Journal of Agriculture, Food Systems, and Community Development
ISSN: 2152-0801 online
https://foodsystemsjournal.org

Does participation in livelihood education programs impact household food security? A comparative study in rural Uganda

Samuel Ikendi,[a] * Francis Owusu,[b] Dorothy Masinde,[c]
Ann Oberhauser,[d] and Carmen Bain [e]
Iowa State University

Submitted March 13, 2023 / Revised May 27, July 2, and August 5, 2023 / Accepted August 30, 2023 / Published online November 17, 2023

Citation: Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023). Does participation in livelihood education programs impact household food security? A comparative study in rural Uganda. *Journal of Agriculture, Food Systems, and Community Development*, *13*(1), 235–265. https://doi.org/10.5304/jafscd.2023.131.009

Abstract

Food and nutrition security projections from global to household levels show that the future requires multifaceted approaches to achieve desired goals. In Uganda, the government has tried several strategies to promote food production, including a public-private partnership with Iowa State University through its Center for Sustainable Rural Livelihoods. In this comparative study, we surveyed 454 households to explore whether participation in livelihood education programs (LEPs) impact household food security. We also determine which LEPs and household characteristics influence food security. Overall, 46.3% of the surveyed households were food secure, while the remaining were insecure or extremely insecure. Significantly, 51.0% of LEP participants were more food secure, compared to 35.5% of nonparticipants. Specific LEPs

[a] * *Corresponding author*: Samuel Ikendi, Master's candidate, Community and Regional Planning, co-major with Sustainable Agriculture, Iowa State University. Samuel is now a doctoral graduate of Agricultural Extension Education, Iowa State University and is an Academic Coordinator for the USDA NIFA-funded Climate Smart Agriculture Project, Agriculture and Natural Resources, University of California; 5200 North Lake Road; Merced, CA 95343 USA; +1-209-228-4400; sikendi@ucanr.edu

[b] Francis Owusu, Professor and Chair, Department of Community and Regional Planning, Iowa State University; fowusu@iastate.edu

[c] Dorothy Masinde, Teaching Professor, Department of Horticulture, Iowa State University; masinde@iastate.edu

[d] Ann Oberhauser, Professor, Department of Sociology, Iowa State University; annober@iastate.edu

[e] Carmen Bain, Associate Dean for Academic Innovation, College of Agriculture and Life Sciences, and Professor, Department of Sociology; Iowa State University; cbain@iastate.edu

Author Note

The first author's masters' thesis formed the basis of this article (Ikendi, 2019). In addition, a section of this article was accepted for presentation at the Western Region of the American Association for Agricultural Education Conference, September 18–20, 2023, Logan City, Utah, USA.

Funding Disclosure

The authors are grateful for financial support provided to conduct this study by the Iowa State University Center for Sustainable Rural Livelihoods, the Department of Community and Regional Planning, and the Graduate Program in Sustainable Agriculture.

including agronomy and postharvest technologies, and livestock integration significantly influence food security, but less so for programs on nutrition and infant feeding, water supply and public health, complementary services like therapeutic porridge and assistance with immunization, and income innovations. Multinomial logistic regression analysis revealed that the household characteristics of keeping livestock and the number of meals eaten during periods of scarcity, influenced households having more food security than insecurity or extreme insecurity. Households participating in LEPs, having larger acreage of land, and having clean water and sanitation facilities were more food secure. The time taken to fetch water, days of illness of male adults, and belonging to community social groups, also influence the level of household food security. Based on these findings, we recommend that households should participate in LEPs to build their capacity to manage crop and livestock production, and also to acquire knowledge of nutrition and feeding, public health, and income innovations.

Keywords
agronomy and land use, food and nutrition security, grain storage and postharvest, income innovations, livelihood education programs, livestock integration, nutrition education centers, nutrition and infant feeding, water supply and public health

Abbreviations
Center for Sustainable Rural Livelihoods, Iowa State University (CSRL)
Food and Agriculture Organization of the United Nations (FAO)
Food and nutrition security (FNS)
Food and Nutrition Technical Assistance (FANTA)
Food security status (FSS)
Global Hunger Index (GHI)
Household Food Insecurity Access Scale (HFIAS)
Iowa State University (ISU)
Livelihood education programs (LEPs)
Nongovernmental organization (NGO)
Nutrition Education Center (NEC)
Uganda Bureau of Statistics (UBOS)
Uganda Food and Nutrition Strategy (UFNS)
Water, sanitation, and hygiene (WASH)

Introduction

Food and nutrition insecurity is an ongoing and severe global problem, despite attempts by organizations and governments to mitigate it (Food and Agriculture Organization of the United Nations [FAO] et al., 2022; 2023). The Sustainable Development Goals (SDGs) set in 2015 by the United Nations to be achieved by 2030, calling for an end to hunger in all forms among all people and for access to nutritious and adequate food throughout the year (United Nations, 2015), began on an unfortunate note: one year after the SDGs were announced, the number of designated hungry people globally increased—from 794.6 million in 2015 to 804 million in 2016 (FAO et al., 2018). Due largely to the impact of the COVID-19 pandemic, the number of food-insecure households has further risen: "Nearly 670 million people will still be facing hunger in 2030—8 percent of the world population, which is the same as in 2015 when the 2030 Agenda was launched" (FAO et al., 2022, p. xiv). The FAO warns that "if we do not redouble and better target our efforts, our goal of ending hunger … by 2030 will remain out of reach" (FAO et al., 2023, pp. vii), particularly in the face of extreme climate variability, economic contractions, and the Ukraine-Russia conflict causing supply disruptions.

In Uganda, food and nutrition insecurity is one of the major factors impeding its development. Uganda ranks among the most ill-nourished nations (von Grebmer et al., 2022). In the 2021 Global Hunger Index (GHI), Uganda was among 15 countries with incomplete data but was rated as having "serious" hunger severity, a rating it had in 2020 as well (von Grebmer et al., 2022). In the 2022 GHI report, child stunting in Uganda was estimated at 25.4%, wasting at 3.6%, and undernutrition at 41.0%, a dire food and nutrition situation (von Grebmer et al., 2022). Conflict is one of the main predictors of hunger and undernourishment (FAO, Economic Commission for Africa et al., 2021; FAO, International Fund for Agricultural Development et al., 2021; FAO et al., 2023), and violence characterized the general electioneering

periods in Uganda (Ahluwalia, 2021). Ethnic conflicts (Sseremba, 2020) and rebel movements in Rwenzori (William, 2020) and Northern regions (Adong et al., 2021) have disrupted crop and livestock production, causing acute food insecurity in affected areas.

Most people in Uganda are rural-based and get their livelihoods from agriculture, the backbone of the economy (Uganda Bureau of Statistics [UBOS], 2016). Agriculture is dominated by small-scale landholder farmers operating at a subsistence level, with over 50% of their output used for home consumption (UBOS, 2016). Agricultural production in Uganda is highly dependent on nature's vagaries, particularly the weather and soil fertility. Food insecurity occurs when insufficient rainfall dries crops and pastures, excessive rainfall causes floods, and destructive pests and plant diseases prevail. In general, low food production explains the high level of food and nutrition insecurity in Uganda, and the prediction for the current path scenario is that Uganda may not achieve food security by 2050 (Hedden et al., 2018). The difficult circumstances exacerbating undernourishment are not new to Uganda. Government and global stakeholders have tried several strategies to promote food production and reduce food and nutrition insecurity, including the 2003 Uganda Food and Nutrition Strategy (UFNS). After the passage of UFNS, an investment plan for achieving its stated goals was drafted (Ministry of Agriculture, Animal Industry and Fisheries & Ministry of Health, 2004). The ministries of local government, health, agriculture, finance, and the Office of the Prime Minister committed their full collaborative support to its implementation. One of the strategies in the UFNS was promotion of private-public partnerships, a strategy adopted and adapted by Iowa State University in 2003 through its Center for Sustainable Rural Livelihoods (CSRL), a program to uplift the livelihoods of communities in rural Uganda (Butler & McMillan, 2015; Ikendi & Retallick, 2023a; 2023b).

Iowa State University and the Center for Sustainable Rural Livelihoods in Uganda

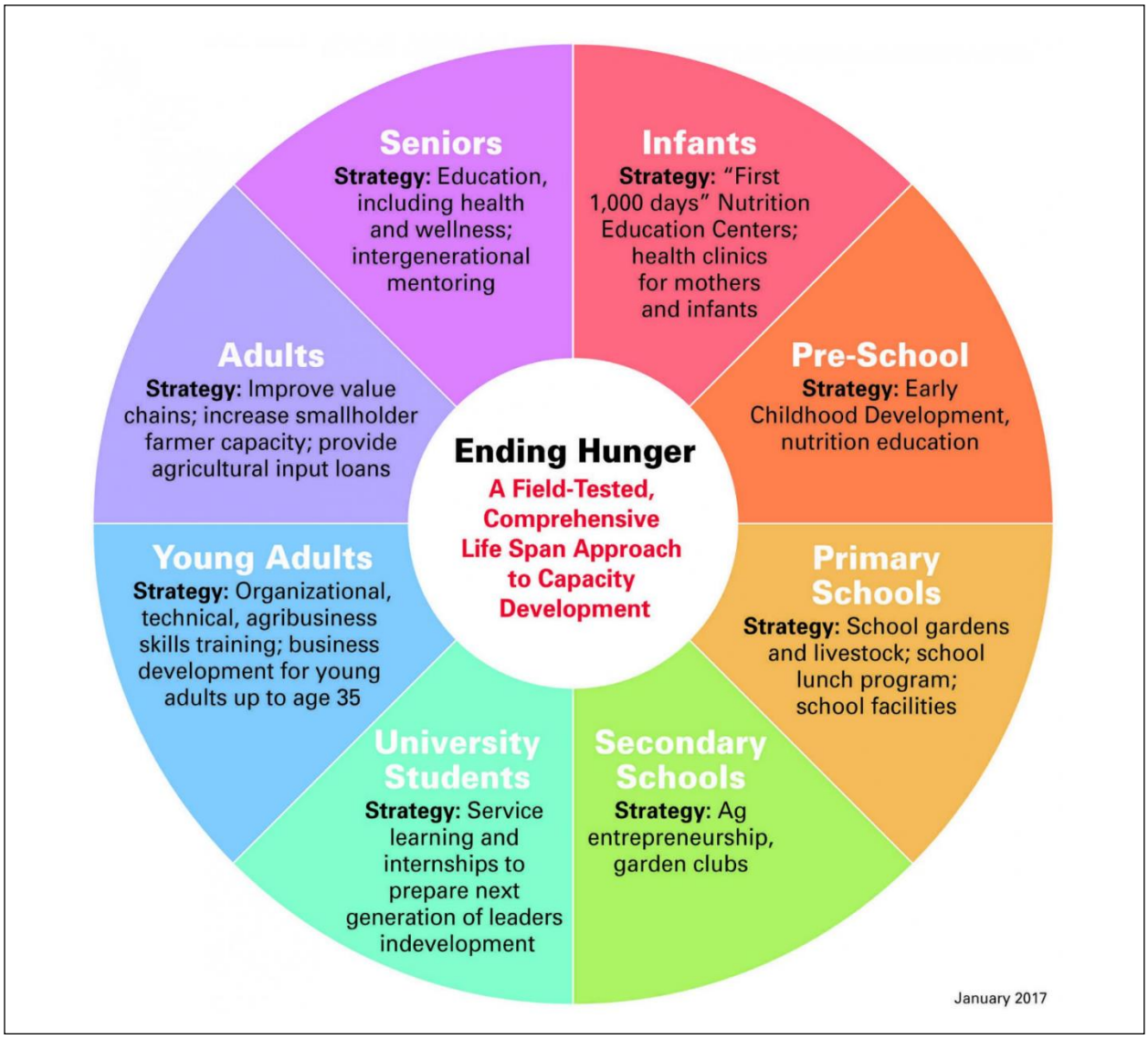
Iowa State University, through its mission to "create, share, and apply knowledge to make Iowa and the world a better place" (ISU, 2016, p. 2), joined the call to reduce hunger by deploying a concept of social change that involves identifying and building on community capital with funds from private benefactors (Butler & McMillan, 2015; Ikendi & Retallick, 2023a, 2023b). To fulfill its overseas mission, ISU in 2003 established the Center for Sustainable Rural Livelihoods (CSRL) in its College of Agriculture and Life Sciences, to help communities in low-income countries, with Uganda targeted because of its current high poverty levels and the availability of reliable partners (Bundy III, 2015; Butler & Mazur, 2015; Kolschowsky & Kolschowsky, 2015). CSRL established its base in Uganda in 2004 with a three-partner model with Makerere University and a local nongovernmental organization (NGO), Volunteer Efforts for Development Concerns (VEDCO). With VEDCO, CSRL operated with the "farmer-to-farmer" model forming food security groups in which extension and support were delivered by the program for capacity building (Butler & Mazur, 2015; Masinde, Butler et al., 2015; Sseguya et al., 2015). In 2014, ISU ended its collaboration with VEDCO and established its own NGO in Uganda, the Iowa State University–Uganda Program (ISU-UP) to improve on the operations with Makerere University remaining as a partner (Butler & Acker, 2015; Ikendi & Retallick, 2023b). The operational field model changed from the "farmer-to-farmer" approach to a "comprehensive lifespan approach to capacity development" (Figure 1) (CSRL, 2017; Ikendi, 2019, p. 50) and restatement of the vision and mission to suit the CSRL/ISU-UP partnership (Ikendi & Retallick, 2023b).

