

# Research, Development and Capacity Building for Food and Nutrition Security in Sub-Saharan Africa

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## Abstract

This paper focuses on research, development and capacity building in relation to food and nutrition security (FNS) in sub-Saharan Africa (SSA). It looks at human capacity, education, teaching and learning, women empowerment, research, innovation and technology, research, indigenous knowledge (IK), institutional aspects, infrastructure, information and communication technologies (ICT), policies and finance. Professional bodies exist in many countries and the extent to which they engage in FNS awareness creation differs. Food and nutrition insecurity continues to affect people in Africa's 54 nations where the population is expected to double by 2050 with the expected doubling of food production to keep pace with population growth. Within the continent there is a substantial number of human capacity professionals who are global leaders in food, nutrition and related professions. Some research organisations in the continent directly or indirectly benefit from grants administered by developed economies but a challenge exists with brain drain and ageing of qualified and experienced experts. Increasing educational need, coupled with the growing population necessitates attention to ensuring a sustained supply of highly trained, adequately equipped and qualified professionals in the relevant fields of food and nutrition sciences. Higher educational institutions exist in especially those that fall within the 500 in world universities ranking. Research activities take place in the continent along with the translation of research outputs into commercialisable products. Research towards transforming agriculture for improved livelihoods is taking place in different parts of the continent. Education, governance, gender and rural development are the key challenges. Income growth and the impacts of climate change on food production have contributed to food insecurity. ICTs can play an important role for FNS. Strengthening research, development, capacity building and industry cooperation are critical for FNS in Africa.

**Keywords:** Research; Human Capacity; Infrastructure; Policy; Food Security; Africa

## 1 Introduction

Food belongs at the heart of the culture of Africa, bringing families and friends together. At the same time, food and its nutrients are essential

for our survival, and food-health issues are now regarded as being as, or even more, important than global warming.

Food security of households and individuals in the developing world is negatively impacted by a

range of issues including chronic poverty, rapid population growth, declining per capita food output/ low food production, poor infrastructure, ecological constraints, limited arable land, inappropriate policies, parasites and diseases, poor water and sanitation, inadequate nutritional knowledge, civil war, and ethnic conflicts (Riely, Mock, Cogill, Bailey & Kenefick, 1999). Other factors militating against food security include: seasonal food shortages; high food prices; high unemployment; low level of nutrition education; and cultural factors and taboos that reduce access to food (Aworh & Egounlety, 2011). Of recent, income growth and the impacts of climate change on food production have contributed to food insecurity. This paper focuses on research, development and capacity issues in relation to food and nutrition security in Africa.

Education, gender and rural development remain a key challenge to the development of Africa. Food security is defined as 'when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life' (Clay, 2003). With the epidemic of obesity in the developed world (Baum, 2014), nutrition refers to the process involved from the choice and consumption of food up to its effects on health and well-being of individuals (Kropff, Van Arendonk & Löffler, 2013). From these definitions, food and nutrition security in low- and middle-income countries still needs significant inputs in terms of higher education, research and community engagement activities to have the desired impact (NORHED, 2013).

Food and nutrition insecurity continue to affect large numbers of people in Africa's 54 nations. FAO estimates indicate that 925 million people are undernourished, with 239 million from sub-Saharan Africa (SSA) alone (FAO and WEP, 2010). Of the nine countries in the world having high population growth rates, five are from SSA (Table 1). Moreover, thirty-three countries in SSA (Figure 1) are among the forty-eight countries globally classified as Least Developed Countries (LDCs) by the United Nations Economic and Social Council (ECOSOC), with characteristics of low income, weak human resources and high economic vulnerability (UN, 2012). Research, development and capacity building are key requisites needed by Africa to be able to

tackle the important challenges facing the continent (Table 4).

Recent research has revealed that the population in Africa is expected to double by 2050, and African nations will have to double their food production just to keep pace with population growth (Lartey, 2013). In the past, food production in Africa has lagged behind population growth, and the source of the problem has been low productivity on Africa's farms. Improving farm productivity requires, *inter alia*, a complex of policy and technological options, such as advocating for the adoption of good mixes of technologies in Africa; focusing on country-specific priorities, existing policies, availability of infrastructure for research and development; the role of diverse technologies that exist in Africa in ensuring adequate food security in the continent; nature and scope of indigenous technology options in Africa; examining the current food security situation in Africa; and the opportunities offered by different technologies in addressing the food security situation (Ozor & Urama, 2013).

Diversifying into biotechnology practices in food production will help the continent's growing population in food and nutrition security. Possibilities exist for genetic modification involving animals, plants, and microorganisms, e.g. genetically modified (GM) foods, GM food ingredients such as flavours and gums, and GM enzymes such as chymosin which contain DNA of bacteria & yeasts.

