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Sub Saharan Africa is a region that has been struggling with food insecurity for decades. Though the percentage of undernourished people in the region has decreased over the last 25 years, the actual number of undernourished people increased by more than forty million. Combatting food insecurity in the region requires an arsenal of skills, knowledge, and abilities across a broad range of disciplines. One way to target food insecurity is through education and capacity building. The purpose of this study was to identify the courses and topics that should be included in a food security (FS) graduate certificate focused on Sub Saharan Africa. Identification of the topics and courses came from faculty and professionals working in the FS field in Sub Saharan Africa. A three-round Delphi technique was conducted to accomplish the purpose of the study with a total of 63 experts. Of the original 101 topics that the expert panel proposed in Round One, 80 reached the level of agreement. Researchers grouped the topics into 28 courses. The final result of the study was 24 courses that reached the level of agreement for determining the main topics and courses that should be included in a graduate certificate focused on FS for Sub Saharan Africa.

Keywords

food security, Delphi, agricultural education, Sub Saharan Africa

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Abstract

Sub Saharan Africa is a region that has been struggling with food insecurity for decades. Though the percentage of undernourished people in the region has decreased over the last 25 years, the actual number of undernourished people increased by more than forty million. Combatting food insecurity in the region requires an arsenal of skills, knowledge, and abilities across a broad range of disciplines. One way to target food insecurity is through education and capacity building. The purpose of this study was to identify the courses and topics that should be included in a food security (FS) graduate certificate focused on Sub Saharan Africa. Identification of the topics and courses came from faculty and professionals working in the FS field in Sub Saharan Africa. A three-round Delphi technique was conducted to accomplish the purpose of the study with a total of 63 experts. Of the original 101 topics that the expert panel proposed in Round One, 80 reached the level of agreement. Researchers grouped the topics into 28 courses. The final result of the study was 24 courses that reached the level of agreement for determining the main topics and courses that should be included in a graduate certificate focused on FS for Sub Saharan Africa.

Keywords: food security, Delphi, agricultural education, Sub Saharan Africa

Introduction

The definition of food security (FS) according to the FAO is "when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (2009a p. 1). This is a complex definition and includes four specific pillars: availability, access, utilization, and stability. In order to achieve FS, these four pillars need to be fulfilled (Napoli, 2011).

The third objective of the first Millennium Development Goals (MDG) was to halve the percentage of undernourished people worldwide between 1990 and 2015. This goal was almost achieved in spite of price volatility, unemployment, climatological constraints, and other challenges faced across the globe during this period (United Nations [UN], 2015). Yet in spite of the apparent progress in tackling food insecurity, the number of undernourished people increased between the period of 2013-2015; currently, 810 million people suffer from chronic hunger (Food and Agriculture Organization of the United Nations [FAO], International Fund for Agricultural Development [IFAD], & World Food Programme [WFP], 2015). As a consequence, FS maintains its position as a critical component in enhancing peoples' quality of life across the globe (FAO, IFAD, & WFP, 2015).

Food Insecurity in Sub Saharan Africa

While food insecurity is a global problem (IFPRI, 2015), the severity of food insecurity varies drastically by region (UN, 2015). Sub Saharan Africa (SSA) and Southern Asia contain more than 60% of the world's undernourished population (FAO et al., 2015). Although food insecurity in SSA was reduced by more than 30% in the last 25 years, the actual number of undernourished people increased by more than 40 million (FAO, 2015; UN, 2015). To add to the problem, the state of food security in SSA deteriorated further in 2016, primarily due to conflicts and climatic conditions (FAO et al., 2017). Several factors contribute to SSA's struggle against food insecurity: meager crop production (Khan et al., 2014), increased prices of essential food staples (Rakotoarisoa, Iafrate, & Paschali, 2011), and rapid population growth – SSA's population has tripled in just thirty years (World Bank, 2016). It is important to stress that three of the four countries that suffered the worst food crises in 2017 are located in SSA (Nigeria, South Sudan, and Somalia) (United States Agency for International Development [USAID], 2017). While drought has contributed to severe food shortages in SSA, social and political conflict across the region continues to be the leading source of food insecurity in the region (Food Security Information Network [FSIN], 2018; FAO, IFAD, & WFP, 2015).

