

Curriculum benchmarks on food safety: Do the universities in East Africa have the capacity to implement?

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Executive summary

Universities in the EAC are offering several courses that are directly or indirectly related to Food Safety. However, there is no food safety program at the undergraduate level. Only two programs are offered at the graduate level. The regional universities need to leverage the wealth of human and physical resources at the universities to offer a BSc in Food Safety to position the EAC to benefit from trading in agricultural products in the continent utilizing the window afforded by the Malabo Declaration and Africa Union Continental Free Trade Area agreements.

Across the EAC universities, benchmark core and supportive courses are being taught though not with a food safety emphasis. There is a difference in the number and type of courses each university is teaching. The human resources available at each university revealed that many courses have staff with PhD qualifications. Universities wishing to translate the benchmarks into a Food Safety curriculum could utilize the expertise available in other universities of EAC and Global South to teach courses where they do not have faculty with PhD qualifications.

The popular mode of delivering the content in the EAC universities remains to be lectures, laboratory practicals, and other practicals such as industrial attachment and special projects. Online and blended modes of content delivery are new and have not been widely used. The assessment revealed that of the 12 universities, half [6] are teaching a proportion of the benchmark core areas using online and blended modes of content delivery. In the courses where faculty with PhD qualifications is not available, such innovative methods could be used by experts from other EAC universities to deliver the course content, without physically leaving their workplaces. This approach would offer the universities with staff deficiencies time to train or employ while having the opportunity to mount the BSc in Food Safety.

Universities are utilizing other professionals from industry, research institutions, and universities in the North and South to deliver both core and supportive courses. This approach helps the students see the relevance of the courses they are taking and get introduced to the broader profession. These institutions are partners in student internships and practical placements to widen their understanding. Using faculties from other universities in the South would also help the Universities to benchmark their programs with peers in the South.

The benchmark core courses are currently taught in programs, where the emphasis is not necessarily on food safety and are attracting an average of 509 students per course across the 26 courses in 12 universities, while supportive courses are attracting an average of 945 students across the 12 universities. If the 12 universities mounted the BSc in Food Safety with an average of 500 graduates yearly, this would reduce the huge deficit in the number of experts in food safety to manage the many food value chains and offer such services also in the informal markets that are crucial in the supply of safe food to majority of the rural and urban populations.

The available physical infrastructure, and the willingness of the faculty at the universities to launch the program during the 2024-2025 academic year, taken together, point to great existing preparedness by the Higher Institutions of Education to launch this program.

Universities have the minimum equipment to enable them to start the BSc in food safety. However, Universities will require an array of equipment to help train an effective hands-on workforce in solving food safety issues.

Potential opportunities for job employment exist in the public and private sectors for graduates of BSc in food safety, making the program attractive to the students. The region is oversupplied with unemployed graduates but graduates from this program will find employment in several sectors to enhance food safety along the farm-to-fork continuum.

The universities ranked as important three top issues in running the program for a smooth exit of the first cohort of BSc in Food Safety. To fast-track the initial launch of the program, the universities ranked the top three issues they would need assistance with, the development of the BSc in Food safety curriculum, influencing accreditation of the program by respective Commissions for University Education, and re-tooling the existing staff to deliver the courses with a food safety emphasis.

Abbreviations and acronyms

AAS	atomic absorption spectrophotometer
BSc	Bachelor of Science
COHESA	Capacitating One Health in Eastern and Southern Africa
DALY	disability-adjusted life year
DNA	deoxyribonucleic acid
DRC	Democratic Republic of the Congo
EAC	East African Community
ELISA	enzyme-linked immunosorbent assay
FAO	Food and Agriculture Organization of the United Nations
FERG	Food Epidemiology Reference Group
HEI	High Education Institutions
HPLC	High-Performance Liquid Chromatography
ILRI	International Livestock Research Institute
IUCEA	Inter-University Council of East Africa
LMIC	low- and middle-income countries
MS	mass spectrophotometer
OHRECA	One Health Regional Centre for Africa
PhD	Doctor of Philosophy
WHO	World Health Organization

1.0 Introduction

Ensuring food safety encompasses routine activities in the farm-to-fork continuum that prevent food illness and injury. Food illnesses or food-borne diseases are caused by biological, chemical, and physical hazards. The World Health Organization (WHO) (2015) published the Food Epidemiology Reference Group (FERG) report that showed that globally, 600 million cases of food-borne illnesses occurred in 2010. An estimated 420,000 deaths and 33 million disability-adjusted life years (DALYs) are lost due to food-borne diseases. Children under five years bore the highest-burden at 38 % of the DALY while they contribute 9% of the global population. African sub-regions bore the highest per capita burden of food-borne diseases. Using the 2010 data and extrapolating these to 2019 populations, Jaffee (2020) estimates that Africa experiences about 135 million cases of food-borne illnesses, 180,000 deaths, and 15 million DALY annually.

A World Bank report by Jaffee (2020), showed that in the Low- and Medium-Income Countries (LMICs), the economic cost of food-borne diseases was \$96 billion arising from lost productivity and a further \$15 billion for treatment costs. Africa incurs a cost of \$20 billion annually from food-borne diseases and \$3.5 billion in treatment costs for food-borne illnesses. This cost has been shown to represent about 1.4% of Egypt's and 5.6% of South Africa's food expenditure in 2010 (Jaffee 2020).

Food safety has emerged as one of the key pillars in the One Health implementation and in the achievement of the Sustainable Development Goals of the United Nations. A number of these goals (1, 2, 3, 5, and 6) are **unlikely** to be met if the world does not track the progress in attaining food safety at the country level (Grace 2019). The targets should be more outcome-based than process-based.