Some benefits of such Genetically Modified Organisms (GMOs) include: improved food quality including better processing qualities/functionality; dramatic increases in agricultural productivity, world food supply (e.g. maize, which is a major staple in many countries in Africa; protection of food (e.g. decreased crop losses due to insect herbivory); lowered production costs; grocery bill reduction to the consumer; and safer farm environment (through fewer/lower insecticide and herbicide use), and reduced exposure to pesticides (Jideani et al., 2013; Keats & Wiggins, 2014). Development and adaptation of these technologies by Africa farmers requires considerable investment in research, education and capacity building. However, some countries are against the use of genetically modified crops.

As stated by Akinyele (2009) three strategic pillars of intervention include

1. support for national and regional centres of excellence;
2. support for infrastructure for higher education, science and technology; and
3. linking higher education, science and technology and the productive sector.

Such an approach will contribute significantly to the strengthening of African institutions of higher education (ADBG, 2008).

## 2 Human Capacity Building

Capacity is defined as ‘the ability of people, organizations and society as a whole to manage their affairs successfully’ (Bester, 2015). Capacity development is the process of unleashing, strengthening and maintaining of such capacity. Leadership matters in capacity development issues; as strong capacities with poor leadership can cause an organization/country to stumble. On the other hand, strong and positive leadership can bring about progress, even with low capacities (Pepping, 2010). Capacity building for food and nutrition security in Africa would require:

1. capacity development and infrastructure building,
2. government commitment,
3. private sector involvement – including industry, and
4. appropriate policies for reform.

It would also imply the promotion of national and regional innovation systems.

In human capacity, there are substantial number of professionals in food, nutrition and related professions in the continent. However, the growth in industries and demand from related international organisations like WHO, FAO, UNICEF, etc creates an apparent scarcity of professional experts in SSA countries. This calls for public-private partnerships (PPP) in

SSA with inherent benefits like the supply of needed funds, exposure of local researchers to more skills, and the creation of an enabling environment for promoting research findings (SPORE, 2013). As stated by Hailu (2013) for the agricultural sector, and applicable to food and nutrition, forging innovative partnerships at different levels and building competencies of women and young people could bring about transformative changes in SSA.

Research in Food and Nutrition in SSA is facing the challenge of brain drain and ageing of highly qualified and experienced experts who will retire before the end of next decade. As reported in SPORE (2013), the goal set by the New Partnership for Africa’s Development (NEPAD) of investing certain amount of agricultural GDP of a country in research and entrusted to the Forum for Agricultural Research in Africa (FARA), could help research among national, sub-regional and international organisations.

### 2.1 Education, Teaching and Learning

The increasing educational need, coupled with the growing population in SSA, particularly the youth, necessitates attention to ensuring a sustained supply of highly trained, adequately equipped and qualified professionals in the relevant fields of food and nutrition sciences. A good number of higher educational institutions (HEI) – universities, colleges and training centres - exist in most counties of SSA, the key ones are listed in Table 5. These HEIs offer training in Food Science/Technology and in Nutrition at Bachelors, Masters, and Doctoral levels.

The study of food and nutrition is a fast-developing discipline especially with the globalisation of the food industry; and is full of practical, technical and intellectual challenges. It draws knowledge from a range of disciplines including chemistry, biology, physics, psychology, geography, business and even art. A graduate of Food Science/Technology and Nutrition has the knowledge and skills to tackle real issues and problems on food faced by society and industry (Leeds, 2014).



Figure 1: The 33 Least Developed Countries in sub-Saharan Africa: Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Mali, Mauritania, Mozambique, Niger, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, Sudan, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Togo, Uganda, United Republic of Tanzania, and Zambia (UN, 2012)

Table 1: Nine countries with high population growth rates

Country	Population in 2011 (in thousands)	Population in 2050 (projected) (in thousands)	Percent change
Afghanistan	32,000	77,000	136
Democratic Republic of the Congo	68,000	149,000	120
Ethiopia	85,000	147,000	73
India	1,250,000	1,736,000	39
Niger	16,000	56,000	246
Nigeria	163,000	392,000	140
Pakistan	178,000	279,000	57
Uganda	35,000	95,000	173
Yemen	25,000	62,000	149

Source: UN, Annual letter from Bill Gates. Department of Economics and Social Affairs. Population Division, UN (2011) The Least Developed Countries: Things to know, Things to do. Office of the High representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States UN (2012). [www.un.org/ohrlls](http://www.un.org/ohrlls). Visited 07-09-2013

The aim and objectives of most Food Science, Nutrition and related programmes in the education system are similar, in that they strive to:

1. strengthen the Biomedical-Social-Environmental Science Partnership;
2. facilitate the transfer of food and nutrition sciences and their partnerships to relevant technologies for human development and environmental sustainability;
3. build the capacity of individuals, institutions and the private sector to optimize food supply so that hunger is overcome, nutritionally-related diseases are prevented, and overall good health is promoted;
4. work with communities to deal with food and nutritionally-related diseases in ways that are culturally-sensitive, sustainable and effective; and
5. support sustainable food and nutrition policies based on sound science (Wahlqvist, 2006).

