



Intersection of Agricultural Education and Training (AET) & nutrition: a review of existing programs and recommendations for training in nutrition-sensitive agriculture

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November 2017

USAID/BFS/ARP-Funded Project

Award Number: AID-OAA-L-12-00002

Acknowledgment

Innovation for Agricultural Training and Education (InnovATE) is a USAID-funded project supporting the capacity development of agricultural training and education systems from primary school through secondary institutions as well as vocational and technical schools and universities. The InnovATE project, implemented by a consortium of U.S. universities led by Virginia Tech and including Pennsylvania State University, Tuskegee University, and the University of Florida, aims to strengthen the range of institutions that train and educate agricultural professionals. This project was made possible by the United States Agency for International Development and the generous support of the American people through USAID Cooperative Agreement No. AID-OAA-L-12-00002. For more information about the InnovATE project and other publications visit our website at <http://www.oired.vt.edu/innovate>, or follow on Twitter, @innov_ATE, or Facebook, www.facebook.com/InnovATEAgEd. Contact us at innovateprogram@vt.edu or call 540-231-6338.

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Executive Summary

An estimated 815 million people are chronically undernourished worldwide. Inadequate nutrition underlies 45% of childhood mortality and a host of other population health and economic problems. The Sustainable Development Goals (SDGs) have set the world on a path until 2030 of striving for a world without hunger, achieving food security for all, eradicating all forms of malnutrition and making significant improvements in sustainable agriculture (SDG 2). Through a series of thematic studies, USAID's InnovATE project explores the areas of agriculture education and training (AET) that are of high interest and contribute to a broader understanding of strategies to build capacity. Overall, InnovATE explores the role AET plays in increasing agricultural production, addressing socio-economic inequalities, and contributing to improved health conditions for all. This paper focuses on the interaction between AET and nutrition, by 1) examining existing literature, and 2) surveying the current connection between AET higher education institutions and nutrition training in 36 Feed the Future focus countries. Given the breadth of the InnovATE project, this topic complements the work related to agricultural education, including pedagogy, training and extension, and human and institutional capacity development. Ultimately, it becomes evident that this is an area with great potential with existing country models of nutrition-sensitive agricultural training from pre-K to the university level that can be scaled up in other countries. Indicators are proposed to keep countries accountable for this needed change to achieve SDG 2 by 2030.

Introduction

Global Malnutrition and the Critical Window

Globally, it is estimated that 815 million are chronically undernourished (FAO, IFAD, UNICEF, WFP and WHO, 2017). Inadequate malnutrition underlies 45% of child mortality in developing countries (Black et al, 2013). Approximately 18% of the population of such countries are living with food insecurity, with the highest rates in Sub-Saharan Africa, Asia, North Africa, and Latin America, (Meade and Thome, 2017). A focus on nutrition can have a positive impact on other targets such as global health (maternal and child health, non-communicable diseases), gender equality, and economic development (ending poverty, achieving economic growth, and innovative change) (World Bank, 2006).

Some major concerns of malnutrition include prevalence of low birth weight (<2500g), stunting (low height-for-age), wasting (low weight-for-height), and increasing rates of obesity (high weight-for-height) (UNICEF, 2017). Figure 1 illustrates the prevalence of stunting worldwide. Having inadequate food has the greatest impact for children under the age of five as the child's physical and mental development occur rapidly during this time, and stunting occurs in children before the age of two. Malnutrition impairs brain development, immune functioning and increases the risk of chronic diseases later in life (Morgane et al, 1993). Micronutrient deficiency disorders (MDDs), often called 'hidden hungers'—deficiencies of iron, folic acid, zinc and vitamin A deficiency—are associated with stunting and affect an estimated 2 billion people worldwide (IFPRI, 2016). MDDs likewise harm human growth and development, health, educability and work capacity as micronutrients are critical ingredients of growth and physiological processes. MDDs are related to inadequate consumption of nutrient-rich foods as well as underlying infectious diseases (e.g. malaria, hookworm) that siphon off nutrients from the gut or bloodstream.

Nearly a third of women of reproductive age suffer from anemia, putting their health and that of their children at risk (FAO et al, 2017). Women are at increased risk of iron deficiency anemia due to blood losses from childbirth and menstruation if iron is not replaced regularly in their diet. Other population groups are also at risk including both male and female internally displaced people, refugees, and school-aged children (IFPRI, 2016). However, women and young children remain the most vulnerable in all countries and contexts. Interventions that impact the small window of the first two years of a child's life can have the greatest effects to prevent malnutrition and the negative consequences that go along with

it (Ainsworth, 2010). This time period is called the “critical window”. The critical window for nutrition intervention occurs from conception to the first two years after birth, the first 1000 days of life (Save the Children, 2012). The pregnant mother, developing fetus and young child all require proper and consistent availability of nutrient-rich foods, as nutrition has been found to be one of the “greatest environmental influence[s] both on fetus and neonate” (Morgane et al, 1993: p. 91). Due to cultural beliefs and taboos related to food allocation and feeding at different points in the life cycle, nutrient-dense foods can be allocated sub-optimally such that malnourished women and children are found in every socioeconomic bracket (World Bank, 2006).