The Food and Agricultural Organization of the United Nations (FAO) has developed manuals that serve as guidelines for developing countries wishing to strengthen their Food Control Systems to enhance Food Safety (FAO, 2003). A critical element of the system is the food inspectorate system, which foresees adherence to food safety laws and regulations. In LMICs, lack of enforcement of food safety is often cited as the main reason for poor food safety situations. The food safety Strategy for Africa 2022-2036, strategic objective two (SO2) identifies strengthening of the human and infrastructural capacity in the public sector, informal and formal food sectors, and economies crucial to ensuring that **qualified and well-trained workforce** and the relevant support services are available for the management of food safety hazards, risks, and emergencies (Food safety strategy for Africa 2022-2036). In the EAC, Kangethe et al. (2021) found that the number of food safety inspectors was insufficient for the many value chains of Animal Source foods and fruits and vegetables. The lack of the necessary workforce to oversee food safety activities exacerbates the problem. Kangethe *et al.* (2019) showed that there was no Higher Education Institution (HEI) in the East African Community (EAC) that was offering an undergraduate program in food safety. This suggests that the region suffers from manpower shortages in this relevant field.

Informal food markets are essential in the urban and rural food supply systems. The majority of the East African population sources their fresh domestic food supplies (animal source food (ASF) and produce) from informal or traditional markets. These markets are not effectively regulated for food safety and lack the infrastructure for effective implementation of hygiene. A survey reviewing the architecture of the Food Control system in the EAC partner states showed that fruits and vegetables from informal markets have only a one in a thousand chance of being inspected compared to a one in ten chance for export-destined ASF and vegetables (Kangethe *et al* 2021).

The International Livestock Research Institute (ILRI) and partners, FAO, Lloyd's Register Foundation, and the Inter-University Council for East Africa (IUCEA) together with a Technical Working Group (TWG) of Food Safety experts drawn from Universities in the EAC, have developed the Benchmarks for Bachelor of Science (BSc) in Food Safety for use by the East African Universities. The use of these benchmarks to develop curricula at the HEI would assist the region in developing the much-needed food safety manpower to work in the food safety sector to improve the inspection, surveillance, and laboratory services and result in safe food for all.

An ILRI study found that a BSc in food safety was not being offered in any partner state University, but several courses linked to food safety were being offered in several programs (Kangethe, 2019). ILRI sought to evaluate capacity needs for Universities starting this program, and the strengths that exist in the region that could be leveraged to successfully offer it.

2.0 Methodology

The sampling frame was the list of universities accredited by the IUCEA in each Partner State. In 2021, ILRI published a document (<https://hdl.handle.net/10568/114571>) that reviewed the Universities accredited to IUCEA that were offering courses with food safety content. This document was used as a reference for HEI-sourced universities to include in the sampling frame. Purposively, it included not only the well-established public universities but also the private universities that have been emerging and rapidly growing in recent decades. In 2019, ILRI organized a two-week training course for academia, and regulatory agencies responsible for food safety in the six EAC Partner States and Ethiopia (<https://hdl.handle.net/10568/105635>). The Universities which provided trainees and trainers for the course were considered and given priority. Although the Democratic Republic of the Congo (DRC) had not joined the EAC regional block at the time of the study, two Universities were selected based on the ease of communicating in English and having public health and veterinary medicine schools. Universities highly ranked by the University Guru and those having partnerships with either Capacitating One Health in Eastern and Southern Africa (COHESA) or One Health Regional Center for East and Central Africa (OHRECA) programs in ILRI were considered. Two to three universities were selected per Partner State.

A data-collecting tool (Annex 1) was developed. The tool covered various topics to evaluate constraints the universities might face as they try to mount a program in food safety. From each University, participants were selected from the following programs: Veterinary Medicine, Public Health, Food Science, Wildlife, Agriculture, and Environmental Science.

The tool, a copy of the benchmarks, the consent form, and the institutional ethical approval letter were sent to the selected participants in advance of the workshop in their respective universities. The workshops were held separately to ensure data confidentiality. The data collected was entered into an Excel sheet, anonymized through coding, and analyzed.

2.1 Ethical clearance

Ethical clearance was sought from the ILRI Institution Ethical Committee. The ILRI institution Research Ethical Committee approved the project and offered an approval certificate **ILRI-IREC2022-38**. The researchers abided by in-country regulations regarding ethical clearance before the start of data collection.

2.2 Selected and surveyed universities

Using the criteria above, Table 1 gives the universities that were selected for the survey. Universities in five partner states were assessed. In the other two partner states (Uganda and Tanzania) authorization from in-country ethical institutions was not given. The universities surveyed were: - University of Juba and Upper Nile (South Sudan), University of Rwanda and University of Global Health Equity (Rwanda), University of Burundi and Hope Africa University (Burundi), University of Kinshasa and Officialle Universiteit des Bukavu (DRC), and University of Nairobi and Moi University (Kenya), and Sokoine University of Agriculture and Muhimbili University of Health and Allied Sciences in Tanzania. Attempts were made to include private universities. The effort was successful in two partner states (Rwanda and Burundi) but not in the other ten partner states.

3.0 Food safety qualification programs in the universities

Only two universities offered programs resulting in qualification with the words “food safety” in the EAC. The two institutions offered the programs at Master’s and diploma but not at undergraduate level. Four other universities listed courses they were offering that were related to food safety but did not result in a qualification with the words “food safety”. Possible reasons could have been the terminologies regarding program, course, module, and unit used in the different universities. The following terminologies are relevant to this discussion. A **program** refers to an award that a student works to get, e.g. Bachelor of Science in Agriculture. A program runs for 4-6 years in undergraduate programs and 3 months - 1 year for most master's programs. A program is made up of courses that are identified by subject and catalog number or code e.g. BIOL 101. **Courses** are made up of modules or sections and modules are made up of units.