The comprehensive lifespan approach touches the lives of vulnerable people from pregnancy to seniors through different interrelated livelihood education programs.

The CSRL/ISU-UP Livelihood Education Programs

The CSRL/ISU-UP's LEPs aim to improve food and nutrition security at the household level by building household capacity to initiate behavioral changes. The programs include: **Agronomy and land use**, improving access to extension knowledge, quality, and diverse crop inputs; grain storage and postharvest technologies help reduce post-

Figure 1. The Center for Sustainable Rural Livelihoods/Iowa State University-Uganda Program (CSRL/ISU-UP) Comprehensive Lifespan Approach to Capacity Development in Uganda



harvest losses in schools and communities (Ikendi, Owusu, Masinde, Bain et al., 2023); **Livestock integration**, increasing household consumption of animal-source proteins, enhancing income, and improving breeding stock through training in sustainable livestock management (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023a; Masinde, McMillan et al., 2015); **Food and nutrition security support groups**, improving food and nutrition security among at-risk-for-malnutrition rehabilitated and graduated nutrition education center (NEC) clients through the provision of technical support and the initiation of sustainable food production and income-generating activities (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b); **Community income-generation innovations program**, diversifying the incomes of graduated NEC clients and of in- and out-of-school youth through projects such as crafts, sewing, soap-making, home gardens, and livestock to build their livelihood assets (Ikendi, 2019; Martin, 2018); **Youth entrepreneurship program**, increasing the knowledge and skills of youth in managing small- to medium-size enterprises to

expand their livelihood strategies; **Education programs**, building the capacity of young program participants through global service-learning, implemented through school gardens and related projects (Ikendi, 2022a; 2022b; Ikendi, Retallick et al., 2023; Nonnecke et al., 2015). All these programs directly affect food availability and access through production and distribution between and among households.

Other programs include the **Nutrition education program** (NEP) addressing nutrition challenges through a community-based approach to the management of malnutrition (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b, 2023c; Masinde, McMillan et al., 2015) and enhanced school lunch programs (Byaruhanga, 2016; Ikendi, Retallick, & Nonnecke, 2023; Nonnecke et al., 2015, 2016). The NEP uses NECs to improve the nutrition and health of children less than five years old and women of reproductive age, promoting behavioral changes in obstetrical, gynecological, and nutrition and infant-feeding practices (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b, 2023c; Ikendi, Owusu et al., 2023; Winham et al., 2016)—obstetrical functions relate to pregnancy, antenatal, and childbirth while and gynecological functions relate to reproductive health functions—all of which are important to the welfare of mother and children (World Health Organization, 2021; 2023); **Water supply and public health programs** (water, sanitation, and hygiene [WASH]), increasing access to an adequate supply of safe water and improving personal and community hygiene and sanitation practices (Ikendi, Owusu et al., 2023). The NEP and WASH programs directly influence the food utilization component by ensuring that members are healthy and have less exposure to diseases, which can negatively affect food absorption and thus contribute to nutrition insecurity (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023c).

The activities of CSRL/ISU-UP partnership seek to affect the overall food and nutrition security of households and communities, this partnership has implemented programs in the Kamuli district of Uganda since 2014 (Butler & Acker, 2015; Ikendi & Retallick, 2023a; 2023b). No specific assessment of program impact on food and nutrition security has been undertaken, which is necessary to determine program outcomes. Regular monitoring and evaluation have determined the outputs; however, the outcomes are yet to be established. This study seeks to fill that gap.

Literature Review and Conceptualization of Food and Nutrition Security

Achieving sustainable, food-secure households requires multifaced approaches at macro levels—global, regional, and national—and at the micro level—households (FAO et al., 2022), as well as continuous assessments of progress (United Nations Environment Programme [UNEP], 2012). Households are food secure when they have consistent access to foodstuffs that meet their nutritional demands for a physically, economically, and socially healthy life (Committee on World Food Security, 2012; FAO et al., 2013). However, food security alone does not guarantee sustainable households; households also need to be nutritionally secured—hence the term food and nutrition security (FNS). Achieving FNS requires all elements of food security coupled with conducive sanitary environments with good healthcare, reducing household predisposition to diseases (CFS, 2012; FAO et al., 2013). The FNS concept is composed of four core pillars: availability, access, utilization, and stability.

The Four Pillars of Food and Nutrition Security

From a consensus in United Nations organizations to call for multifaceted approaches to FNS, the four pillars—availability, access, utilization, and stability—reinforce each other to achieve sustainable FNS (CFS, 2012; FAO et al., 2013). The elements of food security focus on food availability and access, while those of nutrition security focus on food utilization within our bodies. Food stability ensures future consistent food supplies even during periods of shock.

Food availability is a proxy indicator of the physical presence of food that households can obtain through their production, aid, gifts, and/or exchange (World Food Programme, 2009). The food production capacity of the nation is influenced by physical resources like climate and soil,

prevailing political activities, and population growth pressures (Barrett et al., 2009; Headey, 2021). Women's access to and control of land resources critically influence food production, as most food production, globally, depends on the efforts of women (Asitik & Abu, 2020; Barak et al., 2023; Doss, 2014). In addition to production, trade also influences food availability (Burchi & De Muro, 2016). Accelerating and integrating agricultural research in the agroecosystem to produce fortified crops like Vitamin A–enriched potatoes, rice, and beans enriched with iron has a multiplier effect on food supplies (Pangaribowo et al., 2013; Ikendi, 2023; Kassam & Kassam, 2021; Snapp & Pound, 2017).

Food access is the ability of households to physically obtain food from available stock, including their production, relief foods, exchanges, and/or purchases (WFP, 2009). The physical availability of food stocks in a nation does not directly correlate to its accessibility; food insecurity can exist even when food is available (Webb, 2010). Low purchasing power is among the factors that limit food access, especially in the current neoliberal economy where food is considered a commodity for sale (Bradley et al., 2023a; Broad, 2016; Clendenning, 2016; Hoddinott, 2021), primarily involving high-price, animal-source foods (Rosegrant et al., 2013). In India, for instance, the discriminative nature of the caste system prohibits some social groups from accessing activities that generate income to help raise their purchasing power (Pankaj, 2019). Other factors influencing food access besides economic are ideological and institutional constraints, for instance, the Ethiopia Orthodox Church since the fourth century has discouraged followers from consuming animal-source foods (Sandler, 1972; Seleshe et al., 2014). Access to healthy foods and the capacity to earn a living wage by all community members are paramount indicators of developing food security and healthy communities (Emmerman & Ornelas, 2021; Martin, 2018).

Food utilization is the ability of the body to absorb the nutrients in food, influenced by the health status of the body, diet, and availability and cleanliness of WASH facilities, which reduce the likelihood of related illnesses (CFS, 2012; Hwalla et al., 2016). Although food availability and access do not guarantee food utilization, income weaves availability, access, and utilization together. High income and certain consumption behaviors, for instance, may not positively influence the quality of diets; preference for hypocaloric (low-caloric foods) and/or hypercaloric (high-caloric foods) diets can lead to underweight and overweight conditions, respectively (Pieters et al., 2013). High income can also be predisposing to unhealthy consumption of alcohol and/or fast foods (Banerjee & Duflo, 2007; Bradley et al., 2023b).

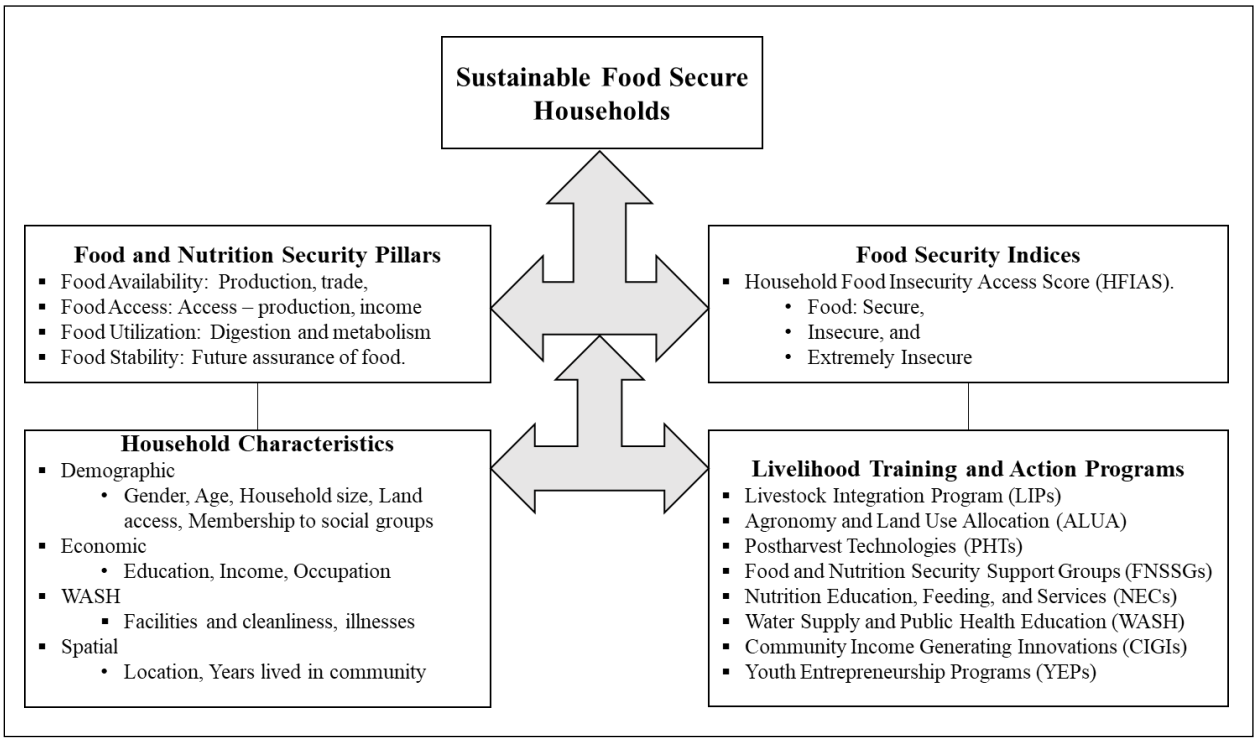
Food stability is sustainable access to food supplies, critically during periods of shock caused by extreme climate or weather events, including the "hunger periods" between planting and harvesting (WFP, 2009). The three parameters of production, prices, and storage are important in sustainable food access (von Braun & Torero, 2009). Investing in livelihood programs for rural development (Butler & McMillan, 2015), sustainable agroecosystem practices like conservation and biodiversity (Ikendi, 2023; Kassam & Kassam, 2021; Snapp & Pound, 2017; Thompson, 2017), price stabilization, and social protection programs help synergistically achieve food stability.

Food and Nutrition Security Status Measures

To determine the contribution of the four pillars of FNS, a method of analyzing their relationship as they contribute to a sustainable FNS state is necessary. Food availability is measured through the physical presence and abundance of food; food access is determined by household ability to physically obtain food; utilization focuses on the absorption of nutrients; and the state of sustainable access to food supplies assesses stability. The Household Food Insecurity Access Scale (HFIAS) developed by the U.S. Department of Agriculture (USDA) and the Food and Nutrition Technical Assistance (FANTA) project for developing countries are the most common measures of food access (Coates et al., 2007). They assess household food security status by determining the relative state of lack of food and its frequency over the 28 days before the survey is taken.