Though SSA has faced significant hurdles in its path to FS, there have been successes along the way. Most of the SSA sub-regions have reduced the percentage of undernourished people over the last 25 years (FAO, 2015). Western Africa has reduced the number of undernourished people in the region by sixty percent since 1990 - 1992, (FAO, 2015). The Central African Region is the only SSA sub-region that did not reduce its percentage of undernourished people (FAO, 2015). This sub-region saw an increase in the number of food insecure people within its borders, primarily due to civil crises and lack of security.

In response to the overall food insecurity levels in the SSA region, and to address the second Sustainable Development Goal proposed by the UN to "end hunger, achieve FS and improved nutrition and promote sustainable agriculture" (UN, n.d.), different organizations have begun exploring integrated approaches to address food

insecurity more comprehensively (FAO, IFAD, & WFP, 2015). Several studies have demonstrated a close relationship among food insecurity, poverty, and education (FAO et al., 2017). Thus, intentionally integrating formal education into a FS strategy is such a comprehensive approach.

Gasperini (2000; 2009) argues that education is critical for achieving FS because it increases the economic capacity of the country. By enhancing people's skills in disciplines related to FS, a region can more readily address the complexity of the problem (Nordin, Boyle, & Kemmer, 2013). Investing in skills and technical knowledge is fundamental for the overall development of a region (United Nations Environment Programme, n.d.). Thus, preparing graduates with contextually relevant agricultural understanding is crucial for providing the population with the tools to not only improve the economy but to sustainably produce enough food to eradicate food insecurity (Nordin et al., 2013). Higher education is essential for achieving food security because it provides professionals with skills and expertise on the topic. It provides graduates with research skills to find innovative solutions to complex phenomena such as food insecurity (Retta & Desse, 2011) and it provides tools to transfer innovations and knowledge to those who need it most. It also strengthens agricultural extension efforts and can enhance the overall productivity of the region (Retta & Desse, 2011).

The curriculum focused on teaching FS to graduate students will enable them to engage in leadership positions within organizations, public services, and different disciplines related to FS in order to address this complex, multi-disciplinary challenge.

Conceptual Framework

This study used the Course Development Process as a conceptual framework (Graves, 2000); specifically, Graves' Need Assessment Cycle (Figure 1). The cycle presents the six steps to evaluate a specific need. The study will be focused on the first four steps of the Need Assessment Cycle.

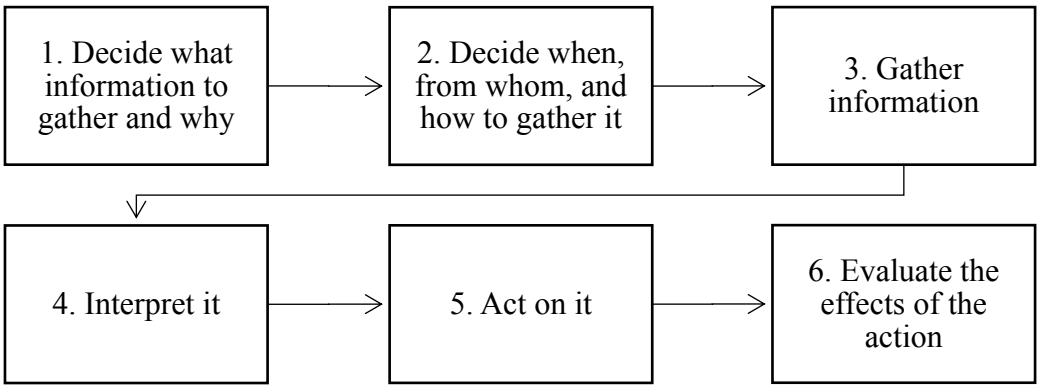

Figure 1. Adaptation of the Need Assessment Cycle.

(1) *Decide what information to gather and the reasons why.* This was achieved when the researchers defined the importance of providing a graduate certificate to address food insecurity in SSA. The second and third step, (2) *decide when, from whom, and how to gather it* and (3) *gather information*, were accomplished through the Delphi

technique. Finally, the fourth step: (4) *interpret it,* was achieved through the researchers' analysis.

Purpose & Objectives

The purpose of this research was to determine the topics and courses that stakeholders in SSA believe necessary to address food insecurity in the region. The topics and courses suggested by the experts are a fundamental inside view of the FS phenomenon in the region. Building a distance-delivered graduate certificate on FS based on what local experts deem important will ensure local perspectives in the region are heard. This study will be guided by the following objectives:

1. Identify the topics that should be included in a graduate certificate focused on Sub Saharan Africa; and
2. Determine the courses that should be included in a graduate certificate focused on Sub Saharan Africa.