4.0 Food safety-related courses in the universities

Universities offered many courses that had some food safety content. A total of 228 courses were listed but only 181 were analyzed after removal of those with missing values. The courses were merged into groups which represented the many courses with titles that indicated that they potentially had similar content (Table 2). This resulted in 25 broad courses. The courses were further grouped according to whether they were directly or indirectly related to Food Safety. The relatedness means that the course has direct relevance to food safety e.g. food microbiology (direct) compared to physics (indirect) which though it contributes to the understanding and application of safety, is not core. Figure 1 shows the food safety courses offered by the 12 universities and the proportion of universities offering the course. Human Nutrition was offered by the majority of the universities while laboratory biosafety course was offered by one university. Thirteen courses were directly related to Food Safety while twelve were indirectly related after the second grouping.

University 1010, 1011, and 109 offered the largest proportions of the 25-food safety related courses, respectively. University 103 offered the least proportion of the courses because it did not offer undergraduate programs but MSc programs only. Quality Control, Food Science and Technology, and Public Health and Food Safety courses had the highest frequency of being offered in 12 universities. University 103 and 107 did not offer any of the directly related food safety courses. University 107 is public but offers many indirectly related courses.

The mean enrollment of students in universities for food safety-related courses was 27 (0-207) in university 101 and 207 (5-700) in university 1011. Overall the student enrollment in the food safety-related courses averaged 70 with a maximum of 935 students. Course-wise, Food Microbiology was the most popular course with a mean enrollment of 215 (3-350) students across all universities.

These courses were offered in programs that contribute to the award of Bachelor of Science degree (73.2%), Master of Science degree (19.3%), Diploma certificates (12.75%), and Doctor of Philosophy degree (0.4%). The food safety experts in all 12 universities thought that the courses would continue to have more demand.

Table 1: Universities that were targeted for the needs assessment

Country	Institution	Justification for inclusion
Burundi	University of Burundi (4),	A public institution participated in food safety training by ILRI, situational analysis, and food safety benchmark development. Ranked 1 out of 7 ranked universities. Oldest university. MOU with ILRI. Partnering OHRECA students.
	International Leadership University (2)	Private. Unranked.
	University of Lake Tanganyika (6),	Private. Ranked 7 out of 7 universities in Burundi.
Uganda	Makerere University (10)	A Public institution participated in food safety training and led situation analysis. Ranked 1 out of 24 ranked universities. Oldest university. Partner in BUILD-UGANDA and COHESA multiplier
	Kampala International University (5)	Private. Ranked 13 out of 24 universities in Uganda in University Guru 2022
	Unicaf – Uganda campus	Private, a new University but Vice the chancellor has expressed interest in mounting the program. The VC participated as a Trainer in food safety and benchmark development
Tanzania – 16 HEI	Sokoine University of Agriculture (15).	Public – In mainland Tanzania, participated in food safety training, led the situational analysis, provided trainers, and participated in benchmark development. Ranked 4 out of 16 ranked universities. Second oldest university and oldest agriculture.
	Muhimbili University of Health Sciences and Allied Sciences (10)	Public – Mainland Tanzania. Ranked 3 out of 16 universities
	Nelson Mandela - African Institution of Science and Technology (NM-AIST)	Public – Arusha COHESA multiplier. Unranked
	State University of Zanzibar (6)	Public, in Zanzibar Island. Ranked 7 out of 16 universities in Tanzania
Rwanda	University of Rwanda (7),	Public, trainees, situation analysis, benchmark development team member, involved in OHRECA student supervision. Ranked 1 out of 26 ranked universities. Oldest university.
	Catholic University of Rwanda (2),	Private. Ranked 18 out of 26 ranked universities
	University of Technology Byumba (3),	Private. Ranked 10 out of 26
	University of Global Health Equity	Private, initiative of Partners in Health; COHESA multiplier. Ranked 2 out of 26 universities
South Sudan*	University of Juba,	Public, trainees, situational analysis, benchmarks development team member
	Upper Nile University,	Public, trainees, situational analysis
Kenya§	University of Nairobi (15)	Public. COHESA Multiplier Oldest faculty of veterinary medicine (for many years was the only university offering a Veterinary Medicine degree). Ranked 1 out of 28 ranked universities
	Moi University (23)	Public. Ranked 2 out of 7 ranked universities
	Jomo Kenyatta University of Agriculture (15)	Public, unranked
	Mount Kenya University (13),	Private, unranked
	Egerton University	Public, young Veterinary Faculty, and faculties of Health and Environment, piloted the EAC short course on Pandemic preparedness.
Democratic Republic of the Congo	Universiteit de Kinshasa	Public. One of the top 3 universities in the DRC, Faculty of Veterinary Medicine and Faculty of Medicine. Unranked.
	Loyola University of Congo	Private The Faculty of Agronomic and Veterinary Science was established in 1994. Unranked.
	Universiteit de Lubumbashi	Public. One of the top 3 universities in the DRC. Faculty of Veterinary Medicine and Faculty of Medicine. Ranked 1 out of 3 universities.

* Universities were not considered when establishing the relevant courses offered as only one university was accredited by IUCEA. Only two are selected considering the country's situation and distances between institutions. Upper Nile is about 400 Km from Juba.

§ All the selected Universities did not participate in previous engagements on food safety. Nairobi University participated in the training and led situation analysis and development of benchmarks. The numbers in brackets after the University name represent the courses offered that were found to be relevant to food safety (Kangethe et al 2021)