This study focuses on the food access pillar of FNS by employing a conceptual framework to

Figure 2. Food Security Conceptual Framework Designed for the Study



identify the pathways to FNS (Figure 2). The framework describes how the livelihood education programs of CSRL/ISU-UP are packaged to influence the four pillars of FNS individually and/or synergistically to achieve sustainable food-secure households.

Starting from where the farmers are (Masinde & McMillan, 2015), this framework illustrates how household characteristics influence their participation in LEPs to produce behavioral change, specifically how the multifaceted approaches adopted by the CSRL/ISU-UP achieve a secure FNS status in rural Uganda. It illustrates an intersection between the confounding variables—household characteristics influencing both participation in LEPs and directly influencing food security. To influence behavioral change in food production and consumption, it is prudent for interventions to understand the nature of the community in which they operate, as it facilitates buy-in of the innovative ideas (Rogers, 2003). Lanou et al. (2021) emphasize the importance of starting from where people are in promoting change in food consumption patterns.

Research Purpose and Objectives

The purpose of this study was to determine whether participation in the LEPs of the CSRL/ISU-UP affects the food security status of small-scale landholder households in Kamuli district, Eastern Uganda. Specifically, the study explored factors that influence household food security status and compared the food security status of LEP participants to that of nonparticipants. We set four objectives to achieve the purpose:

1. Describe the characteristics that influence household participation in CSRL/ISU-UP LEPs.
2. Determine the comparative household food security status among CSRL/ISU-UP LEPs participants and nonparticipants.
3. Determine the influence of CSRL/ISU-UP LEPs on household food security.
4. Explain the factors that influence household food security status.

Methodology

This comparative study was part of a larger survey study conducted among CSRL/ISU-UP LEP par-

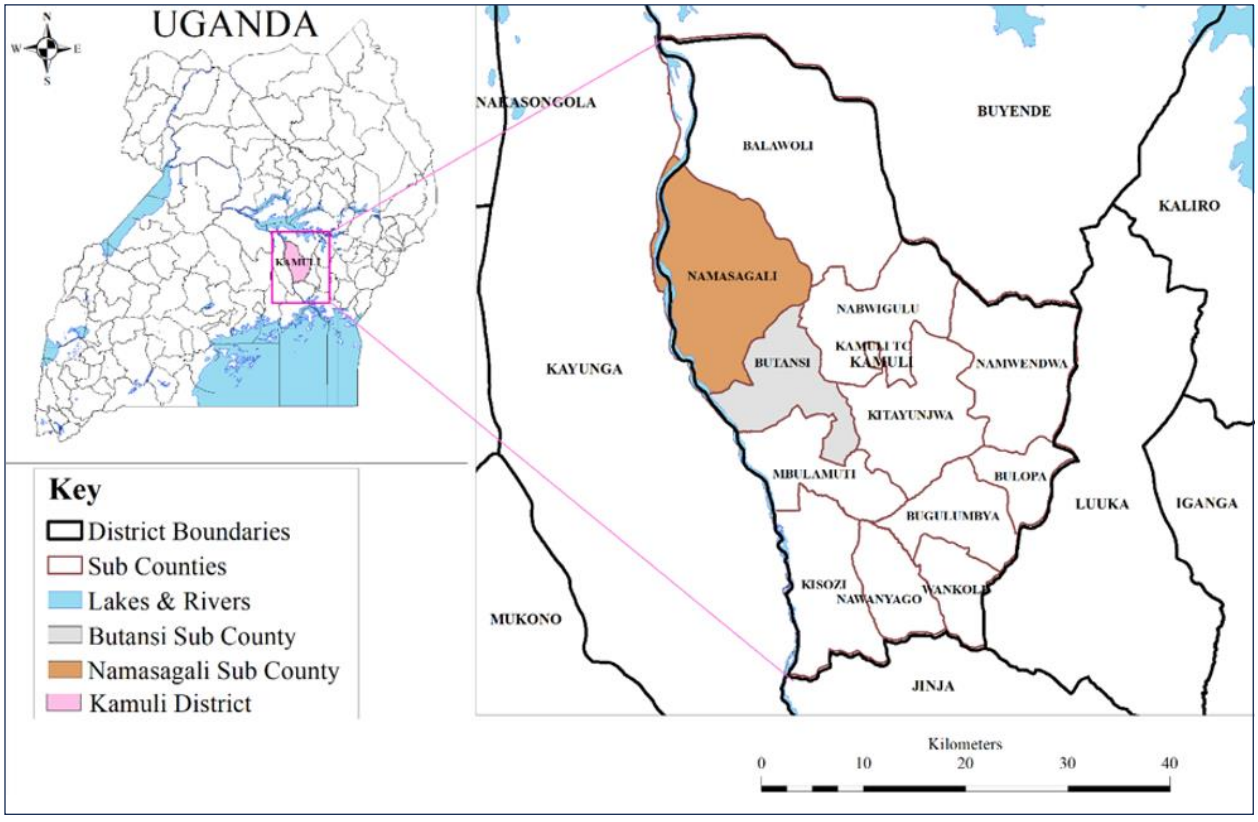
ticipants and nonparticipants (Ikendi, 2019). The goal was to determine the status of their food and nutrition security and to assess the state of implementation of relevant practices related to specific LEPs to signify changes toward desired behaviors in food and nutrition security. The study was part of a program impact evaluation of the 2014/2019 CSRL/ISU-UP strategic plan conducted concurrently with a comprehensive internal and external evaluation to determine the plan outcomes and set a foundation for the 2020–2024 strategic planning (Ikendi & Retallick, 2023b). The NEC participants and non-NEC community members who were or had engaged with the work of the CSRL/ISU-UP in the subcounties of Butansi and Namasagali in Kamuli district (Figure 3) represented program participants, while non-NEC clients represented nonparticipants.

The NECs are community-based centers where at-risk-for-malnutrition breastfeeding and pregnant mothers and children of 0–59 months of age are enrolled to be rehabilitated through nutrition therapy (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b). The CSRL/ ISU-UP is implementing sustainable rural LEPs in the Butansi and Namasagali subcounties of Kamuli district. The NECs are located in these subcounties where the study was conducted. A cross-sectional survey was employed to determine what impacts participation in LEPs had on participants' household food security (Table 2).

Sampling and Sample Size

Approval for the study was obtained from the Institutional Review Board at ISU (#IRB-18-356-01). Program participants were current and graduated NEC clients or had participated in any other CSRL/ISU-UP program, while nonparticipants did not participate in any CSRL/ISU-UP activities. The sampling frame for program participants was

Figure 3. Study Areas of Butansi and Namasagali Subcounties in Kamuli District, Uganda



Source: The authors generated the map using GIS ArcMap tools with administrative layers and shape files adopted from the Uganda Bureau of Statistics (2018).

the 1,503 households served by the NECs during 2014–2018. Using a 95% confidence interval with a 5% margin of error, we established a sample size of 306 potential participants randomly drawn based on proportions and spatial location of NECs; where areas that had more NECs, more clients were sampled. Participants were presented with the consent forms in Lusoga, the native language of the co-principal investigator and most research assistants. Only participants who provided verbal consent proceeded with the survey. All questions were asked in Lusoga, and responses were recorded on the paper survey in English. Appendix A provides a reflective essay exploring the positionality of the first author.

Community-based NEC trainers assisted the research team in identifying the NEC households. Of the 306 representative sample households, 253 (82.7%) were accessed and interviewed. For comparison, the study sought to sample one non-NEC household within a quarter-mile radius of an NEC household which had been interviewed. While we accessed and interviewed 201 non-NEC households, 63 had participated in other CSRL/ISU-UP LEPs; however, these were disaggregated and labeled "Program participants: Non-NEC clients." The remaining 138 households who had never participated in any of the CSRL/ISU-UP LEPs were categorized as "Nonparticipants." The study thus had a total of 316 households categorized as program participants, and 138 nonparticipant households, for a total of 454 households. Table 1 provides the spatial proportionate sampling of households by Subcounty and parish in the study area.

Data Collection and Analysis

Determination of food security

The response variable of interest under household food security was food access, employing the HFIAS (Coates et al., 2007). The HFIAS utilizes nine sets of questions that ask whether a food security–relevant situation occurred and the relative rate of frequency of occurrence (Table 2).

Determination of food security status was based on summing the frequency indices for 0 = None, 1 = Rarely, 2 = Sometimes, and 3 = Often, which generated a minimum of 0 and a maximum of 27 points for all nine questions. A three-equal cluster was generated with points: 0.0–9.0 as Food Secure, 9.1–18.0 as Food Insecure, and 18.1–27.0 as Extremely Food Insecure.

Participation in the LEPs and Household Factors that Influence the Food Security

The independent variables were identified as participation in the CSRL/ISU-UP LEPs and the

Table 1. Percentage of Spatial Distribution of Households in the Survey by Subcounties and Parishes

Subcounties	Parishes in the Subcounties	Number of NECs (*n*=12)	NEC Client (*n*=253)	Non-NEC Client (*n*=63)	Nonparticipant (*n*=138)	Overall (*n*=454)
Butansi	Naluwoli	16.7	26.9	34.9	19.6	25.8
	Bugeywa	25.0	21.7	15.9	16.7	19.4
	Butansi	16.7	13.0	12.7	9.4	11.9
	Naibowa	-	0.4	-	0.7	0.4
	Subtotal	58.3	62.0	63.5	46.4	57.5
Namasagali	Namasagali	-	1.2	4.8	13.0	5.3
	Kasozi	8.3	4.0	0.0	5.1	3.7
	Bwiiza	25.0	32.8	23.8	34.1	31.9
	Kisaikye	8.3	-	7.9	1.4	1.5
	Subtotal	41.7	38.0	36.5	53.6	42.4

Author note: There were 12 NECs by the time of the survey in 2018. Borders between subcounties and parishes are porous; clients can cross over. We did not interview NEC clients from Kisaikye parish because the NEC in that area was started a few months before our impact assessment.

Table 2. The Adapted Household Food Insecurity Access Scale Questions to Assess Food Access

No.	Question and Frequency of Occurrence
1.a.	In the past four weeks, did you worry that your household would not have enough food? 0 = No (skip to question 2), 1 = Yes (go to question 1. b.)
1.b.	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6.	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Adapted from Coates et al. (2007, p. 4).

household characteristics which are the confounding factors believed to influence household food security: age of household head, education of household head, land ownership, livestock production, time spent to collect water, condition of WASH facilities, number of sick days for household heads by gender, number of meals consumed during the period of scarcity (typically the hunger periods between planting and harvesting), and membership in community social groups.

A multinomial logistic regression analysis tested whether participation in the LEPs and identified household characteristics influenced household food security status (FSS). The stated predictor variables were assessed against the response variable of household FSS, in terms of being Food Secure (FS), Food Insecure (FI), or Extremely Food Insecure (EFI). The LEP components of agronomy and postharvest technologies, livestock integration, nutrition and infant feeding, water supply and public health, complementary services, and community income-generation innovations, were merged as one variable that we labeled Participation in LEPs. Individually, the LEPs failed to meet the criteria for participation when they were tested for multicollinearity on indicators of Variance Inflation Factor (VIF) and/or Tolerance Value (TV). Leech et al. (2007) suggest merging such variables in cases where they are measuring a similar effect on the dependent variable, which in the case of this study was FSS measured in terms of food access using HFIAS.

Upon merging LEP components, a linear regression was then re-run to assess the multicollinearity for the merged LEP components and the household characteristics. The criteria for both VIF and TV were met (Appendix B). The final multinomial logistic regression model was run on household FSS as the dependent variable with three categories (FS = 1 as the reference category, FI = 2, and EFI = 3). The linear regression model results indicated an adjusted R^2 of 0.155, meaning that the model explained 15% of the independent variables. All factors in the model were greater than

the TV of 0.835, given as TV = 1 - R^2 (1 - 0.155 = 0.845) and exhibited a VIF greater than 1 but less than 2.5, as required (Leech et al., 2007). The model was run at a 5% significance level, with a less conservative 10% significance level also considered due to the high level of categorization of factors in the variables, which reduced their predictive power (Menard, 2000). All other household characteristics believed to potentially influence the level of food security were dropped to prevail over the multicollinearity problem.