Methodology

The purpose of the study was accomplished through a Delphi technique. A Delphi technique is a recognized method of group facilitation often used to determine consensus among a panel of experts about a specific topic (Hsu & Sandford, 2007; Turoff, 1970). This iterative process consists of a systematic series of phases in which experts are asked their opinions regarding a specific topic, the results of which are summarized and fed back to the experts in subsequent rounds of questioning until consensus is reached (Hasson, Keeney, & McKenna. 2000; Sackman, 1975).

In this study, results were gathered through a Three-Round Delphi, which included 63 experts representing all the regions from SSA.

Panel of Experts

Experts who participated in this study belonged to academia, industry, governmental organizations, and non-governmental organizations in SSA. The selection of the panel was made through a nomination process in which experts from the United States with experience in food security and SSA nominated individuals with expertise on the topic and the region. Then, a snowball sample was used to expand the group of experts. There was at least one expert from each of the following regions: West Africa, Central Africa, Southern Africa, and East Africa.

The panel of experts received an invitation email where they were informed about the purpose of the study and the steps that the study comprehended. They had the option to refuse to participate or to leave the study at any time if they felt uncomfortable in any circumstances. Sixty-three experts from the Sub Saharan region agreed to participate in the study.

Round one. Following recommendations in the literature (Turoff, 1970) a single question was asked to the panel of experts via email: *Which course topics should be included in a distance-delivered graduate certificate focused in FS?* Of the 63 experts who agreed to participate, 52 responded to the question for a total response rate of 83%. Responses were reviewed to reduce duplication and sorted within the four dimensions of FS and a general/others category.

Round two. Based on the topics identified on Round One, a Likert scale from Strongly Disagree (1) to Strongly Agree (4) was developed. This instrument was sent to the panel of experts who completed the first round of the study. Consensus for inclusion was considered to be reached when at least 75% of the panel indicated 'agree' or 'strongly agree' on the Likert scale (Akers, Vaughn & Lockaby, 2001). The topics that

did not reach at least 75% agreement were discarded. This instrument was sent to the 63 initial participants. Experts then ranked the topics based on their importance. Fifty-four experts responded to the instrument for a total response rate of 86%.

Round three. Topics that reached consensus in Round Two were grouped by the researchers into courses. The courses listed were organized in alphabetical order and returned to the panel of experts with the request to score each course on a 10-point Likert-type scale according to the importance from 1 = Not important and 10 = Essential. The same criterion of inclusion (a minimum of 75% of agreement) was used. Round Three was sent to the 54 experts who completed phase two of the study. Forty-three experts responded to the instrument for a total response rate of 80%.

The size of the panel and its diversity were key to achieve reliability and validity in this study (Hasson et al., 2000; Ludwig, 1997).

Results

The results of the Delphi Study are summarized in Figure 2:

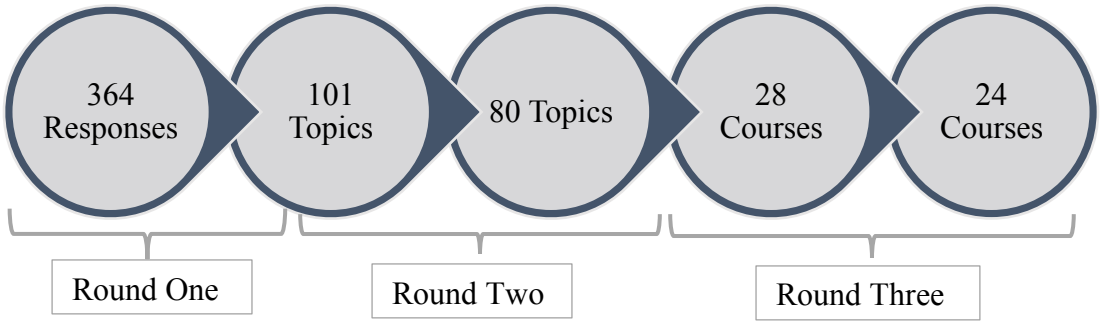

Figure 2. Three-Round Delphi Study Design.

The result of this research was a list of courses and topics reflecting the principal issues that need to be taught in the region in order to address food insecurity.