Table 2: Broad categories of merged courses and their relatedness to food safety

Broad category	Courses merged	Relatedness to food safety
Agricultural trade	Agricultural trade and marketing; Agricultural marketing and organization; Agricultural trade and international economics	Direct
Anatomy and physiology	Physiological regulation of eating behavior; Physiology of nutrition in children; Physiology; Physiology and anatomy; Anatomy. General and specific pathology of food animals	Indirect
Animal Health	Livestock economics; Veterinary medicine; Veterinary science; Veterinary mycology and virology; Avian and fish health	Indirect
Biotechnology	Biotechnology; Ethics and risks in biotechnology; Biotechnology and health; Biotechnology agriculture; Biotechnology biochemistry	Indirect
Environmental Health	Environmental health; Health and Environment; Environmental toxicology; Principles of environmental health; Environmental sciences; Introduction to environmental and occupational health	Direct
Food hygiene, sanitation, and waste management	Food hygiene, sanitation and waste management; Food hygiene and safety; Food, plant sanitation; Food hygiene; Food hygiene and sanitation	Direct
Food Microbiology	Food microbiology, Introduction to food microbiology; introductory food microbiology; Applied food microbiology; Advanced food microbiology; Food microbiology and hygiene	Direct
Food policy and legislation	Food legislation; Agricultural policy and law; Food policy analysis; Food legislation and nutrition policy; Food legislation and regulation; Food safety policy, standards and law; Food laws and regulations; Legislation on plants, food and agricultural inputs	Direct
Food processing	Food processing technology; Fish processing I & II; Food processing; Food processing and preservation; Food processing, preservation, and safety; Management of food industry; Food industries technology; Enzymology; Food storage and processing	Direct
Food production	Meat, dairy, and poultry production; Fruits and vegetables; Edible oils and fats; Agronomy; Animal and sustainable plant production; Fisheries and aquaculture; Feed manufacturing technology; Milk and milk products; Meat and meat products; Organic farming; Vegetable production; Fruit production	Indirect
Food science and technology	Food science and technology; Food biotechnology; Meat, dairy, and poultry technology; Fundamental of food science and technology; Food technology and hygiene; Food technologies; Meat technology; Dairy technology; Animal products processing and quality control; Meat science and technology; Food Biotechnology; Food fermentation technology; Food biotechnology and industrial fermentation	Direct
Food security	Food security; Food security and safety; Food and nutrition security; Sustainable agriculture and food security; Food systems health;	Indirect
Food Toxicology	Food toxicology; Experimental toxicology of foods and nutrition; Food and environmental toxicology; Advanced food toxicology	Direct
General sciences (Math, Biology, Chemist, Physics)	Physiology and anatomy; General biochemistry; Mathematics and physics; Biological science; Chemistry; Biochemistry and microbiology; Biology; Biochemistry I & 2; Biology of viruses; Chemistry of natural products; Plant mycology; Phyto bacteriology	Indirect
Health and Education	Health service management; Health education and promotion; Behavioral sciences and ethics; Communication skills; COBES 1, 11, 111, 1V, & V; Food community health and health promotion; Food and health	Indirect
Human nutrition	Human nutrition; Food and nutrition; Nutrition in the life cycle; Human nutrition: dietary assessments; Nutritional seminar I & 2; Nutrients enteral and parental nutrition in children and adults; Nutritional anthropology 1 & 2; Nutrition and hygiene in developing countries; Nutritional and religion; Food for people living with HIV AIDS; Infant and young child nutrition; Food chemistry and nutrition; Nutritional epidemiology; Food nutrition and dietetics; Nutrition and Health F E; Food systems nutrition and diets; Food system, composition, and nutrition; Basic and clinical nutrition' Fundamentals of food nutrition; Nutritional assessment and surveillance	Indirect
Laboratory biosafety	Biosafety and laboratory biosecurity	Indirect
Microbiology	Microbiology; General Microbiology; Microbiology and parasitology; Veterinary microbiology; Advanced microbiology; Fundamentals of microbiology; Animal microbiology; Agricultural Microbiology	Indirect
One Health	One health; Zoonosis and one health	Direct
Pests and diseases	Pests and diseases of horticultural crops; Animal diseases and preventive measures; Infectious diseases; Infectious disease management; Dietetic and nutritional diseases; Pathologies animals; Wildlife, laboratory, and emerging food anima diseases; Pathology of avian diseases; Pathology of wildlife diseases; Control of bacterial infections; Epidemiology of bacterial diseases; Epidemiology of viral infections; Control of viral diseases; Microbial diseases of fish; Diagnostic pathology of fish diseases	Indirect
Post-harvest (physiology and practices)	Post-harvest physiology; Food storage; Principles of food preservation; Post-harvest physiology and technology; Food packaging; Post-harvest and seed pathology; Postharvest physiology and management; Postharvest physiology and technology for fresh produce	Direct
Public health and food safety	Veterinary microbiology (Zoonosis); Veterinary public health and food safety; Public health; Crop production and food safety; Veterinary public health 1 & 11; Food safety and quality management; Economics of food	Direct

	safety; Consumer and food safety; Food quality and safety management; Principles and public health and one health; Food and nutritional safety	
Quality control	Quality control of horticultural crops; Food analysis; Quality control and food laws; Quality control; Food inspection and control; Chemical analysis of food; Food quality control; Food biochemistry; Clinical biochemistry; Food quality and safety management; Food quality assurance and legislation; Food chemistry; Inspection of animal products; Advanced food chemistry; Hazard analysis and critical control points (HCCP); Water supply and quality control; Meat inspection and pathology; Food quality medicine; Food hygiene and quality assurance; Fish inspections, certifications and HACCP; Food quality control, safety and legislation; Food risk analysis; Food quality control and inspection	Direct
Research	Epidemiology; Research project; Research tools	Indirect
Toxicology	Toxicology and forensic medicine; Principles of Toxicology; Principles of pharmacology and toxicology; Environmental toxicology; Pesticide chemistry and toxicology	Indirect