Table 3. Percentage Description Characteristics of Households in the Study Area (*n*=454)

Characteristic	Indicators	Frequency	Percentage
Spatial Distribution			
Sub-Counties	Butansi	261	57.5
	Namasagali	193	42.5
Years Lived in Community	Less than 10 years	231	50.9
	Over 10 years	223	49.1
Social Demographic			
Marital Status	Single – Never Married	08	1.8
	Married – Monogamous	335	73.8
	Married – Polygamous	57	12.6
	Separated/Divorced	24	5.3
	Widowed	30	6.6
Gender	Male	373	82.2
	Female	81	17.8
Age	18–35 years	197	43.4
	36–59 years	207	45.6
	60+ years	50	11.0
Religion	Anglican	212	46.7
	Roman Catholic	91	20.0
	Islam	88	19.4
	Born Again	55	12.1
	Seventh-Day Adventists	05	1.1
	Noa	02	0.4
	African Tradition	01	0.2
Membership in Community Groups	Member	389	85.7
	Not a Member	65	14.3
Socio-Economic			
Education Level	Primary level	308	67.8
	Post-primary	146	32.2
Acreage of Land Owned	Less than 3.0 Acres	279	61.5
	Over 3.0 Acres	175	38.5
Water, Sanitation, and Hygiene			
Distance to Primary Water Sources	Less than two kilometers	433	95.8
	Greater than two kilometers	21	4.2
Time to Collect Water	Less than 30 minutes	283	62.3
	Greater than 30 minutes	171	37.7
Availability of WASH Facilities	Latrine	440	96.9
	Bathrooms	376	82.8
	Kitchens	394	86.7
	Rubbish pits	230	50.7
	Plate stands	157	34.6
	Tippy taps	206	45.4

Author note: Born Again resonates with the Ugandan understanding of Pentecostalism and the wholewide evangelical Christianity and emphasizes a spiritual rebirth to get saved from eternal fire especially members having ascribed to other religious affiliations in their previous life (Isiko, 2019).

Results and Discussion

This section presents results concurrently with discussion, aligned by the set objectives relating to household characteristics, livelihoods education programs and their influence on food security status, and the multinomial regression results on factors that influence household food security status.

Household Characteristics

Certain household characteristics were believed to influence both participation in LEPs and food security status. Table 3 describes the characteristics as assessed at the household level and/or at the level of household head. By spatial distribution, most households (57.5%) were from Butansi subcounty, where most NECs were located, and (43.7%) were from Namasagali. The majority were married in a monogamous setting (73.8%), and most households (82.2%) were male headed. Most household heads (45.6%) were between 36 and 59

years. Religion influences food consumption patterns; whereas the majority of participants were Anglicans and Catholics, religions such as Islam and the Seventh-Day Adventist Church prohibit consumption of certain animal-source foods like pork, adversely affecting their animal protein choices (Newell, 2023). Most households (85.7%) were members of community social groups, a crucial element in the development of social capital, which positively influences food security (Sseguya et al., 2018).

In water access, 95.8% accessed their primary water within two kilometers, and 62.3% fetched water in less than 30 minutes for a round trip to their primary water source. This is better than the national average of 45.0% taking less than 30 minutes for a round trip (UBOS & International Classification of Functioning, 2018). The availability of WASH facilities contributes to community safety and development. Proper maintenance of WASH facilities and good sanitary practices like washing hands are barriers to pathogen transmission, as feces contact primary sources and finally reaches food (Amadei, 2014; Ikendi, Owusu et al., 2023). Proper disposal and good sanitary practices reduce WASH-related diseases such as diarrhea and dysentery, and epilepsy, which is related to consuming tapeworm-infested pork due to open defecation (Nsadha, 2018).

In household size, there were a total of 2,728 members (1,320 males and 1,408 females) in 454

Figure 4. Total Number of Household Members by Age Group in the Study Area

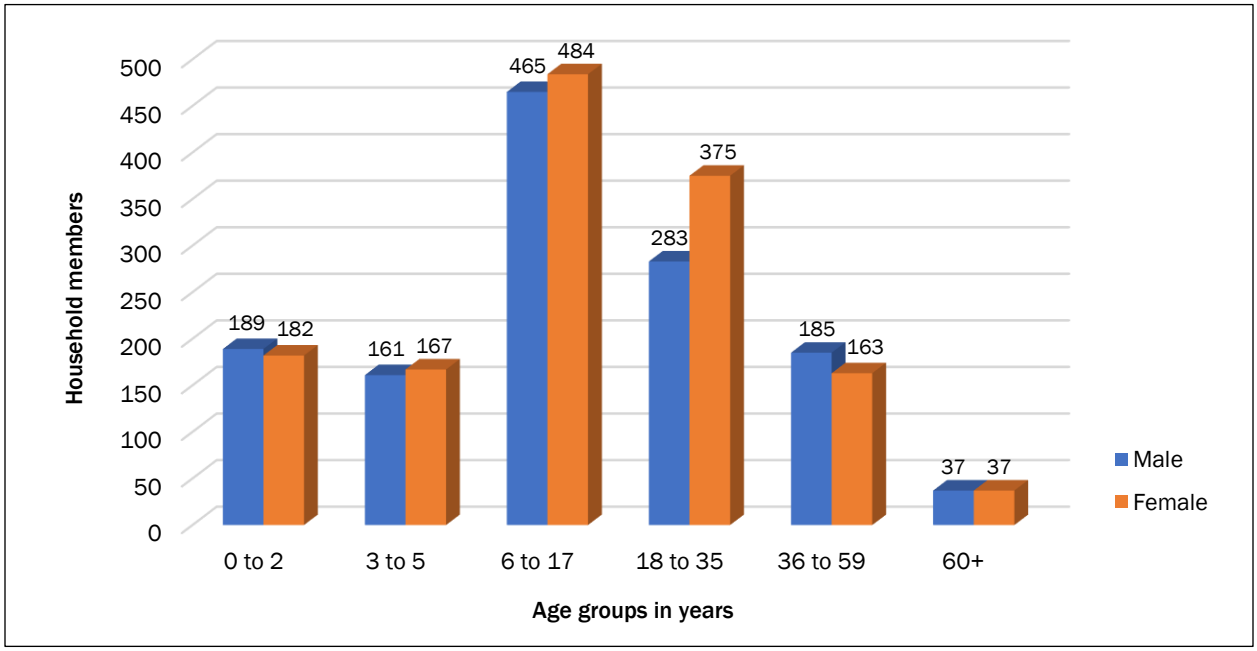


Table 4. Percentage and Mean Comparison of Household Food Security Status Between and Among Groups Studied

Household FSS as Measured by the HFIAS Index		NEC Households (*n*=253)	Non-NEC Households (*n*=63)	Nonparticipants (*n*=138)	Overall Households (*n*=454)	*p*-value
Food Security Status	Food secure	47.8	63.5	35.5	46.3	0.003
	Food insecure	45.5	28.6	52.9	45.4	
	Ext. food insecure	06.7	07.9	11.6	08.4	
ANOVA *post hoc* for HFIAS		9.54[b]±6.15	7.19[a]±7.33	10.94[b]±6.32	9.64±6.47	<0.001

[a & b] depict significant differences in mean scores between groups for the HFIAS.

households with an average of 6.0 members per household, above the national average of 5.0 persons per household (UBOS, 2017). This average suggests a growing population through higher childbirth and high dependence ratios, with a higher population of dependents between 0–17 years, as illustrated in Figure 4.

Household Food Security Status (FSS)

Households varied in their FSS both by affiliation with the NECs and participation in the LEPs (Table 4).

All 454 households were food insecure, with a mean of 9.64±6.47. However, there were substantial differences in mean scores among the groups. Analysis revealed that LEP participants who are Non-NEC clients were food secure, overall, with a mean of 7.19^{a}±7.33. However, participants who are NEC clients and Nonparticipants were not different from each other, despite the former having a lower mean of 9.54^{b}±6.15, below the overall mean, and the latter having a higher mean of 10.94^{b}±6.32, above the overall mean; both, overall, were food insecure.

When merged, the NEC clients and Non-NEC clients represent CSRL/ISU-UP household clients in this study. Cross-tabulation revealed that CSRL/ISU-UP participants were 51.0% more likely to be food secure compared to 35.5% of nonparticipants ($\chi^2 = 9.888$, $df = 2$, $p = 0.007$). These findings suggest a significant role for LEPs in improving food and nutrition security. These results are consistent with the findings of Seguya et al. (2018): households in their study participating in the CSRL/VEDCO program for 2004–2008 in Kamuli were 63.1% more food secure than nonparticipants. The CSRL 2004 baseline data revealed a 9.0% food-secure status; five years after the livelihood interventions, however, food-secure households rose to 53.7% overall (Sseguya et al., 2018), and increased further to 61.1% at the 2015 inception of the CSRL/ISU-UP partnership (Ikendi, 2019). Appendices C and D provide details of the food security statuses over 2004/2005, 2008/2009, 2015/2016, and 2018/2019 assessment periods.

In general, food-secure households increased in the study area after the inception of the CSRL in 2004 to 2015, and then declined by 2018. The improvement in food security 2004–2015 may be attributed to the "farmer-to-farmer" extension, which built group cohesion in food security through working with extension personnel to build capacity (Masinde, Butler et al., 2015; Sseguya et al., 2015). The program embraced indigenous knowledge to guide programming toward technology adoption (Ikendi & Retallick, 2023a; Masinde & McMillan, 2015). Emmerman and Ornelas (2021) contend that "changes stemming from community efforts are the most important to generating long-term improvements to food access" (p. 50) as well.

The CSRL/ISU-UP initiative relies on scientific findings to guide field operations in the assessment and adoption of innovative ideas (Acker et al., 2015; Ikendi & Retallick, 2023b). Findings and recommendations from several studies conducted in the programs and/or supported by the program directors inform action areas to improve FNS improvement strategies. Research areas have included livestock improvements (Ampaire, 2011; Kugonza et al., 2014; Marshall et al., 2023; Semahoro et al., 2018; Walugembe et al., 2014); postharvest technologies in grains and pest management (Bbosa et al., 2017; 2020; Brumm et al., 2021; Mayanja et al., 2018; Sserunjogi et al., 2021; Taku-Forchu, Lambert et al., 2023; Taku-Forchu, Qu et., 2023); food safety and food handling (Nabwiire et al., 2022; Nabwiire et al., 2023); global service-learning through school gardens (Ikendi, 2022a; 2022b; Snodgrass, 2012); school lunches (Byaruhanga, 2016; Nonnecke et al., 2016); value chains in tomato production (Taku-Forchu, 2019; Tusiime, 2019; Tusiime et al., 2019) and tropical pumpkins (Kwikiiriza, 2022); sweet potato production through climate-smart agriculture (Waaswa et al., 2021a; 2021b; Waaswa, Nkurumwa, Kibe, & Ng'eno, 2021); soil amendments (Akitwine, 2021; Anderson, 2023; Bwambale, 2015; 2019; Wokibula & Westgate, 2016); and promotion of amaranth production (Muyonga et al., 2010; Nampeera et al., 2019) – a major ingredient in therapeutic porridge at the NECs (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b) and school lunches (Byaruhanga, 2016; Ikendi, 2022b; Nonnecke et al., 2016).

However, after the CSRL/ISU-UP transitioned in 2014 to the "comprehensive approach to the capacity development model" (CSRL, 2017; Ikendi, 2019, p. 50), a baseline conducted in 2015 revealed 61.1% food-secure households and then a drop to 46.3% by 2018. This drop was commensurate with national and global trends; FAO et al. (2020) report that "five years after the world committed to ending hunger … we are still off track to achieve this objective by 2030" (p. 1). We found incidents when households often went an entire day and night without food (Appendix D), a high risk of food insecurity in Uganda reflected in the GHI (von Grebmer et al., 2022). Earlier projections of the current path scenario showed that "Uganda does not reach a food-secure future by 2050" (Hedden et al., 2018, p. 2), demonstrating the need to bolster partnerships with NGOs in the fight against hunger (Ikendi & Retallick, 2023b; Office of the Prime Minister, 2020).