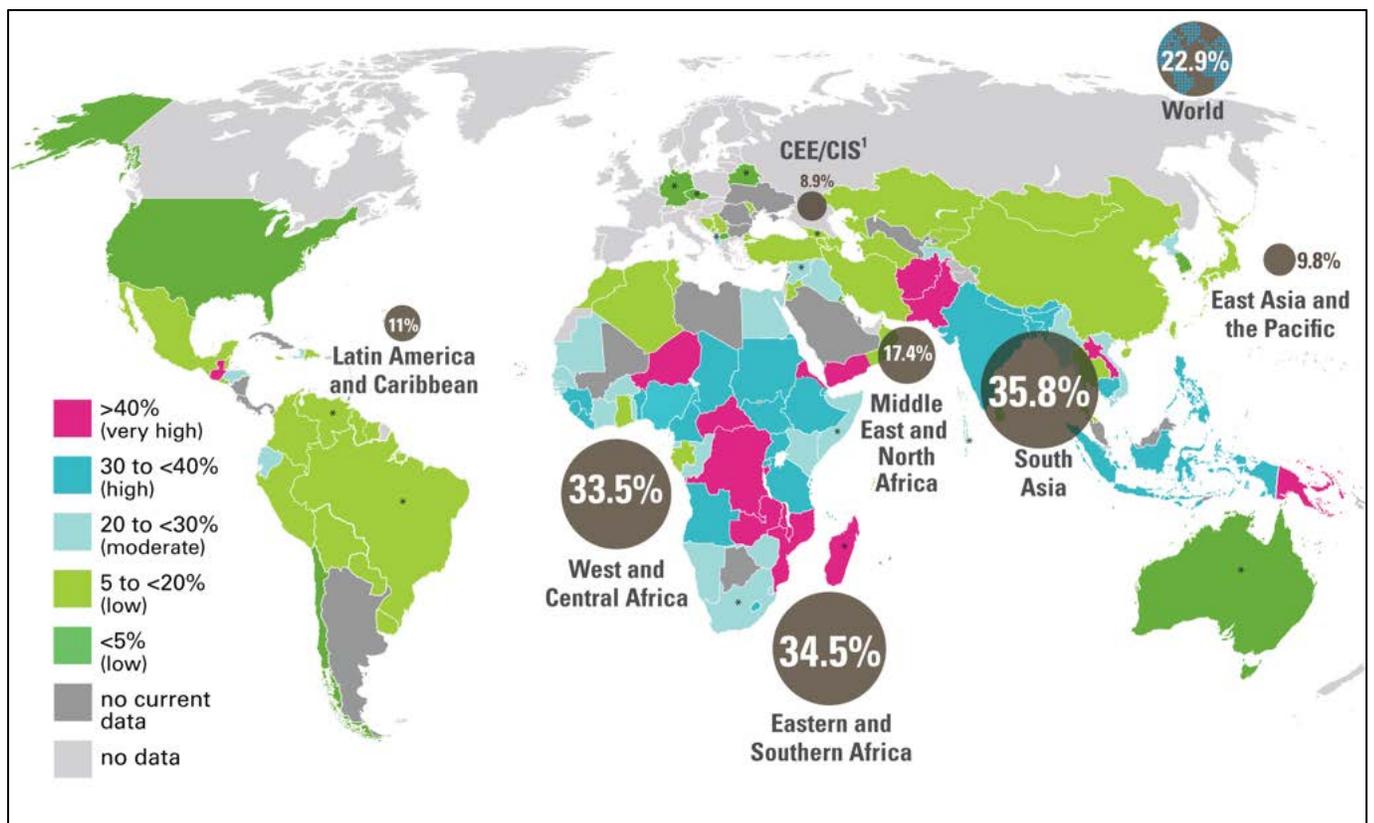


Figure 1: Percentage of children under the age of 5 who are stunted
Source: UNICEF, 2017

Nutrition Education and Health Outcomes

One way to tackle the challenges in global nutrition is through nutrition education. Dating back decades, the impact of nutrition education in developed countries generally has been shown to be effective, not only in increasing knowledge, but in shifting attitudes and behaviors (Contento, 2011). This includes interventions with diverse populations (Contento et al, 1995; Perez-Rodrigo and Aranceta, 2001) and those with a focus on increasing consumption of nutritious fruits and vegetables (Stables et al, 2005; Howerton et al, 2007). A review of school-based nutrition education programs showed the positive potential to develop healthy eating practices for young people (Perez-Rodrigo and Aranceta, 2001).

On a global level, nutrition education and promotion has had varied impacts and is primarily conducted by community-based organizations outside of the formal education system. In a review of nutrition-education interventions, Majamanda et al (2014) found that all studies had positive impacts on preschool children's (under age five) nutritional status, including measures of height, weight and upper arm circumference. Effects differed by implementer characteristics, differences in strategies, age and nutritional status of child at the start of the intervention, intensity of the intervention and content of the intervention. Approaches, such as home visits and group meetings with caregivers and community leaders, to increase awareness of the benefits of healthy food choices and dietary diversity, twice weekly sessions, and cooking demonstrations showed highly significant findings (Majamanda et. al., 2014). Additionally, promotion of breastfeeding and healthy complementary feeding, which is the addition of other foods and liquids to breastmilk for infants from 6-24 months, can have widespread positive impacts on the child's health (UNICEF, 2009). However, even with awareness and training, the ability of households or caregivers to change their behaviors related to nutrition and food consumption can depend on socioeconomic and cultural factors as well as household food security. Therefore, despite nutritional education, health related outcomes are not guaranteed (Majamanda et. al., 2014).

