x	x		x		x				x	x	
55	Measurement and control engineering (P)												x		x	x	x	`			x		
56	Material properties and structures in food				x	x	x	x	x														

	applications (A)																						
57	Fats and oils Science and Technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
58	Sugar technology (P)				x	x	x	x	x	x		x	x		x		x				x	x	
59	Industrial attachment and or Internship (P)					x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x
60	Research projects (P)												x	x	x	x	x	x	x	x	x	x	x

Table 6.5. Explanation of the numbers in Table 6.4

1. *Provide knowledge and understanding of higher level courses in terms of the principles and fundamentals*
2. *Provide knowledge understanding, an ability in written and oral communication*
3. *Demonstrate knowledge of sciences related to food science and technology*
4. *Demonstrate and understand the principles, current practices and skills in food processing techniques and impact on product quality*
5. *Demonstrate knowledge, understanding of concepts principles, theories and skills related to food safety concerns and environmental issues*
6. *Demonstrate competence, skills and knowledge in food storage and processing*
7. *Demonstrate knowledge, understanding and skills on value addition of produce, postharvest quality management and processing*
8. *Demonstrate knowledge, understanding of business principles, economics and entrepreneurship skills in food businesses*
9. *Demonstrate competence in creative thinking, innovation and adaption skills of appropriate technologies in food science and technology*
10. *Exhibit and commit to the highest standards of professional integrity and ethical values*
11. *Demonstrate competence, skills and knowledge to handle issues from production, marketing and at all levels of the value chain in the food sector*
12. *Demonstrate ability to work on research and extension systems within the food industry*
13. *Model, design and plan the flow of work in a food plant and develop food processing engineering system*
14. *To apply unit operations in food processing industry and implement Quality Management Systems (GHP, GMP, HACCP and ISO)*
15. *Capable of conceptualizing a research problem and proposal development*
16. *Apply and incorporate the principles of Food Science in practical real-world problem solving*
17. *Apply statistical tools in research, and production system in food sector*
18. *Demonstrate competence, knowledge and understanding in executing / implementing research projects, data processing and dissemination of outcomes*
19. *Demonstrate motivation to continuous self-learning, commitment to highest standards of professional integrity and ethical values, team work qualities and ability to interact with individuals from diverse cultures.*
20. *Exhibit awareness and understanding of professional ethics and food quality standards in Food Science and Technology*
21. *Embrace creativity and innovativeness in developing food solutions for EAC problems*
22. *Demonstrate knowledge and understanding on ways to communicate effectively and display leadership skills*

6.7 The Role of Industrial Attachment and Research Project

6.7.1 Industrial Attachment

An attachment in Food Science is traditionally a compulsory, short-term, unpaid employment in the food industry that is at least 8 week period. It enables the students to link theory with practice. It is intended to provide students with practical knowledge. It enhances employability. Students are placed in food processing industries, government institutions (example: regulatory bodies, ministries etc.,), NGO's, cooperatives etc., Industrial internship entails students be attached to a supervisor in the industry; the industrial attachment officer from the university sends an academic staff to follow –up the progress of the student during the attachment phase. At the end of the internship students are expected to submit a report documenting the experiences acquired during this period. The student is evaluated based on the oral presentation, report from the industrial supervisor, academic supervisor and the report submitted.

6.7.2 Reseach Project

This provides opportunity for students to answer the questions during the course of the study. The student is given the opportunity to address a challenge in the community or participate in a university funded research activities. Research extends to two semesters starting with research methods that enables the student to embark on proposal writing and presentation. The following semester, the student initiates and works on the research problem demonstrating skills acquired over the 4 year period. This provides individuality to carry out research to solve questions, demonstrate analytical skills, data analysis, writing and presentation skills etc., The report is evaluated by the supervisor and by internal staff in the faculty by examining the hard copy and also the oral presentation.