Impact of Livelihoods Education Programs on Food Security Status

In Table 5, agronomy and postharvest technologies and livestock integration had a more significant

Table 5. Relationship Between Participation in Livelihood Education Programs and FSS

	Nonparticipant		LEP Participant		
LEPs and Household Food Security Status	*f*	%	*f*	%	*p*-value (χ^2)
Agronomy and Postharvest Technology					
Food Secure	86	36.6	124	56.6	<0.001
Food Insecure	121	51.5	85	38.8	
Extremely Food Insecure	28	11.9	10	4.6	
Total	**235**	**100**	**219**	**100**	
Livestock Integration					
Food Secure	109	38.9	101	58.0	<0.001
Food Insecure	143	51.1	63	36.2	
Extremely Food Insecure	28	10.0	10	5.7	
Total	**280**	**100**	**174**	**100**	
Nutrition and Infant Feeding					
Food Secure	91	44.2	119	48.0	0.141
Food Insecure	92	44.7	114	46.0	
Extremely Food Insecure	23	11.2	15	6.0	
Total	**206**	**100**	**248**	**100**	
Water and Public Health					
Food Secure	91	44.6	119	47.6	0.130
Food Insecure	90	44.1	116	46.4	
Extremely Food Insecure	23	11.3	15	6.0	
Total	**204**	**100**	**250**	**100**	
Complementary Services					
Food Secure	75	43.9	135	47.7	0.393
Food Insecure	78	45.6	128	45.2	
Extremely Food Insecure	18	10.5	20	7.1	
Total	**171**	**100**	**283**	**100**	
Community Income-Generating Innovations					
Food Secure	194	45.8	16	53.3	0.218
Food Insecure	192	45.3	14	46.7	
Extremely Food Insecure	38	9.0	-	-	
Total	**424**	**100**	**30**	**100**	

relationship with household food security among LEP participants than among nonparticipants.

Households involved in agronomy and postharvest programs benefit from education related to land use planning, soils, composting, micronutrient gardening, postharvest handling, gross margin and marketing of produce, and from planting crops such as soybeans, amaranths, millet, iron beans, orange-fleshed sweet potatoes, tomatoes, spinach, eggplants, and collards (Ikendi, Owusu, Masinde, Bain et al., 2023). The findings of Muyonga et al. (2010) and Tusiime et al. (2019) on amaranth and tomato production, respectively, guided implementation of such projects to ensure increased production as well as enhanced income. Trained farmers also have access to silos, tarpaulins, and grain cleaners at subsidized prices from grain storage and postharvest projects (Ikendi, Owusu, Masinde, Bain et al., 2023). Research on pest management in stored grains (Bbosa et al., 2017; 2020; Brumm et al., 2021; Sserunjogi et al., 2021; Taku-Forchu, Lambert et al., 2023) and grain cleanliness (Mayanja et al., 2018) has been influential in programming interventions. The program bases its interventions on both scientific findings (Acker et al., 2015; Ikendi & Retallick, 2023b) and indigenous knowledge (Ikendi & Retallick, 2023a; Masinde & McMillan, 2015), which are significant determinants in the adoption and diffusion of innovations for community development (Chambers et al., 1989; Morrone, 2017; Pound & Conroy, 2017; Rogers, 2003).

For livestock integration, in addition to building participant capacity to manage enterprises involving local and exotic pigs, goats, cattle, and chickens, as well as forage and livestock marketing, access was developed to veterinary services including vaccinations and treatment through the Community Based Animal Health Workers [CBAHWs] (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023a; Masinde, McMillan et al., 2015). Depending on the availability of funds, trained households are supported in starting and/or boosting their enterprises with resources such as building materials, layer chicks, Kuroiler chickens, ducks, breeding goats, pigs, forage seeds, feeds and ingredients, and water tanks to improve water access for livestock, crops, and household use. Based on the findings of Kugonza et al. (2014) to improve the breeding of local goats, the livestock program introduced Mubende (Bucks) goats for their breeding efficiency and superior profit margin. Other research that informed programming included Semahoro et al. (2018) on Kuroiler chickens, Marshall et al. (2023), Walugembe et al. (2014), Dione et al. (2014) on pig management, Maas et al. (2014) on forage production, indigenous chickens (Natukunda et al., 2011a; 2011b), and gender in livestock programs (Ampaire, 2011).

To improve nutrition security, nutrition and infant feeding programs are designed to promote behavioral change in obstetrical, gynecological, and feeding practices (Ikendi, Owusu et al., 2023; Masinde, McMillan et al., 2015; Winham et al., 2016). Participants learn about (exclusive) breastfeeding, complementary feeding, a balanced diet, and the clinical signs of malnutrition. Nutrition programs encourage mothers and youth to grow vegetables such as collards, onions, eggplants, tomatoes, spinach, and carrots in micronutrient gardens like sacks, keyholes, and kitchen gardens due to limited household land access (Duerfeldt et al., 2016; Ikendi, 2022b; Ikendi, Owusu, Masinde, Bain et al., 2023; Masinde & McMillan, 2015). The programs offer complementary services such as therapeutic porridge served to at-risk-for-malnutrition pregnant and breastfeeding mothers and children in malnutrition rehabilitation; the NECs use therapeutic nutrient-dense porridge locally made from grain amaranths, soybean, millet, and silver fish, and cooked with milk and (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b). The programs also work with government nurses to assist with immunizations and vaccinations, family planning, HIV counseling and testing, and training on domestic violence (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b; Ikendi, Owusu, Masinde, Bain, & Oberhauser, 2023; Masinde, McMillan et al., 2015; Winham et al., 2016).

Water supply and public health education promoted awareness of WASH, informing participants about personal and community hygiene, rat and jigger (a harmful sand flea) controls, and management of water resources (Ikendi, Owusu et al., 2023). Proper sanitation and health contribute to food uti-

lization (Burchi & De Muro, 2016). WASH projects ensure health as defined as the "ability to adapt and self-manage in the face of social, physical, and emotional challenges" to contribute to food production while "successfully adapting to an illness" (Huber et al., 2011, pp. 235–236). Proper sanitation reduces household vulnerability to WASH-related diseases like dysentery, diarrhea, and malaria (Ikendi, Owusu et al., 2023; Nsadha, 2018), while supporting household food production.

The community income generating innovations program supports the efforts of nutritionally rehabilitated mothers to work on crafts, primarily four products: bead products like bangles and purses, sewing machine products like backpacks and laptop bags, palm leaf products like mats, and raffia fiber products like baskets (Ikendi, 2019; Martin, 2018). The innovations program has expanded to include producing books for schools, soap, saving plans, small livestock projects, and engaging in- and out-of-school youth in home gardening programs. With the goal of sustainability, participants are trained toward self-maintenance of their projects, with the program offering technical support. In his change continuum, Rogers (2003) urges extension agents to provide discontinuance reinforcement through education and monitoring to make the community move on by themselves, a precursor to adoption of innovation for sustainable community development.

Factors Influencing Household Food Security Status

In the two models shown in Table 6, the resultant constants in a multinomial logistic regression—–1.150 in model one of food insecure (FI) and –4.325 in model two of extremely food insecure (EFI)—define their respective household FSS, which does not depend on the variables used in the models. All independent variables, except age

Table 6. Multinomial Logistic Regression Models for Factors That Influenced Food Security Status

FSS	Model Variables	B	SE	Sig.	Exp(B)
FI	Intercept	–1.150	0.269	.000	
	Participation in LEPs	0.413	0.233	.077*	1.511
	Age of household head	–0.281	0.237	.236	0.755
	Education level of household head	–0.077	0.226	.732	0.926
	Acreage of land owned	0.558	0.225	.013*	1.747
	Does the household keep any livestock	0.670	0.284	.018*	1.953
	Time in minutes spent to fetch water	0.350	0.221	.113	1.420
	General cleanliness of WASH facilities	0.785	0.216	.000*	2.193
	Days spent while sick for most adult males	0.527	0.332	.113	1.694
	Number of meals eaten during food scarcity	1.425	0.478	.003*	4.158
	Membership in community social groups	0.114	0.218	.600	1.121
EFI	Intercept	–4.325	0.619	.000	
	Participation in LEPs	0.485	0.404	.230	1.623
	Age of household head	–0.234	0.440	.594	0.791
	Education level of household head	0.323	0.460	.482	1.382
	Acreage of land owned	0.219	0.433	.614	1.244
	Does the household keep any livestock	1.014	0.449	.024	2.757
	Time in minutes spent to fetch water	0.993	0.396	.012*	2.700
	General cleanliness of WASH facilities	0.190	0.407	.640	1.209
	Days spent while sick for most adult males	1.942	0.456	.000*	6.972
	Number of meals eaten during food scarcity	2.467	0.608	.000*	11.787
	Membership in community social groups	1.365	0.437	.002*	3.914

* Significant factors.

and education of the household head, demonstrated a significant effect on the household FSS. These variables influenced the levels of FSS defined by Food Secure (FS) as the preferred category against FI and EFI individually and/or in combination.

Factors Influencing Households Being Food Secure Versus Being Food Insecure or Extremely Food Insecure

From the model, the factors of households keeping livestock and eating more meals during periods of food scarcity both influenced households being more FS than FI or EFI. Households keeping any form of livestock had a 95.3% likelihood of being more FS than FI and were 75.7% more likely to be FS than EFI. Livestock contributes to livelihood through products such as eggs, meat, and milk, and the sale of products and manure to meet family needs. Livestock, especially poultry, pigs, and small ruminants like goats and sheep, are pathways to food and nutrition security and poverty reduction in rural Uganda (Ampaire, 2011; Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023a; Kugonza et al., 2014; Masinde, McMillan et al., 2015; Marshall et al., 2023; Natukunda et al., 2011a; 2011b; Semahoro et al., 2018; Walugembe et al., 2014). As small animals are more easily managed by females, this favors involvement by women (Ampaire, 2011; Dione et al., 2014). Livestock is also insurance against crop failures, as their products can be sold off to buy food (Herrero et al., 2010).

The number of meals eaten during seasons of food scarcity was dichotomized into households eating at least two meals, and one or none, per day. Households having at least two meals had a 15.8% likelihood of being more FS than FI and were 78.7% more likely to be FS than EFI. Lack of food is a precursor to poor scores in dietary diversity and caloric consumption, alternative measures of food security (Swindale & Bilinsky, 2006). Poor food access increases the likelihood of birth of malnourished children due to poor fetal growth, with long-term effects such as poor cognitive development (Headey & Ruel, 2023; Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023c; Victora et al., 2021).

Factors Influencing Households Being More Food Secure Than Being Food Insecure

Overall, households that participated in the CSRL/ISU-UP LEPs had a 51.1% likelihood of food security rather than food insecurity. The factors that significantly influenced households being more FS than FI, but not significant for more FS than EFI, were general cleanliness of WASH facilities and acreage of land owned. Households with clean WASH facilities were 19.3% more likely to be FS than FI. As discussed earlier regarding the water supply and public health program, clean WASH facilities are less likely to predispose households to diseases like diarrhea and dysentery associated with households with dirty WASH facilities (Murray, 2020; Nsadha, 2018). Households having at least 3.0 acres (1.2 ha) were 74.7% more likely to be FS than FI, a finding consistent with a study by Malual and Mazur (2020) in Lira, Uganda, where households that cultivated at least 3.0 acres of land were determined to be more food secure. In Kamuli district, as available land has been shrinking over the years, the CSRL program has promoted land-sparing techniques of production such as sacks, keyholes, and kitchen gardens to increase vegetable production (Duerfeldt et al., 2016; Ikendi, 2022b; Ikendi, Owusu, Masinde, Bain et al., 2023; Masinde & McMillan, 2015).

Factors Influencing Households Being More Food Secure Than Extremely Food Insecure

The factors that influenced household being more FS than being EFI were number of sick days of most adult males, social group membership, and time spent for a round trip to fetch water from primary water sources. Households where most male adults had five days or less of illness were 97.2% more likely to be FS than EFI. Body productivity is lowered the more one stays bedridden. This is highly concerning in a population in which 82.2% of households are male- headed and men are traditionally considered household breadwinners. Therefore, the empowerment of women for access to household resources like land is an important means to improve livelihood (Matembe, 2002). Research indicates that women actually contribute the greatest amount of food production

globally (Asitik & Abu, 2020; Barak et al., 2023; Doss, 2014).

Membership in social groups, especially burial and festival groups, showed a 91.4% likelihood of households being more FS than EFI. Burial groups are community safety nets in times of grief, when members solicit foodstuffs for grieved families to help them manage the funeral. It is also a form of bidding farewell and creating social bonds with the dead (Shimane, 2018) rather than treating them as they are "just thrown away," as the Barlonyo in the Lira district of Uganda have been described (Proctor, 2013). Social groups are a sign of social capital development crucial in achieving FNS in communities (Malual & Mazur, 2020; Sseguya et al., 2018). In addition, in limited-resource communities, social groups serve as safety nets to access basic needs; for instance, rural women in Bangladesh have formed groups to help themselves during periods of food shock (Pieters et al., 2013).

Households that spent 30 minutes or less for a round trip to fetch water were 70.0% more likely to be FS than EFI. A combination of carrying by head and hand was the main method of carrying water (48.7%), followed by bicycles (37.2%). The average distance was 0.54 km (0.34 miles), with a maximum of 5.0 km (3.1 miles), to the primary water sources. A factor in these findings is that time saved fetching water can be used for other household or farm activities. Overall, 38.2% of households spent more than 30 minutes on a round trip, less than the established national average of 55.0% for rural dwellers (UBOS & ICF, 2018).