To achieve these objectives to their fullest extent, and to ensure that the study of food and nutrition sciences and cognate technologies have their impact on the human condition and on national economies, it is imperative that there is

a greater flow of resources into the teaching and development of these sciences/technologies. Science/technology partnerships and mounting major internationally significant projects can help to provide part of the solution to these major challenges facing all African Universities, and training and research institutions.

A snapshot survey of food science and related curricula in 17 universities across 11 African countries by Minnaar, Taylor, Haggblade, Kabasa and Ojijo (2017) revealed the following fundamental problems:

1. given the tight links between the growing prevalence of processed foods and declining health status, solutions to Africa's emerging public health problems will require cross-disciplinary work linking food technology, human nutrition and public health;
2. yet collaborative degree programmes are almost completely lacking at national, regional and international levels for most countries in SSA;
3. too little extension work and training (non-degree education); and (iv) very few universities present BSc Nutrition/ BSc Food Science/Technology and Nutrition programmes.

Minnaar et al. (2017) also highlighted the following challenges faced by Food Science and Technology educators: lack of modern food processing equipment; lack of “state-of-the-art” analytical equipment; lack of technical support within institutions; and insufficient numbers of academics to run programmes. The low student numbers and poor quality of students (many potential students perceive Food Science and Technology to be the less attractive compared to other programmes). In addition to the above problems, a good proportion of students are not aware of the differences between Food Science, Nutrition and allied professions (Jideani et al., 2013). Other compounding problems include the facts that:

1. there is little nutrition education at school level (FAO, 2011a), and
2. most Food Security interventions rarely emphasise the issue of nutrition, and prevention of malnutrition.

Professional training in Food and Nutrition education and communication is needed not only by the new entrants into professions related to food security, but also by those already in practice, such as Nutrition Educators; Agricultural Economists; Agribusiness Executives and Managers; Rural Development Specialists, Parliamentary Portfolio Committee members on Agriculture and Fisheries, Food Biotechnologists, Agriculture Extension Officers, women farmers, officials from local and regional agricultural research organizations, Parliamentary Portfolio Committee members on Water and Environmental Affairs, agricultural scientists, officials of state and national departments of agriculture and fisheries officials, Cooperatives Development Centers, agricultural ICT experts, farmers and community organizations, Food Security experts / Information Specialists, academics and researchers from college and universities, officials from FAO, SADC, IFPRI, USAID, IFAD, NEPAD, CGIAR, scientists in agricultural research institutes, women working in agricultural research and development, staff of Food and Nutrition Associations, etc.

## 2.2 Women Empowerment for Food & Nutrition Security

Smallholder agriculture must have a central investment focus to support broad-based poverty reduction and food and nutrition security. Furthermore, gender issues must not be neglected, as African agriculture and food security are very much female-dominated in terms of the actual farm work (although not in terms of land ownership and financial benefits). Women make up more than 50% of the agricultural labour force in the LDCs (UN, 2012). Women therefore, can play an important part in helping to improve productivity, profitability and sustainability of smallholder farming. Experts agree that women are a critical part of expanding agricultural output, particularly in sub-Saharan Africa. There is therefore a need to

1. develop training and skills programmes in Food Science and Nutrition and agriculture for African women;
2. make funding available for African women to engage in Food Science and Nutrition research and development,
3. establish appropriate mechanisms at all levels to promote the advancement of African women economically, culturally and socially, through provision of equal access of women and girls to education, basic services, health care, economic opportunities, and decision-making at all levels (UN, 2012).

The Global Food Security Index (GFSI) showed a 0.93 correlation with the Economist Intelligence Unit’s Women’s Economic Opportunity Index, a measure of the global environment for female economic participation (Unit, 2012). Similarly, an FAO (2011b) report states that as women make up 43% of the world’s farmers, women empowerment would increase total agricultural output in developing countries by 2.5% to 4% and reduce hunger globally by 12% to 17%.