GLOSSARY[9]

Attitude	Attitude means a settled way of thinking or feeling about something.
Bachelor degree	It is a degree in which the holder of the qualification will be able to apply knowledge, skills and understanding in a wide and unpredictable variety of contexts with substantial personal responsibility, responsibility for the work of others and responsibility for the allocation of resources, policy, planning, execution and evaluation.
Basic phase	The first phase of the Bachelor programme, compulsory for all students (2 in a 3 years bachelor and 3 years in a 4 years Bachelor.
Benchmark	point of reference against which something may be measured.
Benchmark standards	Subject benchmark statements set out expectations about standards of degrees in a range of subject areas. They describe what gives a discipline its coherence and identity, and define what can be expected of a graduate in terms of the abilities and skills needed to develop understanding or competence in the subject. (T)
Competencies	Is a product of individual characteristics and achieved learning outcomes
Core subject	These are the essential subjects offering a thorough foundation of the discipline. The core subjects are the backbone of the discipline.
Course(unit)	A self-contained, formally structured learning experience. It should have a coherent and explicit set of learning outcomesand appropriate assessment criteria. Course /units can have different numbers of credits.
Curriculum alignment matrix	An instrument for checking the contribution of a course, unit or module to the achievement of the programme learning outcomes.
Curriculum	See programme
Elective subjects	These are subjects out of which a student has to make a selection, to deepen or to broaden their learning experience in the programme.
Equivalency	Having the same value, without being uniform.
Generic learning outcomes	Generic Learning outcomes are those learning outcomes, expected from all academic trained graduates, irrespective of the study programme. Examples of generic learning outcomes are problem solving, communication skills, and ability to cooperate.
Harmonization	Harmonization of programmes means that the programmes in the region are comparable based on agreed benchmarks.
Internship	Is a period of supervised training *at the workplace* and is an important part of the programme. It offers the student the opportunity to become acquainted with his /her future job. It provides the student with experiences at working floor level.
Knowledge	Is the body of facts, principles, theories and practices that is related to a field of work or study. It is the outcome of the assimilation of information through learning and is described as theoretical and/or factual
Learning outcomes	Statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and attitude.
Master degree	It is a degree in which the holder of the qualification will be able to display mastery of a complex and specialized area of knowledge and skills, employing knowledge and understanding to conduct research or advanced technical or professional activity, able to work autonomously and in complex and unpredictable situations.
Module	A formal learning experience encapsulated into a block of study, usually linked to other

[9] *Use is made from the Tuning glossary in Tuning, A Guide to Formulating Degree Programme Profiles, Bilbao/The Hague, 2010 (chapter 3, page 51-57). The descriptions of Tuning are marked with (T).*

	modules to create a programme of study.
Module description	Module description is statement of the aims, objectives/learning outcomes, content, learning and teaching processes, mode of assessment of students and learning resources applicable to a block of study.
National Qualification Framework (NQF)	The policy framework that defines all qualifications recognized nationally in post-compulsory education and training within a country. The NQF comprises titles and guidelines, which define each qualification, together with principles and protocols covering articulation and issuance of qualifications, and Statements of Attainment. *See also Qualifications framework.*
Programme	A set of coherent educational components, based on learning outcomes, that are recognized for the award of a specific qualification through the accumulation of a specified number of credits and the development of specified competences.(T)(IUCEA definition)
Programme objectives	Overall specification of the intention or purpose of a programme of study (T)
Project work	Is a form of study, which is problem oriented. The project is normally based on an actual existing problem which may be linked to internship and leads to possible solutions. The project may be practical or research oriented.
Qualifications framework	Is an instrument for the development and classification of qualifications according to a set of criteria for levels of learning and skills and competences achieved
Skills	The ability to apply knowledge and use know-how to complete tasks and solve problems.
Standards	Explicit levels of academic attainment, which are used to describe and measure academic requirements and achievements of individual students and groups of students.
Subject specific learning outcomes	Are those learning outcomes that are typical for that discipline. See also generic learning outcomes
Supporting subjects	These are subjects for backing the core subjects. Without these subjects it will be difficult to understand the core subjects.
Tuning	Tuning is a collaborative, consultative process involving academics working in subject groups with employers and other stakeholders in curriculum development to enhance student competences. Tuning projects which are funded by the European Commission in higher education have been successfully completed in over sixty countries around the world