Round one. In Round One, experts provided 364 topics. After reducing duplicates, Round One provided researchers with a list of 101 topics that were divided into the following categories: Access (6), Availability (23), Utilization (27), Stability (12), and General/Others (33).

Round two. The 101 topics were sent to the panel of experts. Eighty topics reached the level of agreement and 21 topics were eliminated because they did not reach the agreement level. The topics with the highest level of agreement are: *Food supply and demand at multiple levels* (M = 3.77, SD = .54), *Climate smart agriculture* (M = 3.72, SD = .49), *Strategies to improve FS* (M = 3.67, SD = .47), *Household livelihood and food insecurity* (M = 3.66, SD = .55), *Value chain* (M = 3.64, SD = .48), *Globalization and FS* (M = 3.62, SD = .52), *Post-harvest practices* (M = 3.60, SD = .59), *Water in production* (M = 3.57, SD = .57), *Climate change* (M = 3.57, SD = .63), *Pillars of FS* (M = 3.55, SD = .53) (Table 1).

Table 1
Topics Ranked in Round Two

Topic	*M*	*SD*	Level of Agreement
Food supply and demand at multiple levels	3.77	0.54	94.6
Climate smart agriculture	3.72	0.49	93.0
Strategies to improve FS	3.67	0.47	91.8
Household livelihood and food insecurity	3.66	0.55	91.5
Value chain	3.64	0.48	91.0
Globalization and FS	3.62	0.52	90.5
Post-harvest practices	3.60	0.59	90.0
Water in production	3.57	0.57	89.3
Climate change	3.57	0.63	89.3
Pillars of FS	3.55	0.53	88.8
Food production systems	3.54	0.57	88.5
Measuring FS with indicators	3.53	0.54	88.3
Land	3.51	0.6	87.8
Urban-rural linkage and FS	3.51	0.66	87.8
Basic concepts, terms, and definition in FS	3.51	0.54	87.8
Challenges to achieving FS	3.51	0.57	87.8
Seed	3.46	0.63	86.5
Gender in FS	3.45	0.69	86.3
Cash crop cultivation vs. staple crop cultivation	3.43	0.66	85.8
Food safety	3.43	0.63	85.8
Indigenous food systems	3.43	0.66	85.8
Value addition	3.42	0.66	85.5
Global and regional patterns of FS	3.42	0.63	85.5
Research methods	3.40	0.71	85.0
Urbanization and effects in FS	3.40	0.56	85.0
Crop production systems	3.37	0.83	84.3
Disaster preparedness and management	3.36	0.75	84.0
Role of NGOs, industry, and international organism in FS	3.36	0.62	84.0
Food and nutrition policies	3.34	0.73	83.5
Nutrition for vulnerable groups	3.34	0.78	83.5
Community participation	3.34	0.61	83.5
Consequences of FS	3.34	0.75	83.5
Interventions in FS	3.34	0.73	83.5
Rural development	3.34	0.73	83.5
Natural resources management	3.32	0.69	83.0
Utilization coping strategies	3.32	0.77	83.0
Sustainable development	3.31	0.75	82.8
Production	3.30	0.70	82.5
Biotechnology in FS	3.30	0.77	82.5
Agricultural extension	3.29	0.66	82.3
Sustainable development goals	3.29	0.82	82.3
Food quality	3.28	0.68	82.0