Table 2: Number of researchers in research &amp; development (R&amp;D) per million population

Countries	Number of Researchers
Brazil	1176
Russian Federation	3101
India	215
China	1176
South Africa	1113
United States	4231
Britain	4299
South Korea	6899

Source: Qhobela (2018)

### 3 Research, Innovation and Technology Development

The number of researchers in research & development per million population is globally comparable (Table 2). In the continent there exist scientists “who are unequivocally recognised by their peers as leading international scholars in their field for the high quality and impact of their recent research outputs” (NRF/RISA, 2019). Hence, the funds made available to universities and research establishments for research and development have positive impact both in terms of excellent scientists, infrastructure and tangible products that are in the market. Numerous research activities are taking place in the continent. This brings to fore the need to translate research outputs into commercializable products and intellectual property. Hence, traditional ways of doing research in laboratories and experimental stations and publishing the papers in academic journals will not be enough (Hailu, 2013). As stated by Lartey (2013), priority research with the potential to address undernutrition in Africa must focus on how effective research interventions can be incorporated into country programmes and scaled up for maximum effect. Research and innovation are informed by development needs to make a good model. Most countries in Africa need national, regional and international partners, as well as the private sector to tackle food and nutrition needs and lead to development outcomes that can impact positively on the population. In-

creased research in nutrigenomics, i.e. the application of high-throughput genomic tools in nutrition studies and research, is needed in the continent, e.g. to help tackle a non-communicable disease, such as obesity. Such research will provide methods and tools for disease prevention and health promoting foods that match lifestyles, cultures and genetics of people living in SSA. Genes and their variants have been evidenced to play a role in obesity-associated metabolic complications through genetic association studies, including candidate gene and genome-wide association approaches in adults and children (Aguilera, Olza & Gil, 2013). A recent report by Baum (2014) states that the overweight population in developing countries has surpassed developed countries, with a higher number of overweight or obese adults in developing countries than in rich countries in 2008 (Stevens et al., 2012).

As it is for agricultural technologies, a significant reduction of food prices and food insecurity in developing countries (IFRI, 2014) will be achieved by the application of different, effective processing innovations and preservation technologies (fermentation, canning, drying, etc) to plant and animal foods. This can most significantly reduce food prices and food insecurity in SSA. As “no single silver bullet exists” in food and nutrition technologies that would provide enough food for the world in 2050, adapting a range of these technologies could yield maximum benefit for the continent and improve food security. However, a positive outcome depends on

SMEs gaining access to these technologies and learning how to use them in food processing operations. This underscores the need for improved food and nutrition education to ensure that processors can use the best available technologies for their region, location and resources.

### 3.1 Research at sub-regional and regional levels

Many regional and sub-regional research towards transforming agriculture for improved livelihoods is taking place in different parts of the continent. The collaborative project between the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and the International Food Policy Research Institute (IFPRI) is a good example which aims at Strategic Priorities for Agricultural Development and Agricultural Research-for-Development in Eastern and Central Africa. The sources of funding for such projects are usually from development partners including the United States Agency for International Development's Regional Economic Development Support Organisation, the European Union, Swedish International Development Agency and the International Maize and Wheat Improvement Center, as well as other funding bodies like the FAO, United Nations Development Programme (UNDP), and New Partnership for African Development (NEPAD). New research areas in Eastern and Central Africa include:

1. sustainable agricultural water productivity enhancement for improved food security and nutrition;
2. facilitating implementation of policies to enhance equitable access to input and output markets;
3. developing and upscaling technologies and innovations for the management of maize lethal necrosis disease;
4. development of smallholder wheat production systems and value chains;
5. crop-livestock-fish integration to enhance food security, nutrition and resilience of smallholder farms;

6. capacity development for sustainable plant genetic resources (PGRS) utilization and conservation;
7. strengthening the value chains of fruits and vegetables for improved production, processing, marketing and nutrition security (ASARECA, 2014).

Cassava which is mostly grown by poor farmers is vital for both food security and for income generation. Through a joint CIAT/ International Institute for Tropical Agriculture (IITA) project, efforts on Cassava Genetic Resources & Breeding, diversity for cassava germplasm have been centralized at regional research centers like the IITA in Nigeria. In 1996, IFAD and FAO initiated work to develop a global strategy for development of cassava considering its diverse utilisation (Table 3).

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), which is located at Makerere University, is a consortium of 42 universities in an increasing number of countries. It tackles the oversee of graduate training and networks of specialization in the countries and universities by fostering innovative and responsive research; high performing and proactive graduates; a dynamic platform for university networking; advocacy for agricultural higher education; and university transformation for relevance. It aims to becoming an essential tool for anyone interested in agricultural research and training in Africa.