Preparing for the world we want in 2030

Achieving food security is a necessary although not sufficient precondition for achieving the diet diversity families need to attain good nutrition. In 2016, the United Nations (UN) launched the Sustainable Development Goals (SDGs) that were adopted by every member nation by January 1, 2017. Building on the previously established Millennium Development Goals (MDGs), the SDGs are intended to be the guiding targets that encompass critical focus areas, which aim to "end poverty, protect the planet, and ensure prosperity for all" (UN, 2015). More recent socio-environmental concerns create the

need for “urgent, high-profile, and change-producing global goals” that incorporate challenges of social inclusion and natural resource sustainability (Sachs & Rey, 2012).

The SDG vision for the world in 2030 includes a world without hunger, an end to all forms of malnutrition, achieving food security and improving sustainable agricultural practices. SDG 2 Target 2.1 seeks “access by all people, in particular the poor and people in vulnerable situations including infants, to safe, nutritious and sufficient food all year round” (Table 1). Integrating agricultural production, food security programming, and nutrition interventions has become the current trend in international development discourse and practice. To accomplish the SDG vision will involve rethinking and redesigning food systems worldwide. A food system refers to all activities related to the production, distribution and consumption of food that affect human nutrition and health (Combs et al 1996; FAO, 1997).

Hunger and malnutrition have diverse underlying causes including household food insecurity, maternal and child caregiving practices and inadequate health/ health environment (UNICEF, 1990). Food security, which refers to the availability, accessibility and utilization year-round of safe and nutritious foods to meet dietary requirements and cultural preferences for an active, healthy life, is dependent on the agricultural sector (World Food Summit, 1996). The demands of agricultural work further impact women’s time for childcare and care for themselves during pregnancy and lactation. Income generated from agriculture (and other sources) and who controls it influences household food acquisition and the utilization of health services.

Given the multi-causal nature of malnutrition, agricultural institutions of higher education have the opportunity to play a central role in reshaping the global food system to address malnutrition and related health concerns. Such institutions will influence the thinking of future agricultural leaders, researchers, and practitioners. To achieve SDG 2, it will be important for agricultural planners to begin with the end (eradicating hunger, food insecurity and all forms of malnutrition and achieving sustainable agriculture) in mind. It should be noted that despite the connection between nutrition and food security in SDG 2, an indicator related to dietary diversity is absent from the sustainable food production system target (Target 2.4). It will only be through a collaborative effort across sectors to address contributing underlying causes that success will be possible.

Table 1. Sustainable Development Goal (SDG) 2, Targets and selected indicators

SDG 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture

| |
|--|
| <p><i>Targets pertaining to nutrition</i></p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p> <p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p> |
| <p><i>Targets pertaining to agriculture</i></p> <p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure <i>sustainable food production systems</i> and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p style="padding-left: 40px;">Indicator 2.4.1 Proportion of agricultural area under productive and sustainable agriculture</p> <p>2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed</p> <p>2.6 Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>2.7 Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round</p> <p>2.8 Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility</p> |

Nutrition-Sensitive Agriculture

There is a growing recognition that food security efforts need to take into consideration issues of malnutrition and obesity in the target population. The term “nutrition-sensitive” refers to programs that draw upon sectors such as agriculture, health, early childhood development, social protection and education, water and sanitation to affect underlying causes of malnutrition (Ruel, Alderman et al, 2013).

International programs, such as the U.S. government’s Feed the Future Initiative, promote development with the “intent to advance food security, resilience and nutrition”, primarily through innovation in agriculture and multi-level and multi-sectoral capacity building (Feed the Future, 2017).

Nutrition-sensitive agriculture often targets women, as the household member responsible for caretaking and child-rearing. Through gender mainstreaming efforts, more policies and programs are focused on improving women’s living conditions and view women’s empowerment as a means to better nutritional outcomes. Guidelines for implementing nutrition-sensitive agriculture focus on nutritionally vulnerable groups (e.g. women of reproductive age, preschool-aged children, refugees, internally displaced persons) and selecting women for programming investment, as they demonstrate a higher return on that investment (Herforth et. al., 2012). More recent trends in nutrition promotion demonstrate an increased effort to consider household nutrition more comprehensively, branching out beyond the mother of the family. Nutrition education can have greater health impacts when including men, elders, grandmothers and other household influencers (Aubel, Toure and Diagne, 2004; Byrd-Bredbenner and Abbot, 2008; Mukuria et al, 2016).

The USAID-funded INGENAES (Integrating Gender and Nutrition in Agriculture Extension Services) project at the University of Illinois, Urbana has a global focus and supports Feed the Future countries “to build more robust, gender-responsive, and nutrition-sensitive institutions, projects and programs” (INGENAES, 2017). INGENAES focuses on in-service training of agriculture extensionists. Project activities are highlighted in Box 1 to illustrate the range of research, planning and programming involved to link nutrition and agriculture.