Table 1
Topics Ranked in Round Two

Topic	*M*	*SD*	Level of Agreement
Human nutrition	3.28	0.76	82.0
Technology	3.27	0.71	81.8
Factors influencing choice in agriculture practices	3.26	0.77	81.5
Food and health	3.26	0.70	81.5
Water	3.26	0.85	81.5
Food processing	3.25	0.61	81.3
Human diseases and FS	3.25	0.72	81.3
Agro-ecology	3.23	0.77	80.8
FS a trans-disciplinary and cross-cultural issue	3.21	0.79	80.3
Program planning and implementation	3.21	0.72	80.3
Diseases in agriculture	3.19	0.89	79.8
Nutritional status and assessment	3.19	0.79	79.8
Access to capital	3.18	0.73	79.5
Macro and micronutrients requirements in human health	3.17	0.82	79.3
Sustainable utilization of animal resources	3.16	0.75	79.0
Food standards	3.15	0.66	78.8
Food waste	3.13	0.68	78.3
Rights to food	3.13	0.85	78.3
Aquaculture	3.11	0.69	77.8
Hunger	3.11	0.90	77.8
FS between regions	3.10	0.77	77.5
Economics	3.09	0.76	77.3
Pros and cons of modern livestock production systems	3.09	0.73	77.3
Program evaluation	3.09	0.76	77.3
Program monitoring	3.09	0.76	77.3
Soil	3.08	0.82	77.0
Food consumption	3.06	0.79	76.5
Communications	3.06	0.83	76.5
Horticulture and urban horticulture	3.04	0.81	76.0
Actor mapping in food marketing systems	3.04	0.87	76.0
Impact of food additives in FS	3.02	0.94	75.5
Food prices	3.02	0.86	75.5
Poverty	3.02	0.76	75.5
Weather and stress tolerant biotic and abiotic factors	3.00	0.94	75.0
Fruit crop processing	3.00	0.71	75.0
Water quality monitoring	3.00	0.82	75.0
Entomology	2.98	0.92	74.5
Environmental studies	2.98	0.81	74.5
Fisheries management	2.96	0.64	74.0
Food culture	2.96	0.80	74.0
Food miles and ecological footprint of food	2.94	0.76	73.5
International laws and policies	2.91	0.81	72.8

Table 1
Topics Ranked in Round Two

Topic	*M*	*SD*	Level of Agreement
Weeds	2.83	0.95	70.8
Terrorism and conflict in FS	2.83	1.00	70.8
Education	2.83	0.87	70.8
Exports	2.77	0.92	69.3
Theories of development	2.77	0.85	69.3
Contaminants	2.75	0.87	68.8
Genetics	2.74	0.95	68.5
Biometry	2.74	0.95	68.5
Population theories	2.72	0.81	68.0
Dietary reference level	2.70	0.86	67.5
Human migration	2.70	0.79	67.5
Energy intake thresholds	2.66	0.89	66.5
Agricultural microbiology	2.64	0.80	66.0
Impact of monetization title II	2.64	0.89	66.0
Energy	2.58	0.76	64.5

Note: Four-point Likert scale from 1 = Strongly Disagree to 4 = Strongly Agree

The topics that reached the level of agreement were divided into the following categories: Access (6), Availability (17), Utilization (21), Stability (7), General/Others (29). These 80 topics were grouped into 28 possible courses that were ranked in order of importance by the panel of experts in Round Three.

Round three. From the 28 courses, 24 reached the level of agreement (Table 2). The highest rated courses included: *Value Chains in FS* (*M* = 9.21), *Water Issues* (*M* = 9.15), *Crop Production* (*M* = 8.95), *Effects of Climate Change on FS* (*M* = 8.93), *Human Nutrition* (*M* = 8.84), *Food Production Systems* (*M* = 8.61), *Food Safety* (*M* = 8.53), *Measuring and Analyzing FS with Indicators* (*M* = 8.53), *Technological Change in FS* (*M* = 8.52), *Sustainability* (*M* = 8.48).

The four courses that did not reach the level of agreement were: *Plant Technology* (*M* = 7.24), *Plant Diseases* (*M* = 7.12), *Smart Regional Design* (*M* = 6.95), and *Introduction* (*M* = 5.90).

Table 2
Courses and Topics Sent to The Panel of Experts in Round Three

Course and Topic	*M*	Level of Agreement
Value Chain in FS	9.21	92.14
Actor mapping in food marketing systems		
Food supply and demand at multiple levels (rural, urban, and regional)		
Value addition		
Value chain		
Water Issues	9.15	91.46

Table 2
Courses and Topics Sent to The Panel of Experts in Round Three

Course and Topic	*M*	Level of Agreement
Water (management and conservation)		
Water in production (harvesting techniques and saving irrigation technologies)		
Water quality monitoring		
Crop Production	8.95	89.52
Crop production systems (plant breeding, plant nutrition, plant physiology, plant pathology, plant protection, and production)		
Traditional crop diversity		
Cash crop cultivation vs. staple crop cultivation		
Production (techniques, interdisciplinary approach, intensification, industrial, constraints, and early maturing crop varieties)		
Effects of Climate Change in FS	8.93	89.30
Climate change (causes, impact, mitigation, and adaptation)		
Climate-smart agriculture)		
Nutrition	8.84	88.37
Food and health		
Food and nutrition policies		
Food consumption		
Household livelihood food insecurity (survival thresholds)		
Human nutrition		
Hunger		
Macro and micronutrients requirements in human health		
Nutrition for vulnerable groups (food insecurity, children, immunosuppressed people, elderly)		
Nutritional status and assessment		
Food Safety	8.53	85.35
Food quality		
Food standards (local & global)		
Food safety		
Measuring and Analyzing FS with Indicators	8.53	85.35
Measuring FS with indicators		
Poverty		
Household livelihood food insecurity (Evaluation)		
Utilization of coping strategies		
Technological Change in FS	8.52	85.24
Communications (Intercultural and behavioral change)		
Factors influencing choice in agriculture practices		
Technology (dissemination, useful)		
Sustainability	8.48	84.76
Sustainable development		
Agro-ecology		