### 4 Indigenous and traditional knowledge

Most countries in Africa have a rich heritage of indigenous knowledge that is being exploited in food and nutrition interventions. One of such countries among others, is Kenya where the Indigenous Food Plants Programme, using locally available edible species to enhance community health, provides income and conserve biodiversity thereby ensuring for and nutrition security (Cousins & Witkowski, 2015). One of the aims is to compile a database of the indigenous food plants of Kenya through research in the

Table 3: Utilisation of cassava

Major uses	Products
Human consumption	Raw cassava Boiled cassava Cooked cassava slices Fried cassava slices Fermented cassava Cassava flour Macaroni Fufu - porridges or pastes (West Africa) Gaplek Composite flour, bread Tapioca Gari (West Africa) Cassaripo or tucupa Cassava rice Beer
Livestock feed	Cassava pellets Cassava meal Cassava chips or slices Cassava leaf meal Broken roots Cassava silage
Industrial products	Starch, glues, binders Filler, stabilizer, food dusting agent Glucose, alcohol, acetone, dextrans

Source: CIAT (2004)

field and at the East African Herbarium as well as the promotion of cultivation, consumption and marketing of these foods through field demonstrations, educational materials and the media. The programme has three components: research, extension and education. It was necessary as

1. people (e.g. younger generation) who took pride in their modern food consumption pattern) were despising their traditional foods in favour of exotic foods,
2. poverty, famine, and malnutrition were common in rural areas even though local foods were readily available, and
3. much local knowledge regarding the nutritional value and cultivation of local edible plants was being lost.

## 5 Institutional Aspects

Most countries have national professional bodies, and the extent to which they engage in food and nutrition security awareness creation differs (FAO, 2011b). Some of these organisations are listed in Table 5. They, along with others such as The African Union of Nutritional Sciences, help to create awareness of food and nutrition security through seminars, conferences and workshops. They also have linkages with similar organisations at the global level, namely the International Union of Nutritional Sciences (IUNS), and the International Union of Food Science and Technology (IUFoST). Regional nutrition leadership and institutional capacity building activities is increasingly gathering momentum, for instance the partnership between IUNS and the

Table 4: Challenges militating research, development and capacity towards food and nutrition security in Africa

Infrastructure and Technology Issues	Production Issues	Finance and Policy Issues
Rudimentary technologies	Inconsistent quality & quantity	Poor market analysis
Inadequate supply of appropriate packaging	Safety & quality constraints	Policy failures - affecting domestic resource mobilization
Poor processing methods	Poor linkages between producers & processors	Inadequate fiscal reforms
Poor health facilities	Climatic conditions - global warming	Governance issues -
Lack of innovativeness and product diversification	Declining per capita food output	
Lack of technical expertise	Climatic conditions - global warming	

United Nations University. Furthermore, inter-scientific union activities have strengthened, e.g. IUNS and IUFOST are collaborating in an on-line Food Science and Technology training initiative in Africa. The IUNS President chairs the International Science Council initiative on the Sciences for Health and Well-Being. This engages all major science unions, so allowing new science platforms and models to develop regarding contemporary and future needs (IUNS, 2013; Wahlqvist, 2006).

## 6 Infrastructure, Information and Communication Technologies (ICT)

Infrastructure, tools and equipment remains an area of challenge in most institutions of higher learning in SSA. However, some institutions exist that are as well equipped for food and nutrition research as in developed countries, especially those that fall within the top 500 in the World Universities Ranking (WUR, 2014); while others are a little less well equipped, such as some of those that fall within the top 50 in the Ranking Web (RW, 2014) of universities in Africa.

The development of renewable energy supply systems has considerable potential in many Africa countries. However, this requires major financial investment and technical know-how. This is another area where capacity building at all levels is critical (UN, 2012).

Information and Communication Technologies (ICTs) can play an important role for Food and

Nutrition Security (FNS) in Africa. While the potential benefits of ICT in FNS are immense, ICT has not penetrated sufficiently in the various aspects of FNS. So far, ICT has remained at the level of mobile phones in practically every African village, however the other applications for FNS have remained largely untapped. Possibilities include improved and timely accessing and dissemination of information for supplementing the food value chain better and integrated production planning, monitoring and follow-up, access to the latest results of research, information on the latest agricultural production technology, markets, pest and disease control improvement of standards of food professionals, etc, all of which can contribute to enhancing productivity and reducing food insecurity in Africa and to meeting the challenges of modernized agro-processing technologies (FAO, 2011a). A major hindrance to the development of ICT is the inadequacy of a regular energy supply. In fact, 92% of rural households in African LDCs have no electricity.

## 7 Policies and Programmes

There have been several initiatives by SSA countries aimed at providing the necessary policy environment for addressing malnutrition in line with the MDG. The various policies articulate the fact that food and nutrition are an integral part of the overall national objective of improving nutritional status and socioeconomic well-

Table 5: Some institutions and societies relating to Food and Nutrition Sciences in sub-Saharan Africa