Box 1: Project Activities within USAID’s Integrating Gender and Nutrition in Agriculture Extension Services (INGENAES) Project

- Integrate service delivery mechanisms that better reach women farmers and promote nutrition-sensitive agriculture
- Assist stakeholders in designing and implementing gender-transformative, nutrition-sensitive activities
- Partner in innovative learning exchanges
- Carry out needs-based assessments and applied research
- Create mentoring programs and strengthen networks
- Support farmer organizations
- Hold regional technology fairs and virtual marketplaces

Source: INGENAES 2017

An example of an agriculture-nutrition linked extension-focused intervention is The “Soils, Food and Healthy Communities” (SFHC) program in Malawi combined agricultural technical assistance to smallholder farmers focusing on intercropping legumes and visits from farmer researchers, combined with nutrition promotion sessions that consisted of home visits and group meetings (Bezner Kerr et al, 2011). The researchers explored whether participation and length of involvement in the project had an effect on child growth over six years. A recent evaluation of this program used a quasi-experimental research design to measure the impact of the intervention and demonstrated a significant increase in children’s weight-for-age (Bezner Kerr et al, 2011). There was an increase in legume consumption and improvements noted in child feeding and caregiving practices. The study called for a “more integrated approach to improve child nutrition”, particularly for rural farmers (Bezner Kerr et al, 2011).

Historically, non-agricultural community-level agents such as health sector staff or volunteers have had the role of promoting nutrition. However, globally the tide has shifted with the recognition that nutrition concepts and messages can be mainstreamed naturally and logically into various sectors’ programming, including agriculture. The director of the SFHC program, Dr. Rachel Bezner Kerr, chose to take courses in both international agriculture and nutrition during her graduate studies in development sociology at Cornell University even though nutrition was not a requirement. Her pre-service training persuaded her of the logical connection and importance of pursuing nutrition-sensitive agricultural interventions (Bezner Kerr, Individual Consultation, 2017). While there now is frequent mention of the term “nutrition-sensitive agriculture” in development discourse, there is much less discussion of the need for pre-service nutrition-sensitive agriculture education.

The objective of this paper is to investigate the linkages between formal agricultural education and nutrition education in developing countries and the current capacity for nutrition-sensitive agricultural training in developing countries. It is unclear how well agricultural education, on a global level, is preparing students to think systematically about the linkages between nutrition, agriculture, food security and sustainable food systems.

Research Questions

Considering the extent of global malnutrition and the linkages between agriculture, sustainable food systems and nutrition, there is a clear need to explore the current state of agricultural education and training. This paper explores the extent to which agricultural education and training institutions, particularly in developing countries, have incorporated human nutrition and/or food system-related concerns into their pre-service training/ degree programs.

Specifically, we ask:

- a) Is there evidence of and research on integrating training on food security, population diets, and nutrition in a school context at any age level, particularly in developing countries?
- b) How is nutrition addressed within agriculture training programs at higher education institutions in selected Feed the Future focus countries?

This review examines literature to determine to what degree AET programs have adopted a role in improving food security, dietary diversity and nutritional well-being in developing countries and beyond. The paper is exploratory and provides more information about the current state of agricultural education and its integration with nutrition education in pre-service training. We will also make recommendations moving forward, as this paper is intended to be an initial exploration of the intersection of AET and nutrition training at the pre-service level.

Methods

The first phase of research involved a literature review. This review covered both a global geographic scope and multiple education levels, with an emphasis on higher education.

The initial methodology included peer-reviewed published literature through June 2017 using Agricola and Web of Science databases. The following search functions were used: agriculture education (or) training AND nutrition (or) food system (or) diet (or) food security (or) malnutrition. Given the limited published findings, the search was broadened using Google and Google scholar with these search terms to include other non-peer reviewed literature (e.g. on-line articles, project reports and policy papers). Results were organized into an Excel spreadsheet. Additionally, a request for publications or information on existing efforts at integrating nutrition into pre-service agriculture education/training was submitted to the Agriculture-Nutrition Community of Practice (Ag2Nut) e-mail listserv, which at the time had over

4000 members from over 90 countries. One-on-one email, in-person or phone communication was used to follow up on leads, which included current and ongoing initiatives from scholars and practitioners. Responses with relevant information were added to the spreadsheet.

The second phase of research was an examination of the current state of agricultural training at 36 agricultural institutions of higher education in Feed the Future countries. By visiting institutional websites, information was collected on mission statements, degree programs offered, academic organizational structures and potential capacity for addressing the linkage between agriculture and nutrition at these institutions. Specifically, the study looked at the availability of nutrition education and the incorporation of nutrition into higher-level agricultural education (pre-service). This review identified strengths and areas of opportunity in terms of nutrition capacity building at the aforementioned institutions.