Table 2
Courses and Topics Sent to The Panel of Experts in Round Three

Course and Topic	*M*	Level of Agreement
Natural resources management		
Animal Production Systems	8.46	84.63
Pros and cons of modern livestock production systems		
Sustainable utilization of animal resources		
FS Policies	8.44	84.42
Land (Management, access, planning, use)		
Rights to food		
Seed (Systems, access, and availability)		
Research Methods	8.38	83.81
Research methods		
Food Processing	8.37	83.72
Fruit crop processing		
Impact of food additives in FS		
Post-harvest practices (Storage, handling of products, management, technologies, waste)		
Future of FS	8.33	83.26
Challenges to achieving FS		
New developments in FS		
Strategies to improve FS		
Sustainable development goals		
Rural Development	8.26	82.56
Agricultural extension		
Community participation		
Indigenous food systems		
Rural development		
Capital in FS	7.83	78.29
Access to capital		
Economics		
Food prices		
Aquaculture	7.74	77.38
Aquaculture		
Human Diseases and FS	7.72	77.21
Human diseases and FS		
Horticulture	7.68	76.83
Horticultural and urban horticulture		
Program Planning and Evaluation	7.67	76.74
Program evaluation		
Program monitoring		
Program planning and implementation		
Soils	7.56	75.61
Soils (quality, types, erosion, conservation, sampling, fertility)		
Food waste	7.52	75.24

Table 2
Courses and Topics Sent to The Panel of Experts in Round Three

Course and Topic	*M*	Level of Agreement
Food waste		
Plant Technology	7.24	72.44
Biotechnology in FS		
Weather and stress tolerant biotic and abiotic factors		
Plant Diseases	7.12	71.22
Diseases in agriculture (horticulture, food crop, economic importance)		
Smart Regional Design	6.95	69.51
Disaster preparedness and management		
Urbanization and effects in FS		
Urban-rural linkage and FS		
Introduction	5.90	58.97
Consequences of FS		
FS a trans-disciplinary and cross-cultural issue		
FS between regions		
Global and regional patterns of FS		
Globalization and FS		
Household livelihood and food insecurity (causes, protection, strengthening, response)		
Interventions in FS		
Pillars of FS (availability, access, utilization, stability)		
Role of emergency aid, co-operatives, NGOs, agro-industries, and international organizations in FS		

Note: 10-point Likert-type scale from 1 = Not important to 10 = Essential.

After Round Three was completed the courses were divided into the following categories: Availability (6), Access (2), Utilization (4), Stability (3), and General/Others (7). The courses selected by the experts are listed in Figure 3 (see Figure 3 below).

Conclusions, Recommendations & Implications

Objective one sought to identify the topics that should be taught in a graduate certificate focused on FS for Sub Saharan Africa. The panel of experts agreed on 80 topics that should be taught. Most of the topics selected were general topics because they covered more than one pillar of food security. The fact that the general category was the most prevalent indicates that food insecurity needs to be targeted in a more holistic way (Spiertz, 2012). A study developed by Frelat and collaborators (2016) reflects the importance of multi-sectoral policies that take into consideration all the components of FS to improve outcomes for food insecure populations.

The second and third categories with the highest number of topics were availability and utilization. This is not surprising considering the lack of available food in many parts of SSA due to climatic constraints and civil unrest, as well as limited access to information on topics related to food security, such as sustainable agricultural practices and proper nutrition (Frelat et al., 2016). A considerable portion

of the population of SSA is still experiencing undernutrition, and the lack of dietary diversity is a major factor in the ongoing battle against malnutrition (FAO, 2015).