Country	Institutions/ Societies
Benin Republic	Higher Educational Institutions: Universite d'Abomey-Calavi;l'Université Nationale du Cotonou; Agronomiques del'Université de Bénin,lomé
Botswana	Botswana Dietetic Association Botswana Technology Centre Gaborone National Food Technology Research Centre, Kanye Higher Educational Institutions: Botswana College of Agriculture, Gaborone; University of Botswana, Gaborone
Cameroon	Higher Educational Institutions: Centre Universitaire de Ngaoundere
Cote d'Ivoire	Higher Educational Institutions: Institute National Supérieur del'Enseignement Technique, Yamoussoukro
DR Congo	Higher Educational Institutions: University of Kinshasha; Universite Catholique du Graben
Ethiopia	Food Research and Development Centre, Ethiopian Food Corporation, Addis Ababa Higher Educational Institutions: Hawassa University; Addis Ababa University; Awasa Junior Agricultural College of Addis Ababa University; Kotebe College of Teacher Education
Gabon	Institute de Recherche Technologique,libreville-Akebe
Gambia	Gambia Food and Nutrition Association, Banjul
Ghana.	Technology Consultancy Centre, University of Science and Technology, Kumasi. Ghana Regional Appropriate Technology Industrial Service, Tema Ghana Nutrition Association (GNA) Higher Educational Institutions: University of Ghanalegon; Kwame Nkrumah University of Science and Technology, Kumasi
Kenya	Higher Educational Institutions: University of Nairobi; Egerton University; Jomo Kenyatta University of Agric \& Technology, Nairobi; Technical University of Kenya; Moi University; Dairy Training School Naivasha; Egerton University
Lesotho	Higher Educational Institutions: National University of Lesotho Maseru
Malawi	TCC/PHN Women in Development Project, Namadzi. Malawi Enterprise Development Institute, Mpela Small Enterprise Development Organisation of Malawi, Blantyre Higher Educational Institutions: The Malawi Polytechnic; University of Malawi
Mauritius	Higher Educational Institutions: University of Mauritius, Reduit
Namibia	Development Centre for Research Information Action in Africa, Windhoek Higher Educational Institutions: University of Namibia

Country	Institutions/ Societies
Nigeria	Federal Institute of Industrial Research, Oshodi (FIIRO) International Institute of Tropical Agriculture, Ibadan Nutrition Society of Nigeria (NSN) Nigerian Institute of Food Science and Technology (NIFST) National Agency for Food and Drug Administration and Control (NAFDAC) Higher Educational Institutions: Ahmadu Bello University; University of Calabar; Michael Okpara (Federal) University of Agriculture, Umuahia; Federal University of Agriculture, Abeokuta; Federal University of Technology, Owerri; University of Agriculture, Makurdi; University of Ibadan; Obafemi Awolowo University; University of Nigeria Nsukka; University of Maiduguri; Michael Okpara University of Agriculture, Umudike; Ibadan State University of Technology, Ogbomoso; Rivers State University of Science and Technology, Port Harcourt; Federal University of Technology, Akure; Federal University of Technology, Yola; Federal University of Technology, Minna; University of Uyo, Uyo; Kogi State University, Anyigba, Bowen University, Iwo; Imo State University, Owerri, Bells University of Technology, Ota; Ebonyi State University, Abakaliki; University of Ilorin, Ilorin; Anambra State University of Technology; Bendel State University; Enugu State University of Science and Technology; Yaba College of Technology; Idah Polytechnic, Idah;
Rwanda	Higher Educational Institutions: National University of Rwanda
Sierraleone	Higher Educational Institutions: University of Sierraleone
South Africa	Food Science Institute for Africa, Human Nutrition Institute, Stellenbosch Medical Research Council, Nutritional Intervention Research Unit, Tygerberg, Cape Town Council for Scientific and Industrial Research, Pretoria Agricultural Research Council - Animal Production, Institute. Human Nutrition and Sensory Science, Irene South African Association for Food Science and Technology(SAAFoST) Nutrition Society of South Africa (NSSA) Higher Educational Institutions: University of Pretoria, Stellenbosch University; University of Venda; Central University of Technology, Bloemfontein; University of the Free State, Bloemfontein; Cape Peninsula University of Technology, Bellville; University of Johannesburg; Tshwane University of Technology, Pretoria; Durban University of Technology; Monash University
Sudan	Food Processing Research Centre, Khartoum Higher Educational Institutions: Ahfad University for Women, Omurdman; School of Hygiene, Khartoum
Swaziland	Higher Educational Institutions: University of Swaziland
Tanzania	Small Industries Development Organisation, Dar-es-Salaam Ministry of Agriculture Training Institute, Mwanza and Kilosa National Food Control Commission, Dar-es-Salaam Food and Nutrition Association of Tanzania (FONATA) Higher Educational Institutions: Sokoine University of Agriculture, Morogoro; University of Dar-es-salaam; University of Dodoma