Summary and Conclusions

The goal of this study was to determine whether participation in the livelihoods education programs (LEPs) of the Center for Sustainable Rural Livelihoods/Iowa State University Uganda Program (CSRL/ISU-UP) improves household food security. We investigated three categories of household: program participants who were nutrition education center (NEC) clients, non-NEC clients, and nonparticipants. Food security status was assessed with the Household Food Insecurity Access Scale at three levels to identify food secure, food insecure, and extremely food insecure households (Coates et al., 2007). Overall, the food secure were 46.3% of the 454 households surveyed, 45.4% were food insecure, and 8.4% were extremely food insecure.

Disaggregation of households showed that 161 (51.0%) of the 316 CSRL/ISU-UP LEP participants were more likely to be food secure compared to the 49 (35.5%) food secure among the 138 nonparticipants. A larger proportion of extremely food insecure households (11.6% of 138) was found within the nonparticipants. We can therefore infer that the intervention of the CSRL/ISU-UP significantly contributed to improving the food security status of program participant households, most significantly among NEC households in or that had participated in the malnutrition rehabilitation program (Ikendi, Owusu, Masinde, Oberhauser, & Bain, 2023b).

In the multinomial logistic regression, overall participation in the LEPs significantly influenced households to be more food secure than food insecure. By program, participation in the agronomy and postharvest technologies and in livestock integration significantly influenced households' food security over insecure or extremely insecure. These programs directly contribute to food access through direct production and/or sale of output to purchase foods. They also increase home and farmgate (own production) and market (purchases) dietary diversity, helping to improve diet and caloric consumption, which are alternative measures of food security in terms of food access (Swindale & Bilinsky, 2006).

Participation in water supply and public health education, nutrition and infant feeding, complementary services, and community income-generating innovations also had a positive association with household food security. These programs, other than income innovation, substantially influence personal and household well-being and have strong multiplier effects in food utilization, a concept used in assessing nutrition security (World Health Organization, 1995; 2003). Income innovations by their nature contribute to food availability, access, stability, and sustainability of households; moreover, the program did not have any households that were extremely food insecure. These programs were mainly composed of households that had

gone through malnutrition rehabilitation and were engaging in efforts to increase their incomes to improve their livelihoods.

Of confounding household characteristic factors that influence both participation in the LEPs and household food security, we found that both keeping livestock and a larger number of meals eaten during seasons of food scarcity are more related to household food security than food insecurity and extreme food insecurity. Similarly, greater land ownership (at least 3.0 acres) and cleanliness of WASH facilities influenced households to be more food secure than food insecure. Lesser time required for a round trip to fetch water (less than 30 minutes), fewer days of illness for most male adults, and belonging to social groups influenced households to be more food secure than being extremely food insecure.

Recommendations at the Household Level

Since involvement with LEPs has a substantial multiplier effect on learning, households should be encouraged to engage more in LEPs to build capacity to manage activities that directly and indirectly influence food production. For example, participants in agronomy could learn how to use land-sparing techniques of production like sacks, kitchens, and keyhole gardens, and postharvest management practices such as using hematic silos to improve grain storage and quality. Techniques in sustainable livestock management, especially breeding programs in small livestock, can also help to improve local stock productivity and access to veterinary services, while complementary services like therapeutic porridge help manage malnutrition. Also, techniques in constructing and managing WASH facilities could help to enhance personal and community health. Income innovations enhance household sustainable livelihood strategies. All these engagements improve social capital through working in groups to improve food and nutrition security strategies.

Acknowledgments

The authors are grateful to the extension and outreach coordinators of the Iowa State University Uganda Program in Kamuli district, Uganda, who helped us with data collection.

References

Acker, D. G., Musoke, H. K., & Sseguya, H. (2015). Capitalizing on impacts & CSRL's multiplier effects. In M. L. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 223–254). Kumarian Press.

Adong, A., Kornher, L., Kirui, O. K., & von Braun, J. (2021). Conflict exposure and food consumption pathways during and after conflict: Evidence from Northern Uganda. *World Development*, *147*, Article 105636. https://doi.org/10.1016/j.worlddev.2021.105636

Ahluwalia, P. (2021). Uganda elections: Museveni's success at what cost? *African Identities*, *19*(2), 121–122. https://doi.org/10.1080/14725843.2021.1911033

Akitwine, F. (2021). *Pedology of typical soils of Kamuli District and pedotransfer functions to predict cation exchange capacity in limited-resource settings* [Master's thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/jw27mp4v

Amadei, B. (2014). *Engineering for sustainable human development: A guide to successful small-scale community projects*. ASCE Press. https://doi.org/10.1061/9780784413531.ch15

Ampaire, A. (2011). *Farmers' experiences with rearing pigs, goats and chickens to improve household nutrition and income in Kamuli, Uganda* [Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/26314

Anderson, A. (2023). *Pedology as a scientific, teachable, and artistic discipline in the 21st century* [Doctoral Dissertation, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/3wxae0ov

Asitik, A. J., & Abu, B. M. (2020). Women empowerment in agriculture and food security in Savannah accelerated development authority zone of Ghana. *African Journal of Economic and Management Studies, 11*(2), 253–270. https://doi.org/10.1108/AJEMS-03-2019-0102

Banerjee, A. V., & Duflo, E. (2007). The economic lives of the poor. *Journal of Economic Perspectives*, *21*(1), 141–167. https://doi.org/10.1257/jep.21.1.141

Barak, F., Efitre, J., Odong, R., & Melgar-Quiñonez, H. (2023). Women's agency in nutrition in the association between women's empowerment in agriculture and food security: A case study from Uganda. *World Food Policy*. https://doi.org/10.1002/wfp2.12063

Barrett, C. B., Bell, R., Lentz, E. C., & Maxwell, D. G. (2009). Market information and food insecurity response analysis. *Food Security*, *1*(2), 151–168. https://doi.org/10.1007/s12571-009-0021-3

Bbosa, D., Brumm, T. J., Bern, C. J., Rosentrater, K. A., & Raman, D. R. (2017). Evaluation of hematic maize storage in 208 liter (55 gal) steel barrels for smallholder farmers. *Transactions of the ASABE*, *60*(3), 981–987. https://doi.org/10.13031/trans.12044

Bbosa, D., Brumm, T. J., Bern, C. J., Rosentrater, K. A., & Raman, D. R. (2020). Effect of blending amaranth grain with maize kernels on maize weevil control during storage. *Transactions of the ASABE*, *63*(2), 401–406. https://doi.org/10.13031/trans.13614

Bradley, M., Ikendi, S., Rongerude, J., & Haddad, M. (2023a, May 15–18). *Food as a commodity: Network analysis and the Des Moines community* (Poster Proceedings, pp. 512–515). American Association for Agricultural Education National Conference. Raleigh, NC. United States. https://aaaeonline.org/resources/Documents/National/2023Meeting/2023%20AAAE%20Poster%20Proceedings.pdf

Bradley, M., Ikendi, S., Rongerude, J., & Haddad, M. (2023b, May 15–18). *Food as lived experience: A photovoice with high school students* (Poster Proceedings, pp. 516–519). American Association for Agricultural Education National Conference. Raleigh, NC. United States. https://aaaeonline.org/resources/Documents/National/2023Meeting/2023%20AAAE%20Poster%20Proceedings.pdf

Broad, G. M. (2016). *More than just food: Food justice and community change*. University of California Press.

Brumm, T. J., Bern, C. J., & Webber, D. F. (2021). Hermetic storage of maize grain in repurposed food oil containers to control maize weevils. *Journal of Stored Products and Postharvest Research*, *12*(2), 42–46. https://academicjournals.org/journal/JSPPR/article-full-text/CAD3B6B67690

Bundy III, R. O. (2015). Identifying opportunities. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 5–36). Kumarian Press.

Burchi, F., & De Muro, P. (2016). From food availability to nutritional capabilities: Advancing food security analysis. *Food Policy, 60*, 10–19. https://doi.org/10.1016/j.foodpol.2015.03.008

Butler, L. M., & Acker, G. D. (2015). Epilogue: The partnership today and looking towards the future. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 255–268). Kumarian Press.

Butler, M. L., & Mazur, R. (2015). Courting perspective partners. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 37–56). Kumarian Press.

Butler, L. M., & McMillan, D. E. (2015). Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda. Kumarian Press.

Bwambale, N. (2015). *Farmers' knowledge, perceptions, and socioeconomic factors influencing decision making for integrated soil fertility management practices in Masaka and Rakai districts, central Uganda* [Masters' Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/29414

Bwambale, N. (2019). *Smallholder farmers' social capital, resource access and adoption of integrated soil fertility management technologies and practices in the Masaka bean innovation platform* [Doctoral Dissertation, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations . https://dr.lib.iastate.edu/handle/20.500.12876/31596

Byaruhanga, L. A. (2016). *Effect of school garden food production on nutrient adequacy and nutrition status of children in Namasagali primary school in rural Kamuli District, Uganda* [Master's Thesis, Kenyatta University]. Kenyatta University Institutional Repository, MST-Department of Foods, Nutrition & Dietetics. http://ir-library.ku.ac.ke/handle/123456789/17759

Center for Sustainiable Rural Livelihoods (CSRL). (2017). *About CSRL*. Iowa State University of Science and Technology. Ames, Iowa, United States. https://www.csrl.cals.iastate.edu/about-csrl

Chambers, R., Pacey, A., & Thrupp, L. A. (Eds.). (1989). *Farmer first: Farmer innovation and agricultural research.* Intermediate Technology Publications.

Clendenning, J., Dressler, W. H., & Richards, C. (2016). Food justice or food sovereignty? Understanding the rise of urban food movements in the USA. *Agriculture and Human Values, 33*(1), 165–177. https://doi.org/10.1007/s10460-015-9625-8

Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide (version 3)*. FHI 360/FANTA. https://www.fantaproject.org/sites/default/files/resources/HFIAS_ENG_v3_Aug07.pdf

Committee on World Food Security. (2012, October 15–20). *Coming to terms with terminology: Food security, nutrition security, food security and nutrition, and food and nutrition security.* CFS: 39th session, Item V.a. https://www.fao.org/3/MD776E/MD776E.pdf

Dione, M. M., Ouma, E. A., Roesel, K., Kungu, J., Lule, P., & Pezo, D. (2014). Participatory assessment of animal health and husbandry practices in smallholder pig production systems in three high-poverty districts in Uganda. *Preventive Veterinary Medicine*, *117*(3–4), 565–576. https://doi.org/10.1016/j.prevetmed.2014.10.012

Doss, C. (2014). If women hold up half the sky, how much of the world's food do they produce? In A. Quisumbing., R. Meinzen-Dick., T. Raney., A. Croppenstedt., J. Behrman., & A. Peterman (Eds.), *Gender in agriculture: Closing the knowledge gap* (pp. 69–88). Springer.

Duerfeldt, K., Tusiime, S., & Nonnecke, G. (2016). Impact of sack gardening by youth in a Ugandan school garden program. *Horticultural Science 51*(9), S371-S372. https://doi.org/10.21273/HORTSCI.51.9S.S1

Emmerman, K. S., & Ornelas, L. (2021). Setting the table, not running it: An inclusive approach to access to healthy foods. *Journal of Agriculture, Food Systems, and Community Development*, *10*(4), 47–50. https://doi.org/10.5304/jafscd.2021.104.026

Food and Agriculture Organization of the United Nations, Economic Commission for Africa, & African Union Commission. (2021). *Africa: Regional overview of food security and nutrition 2021: Statistics and trends*. https://doi.org/10.4060/cb7496en

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund., World Food Programme, & World Health Organization. (2021). *The state of food security and nutrition in the world 2021: Transforming food systems for food security, improved nutrition and affordable healthy diets for all.* https://doi.org/10.4060/cb4474en

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2023). *The state of food security and nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum.* https://doi.org/10.4060/cc3017en

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, & World Food Programme. (2013). *The state of food insecurity in the world 2013. The multiple dimensions of food security.* https://www.fao.org/3/i3434e/i3434e.pdf

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2018). *The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition*. https://doi.org/10.18356/c94f150c-en

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2022). *The state of food security and nutrition in the world 2022. Repurposing food and agricultural policies to make healthy diets more affordable.* https://doi.org/10.4060/cc0639en

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2020). *The state of food security and nutrition in the World 2020. Transforming food systems for affordable healthy diets*. https://doi.org/10.4060/ca9692en

Headey, D. (2021). Turning economic growth into nutrition-sensitive growth. In S. Fan & R. Pandya-Lorch (Eds.), *Reshaping agriculture for nutrition and health* (pp. 39–46). International Food Policy Research Institute (IFPRI). http://doi.org/10.2499/9780896296732

Headey, D., & Ruel, M. (2023). Food inflation and child undernutrition in low and middle income countries. *Nature Communications*, *14*(1), Article number, 5761. https://doi.org/10.1038/s41467-023-41543-9

Hedden, S., Rafa, M., & Moyer, J. D. (2018). *Achieving food security in Uganda* [Report]. USAID.