Results: Integrated training on food security, diet, and nutrition in AET

Findings from the literature review

While we identified examples in preschool through high school education, there is scant published information about similar curriculum or teaching strategies bridging agriculture and nutrition education at the university or post-graduate level. Despite the potential of joining these two closely related thematic areas, the refereed and non-refereed literature search revealed limited integration of agriculture training and nutrition/food system topics worldwide. Of the 37 publications reviewed, less than ten related to pre-service agriculture training in a developing world context. The majority of the integrated agriculture-nutrition education/training literature described programs focused on in-service extension trainings or youth programs both in industrialized and developing countries. There are also online trainings and outreach programs to reach a broader audience.

Most of the examples of linked agriculture-nutrition education in the published literature were through extension systems or school system for children up through high school. There are examples of nutrition focused agricultural training through formal education at different levels ranging from pre-K to higher education (see Table 2). The integrated training in the formal education system such as learning boxes at the pre-kindergarten level or school gardens and food preparation demonstrations can provide a foundation of understanding of key concepts related to agriculture, food security, diet diversity and

nutrition among youth. Having an integrated understanding of how food is produced and then available for human consumption may contribute to increased interest in agricultural or nutrition-related careers.

Over 30 years ago, in response to the evident need for nutrition education in Jamaica, a nutrition curriculum for ninth grade was designed and implemented in two secondary schools (Hamilton 1980). Nutrition information was integrated within the subject areas of general science, home economics, and agriculture. The project aimed to increase students' knowledge of basic nutrition principles and to encourage their appreciation of the importance of nutrition for themselves and their community, although no evaluation data were shared.

Table 2: Examples of Nutrition Education

| Type of Education | Nutrition-focused agriculture education | Examples |
|--|---|---|
| Pre-K (Formal) | Farm and food focused learning boxes for children and parents | Hughes, 2002 |
| Elementary School (Formal) | School gardens, cooking with fruits and vegetables | Morris, Briggs & Zidenberg-Cherr, 2002 |
| Secondary School (Formal) | Integration of nutrition within agriculture curricula (Jamaica) | Hamilton, 1980; |
| | School gardens to enhance agricultural and nutritional literacy | Sustainability Institute, Education and Leadership program, UC Davis |
| University Level^a (Formal) | ENGINE Project (Ethiopia) | Abebe et al, 2017 |
| | Majors or programs of study linking agriculture/ sustainable agriculture <i>and</i> food/ nutrition/ food systems | Michigan State, Tufts University, UC Berkeley, UC Davis, U. Hawaii, U. Massachusetts, U. Minnesota, U. Vermont, Virginia Tech, Montclair State, U. Montana-Missoula, College of the Atlantic, Goshen College, Green Mountain College, Sterling College, Unity College |
| Extension Services (Informal) | Combined programming with technical crop production and supplemental nutrition information | Bezner-Kerr et. al., 2011 |
| | Online trainings: Agrilinks; ENACT | Agrilinks 2017; FAO 2017 |

^aData represent a sampling from <http://www.sustainableaged.org/projects/degree-programs/>

In the U.S., at the university level, agricultural colleges historically had been separating nutrition specializations from agricultural majors. However, the changing times and new global goals are motivating the new trend whereby dozens of academic programs are springing up around the country linking agriculture/ sustainable agriculture and food/nutrition or food systems (Table 2) (W. Masters, Personal communication; S. Ahmed, Personal communication). The Sustainable Agriculture Education Association (SAEA) is devoted to “promoting the teaching and learning of sustainable agriculture” and their website (see below Table 2) keeps track of the growing list of U.S. and foreign universities committed to sustainable agriculture education and notes the major or programs relevant to sustainable agriculture, many of which include a food, nutrition or food systems component (A. Jones, Individual Consultation; SAEA, 2017). Over 40 North American land grant universities, 15 private four-year colleges or universities, 10 private liberal arts colleges, 21 community and junior colleges, 3 programs outside North America, and four open enrollment summer programs now exist as part of the SAEA. Majors, concentrations or certificate programs at these universities are various including: agroecology; organic agriculture; sustainable farming and food systems; sustainable urban agriculture; sustainable local foods farming; and agriculture, food and sustainability.

More recently, the U.S. Agency for International Development (USAID) funded the ENGINE project in Ethiopia to enhance the capacity of selected agricultural technical vocational education and training (ATVET) colleges to provide high-quality nutrition education (Abebe et al, 2017). Nutrition topics were integrated into pre-service agricultural curricula. An evaluation of students’ nutrition-sensitive agriculture competency revealed that half of students passed the competency exam. Male students and federal institutions performed better than females and regional colleges, respectively. The authors concluded that to develop agriculture students competent in understanding nutritional issues they needed to strengthen the curriculum, teachers’ capacity, and to offer additional support for female students and regional colleges.

There has been a much greater emphasis on in-service training in nutrition and food-related issues for agriculture extension workers. USAID produced an online, three-hour course on Nutrition-Sensitive Agriculture for pre-service or in-service training of agricultural professionals (AgriLinks, 2017). Designed for USAID staff and external partners, the course “introduces the principles of nutrition-sensitive agriculture and how those principles can be applied to existing and future agriculture and food security

programs.” The course description explains that the content is “intended for individuals that do not have a nutrition or health background who are working on any facet of an agriculture project.”