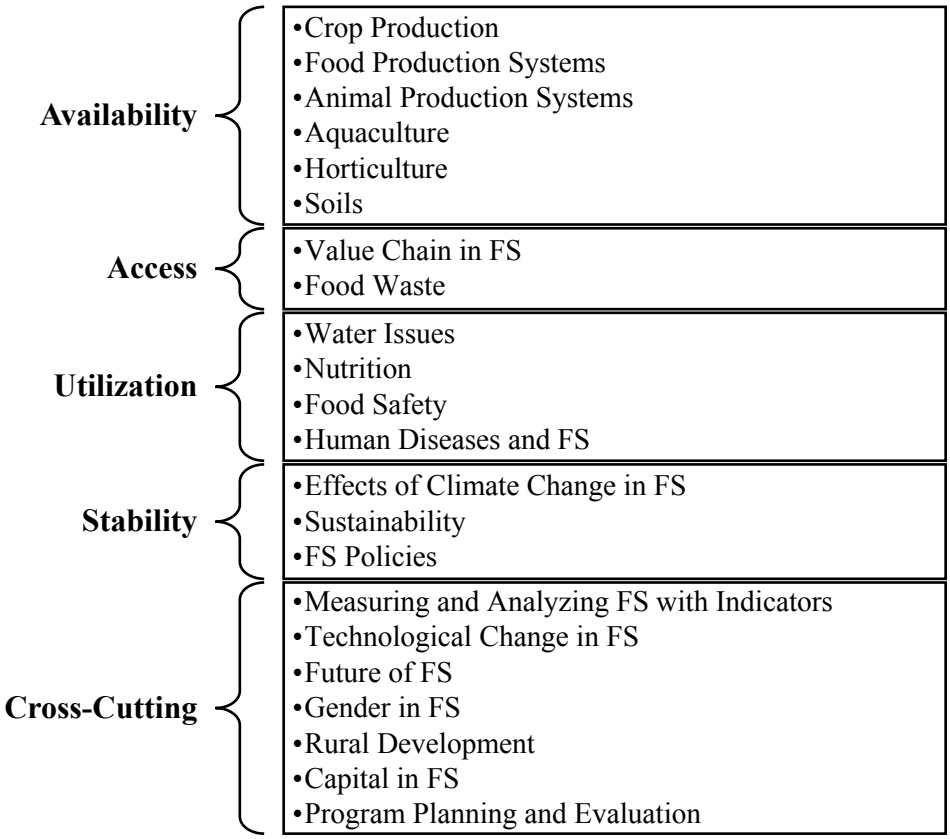

Figure 3. Courses Included in the Curriculum.

The second objective of this study sought to determine the courses that should be included in a graduate certificate focused on FS for Sub Saharan Africa. The courses that reached the level of agreement among the experts are: (1) *Value Chains in FS*, (2) *Water Issues,* (3) *Crop Production*, (4) *Effects of Climate Change in FS*, (5) *Nutrition*, (6) *Food Production Systems*, (7) *Food Safety*, (8) *Measuring and Analyzing FS with Indicators*, (9) *Technological Change in FS*, (10) *Sustainability*, (11) *Animal Production Systems*, (12) *FS Policies*, (13) *Research Methods*, (14) *Food Processing*, (15) *Future of FS*, (16) *Gender in FS*, (17) *Rural Development*, (18) *Capital in FS*, (19) *Aquaculture*, (20) *Human Diseases and FS*, (21) *Horticulture*, (22) *Program Planning and Evaluation*, (23) *Soils*, (24) *Food Waste*.

Most of these courses are aligned with the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods (African Union Commission, 2014). This Declaration was build based on the lessons learned from other programs focused on agriculture and FS developed in the region (African Union Commission, 2014).

The courses *Value Chains in FS* and *Food Waste* belong to the FS pillar of access. The Malabo Declaration states the importance of improving the access to quality and affordable food for the

population of Sub Saharan Africa. Improving access to food and quality of food involves several components such as geographical access and the purchasing power (FAO, 2015).

The courses *Water Issues*, *Nutrition*, *Food Safety*, *Food Processing*, and *Human Diseases and FS* are courses that belong to the utilization pillar. Twenty-three percent of the population in Sub Saharan Africa is undernourished (FAO et al., 2017). The region has developed several strategies to target undernutrition in the utilization pillar. The Africa Regional Nutrition Strategy aims to strengthen three specific conditions in order to achieve nutrition: access to nutritious food, access to adequate water and sanitation for human health, and understanding adequate maternal and child care practices (African Union, 2015). In 2011 the region implemented the Agriculture Nutrition Capacity Development Initiative with the aim of reducing malnutrition and improving food safety (FAO, 2017). These initiatives will need trained professionals with a comprehensive understanding of food security in order to succeed.