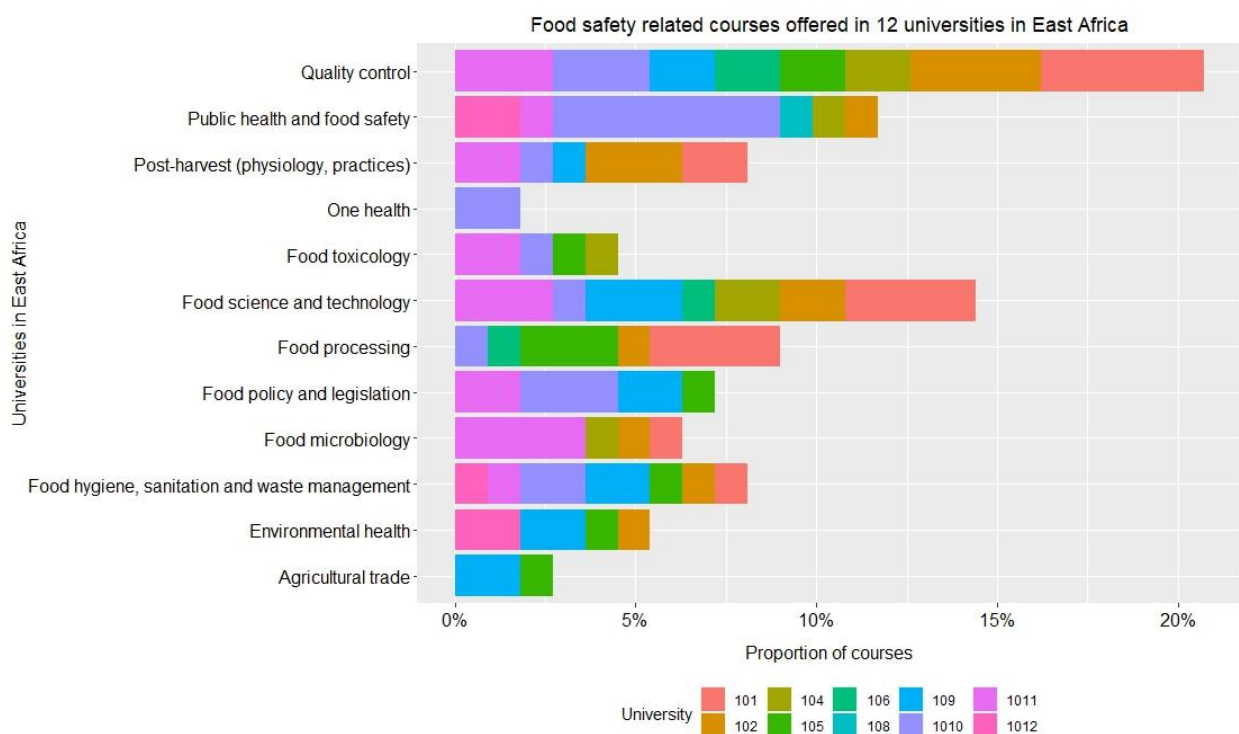


Figure 1: Food safety courses offered by the 12 universities in EAC

5.0 Food safety benchmarks courses offered by EAC universities

5.1 Benchmark core courses

The food safety Benchmarks, published by the IUCEA and endorsed by the EAC, were developed with ILRI support. They are made up of 26 core courses and 11 supporting courses, and all are compulsory. All the 26 benchmark core areas were offered by the 12 universities, though with varying numbers of courses per university. Biostatistics; Environmental Health and Climate change; Food microbiology and Parasitology; Introduction to Epidemiology; Physiology, anatomy, and Nutrition, and Research methods were offered across the 12 universities. Jurisprudence and Food safety culture; Risk Psychology; and Food safety surveillance were offered in 5, 5, and 4 universities, respectively.

There are many courses NOT taught currently across the 12 universities. Figure 2 shows the courses that are **NOT** taught in each of the twelve universities. University 107 is a public university that instead of listing courses, listed programs. It appears then as not teaching any courses related to Food Safety. Since the core courses are not specifically taught for the Bachelor of Science in Food Safety but are taught in other programs, this situation of some courses not being taught is expected. Physical infrastructure and human resources demanded to teach these missed courses in the universities may present gaps in preparedness if the same universities wish to launch the new BSc in Food safety curriculum.

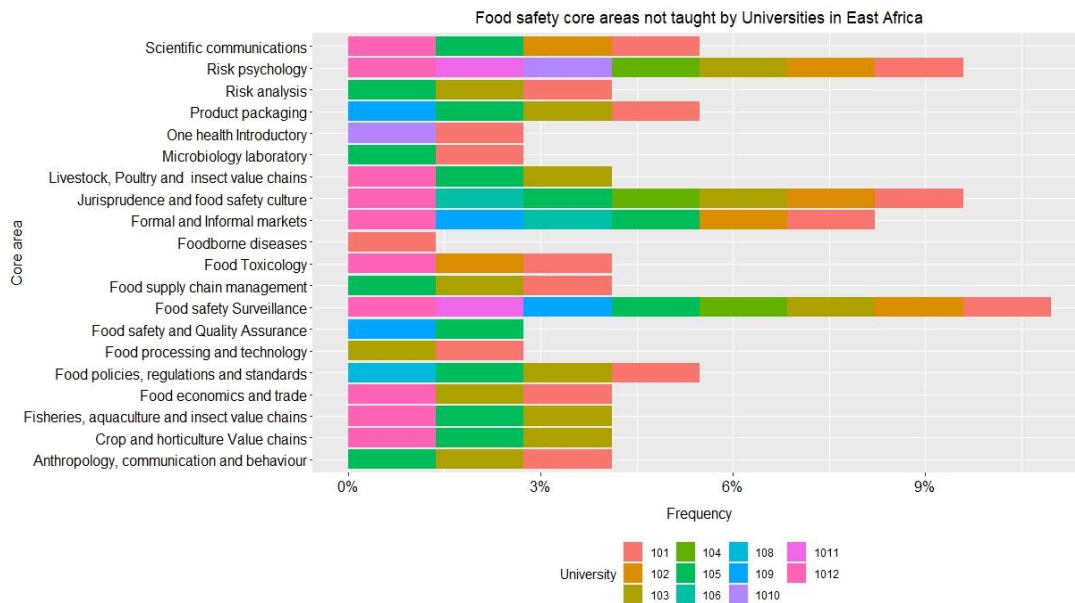


Figure 2: Core courses NOT taught in the various 12 universities in the EAC

5.2 Benchmark support courses

The 10 supportive courses were offered across the universities. Three courses (General Microbiology, Introduction to Genetics, and Introduction to Immunology) were offered in all 12 universities, while University 103 offered only four of the support courses. However, courses like informatics, gender, social economics, and entrepreneurship are taught by seven and nine universities, respectively. University coded 103 did not teach many foundation courses as it offered programs at the MSc level. Figure 3 shows the supportive courses offered in the respective universities.