Country	Institutions/ Societies
Uganda	Uganda Manufacturers Association, PO Box 6966, Kampala Uganda Small Scale Industries Association, Mbale National Agricultural Research Organisation, Kampala Nile Vocational Institute, Jinja Higher Educational Institutions: Makerere University, Kampala; Gulu University; Mbarara University of Science and Technology
Zambia	Higher Educational Institutions: University of Zambia; Natural Resources Development College Lusaka
Zimbabwe	Ranche House College, Harare Higher Educational Institutions: Chinhoyi University of Technology, Zimbabwe; Midlands State University, Zimbabwe; University of Zimbabwe, Harare

being of the people, particularly of the most vulnerable groups. However, with 115 people dying every hour in SSA from diseases linked to poor sanitation, poor hygiene and contaminated water, there is need to halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation (UN, 2012). Akinyele (2009) outlined that such policies should aim at:

1. promoting the establishment of a viable system for guiding and coordinating food and nutrition activities;
2. incorporating food and nutrition considerations in development plans and allocating adequate resources toward solving the problems pertaining to food and nutrition at all levels;
3. promoting habits and activities that will reduce the level of malnutrition and improve the nutritional status of the population; and
4. promoting good indigenous food cultures and dietary habits for healthy living and development.

Some other challenges common to all SSA countries on food and nutrition security include:

1. lack of government policies on innovation sensitive to the African context in optimizing abundant resources;

2. translation of outputs from R&D into usable and accessible solutions; and
3. lack of nutritional guidelines to help consumers and chefs.

Indicators of food insecurity in SSA include very low levels of average food consumption, large fluctuations of food consumption and the large population of absolute poor (Aworh & Egoulety, 2011).

## 8 Financial and other resources

The impact of the world economic and financial crisis, combined with food and fuel crises, has undermined the development and progress of many developing economies. Lack of financial resources is one of the biggest constraints to both LDCs and other countries in achieving sustainable development and progress (UN, 2012). Increased access to financial services especially for SMEs, increased government spending on productive capacity-building, and support development to science and technology by all stakeholders will increase agricultural output and impact positively on food and nutrition security. Most countries in SSA have put in place financial resource mechanisms contributing to objectives such as:

1. internationalising the research platform,
2. enhancing networking within the global science system,

### Top FP7 International Partners Participations per Country

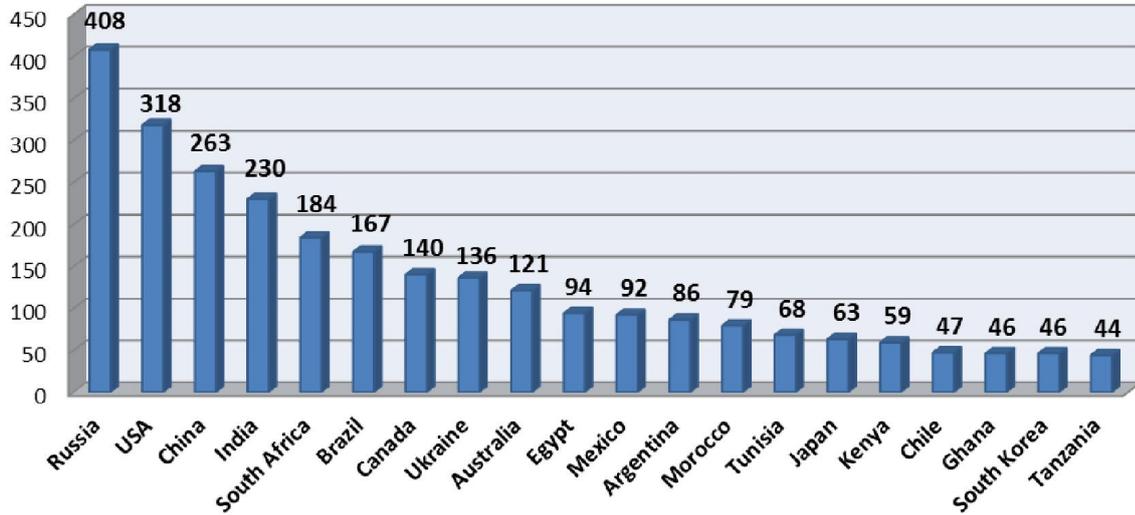


Figure 2: International participation in European Union FP7 (Hogan, 2013)