APPENDICES

Appendix 1: Proposed course outline for prevention and control of Aflatoxins and Other Mycotoxins

In case there is need to establish a new course on mycotoxins, the following outline could be adopted and developed further:

1. Definition of mycotoxins and their importance in food value chains
2. Types of mycotoxins and producing moulds
3. Mycotoxigenic mould isolation, characterization and identification
4. Factors favouring mycotoxin contamination in food and feeds
5. Mycotoxin exposure, metabolism and risk assessment
6. Mycotoxin management practices
7. Effects of mycotoxins on agriculture, health and trade
8. Methods for analysis of mycotoxins in food and feeds

Appendix 2: List of experts that developed the benchmarks

S/N	Names	Institutions	Country
1	Prof. Mark Ollunga Odhiambo	Moi University	Kenya
2	Prof. George Maina Ndegwa	University of Rwanda	Rwanda
3	Prof. Florence K. Lenga	Jomo Kenyatta University of Agriculture and Technology	Kenya
4	Prof. Cornel Lawrence Rweyemamu	Sokoine University of Agriculture	Tanzania
5	Dr. Sylvester Katuromunda	Makerere University	Uganda
6	Mr. Paul Mbuni	Kenya Society of Agricultural Professionals	Kenya
7	Johnny Mugisha	Makerere University	Uganda
8	Dr. Melance Ntunzwenimana	University of Burundi	Burundi
9	Dr. Daniel Mushi	Sokoine University of Agriculture	Tanzania
10	Prof. Felix Bareeba	Makerere University	Uganda
11	Dr. Anselme Shyaka	University of Rwanda	Rwanda
12	Dr.Francis Njonge	Jomo Kenyatta University of Agriculture and Technology	Kenya
13	Dr. Gregoire Nahimana	University of Burundi	Burundi
14	Dr. Elias Richard Mgembe	Sokoine University of Agriculture	Tanzania
15	Prof. Patrick Rubahaiyo	Makere University	Uganda
16	Prof. Mwangi Githiri	Jomo Kenyatta University of Agriculture and Technology	Kenya
17	Prof. Charles Bucagu	University of Rwanda	Rwanda
18	Dr. Ir. Deo Ndikumana	University of Burundi	Burundi
19	Prof. Frederic Bangirinama	National Commission for Higher	Burundi

		Education, Burundi	
20	Dr Freedom King	University of Burundi	Burundi
21	Prof . Samuel K. Mbugua	University of Nairobi	Kenya
22	Dr. Richard J. Mongi	Sokoine University of Agriculture	Tanzania
23	Dr. Hilda Vasanthakaalam	University of Rwanda	Rwanda
24	Dr. Constantine Loum	Gulu University	Uganda
25	Dr. Aloys Nzigamasabo	University of Burundi	Burundi
26	Prof. Archille Kaaya	Makerere University	Uganda
27	Dr. Abel Atukwase	Makerere University	Uganda
28	Dr. Mollel K. Katunzi	Tanzania Commission for Universities	Tanzania
29	Dr. Meshack Obonyo	Egerton University	Kenya
30	Prof. Joshua Ogendo	Egerton University	Kenya
31	Ms. Lynette G. Kisaka	Commission for University Education	Kenya
32	Dr. Derrick Bugenimana	University of Kibungo	Rwanda
33	Mr.Fabien Matsiko	University of Rwanda	Rwanda
34	Mr. Nicolas Niko	Institut des Sciences Agronomiques du Burundi	Burundi
35	Dr. Kephas Nowakunda	National Agricultural Research Organisation	Uganda