Similarly, FAO produced the ENACT online training course for pre-service or in-service training of agricultural professionals (FAO, 2017). The course was developed to introduce participants to the principles and practice of “education for effective nutrition in action” (ENACT). According to the website, “ENACT aims at promoting long-term improvements in diet through an active approach based on identified needs, with attention to social and environmental contexts, all relevant sectors and the whole food cycle (production, processing, marketing, consumption).” While the course materials and cases mostly relate to Africa, the broad principles and activities are relevant to any country, which needs to upgrade capacity in this field. The course targets undergraduates; however, the website notes that the ENACT course is relevant to anyone responsible for providing nutrition education or acquiring it in some form. Their audience thus includes university and medical school students, agriculturists, district nurses, health service managers, NGO staff, Information-Education-Communication (IEC) specialists, rural development or community workers, and school teachers.

Box 2. Leading questions in FSN Forum on Integrating Nutrition in Agricultural Education

- What should be the role of agricultural colleges and higher education institutions to promote nutrition sensitive agriculture?
- What is meant by “integrating nutrition into the curriculum:” Does this mean nutrition knowledge alone or also include some competencies in promoting desirable food and dietary behaviors? In other words, what are the absolutely essential competencies of “nutrition” to include in the training of agricultural workers? Do the institutions see the relevance of including nutrition into the curriculum?
- For what purpose? What is expected to result from this extra curriculum element? How do we expect graduates (i.e. agricultural workers) to use the new knowledge and skills in their daily work? What can they do to promote food and dietary diversification and better nutrition outcomes?
- Do you have experiences of integrating nutrition into the curricula of an agricultural higher institution? If yes, how will the curriculum change contribute to national nutrition goals or to nutrition objectives adopted by the governments? What are the opportunities, challenges, successes, lessons learnt?

In a paper for the World Bank, India's agricultural extension pre- and in-service training curriculum was reviewed in three states. The evaluation shows that nutrition-sensitive agricultural knowledge is not currently incorporated. The report makes recommendations for utilizing many existing opportunities through extensive extension system, from national to local levels (Babu et. al., 2016). This study also stresses the importance of using a multidisciplinary approach including health, social welfare, and agriculture through a curriculum review of public agricultural universities, focusing on nutrition extension (Babu et. al., 2016).

An online discussion, open from 10-27 November 2015, via FAO's Food Security and Nutrition (FSN) Forum, facilitated by Mebit K. Tariku, the Pre-Service Education Advisor for Nutrition of the ENGINE project, focused on this topic. Tariku posed four questions (Box 2) inviting participants' opinions and experiences relevant to integrating nutrition into agricultural education. The complete proceedings and a summary note are available online (FAO 2015). He received over 30 entries with over 18 participants from developing countries.

The general consensus of the discussion was that agriculture is the foundation of the global food system and that the food system needs to be better directed to meeting human nutritional needs. To reach that end, agricultural planners and practitioners need to have a better understanding of nutrition. Preventing malnutrition is more complex than simply eradicating hunger through higher yields of staple foods, which has been the longstanding focus of the agriculture sector. Despite the growing acknowledgement of the importance of combining pre-service agricultural education and nutrition topics, there is little published research exploring this subject.

Results: Nutrition within agriculture training programs in developing countries

Tufts University, a member of the SAEA, is responsible for the Nutrition Innovation Lab that is part of the Feed the Future Initiative. Part of the mission of the Nutrition Innovation Lab includes human and institutional capacity building in the area of agriculture, health and nutrition in Africa and Asia (Nutrition Innovation Lab, 2017).

In a developing country context, the Ethiopian initiative described above (Abebe et al, 2017) was a unique example identified in the published literature linking pre-service agriculture education with food

system, food security, diet and or nutrition topics. Yet, a website review of agriculture programs at 36 universities in Feed the Future (FTF) countries yielded more revealing results. These countries included were Bangladesh, Cambodia, Ethiopia, Ghana, Honduras, Kenya, Nepal, Senegal, Tanzania, Tajikistan, Uganda and Zambia. The list of universities within these countries is shown in Table 3. Along with university name and country is information about whether the university is agriculture-focused or not, whether there is a nutrition program offered, if agriculture and nutrition are offered in the same college, if food security or hunger are included in the institutional mission, and finally if nutrition is a part of the institutional mission. Table 3 is not intended to be exhaustive, but to cover a range of geographical regions as well as size and prominence of the university. It should also be noted that the reliance on the website information does not guarantee complete accuracy as some of the institutions did not have updated, functioning websites. Table 3 shows the findings according to country alphabetically.

Eleven of the institutions were exclusively agriculture focused while the remaining offered a diverse range of degrees and programs across many disciplines. A majority of the institutions participated in some type of extension programming or outreach that is intended to support surrounding communities. Many of them offered agriculture education and extension training.