Herrero, M., Thornton, P. K., Notenbaert, A. M., Wood, S., Msangi, S., Freeman, H. A., Bossio, D., Dixon, J., Peters, M., van De Steeg, J., Lynam, J., Parthasarathy R. P., Macmillan, S., Gerard, B., McDermott, J., Seré, C., & Rosegrant, M. (2010). Smart investments in sustainable food production: Revisiting mixed crop-livestock systems. *Science*, *327*(5967), 822–825. https://doi.org/10.1126/science.1183725

Hoddinott, J. (2021). Agriculture, health, and nutrition: Toward conceptualizing the linkages. In S. Fan & R. Pandya-Lorch (Eds.), *Reshaping agriculture for nutrition and health* (pp. 13–20). International Food Policy Research Institute. http://doi.org/10.2499/9780896296732

Huber, M., Knottnerus, J. A., Green, L., van der Horst, H., Jadad, A. R., Kromhout, D., Schnabel, P., Smith, R., van Weel, C., & Smid, H. (2011). How should we define health? *British Journal of Medicine*, *343*(d4163), 235–237. https://doi.org/10.1136/bmj.d4163

Hwalla, N., El Labban, S., & Bahn, R. A. (2016). Nutrition security is an integral component of food security. *Frontiers in Life Science*, 9(3), 167–172. https://doi.org/10.1080/21553769.2016.1209133

Ikendi, S. (2019). *Impact of nutrition education centers on food and nutrition security in Kamuli District, Uganda* [Masters' Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/31215

Ikendi, S. (2022a). *Exploring changes in academics, skills, and intercultural competence development of global service-learning students* [Doctoral Dissertation, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/JvNVO1Xv

Ikendi, S. (2022b, May 16–19). *Developing school-based agriculture education through school gardens* (Poster presentation). National American Association for Agricultural Education Conference: Brick by brick: Building our future together. Oklahoma City, Oklahoma, USA. http://aaae.agedweb.org/downloadfile.asp?ID=4996

Ikendi, S. (2023). Ecological conservation, biodiversity, and agricultural education as integrated approaches for envisioning the future of sustainable agriculture in North America. *International Journal of Sustainable Development & World Ecology, 30*(2), 152–163. https://doi.org/10.1080/13504509.2022.2127032

Ikendi, S., Owusu, F., & Masinde, D. (2023, May 15–18). *Community education for behavioral change towards food and nutrition security* (Poster Proceedings, pp. 395–398). National American Association for Agricultural Education Conference. Raleigh, North Carolina, United States. https://aaaeonline.org/resources/Documents/National/2023Meeting/2023%20AAAE%20Poster%20Proceedings.pdf

Ikendi, S., Owusu, F., Masinde, D., Bain, C., & Oberhauser, A. (2023, May 15–18). *Assessment of agronomy extension education on farmers' empowerment towards food production in rural Uganda* (Paper Proceedings, pp. 1016–1036). National American Association for Agricultural Education Conference. Raleigh, North Carolina, United States. https://aaaeonline.org/resources/Documents/National/2023Meeting/23_AAAE_Proceedings_combined_FINAL.pdf

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023a, September 18–20). *The renascence of African livelihoods through livestock extension education programs* (Poster presentation). Western Region of the American Association for Agricultural Education Research Conference: The crossroads of food, agriculture and innovation. Logan, Utah, United States. https://www.researchgate.net/publication/374153427

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023b, September 18–20). *Towards nutrition security among mothers and children through livelihood programs* (Poster presentation). Western Region of the American Association for Agricultural Education Research Conference: The crossroads of food, agriculture and innovation. Logan, Utah, USA. https://www.researchgate.net/publication/374153419

Ikendi, S., Owusu, F., Masinde, D., Oberhauser, A., & Bain, C. (2023c). Nutrition education centers: A community-based approach to management of malnutrition [Commentary]. *Journal of Agriculture, Food Systems, and Community Development*. Advance online publication. https://doi.org/10.5304/jafscd.2023.131.010

Ikendi, S., & Retallick, M. (2023a, April 26–29). *Exported through the theory of change: An inquiry into the compatibility of the U.S. land grant philosophy in Uganda* (Conference Proceedings, pp. 358–361). Association for International Agricultural and Extension Education Annual Conference: Technology, pluralism and inclusiveness in agriculture, food, and environment. Guelph, Ontario, Canada. https://www.aiaee.org/resources/Documents/2023%20AIAEE%20Conference%20Proceedings%20Final.pdf

Ikendi, S., & Retallick, M. (2023b, May 15–18). *Improving managerial and leadership effectiveness in multistakeholder organizations* (Paper Proceedings, pp. 636–655). National American Association for Agricultural Education Conference. Raleigh, North Carolina, United States. https://aaaeonline.org/resources/Documents/National/2023Meeting/23_AAAE_Proceedings_combined_FINAL.pdf

Ikendi, S., Retallick, M., & Nonnecke, G. (2023, May/June). Implementing global service-learning through school garden. *The Agriculture Education Magazine, 95*(6), 25-28. https://www.naae.org/profdevelopment/magazine/archive_issues/Volume95/2023%2005%20-%20May%20June.pdf

Iowa State University. (2016). *2017–2022 strategic plan*. Iowa State University, Office of the President. https://strategicplan.iastate.edu/iowa-state-university-strategic-plan-2017-2022.pdf

Isiko, A. P. (2019). State regulation of religion in Uganda: Fears and dilemmas of born-again churches. *Journal of African Studies and Development*, *11*(6), 99-117. https://doi.org/10.5897/JASD2019.0551

Kassam, A., & Kassam, L. (2021). *Rethinking food and agriculture: New ways forward*. Woodhead Publishing.

Kolschowsky, G. A., & Kolschowsky, K. A. (2015). Foreword. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. IX–XII). Kumarian Press.

Kugonza, D. R., Stalder, K. J., & Rothschild, M. F. (2014). Effects of buck and doe size on the growth performance and survival of their progeny. *Livestock Research for Rural Development, 26*(3), Article 47. http://www.lrrd.org/lrrd26/3/kugo26047.html

Kwikiiriza, S. (2022). *Evaluation of horticultural practices for tropical squash production and marketing among smallholder youth farmers in Kamuli, Uganda* [Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/Nr1VX8nz

Lanou, A. J., Mathews, L. G., Speer, J., Mills, L, & Gold-Leighton, N. (2021). Effects of experiential food education on local food purchasing and eating behavior. *Journal of Agriculture, Food Systems, and Community Development, 10*(4), 211–224. https://doi.org/10.5304/jafscd.2021.104.006

Leech, L. N., Barret. K. C., & Morgan, G. A. (2007). *SPSS for intermediate statistics: Use and interpretation* (3rd ed.). Routledge. https://doi.org/10.4324/9781410616739

Maass, B. L., Kabirizi, J. M., Pezo, D. A., Carter, N., Ouma, E. A., Zziwa, E., & Chiuri, W. L. (2014, September 17-19). *Opportunities for feeding forages to pigs in Uganda. Bridging the gap between increasing knowledge and decreasing resources* (Conference presentation). Tropentag Conference. Prague, Czech Republic. https://www.researchgate.net/publication/276294093

Malual, J. D., & Mazur, R. E. (2022). Social capital and food security in post-conflict rural Lira District, northern Uganda. *Disasters*, *46*(1), 80–94. https://doi.org/10.1111/disa.12465

Marshall, K., Poole, J., Oyieng, E., Ouma, E., & Kugonza, D. R. (2023). A farmer-friendly tool for estimation of weights of pigs kept by smallholder farmers in Uganda. *Tropical Animal Health and Production*, *55*(3), 219. https://doi.org/10.1007/s11250-023-03561-z

Martin, T. (2018). *Individual capacities (human capital) of the Tusubila crafts group* [Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Creative Components. https://lib.dr.iastate.edu/creativecomponents/85

Masinde, D., & McMillan, D. E. (2015). Starting where the people are. In M. L. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 111–144). Kumarian Press.

Masinde, D., Butler, M. L., & Mazur, R. (2015). Getting started. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 57–81). Kumarian Press.

Masinde, D., McMillan, E. D., Rothschild, M., & Nonnecke, G. (2015). Leaving the door open to emerging needs and opportunities. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 145–164). Kumarian Press.

Matembe, M. R. K., & Dorsey, N. R. (2002). *Gender, politics, and constitution making in Uganda*. Fountain Publishers.

Mayanja, I. K., Kigozi, J., Kawongolo, J., & Brumm, T. (2018). Design, fabrication, and testing of a pedal-operated maize grain cleaner. *Journal of Advances in Food Science & Technology 5*(3), 105–111. https://www.ikppress.org/index.php/JAFSAT/article/view/4321

Menard, S. (2000). Coefficients of determination for multiple logistic regression analysis. *The American Statistician*, *54*(1), 17–24. https://doi.org/10.1080/00031305.2000.10474502

Ministry of Agriculture, Animal Industry and Fisheries & Ministry of Health. (2004). *Uganda food and nutrition strategy and investment plan: Draft final*. https://extranet.who.int/nutrition/gina/sites/default/filesstore/UGA%202004%20FoodandNutritionStrategyAndInvestmentPlan.pdf

Morrone, V. (2017). Outreach to support rural innovation. In S. Snapp & B. Pound (Eds.), *Agricultural systems: Agroecology and rural innovation for development* (2nd ed.) (pp. 407-439). Academic Press.

Murray, C. J. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Muyonga, J. H., Ugen, M., Bisikwa, J., Nakimbugwe, D., Masinde, D., Bbemba, J., & Wambete, J. (2010). *Promoting production and utilization of grain amaranth for improved nutrition and health in Uganda*. *Annual progress report*. McKnight Foundation. https://docplayer.net/100909854-Promoting-production-and-utilization-of-grain-amaranth-for-improved-nutrition-and-health-in-uganda.html

Nabwiire, L., Shaw, A. M., Nonnecke, G. R., Minner, D. D., Johnsen, E., & Petersen Jr, L. E. (2022). Cultural sensitivity: A requirement when developing food safety interventions. *The Journal of Extension*, *60*(1), Article 4. https://doi.org/10.34068/joe.60.01.04

Nabwiire, L., Shaw, A., Nonnecke, G., Talbert, J., Muyanja, C., Boylston, T., Tarté. R., & Prusa, K. (2023). Compliance with food safety standards by beef vendors at butcheries in Kamuli district, Uganda. *African Journal of Food Science, 17*(9), 192-206. https://academicjournals.org/journal/AJFS/article-full-text-pdf/322527071169

Nampeera, E. L., Nonnecke, G. R., Blodgett, S. L., Tusiime, S. M., Masinde, D. M., Wesonga, J. M., Lucy K Murungi, L. K., Baidu-Forson, J. J., & Abukutsa-Onyango, M. O. (2019). Farmers' knowledge and practices in the management of insect pests of leafy amaranth in Kenya. *Journal of Integrated Pest Management*, *10*(1), Article 31, 1-12. https://doi.org/10.1093/jipm/pmz029

Natukunda, K., Kugonza, D. R., & Kyarisiima, C. C. (2011a). Indigenous chickens of the Kamuli Plains in Uganda: I. Production system and flock dynamics. *Livestock Research for Rural Development*, *23*(10), Article 220. http://www.lrrd.org/lrrd23/10/natu23220.htm

Natukunda, K., Kugonza, D. R., & Kyarisiima, C. C. (2011b). Indigenous chickens of the Kamuli Plains in Uganda: II. Factors affecting their marketing and profitability. *Livestock Research for Rural Development*, *23*(10), Article 221. http://www.lrrd.org/lrrd23/10/natu23221.htm

Newell, C. L. (2023). Vegetarianism, religion, and food. In W. A. Bauman, R. Bohannon, & K. J. O'Brien (Eds.), *Grounding religion: A field guide to the study of religion and ecology*. (3rd ed.) (pp. 194–206). Taylor & Francis.