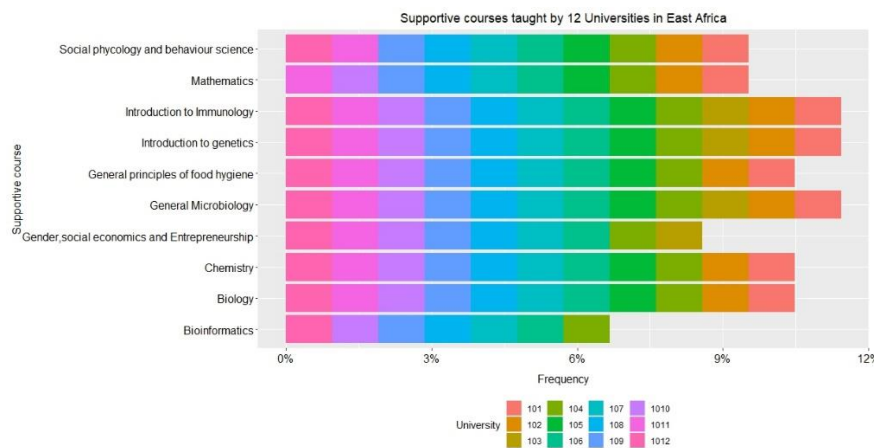


Figure 3: Benchmark Supportive courses offered by each university

The gaps in teaching supportive courses exist because universities are not teaching all the prerequisite foundation courses. There is no supportive course not taught in the 12 universities. Although individual universities may have this shortfall in particular expertise, the expertise exists in universities across the region. Figure 4 shows supportive courses not taught in each of the twelve universities.

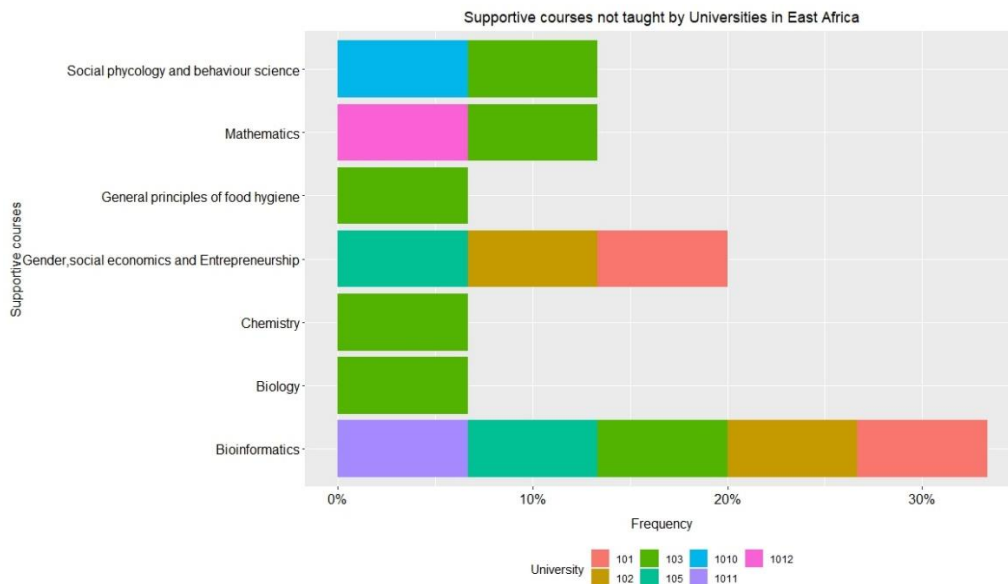


Figure 4: Supportive courses NOT taught in the 12 universities

6.0 Human resources at universities to teach the benchmark courses

6.1 Benchmark core courses

The human resources to teach the core courses of the BSc in Food safety averages 10 members of the faculty with PhD qualifications per core course with a range of 0-70 staff (Table 3) across the universities. University 1010 has the highest mean of staff with PhD qualifications while University 101 had the lowest average number of staff with PhDs for all the 26 benchmark core courses. Across the 12 universities, fourteen courses do not have staff who hold a PhD qualification in specific universities. Six courses are from University 101; 4 courses from University 102; 2 courses from University 108 and one course each from University 103 and 107 (Table 4).

Staff with MSc degrees are teaching core courses and the core areas with a mean of less than 2 MSc per core area are Food Safety Surveillance, Jurisprudence, and Food Safety Culture; Risk Psychology; Food Toxicology, and Policy, regulations, and Standards. The mean of staff with master's degree as the highest qualification are from universities 102, 103, 106 and 109 with the mean approaching or less than 1 with university 1010 with no staff with an MSc degree teaching

the core courses. This is commendable because the universities are aspiring to have all staff teaching in the university to hold a PhD. University 1010 did not indicate that they have a staff with MSc teaching any of the core courses.