Table 3: Examples of Higher Education Institutions in Feed the Future Countries

| | Institutional Name | Ag Only Univ. | Country | Offer Nutrition Program | Ag/Nut Co-located | Food Security or Hunger in mission | Nutrition in mission |
|-----------|---|----------------------|----------------|--------------------------------|--------------------------|---|-----------------------------|
| 1 | Bangladesh Agricultural University | Yes | Bangladesh | No | No | No | No |
| 2 | Bangabandhu Sheikh Mujibur | Yes | Bangladesh | No | No | No | No |
| 3 | Patuakhali Science and Technology University | No | Bangladesh | Yes | Yes | Yes | No |
| 4 | Noakhali Science and Technology University | No | Bangladesh | Yes | Yes | No | No |
| 5 | Sher-e-Bangla Agricultural University | Yes | Bangladesh | No | No | No | No |
| 6 | Hajee Mohammad Danesh Science and Technology University | No | Bangladesh | Yes | No | No | No |
| 7 | Khulna University | No | Bangladesh | No | No | No | no |
| 8 | Rajshahi University | No | Bangladesh | No | No | No | No |
| 9 | Sylhet Agricultural University | Yes | Bangladesh | No | No | Yes | No |
| 10 | Bangabandhu Sheikh Mujibur Rahman Science and Technology University | No | Bangladesh | No | No | No | No |

| | Institutional Name | Ag Only Univ. | Country | Offer Nutrition Program | Ag/Nut Co-located | Food Security or Hunger in mission | Nutrition in mission |
|----|--|----------------------|----------------|--------------------------------|--------------------------|---|-----------------------------|
| 11 | Royal University of Agriculture | Yes | Cambodia | No | No | No | No |
| 13 | Haramaya University | No | Ethiopia | No | No | No | No |
| 14 | Hawassa University | No | Ethiopia | Yes | Yes | No | No |
| 15 | Jimma University | No | Ethiopia | Yes | No | No | No |
| 16 | Mekelle University | No | Ethiopia | Yes | No | No | No |
| 17 | Bahir Dar Institute of Technology | No | Ethiopia | Yes | Yes | Yes | No |
| 18 | Debre Markos | No | Ethiopia | No | No | No | No |
| 20 | University College of Agriculture and Environmental Sciences | Yes | Ghana | No | No | No | No |
| 21 | University of Ghana | No | Ghana | Yes | Yes | N/A | N/A |
| 22 | Zamorano Pan-American Agricultural School | Yes | Honduras | Yes | Yes | N/A | N/A |
| 23 | University of Nairobi | No | Kenya | Yes | Yes | N/A | N/A |
| 24 | Egerton University | No | Kenya | No | No | No | No |
| 25 | Jomo Kenyatta University of Agriculture and Technology | No | Kenya | Yes | Yes | No | No |
| 26 | Pwani University School of Agriculture | No | Kenya | Yes | No | No | No |
| 27 | Agricultural and Forestry University | Yes | Nepal | No | No | No | No |
| 28 | Tribhuvan University | No | Nepal | No | No | No | No |
| 29 | Universite de Thies | No | Senegal | No | No | N/A | N/A |
| 30 | Sokoine University of Agriculture | No | Tanzania | Yes | Yes | No | No |
| 31 | Shirinsho Shotemur (Tajik Agrarian University) | Yes | Tajikistan | No | No | No | No |
| 32 | Bukalasa Agricultural College | Yes | Uganda | No | No | No | No |
| 33 | Makerere University | No | Uganda | Yes | Yes | N/A | N/A |
| 34 | Gulu University | No | Uganda | Yes | Yes | No | No |
| 36 | University of Zambia | No | Zambia | Yes | Yes | No | No |
| 37 | Natural Resources Development College | Yes | Zambia | Yes | Yes | No | No |
| 40 | Mulungushi University | No | Zambia | No | No | No | No |
| | | | | | | | |
| | Total | 11 | 12 | 18 | 14 | 3 | 0 |

Even so, this research looked more broadly at all agriculture degree programs and whether or not students were either required to or had the opportunity to take nutrition coursework. Seventeen of the 36 agricultural universities offered a nutrition program, ranging from no current faculty to nine

nutrition-focused faculty members. In 14 of the 18 that had nutrition programs, nutrition was combined with food science or food technology. In three cases, it was not within the agriculture college, but as a standalone program. Four additional institutions had food science programs, but did not include nutrition as a degree program or research focus. It was not evident that other agricultural sciences programs require students to take nutrition courses as part of their major requirements or as part of a general education program.

In the university mission and vision statements, only a few institutions mentioned food security as an overall goal of the institution. One that did was Patuakhali Science and Technology University of Bangladesh, which stated that their vision was “to build a modern, technologically developed, poverty and hunger free digital Bangladesh” (PTSU, 2013). This university had a nutrition program housed with food science and technology. One institution appears to have either an institute or expressed focus on food security, but did not include nutrition in this programming.

In summary, slightly about half of the universities that offer agricultural training offer nutrition programs, and when they do, they are generally co-located within the college of agricultural sciences. Few institutions had an explicit goal related to improving food security, diets or nutrition together with improving agriculture in the country.

Discussion

Gap between current training and global needs.