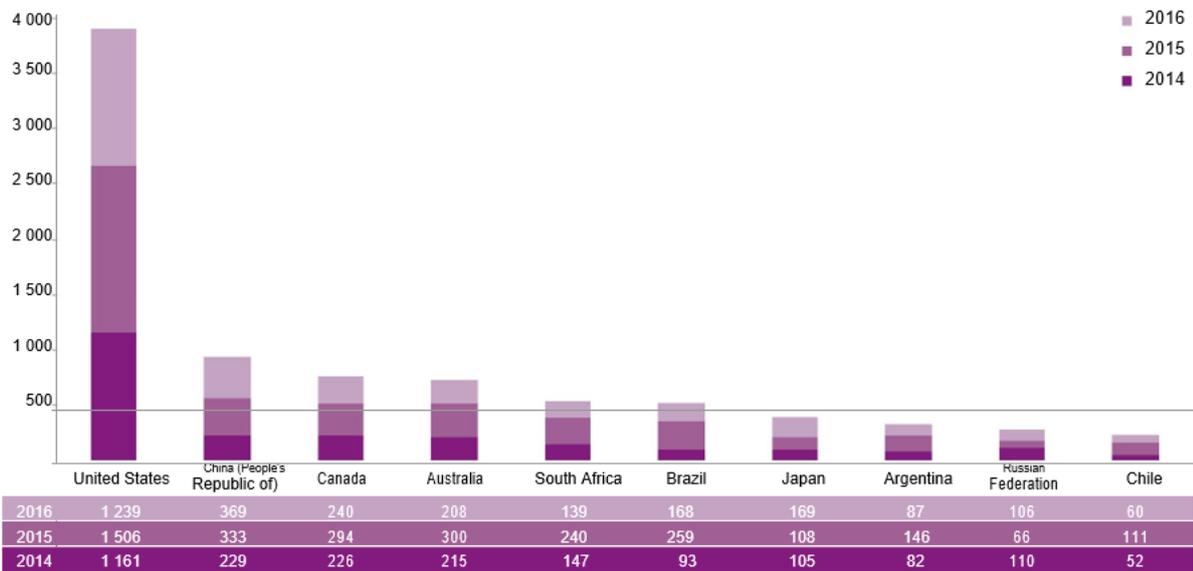


Figure 3: Number of Horizon 2020 applications from the 10 most active third countries, 2014-2016 (European Commission, 2018)

3. fostering collaboration in order to improve the quality of research outputs by researchers,
4. promoting research into how climate change can alter agricultural strategies to support food security and nutrition in Africa,
5. identifying research priorities for Food Security and Nutrition Adequacy,
6. tackling land issues that impact on Food and Nutrition Security,
7. investigating ways to meet the food and nutrition needs of the Africa's growing population without damaging the soils,
8. collecting and disseminating national statistics for policy, planning and research
9. developing knowledge and approaches through applied research, and
10. developing irrigation and water harvesting systems to increase production.

Research organisations in African countries directly or indirectly benefit from financial support administered by developed economies like the EU-Horizon 2020 (n. d.), which is the European Union's biggest (2014-2020) ever research and innovation framework programme. However, few countries in the continent were among the top participants in the EU-Framework Programme 7 (2007 - 2014) grant as shown in Figure 2. The strategic programme (focus areas) of most developed economies include: Personalising health and care for quality of life, sustainable food security, and water innovation (Hogan, 2013). In addition to bilateral and multilateral financing instruments, Africa has put in place several domestic financing mechanisms. A good example is the National Research Foundation (NRF) of South Africa. The internationalisation of research is an intrinsic part of funding instruments, built into research grants awarded through programmes such as Competitive Funding for Rated Researchers, the South African Research Chairs Initiatives (SARChI), and the Centres of Excellence (CoE) Programme (NRF, 2014). The number of Horizon 2020 applications

from the 10 most active third countries, 2014-2016 is shown in Figure 3) (European Commission, 2018).

## 9 Conclusion

Strengthening research, development and capacity building is critical for food and nutrition insecurity in Africa. This will require among others actions, the

1. acceptance of the application of biotechnology in food production by all countries,
2. effective collaboration within and outside sub-Saharan Africa,
3. provision, by the government of each country in the continent, of enhanced financial and technical support to research and innovation, science and technology, including strengthening national and regional institutions,
4. ensuring that science and technology are mainstreamed into national development and sectoral policies as this will ensure better information dissemination typical of digitalisation age,
5. broadening access to secondary, tertiary and vocational education and skill development training,
6. eliminating gender disparities in education and training,
7. increasing the quality of education and training at all levels,
8. helping African countries go beyond MDG education targets, especially in increased enrolment and decreased drop-out rates,
9. strengthen the sharing of knowledge, applied research and extension as well as transfer of technology under mutually agreed terms to African countries and support them in strengthening their capacity to manage their natural resources, and
10. good governance for greater efficiency and better delivery of goods and services.

Good governance and rule of law are essential for sustained, inclusive and equitable economic growth, sustainable development and the eradication of poverty and hunger (UN, 2012). Also, attention is needed in reducing food losses as it has immediate and significant impact on livelihoods and wellness, tackling poor infrastructure (access to farm gate, processing facilities/consumer), developing irrigation, water harvesting systems, use of renewable energy, effective use of resource wealth - land resources for food crops, and nutrition education and communication - helping people to improve their diet through discussion, demonstration and practice (FAO, 2011a; FAO and WEP, 2010).

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