Table 3: Average number of staff with PhD qualifications teaching core courses across the 12 universities

Food safety core courses	Mean	Minimum	Maximum
Anthropology, communication, and behavior	11	1	70
Biostatistics	8	0	70
Crop and horticulture value chains	8	0	50
Environmental health and climate change	8	1	50
Fisheries, aquaculture, and insect value chains	8	0	50
Food economics and trade	10	1	70
Food microbiology and parasitology	8	0	70
Food policies, regulations, and standards	12	0	70
Food processing and technology	11	0	70
Food safety and quality assurance	10	0	70
Food safety surveillance	13	0	50
Food supply chain management	11	0	70
Food Toxicology	10	1	70
Foodborne diseases	8	1	70
Formal and informal markets	15	1	70
Introduction to epidemiology	8	0	50
Jurisprudence and food safety culture	12	2	50
Livestock, poultry, and wildlife value chains	10	0	50
Microbiology laboratory	16	0	70
One Health introductory	6	3	15
Physiology, nutrition, and anatomy	8	1	50
Product packaging	12	1	70
Research methods	12	1	70
Risk analysis	10	2	50
Risk psychology	2	0	5
Scientific communications	11	0	50

Table 4: Core courses being instructed by staff without a PhD qualification

No.	Food safety courses	University
1	Crop and horticulture value chains	101
2	Fisheries, aquaculture, and insect value chains	101
3	Food microbiology and parasitology	101
4	Food safety and quality assurance	101
5	Introduction to epidemiology	101
6	Livestock, poultry, and wildlife value chains	101
7	Biostatistics	102
8	Food policies, regulations, and standards	102
9	Food supply chain management	102
10	Microbiology laboratory	102
11	Scientific communications	103
12	Risk psychology	107
13	Food processing and technology	108
14	Food safety surveillance	108

Three universities have the highest number of staff with MSc teaching core courses than other universities. University 104 with a mean of 7; University 107 with a mean of 6 and 1011 with a mean of 6. Four universities have courses being taught but have no staff with a PhD or MSc. These are University 102 – Biostatistics and Microbiology laboratory; University 101- Food safety

and quality Assurance; University 107- risk psychology and University 108 food safety surveillance.

6.2 Benchmark supportive courses

The supportive courses offer the foundation and support for students' understanding of the concepts of Food safety. The average number of staff members in the EAC universities with Ph.D qualifications teaching supportive courses is 6, with a range of 0 – 30. Universities 101 and 103 have the fewest members of staff on average with PhD teaching supportive courses. Amongst the 12 universities, Bioinformatics, General Principles of Food Hygiene, and Social Psychology and Behavior Science have the fewest staff with PhD teaching when compared to other courses University 1010 had no staff with MSc teaching any of the supportive courses.

7.0 Student numbers taking the benchmark courses

7.1 Student numbers taking the benchmark core courses

Student enrollment for all the core courses averages 509 with a range of 0 - 10,000 in the 12 universities. The individual course with the highest enrollment mean was Research Methods with an average of 1919 and a range of 0 – 10,000 students. Research Methods, Scientific Communications, and Biostatistics had the highest enrollment mean of 1919, 1147, and 714, respectively. The course with the least student enrollment was Product Packaging with a mean of 278 students and a range of 20-100 students.

7.2 Number of students taking the benchmark supportive courses

Supportive courses are foundational, and many programs require their students to take them. This explains the high enrollment in some of these courses. The mean number of students taking supportive courses was 945 with a range of 0-10,000. One university (106) did not indicate the number of students for any of the supportive courses. Biology, Chemistry, Gender, Social Economics, Entrepreneurship, and Mathematics had more students with mean of 1197, 1197, 2387, and 1432, respectively compared with more specialized courses like Introduction to Immunology (384), and General Principles of Food Hygiene (225). The overwhelming majority of universities foresee an increase in the demand for core and supportive courses.

8.0 Use of other resources to train in the benchmark courses

8.1 Use of other resources to train benchmark core courses

Despite universities having personnel with PhDs in most core areas, utilization of personnel from other sectors can broaden and improve the quality of the training and improves students' perspective of the program, widening the horizons for employment opportunities, and career progression. Universities employ these resources to teach all core courses. Table 5 Summarizes the number of courses out of 26 that are taught using industry, research institutions, and universities from the global South or North across the 12 universities.

Table 5: Utilization of personnel from other sectors by universities to teach benchmark core courses

University	Number of benchmark core courses taught using the following personnel			
	Industry	Research Institutions	Global North	Global South
101	0	1	0	2
102	0	0	0	0
103	2	2	2	13
104	0	0	0	23
105	4	9	0	12
106	24	24	0	0
107	24	24	0	8
108	14	9	0	18
109	20	18	3	0
1010	24	24	24	0
1011	10	23	0	6
1012	1	0	1	4

All the universities used industry, research institutions, and personnel from universities in the global North and South to teach benchmark core courses. Two universities taught some core courses without using personnel from either industry, research institutions, or universities from the global north or south.

8.2 Use of other resources to train benchmark supportive courses

Table 6, Summarizes the number of supportive courses out of 10 that are taught using industry, research institutions, and universities from the global South or North across the 12 universities. Research Institutions remained the most common resource employed by Universities at 56.2% to instruct students. This is recommended as it helps stimulate young minds and interests them in considering the role of research in providing solutions facing the country. The other resources were Industry at 46.7%, Universities from the global South at 38.1%, other available resources at 8.6%, and universities in the global North at 3.8%. The use of other universities in the global south to teach in 8 universities, the trend augurs well as this creates relationships to help cover deficiencies in personnel by having them offer teaching either physically or online.

Table 6: Utilization of personnel from other sectors by universities to teach benchmark supportive courses

University	Number of benchmark supportive courses taught using the following personnel			
	Industry	Research Institutions	Global North	Global South
101	0	0	4	4
102	0	0	0	0
103	0	0	0	4
104	0	0	0	10
105	0	3	0	3
106	10	10	0	0
107	10	10	0	0
108	1	8	0	10
109	10	10	0	0
1010	9	9	0	1
1011	9	9	0	7
1012	0	0	7	1

9.0 Modalities used for content delivery

9.1 Modalities of training of benchmark core causes

Universities employed all evaluated methods in training benchmark courses. Lecturing face-to-face was the main method of instruction employed at 86.9%, laboratory practicals at 62.1%, practicals other than laboratory at 69.7%, special projects at 36.8%, online at 24.7%, and blended at 39.4%. Online instruction mode only employed by three universities (106, 1010, and 1012), while blended (online and in-person instruction) was employed by an additional three universities. Table 7 summarizes the number of courses taught using different modes of instruction by the universities. Universities in the EAC will have to innovate and adopt online and blended modes of content delivery to remove the costly mode of taught lecture that requires the movement of staff from one university to another to deliver the content in universities lacking qualified personnel.