It is common for all countries to sponsor university-level training in agriculture. This review demonstrated that there is a lack of literature on how well nutrition and food or food system concepts are being integrated into agricultural training in developing countries at this time. Further, there is a lack of published literature on how well students are gaining competency in mastering concepts, terminology and issues in agriculture-nutrition related issues apart from the ENGINE project in Ethiopia (Abebe et al, 2017). However, through a survey of websites of agricultural institutions of higher education in FTF target countries, it appeared that nutrition training was available within an agricultural training institution in about half of the countries suggesting that it is a low-hanging fruit opportunity to strengthen linkages between these fields of study. Future investigation can examine the relationship between nutrition and agriculture programs and the degree of integration. Are agricultural majors required to take any coursework in nutrition, food or food systems and vice versa? Are there any

nutrition competencies required of agriculture students? Are there agriculture competencies required of nutrition students? Expanding the scope of institutions to also include more ATVET institutions could also be included in future research.

USAID and other donors can play a catalytic role in encouraging the integration of agriculture-nutrition integration in pre-service training, such as the ENGINE project in Ethiopia illustrated. Further, both developing and industrialized nations need greater integration at primary, secondary and university levels. School garden programs have been supported by various agencies and organizations introducing concepts of agriculture and nutrition to young children. Within the U.S. universities identified through the Sustainable Agriculture Education Association website, there is a growing trend in new sustainable agriculture-food system programming that could lead to studies of student competency, models of training, and partnerships with developing country institutions.

Table 1 highlighted the target under SDG 2 related to sustainable food systems and how it will be measured: *Indicator 2.4.1 Proportion of agricultural area under productive and sustainable agriculture.* As noted earlier, this indicator only covered the production end of the food system. The points along the chain ending up at the household meal are absent, including any consideration about crop diversity. Dietary diversity will only be achieved if there is year-round adequate availability of affordable foods to meet human nutritional needs. Although it may be difficult to add more indicators formally to the SDGs, countries have the autonomy to add helpful indicators. One of the lessons learned from the Millennium Development Goals was that “what gets measured gets done” (phrase attributed to Peter Drucker). If a goal of the SDGs is sustainable food systems able to provide adequate nutrition for the global population, it will be important to have indicators to measure this. Finally, there is a need for pre-service training curricula in agriculture to include indicators on food system analysis and assessment, population dietary requirements, and issues in human nutrition.

Conclusions and Recommendations

Malnutrition is a severe global problem that requires collaboration across sectors to arrive at sustainable solutions. Improved access to nutrition training in all affected countries and especially through formal agricultural education will further develop professionals and leaders with the capacity to tackle these complex issues. The growing trend in the U.S. to integrate these fields is a source of encouragement. U.S. universities can be further encouraged to partner with those in developing countries to strengthen

their related training and research programs. In the future, there needs to be a collaborative effort to understand the impact produced by those trained in AET and nutrition in terms of policies and programs resulting from this human capacity development. Further still, researchers can explore population nutrition and health trends in countries or areas where AET and nutrition have been merged and resulted in community-level interventions. The search of the structure and incorporation of nutrition into agricultural institutions in FTF countries could be expanded in the future to include semi-structured interviews with key faculty and administrators. Additional research could also include a deeper analysis of the motivation and resourcing behind the trend in the U.S. and other industrialized countries of offering degrees in sustainable agriculture or food systems. Insights could be gained for developing country institution capacity building.

There also remains a pressing need for indicators to measure progress in this capacity building area.

Considerations for indicators include:

- Inclusion of nutrition education in primary education at the national level
- Inclusion of nutrition education in secondary education at the national level
- Presence of a linkage between existing agriculture, food science and nutrition programs at existing national or state (e.g. Feed the Future countries, U.S. land grant) universities
- Number of courses offered in food security, sustainable food systems and issues in human nutrition (e.g. nutritional problems in developing countries).
- At least one course on human nutrition concepts (main nutrition problems, causes of malnutrition, critical window of intervention) is a required component of undergraduate agricultural degree programs
- At least one course on human nutrition concepts (main nutrition problems, causes of malnutrition, critical window of intervention) is a required component of graduate agricultural degree program
- At least one nutrition faculty member is affiliated with and able to teach (co-located) at the agricultural institution of higher education
- Agriculture institutions of higher education include some reference to addressing food security, hunger, or promoting sustainable food systems in their mission
- Agriculture institutions of higher education include some reference to addressing malnutrition in their mission

- At the university and post-graduate levels, ensure that agriculture students can understand and select appropriate nutrition indicators for programs (e.g. women's and children's nutritional status, minimum acceptable diet for children, minimum dietary diversity-women)
- At the university and post-graduate levels, agriculture students understand the UNICEF conceptual framework for the underlying causes of malnutrition (food, health and care)
- Countries include an indicator for SDG Target 2.4 related to food system diversification and timing thereof during the year (inclusive of crop diversity, food imports) so as to have adequate diversity of foods at an affordable price available year-round for the population.
- Inclusion of nutrition education concepts (main nutrition problems, causes of malnutrition, critical window of intervention) in agriculture extension training
- Availability of on-line options with a method to assess student competency suitable for university credit or continuing education as needed

Finally, this critical issue needs more attention in education research. As development and government initiatives incorporate nutrition programming to address critical health problems, our informal training and formal education systems need to align. Future research needs to focus on how nutrition experts and AET can work together to help achieve a worldwide reduction in malnutrition.

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