The courses *Crop Production*, *Food Production Systems*, *Animal Production Systems*, *Aquaculture*, *Horticulture*, and *Soils* belong to the availability pillar of FS. It is essential to take into consideration not just the quantity of food produced in the region, but also the quality. Food availability has improved in more than 10% in the last 20 years, and several initiatives specifically target food availability in the region (FAO, 2015). The overall dietary intake improved in all regions, however, central Africa, due to the political and social instability, currently presents even lower levels of dietary intake than in the 1990-1992 period (FAO, 2017). Furthermore, food imports are a current issue throughout SSA because the region imports a high quantity of foodstuffs creating a dependency on external markets (FAO, 2017).

The courses *Effects of Climate Change in FS*, *Sustainability*, and *FS Policies* belong to the stability pillar of FS. It is necessary to ensure political stability in the region and propose food security policies beneficial for all the population in order to reduce food insecurity in a sustainable way (FAO, 2017). Some experts predict that the region will face a reduction of the crop production, soil erosion, and higher market prices, and as a result, food insecurity will increase even more (Thompson, Berrang-Ford, & Ford, 2010). In the face of the many challenges facing the SSA region, preparing graduates with the necessary tools to confront these challenges and enhance food security in the region (Thompson et al., 2010).

The courses *Measuring and Analyzing FS with Indicators*, *Technological Change in FS*, *Research Methods*, *Future of FS*, *Gender in FS*, *Rural Development*, *Capital in FS*, and *Program Planning and Evaluation* are cross-cutting courses. Most of the initiatives developed to improve food security in the region in recent years have an active component of monitoring and evaluation (FAO, 2017). As such, it is fundamental that professionals acquire the abilities necessary to evaluate regional initiatives. The Malabo Declaration states the importance of accountability in all the projects and programs; this statement is closely related to the course chosen by the experts: *Program Planning and Evaluation*.

Gender plays a key role in food security. Several studies are supporting the positive role of women empowerment in food security (FAO et al., 2017). There are numerous advantages to household food security when women's participation in decision-making and productive pursuits is increased (FAO et al., 2017). Enhancing opportunities for women to generate income

can improve their families' access to better nutrition, health, and education (Gödecke, Stein, & Qaim, 2018; FAO, 2009b). Education of women opens employment opportunities for them in a variety of sectors, creating an additional safety net for their families and significantly reducing chronic hunger (Gödecke et al., 2018; Mwaniki, 2006). Finally, empowering women can have a positive impact on agriculture, since women play important roles along the value chain of many agricultural commodities, but lack access to many educational and other opportunities to enhance productivity (Agricultural Development Economics [ESA] & Doss, 2011). Professionals working in food security need to understand the complexity of gender issues to help improve women's economic participation, reduce discrimination, and increase household food security levels (FAO et al., 2017). It is essential to have a gender component in an educational curriculum geared toward food security.

The cross-cutting courses can be adapted for use in each of the four pillars of food security. These courses meant to provide graduate students with skills necessary to develop quality research and comprehensively evaluate and implement the programs and projects to address food security. Food security is a multi-disciplinary challenge and providing graduate students with cross-cutting courses will facilitate an integrated approach to addressing the challenges of achieving food security.

This study used Graves' Need Assessment Cycle as a conceptual framework. Following the cycle, researchers were able to decide what information to gather, how to gather it, and how to interpret the information to create a comprehensive curriculum for food security in Sub Saharan Africa. The next step in the cycle is to implement the curriculum.

The development of the curriculum and its content requires faculty who possess the necessary skills and knowledge to teach the courses and have an impact on the students. Faculty need to focus on the region and have expertise in the region to provide graduate students with the most relevant content.

As recommended in previous studies, this study can serve as the base for future studies focused on food insecurity and the region's education (Millares Forno, Brashears, Baker, Boren, & Carpio, 2016). At the same time, it is essential that master's degrees in food security cover the four pillars of food security and provide courses able to integrate all the ideas.

It is recommended to do a comparative global study to show the specific courses deemed as necessary by local experts in each region of the world to address global food insecurity more effectively.

Future research can explore the courses focused on the specific pillars of food security. Different research techniques can be examined to complement the results of this study.

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