Table 7: The number of benchmark core areas instructed using different modes by universities

University	Modes of instruction					
	Lecture	Laboratory	Other practical	Special Project	Online	Blended
101	10	0	0	0	0	0
102	17	3	3	3	0	0
103	12	4	3	3	0	11
104	23	15	23	23	0	23
105	12	0	0	0	0	0
106	24	24	24	24	24	0
107	26	16	26	26	0	0
108	24	18	24	24	0	0
109	9	9	11	11	0	20
1010	24	24	24	24	24	24
1011	22	21	21	22	0	1
1012	16	9	14	16	16	16

9.2. Modality of training used to instruct benchmarks supportive courses

Taught Lecture is still the most common mode of content delivery while online teaching is the least utilized. Online was being used by 2 universities 106 and 1010 delivering 10 and 9 supportive courses respectively. University 107 did not indicate the mode they use to train the supportive courses.

Table 8: Number of supportive courses taught using the different modalities by each university

Universities	Number of supportive benchmark courses taught using different modalities					
	Taught Lecture	Laboratory	Other Practical	Special Project	Online	Blended
101	8	0	0	0	0	0
102	6	6	0	0	0	0
103	4	1	0	0	0	0
104	10	6	10	10	0	10
105	8	0	0	0	0	0
106	10	10	10	10	10	0
108	9	8	9	0	0	0
109	0	8	9	0	0	10
1010	9	9	9	9	9	0
1011	8	8	8	8	0	9
1012	9	5	9	9	0	9

Blended mode of delivery added 4 additional universities that did not use online teaching.

10. Impediments to starting the BSc in food safety

10.1 Physical infrastructure available at the universities

All the universities had the basic listed equipment. Microscopes and demonstration slides were present across the 10 universities with a mean of 20 and 48 respectively. For other equipment, the mean was in single digits. Individually, university 104 had the highest mean (39) indicating it has more equipment than the other universities. University 102 had no listed equipment projecting the precarious position of having to shift from its normal location due to national security challenges. This additional equipment requested (Table 9), indirectly points to the existence of a highly trained workforce in our universities (12) of the caliber found in universities in the global North, able to train and transform the food safety workforce which would have great positive impacts on the food safety situation in the EAC.

Table 9: Additional equipment listed by universities

Equipment	Universities Requesting
Simulation laboratory	103
HPLC	104, 1012
ELISA	104,1010, 1012
PCR	104,1010, 1012
Sequence Allumina & Nanopore	104,1012,1010
Nanodrop DNA quantification	104,103
Spectrophotometer	104,1011, 1012
GC	104,1012
MS	104,1012
Rotary evaporator	104
pH meter	1011
Moisture Analyzer	1011
NMR	1012
Stomacher	1012
Texture analyzer	1011

10.2 Job opportunities for food safety graduates

The experts from the Universities indicated that the graduates from this program will have opportunities in several sectors that will absorb many of the graduates. From the frequency of the named sectors, many of the graduates will be absorbed in: -

- i. The formal private sector where they will work in food production and processing
- ii. The public service as food inspectors, hygiene officers, Technical, and Vocational Education and Training (Tvet), and disciplined forces as regulatory authority officers
- iii. The import and export trade in food products
- iv. Entrepreneurs starting businesses in the food industry
- v. Academia

10.3 Required assistance to start the program

Most of the universities indicated that upon confirmation of the benchmarks by the IUCEA, they would be ready to start the program during the 2023/2024 academic year. Only one university pushed this to the 2026 academic year. This is realistic considering that most universities have the personnel required. Ranking the assistance needed to achieve the above target of starting the program, the universities rated the top three areas as follows: -

- i) The development of the curriculum and its content
- ii) Having the program approved by the Commission for University Education
- iii) Provision of laboratory equipment

10.4 Student enrollment

EAC partner states fund the University education using different models. Where the students get scholarships, loans, or pay for the cost of university education, the number of students enrolled to make the program viable is critical. On average 50 students were considered a good number to start the program. A maximum number of 100 was suggested considering the equipment to conduct the many practical courses and needs to make economic sense.

11.0. Validation workshop

A virtual validation workshop was held on 27th March 2024. Six of the seven EAC partner states, eight Universities out of 12, and IUCEA were represented. Uganda where the assessment was not carried out had two representatives and One University present. Uganda representatives concurred with the results of the assessment and said they represented a true picture of the situation in the EAC.

Participants encouraged universities to launch the program and use equipment in sister universities if they lack it. A model used to train veterinarians in the early sixties involved cohosting the students in two colleges of the then-University of East Africa. If two Universities are willing to work together and pilot the program, there would be negotiations on how to offer a joint certificate from two different institutions. This will result in the sharing of staff and equipment which could be a hindrance if one university went it alone.

The choice of universities to take part in the assessment using the criteria of the presence of a school of Veterinary Medicine and Public Health was questioned as it did not represent the OHHLEP definition of One Health. The representatives from the Universities were drawn from Veterinary, Public Health, Agriculture-crop Science, Food Science and Technology, wildlife, and environmental health.

The IUCEA agreed to support the universities in their endeavor to develop the curriculum. The way forward, Uganda representatives said they will plan to hold a meeting of the academic stakeholder departments to plan the way to implement the program. Rwanda is currently busy with plans to start the BSc in Food Science but will look at the 2026/27 academic year to start the BSc in Food Safety. Other Universities did not commit to plans to start the program but pointed to the current MSc programs in Food Safety and Quality existing in the Universities in Kenya and Tanzania. They said they are going to consult on the issue. IUCEA of East Africa was requested in addition to the support in curriculum development, they should hold hands of the first responders who start the program.

12.0 References

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