Nonnecke, G., Masinde, D., Byaruhanga, L., Lutwama, D., & Acker, D. (2016). Using school gardens to support school feeding programs at elementary Schools in Uganda [Poster presentation]. *HortScience*, *51*(9S), S370. https://doi.org/10.21273/HORTSCI.51.9S.S1

Nonnecke, G., McMillan, D. E., Kugonza, D., & Masinde, D. (2015). Leaving the doors open to new beneficiaries. In L. M. Butler & D. E. McMillan (Eds.), *Tapping philanthropy for development: Lessons learned from a public-private partnership in rural Uganda* (pp. 165–189). Kumarian Press.

Nsadha, Z. (2018). *Porcine cyticercosis in selected districts of Uganda: Prevalence, pathology and relationship with human epilepsy* [Doctoral Dissertation, Makerere University]. Makerere University Institutional Repository. http://hdl.handle.net/10570/7102

Office of the Prime Minister (2020). *Uganda nutrition action plan (2020–2025): Leaving no one behind in scaling up nutrition actions*. https://scalingupnutrition.org/sites/default/files/2022-06/national-nutrition-plan-uganda.pdf

Pangaribowo, E. H., Gerber, N., & Torero, M. (2013). *Food and nutrition security indicators: A review* (ZEF Working Paper No. 108). Center for Development Research (ZEF), University of Bonn, Germany. https://doi.org/10.2139/ssrn.2237992

Pankaj, A. K. (2019). Caste and discrimination in welfare: Social exclusion of Dalits in Uttar Pradesh. *Contemporary Voice of Dalit, 11*(2), 139–149. https://doi.org/10.1177/2455328X18821447

Pieters, H., Guariso, A., & Vandeplas, A. (2013). *Conceptual framework for the analysis of the determinants of food and nutrition security* (FOODSECURE Working Paper No. 13). LICOS-Centre for Institutions and Economic Performances & Department of Economics, KU Leuven, Belgium. https://doi.org/10.22004/ag.econ.285141

Pound, B., & Conroy, C. (2017). The innovation systems approach to agricultural research and development. In S. Snapp & B. Pound. (Eds.), *Agricultural systems: Agroecology and rural innovation for development* (pp. 371-405). (2nd ed). Academic Press.

Proctor, K. (2013). *"They were just thrown away, and now the world is spoiled": Mass killing and cultural rites in Barlonyo* (Report). Feinstein International Center, Tufts University, United States. https://fic.tufts.edu/wp-content/uploads/They-Were-Thrown-Away-3-25-2013.pdf

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Rosegrant, M. W., Tokgoz, S., & Bhandary, P. (2013). The new normal? A tighter global agricultural supply and demand relation and its implications for food security. *American Journal of Agricultural Economics*, *95*(2), 303–309. https://www.jstor.org/stable/23358396

Sandler, B. (1972). *The African cookbook*. World Publishing Company.

Seleshe, S., Jo, C., & Lee, M. (2014). Meat consumption culture in Ethiopia. *Korean Journal for Food Science of Animal Resources*, *34*(1), 7–13. https://doi.org/10.5851/kosfa.2014.34.1.7

Semahoro, F., Kugonza, D. R., Babigumira, B. M., Walusimbi, S., Nadiope, G., & Okot, M. W. (2018). *Growth performance of chicken genotypes based on indigenous populations of Eastern Uganda.* World Congress on Genetics Applied to Livestock Production. https://web.archive.org/web/20220120122638/http://www.wcgalp.org/system/files/proceedings/2018/growth-performance-chicken-genotypes-based-indigenous-populations-eastern-uganda.pdf

Shimane, K. (2018). Social bonds with the dead: How funerals transformed in the twentieth and twenty-first centuries. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1754), 20170274. https://doi.org/10.1098/rstb.2017.0274

Snapp, S., & Pound, B. (2017). *Agricultural systems: Agroecology and rural innovation for development: agroecology and rural innovation for development* (2nd ed). Academic Press.

Snodgrass, A. N. (2012). *The impact of a school garden program on agriculture learning by primary school children in rural Uganda* [Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/26657

Sseguya, H., Mazur, R. E., & Flora, C. B. (2018). Social capital dimensions in household food security interventions: Implications for rural Uganda. *Agriculture and Human Values, 35*(1), 117–129. https://doi.org/10.1007/s10460-017-9805-9

Sseguya, H., Mazur, R. E., Wells, B., & Matsiko, F. (2015). Quality of participation in community groups in Kamuli District, Uganda: Implications for policy and practice. *Community Development*, *46*(1), 14–25. https://doi.org/10.1080/15575330.2014.971036

Sseremba, Y. (2020). Ethnic emancipation and conflict escalation in Uganda. *Third World Quarterly*, *41*(12), 2030–2047. https://doi.org/10.1080/01436597.2020.1803059

Sserunjogi, M., Bern, C. J., Brumm, T. J., & Maier, D. E. (2021). Periodic disturbance time interval for suppression of the maize weevils, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) in stored maize (Zea mays L.). *Journal of Stored Products Research*, *94*, Article 101875. https://doi.org/10.1016/j.jspr.2021.101875

Taku-Forchu, N. (2019). *Linking smallholder farmers to markets: The role of extension in market information for poverty reduction in Fako, Cameroon* [Master's Thesis, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/31514

Taku-Forchu, N., Lambert, M. D., Retallick, M. S., Ulmer, J. D., & Opit, G. P. (2023). Drivers of farmers' adoption of hermetic storage bags in Ghana. *Journal of International Agricultural and Extension Education*, *30*(2), 116-136. https://doi.org/10.4148/2831-5960.1064

Taku-Forchu, N., Qu, S., Lambert, M. D., Retallick, M. S., Ulmer, J. D., & Opit, G. P. (2023). Maize farmers' use, preference, and trustworthiness of information sources and communication channels in Dormaa, Ghana: A gender comparison. *Journal of Applied Communications*, *107*(3), 4. https://doi.org/10.4148/1051-0834.2479

Thompson, P. B. (2017). *The spirit of the soil: Agriculture and environmental ethics*. Routledge.

Tusiime, S. M. (2019). *Current status and prospects of tomato seed production and distribution in Uganda* [Doctoral Dissertation, Iowa State University]. Iowa State University Digital Repository, Theses and Dissertations. https://dr.lib.iastate.edu/handle/20.500.12876/31772

Tusiime, S. M., Nonnecke, G. R., Masinde, D. M., & Jensen, H. H. (2019). Evaluation of horticultural practices for sustainable tomato production in eastern Uganda. *HortScience*, *54*(11), 1934–1940. https://doi.org/10.21273/HORTSCI14277-19

Uganda Bureau of Statistics. (2016). *The National Population and Housing Census 2014—Main report.* https://unstats.un.org/unsd/demographic/sources/census/wphc/Uganda/UGA-2016-05-23.pdf

Uganda Bureau of Statistics (2017). *The National Population and Housing Census 2014—Area specific profile series: Kamuli District.* https://www.kamuli.go.ug/sites/files/KAMULI%20CENSUS%20%20AREA%20SPECIFIC%20%20POPULATION%20PROFILE%202014.pdf

Uganda Bureau of Statistics (2018). *Uganda—Administrative level 5 boundaries*. Humanitarian Data Exchange, United Nations Office for the Coordination of Humanitarian Affairs. https://data.humdata.org/dataset?q=Uganda+-+Admin+Level+5+Boundaries

Uganda Bureau of Statistics & International Classification of Functioning. (2018). *Uganda demographic and health survey 2016*. https://dhsprogram.com/pubs/pdf/FR333/FR333.pdf

United Nations. (2015). *Take action for the Sustainable Development Goals.* https://www.un.org/sustainabledevelopment/sustainable-development-goals/.

United Nations Environment Programme. (2012). *Avoiding future famines: Strengthening the ecological foundation of food security through sustainable food systems—A UNEP synthesis report*. https://www.unep.org/resources/report/avoiding-future-famines-strengthening-ecological-foundation-food-security-through

Victora, C. G., Christian, P., Vidaletti, L. P., Gatica-Domínguez, G., Menon, P., & Black, R. E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries: Variable progress towards an unfinished agenda. *The Lancet*, *397*(10282), 1388-1399. https://doi.org/10.1016/S0140-6736(21)00394-9

von Braun, J., & Torero, M (2009) *Implementing physical and virtual food reserves to protect the poor and prevent market failure* (IFPRI Policy Brief No. 10). International Food Policy Research Institute. https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/23801/filename/23802.pdf

von Grebmer, K., Bernstein, J., Wiemers, M., Schiffer, T., Hanano, A., Towey, O., Chéilleachair, N. R., Foley, C., Gitter, S., Larocque, G., & Fritschel, H. (2022). *2022 Global Hunger Index: Food systems transformation and local governance*. Welthungerhilfe, Concern Worldwide. https://www.globalhungerindex.org/pdf/en/2022.pdf

Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Kipkemoi, J. N. (2021a). Climate-smart agriculture and potato production in Kenya: Review of the determinants of practice. *Climate and Development*, *14*(1), 75–90. https://doi.org/10.1080/17565529.2021.1885336

Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Kipkemoi, N. J. (2021b). Communicating climate change adaptation strategies: Climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya. *Heliyon*, *7*(8), e07873. https://doi.org/10.1016/j.heliyon.2021.e07873

Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Ng'eno, J. K. (2021). Understanding the socioeconomic determinants of adoption of climate-smart agricultural practices among smallholder potato farmers in Gilgil Sub-County, Kenya. *Discover Sustainability*, *2*, Article 41. https://doi.org/10.1007/s43621-021-00050-x

Walugembe, M., Nadiope, G., Stock, J. D., Stalder, K. J., Pezo, D., & Rothschild, M. F. (2014). Prediction of live body weight using various body measurements in Ugandan village pigs. *Livestock Research for Rural Development, 26*(5), Article 96. https://www.lrrd.cipav.org.co/lrrd26/5/walu26096.htm

Webb, P. (2010). Medium-to long-run implications of high food prices for global nutrition. *The Journal of Nutrition*, *140*(1), 143S–147S. https://doi.org/10.3945/jn.109.110536

William, M. (2020). Symbolic post-conflict recovery in the Rwenzori sub-region of Uganda. *Journal of Asian and African Studies*, *55*(5), 699–715. https://doi.org/10.1177/0021909619888766

Winham, D. M., Masinde, D., Byaruhanga, L., Nonnecke, G., & Rothschild, M. (2016). Improving accessibility and quality of nutrition and health care in Kamuli district, Uganda. *The FASEB Journal*, *30*(Suppl. 1), 674.27. https://faseb.onlinelibrary.wiley.com/doi/abs/10.1096/fasebj.30.1_supplement.674.27

Wokibula, A. R., & Westgate, E. M. (2016, November 6–9). *Green manure intercropping systems to boost maize yields: A case study in Kamuli district, Uganda* (Poster presentation). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America 2016 Meeting: Resilience Emerging from Scarcity and Abundance, Phoenix, AZ, United States. https://scisoc.confex.com/scisoc/2016am/webprogram/Paper100198.html

World Food Programme. (2009). *Comprehensive Food Security & Vulnerability Analysis guidelines—First edition, 2009*. https://www.wfp.org/publications/comprehensive-food-security-and-vulnerability-analysis-cfsva-guidelines-first-edition

World Health Organization [WHO]. (1995). *Physical status: The use of and interpretation of anthropometry* (WHO Technical Report Series No. 854). https://iris.who.int/bitstream/handle/10665/37003/WHO_TRS_854.pdf

WHO. (2003). *Diet, nutrition and the prevention of chronic diseases: Report of a joint WHO/FAO expert consultation* (WHO Technical Report Series No. 916). http://health.euroafrica.org/books/dietnutritionwho.pdf

WHO. (2021). *WHO antenatal care recommendations for a positive pregnancy experience. Nutritional interventions update: zinc supplements during pregnancy*. https://www.ncbi.nlm.nih.gov/books/NBK573177/pdf/Bookshelf_NBK573177.pdf

WHO. (2023). *Trends in maternal mortality 2000 to 2020: Estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division*. https://iris.who.int/bitstream/handle/10665/366225/9789240068759-eng.pdf

Appendices

Appendix A. Reflective Essay

This article on food security was extracted from the first author's (Samuel Ikendi) masters' thesis research conducted in Kamuli district, Uganda, where the Center for Sustainable Rural Livelihoods (CSRL) implements livelihood education programs (LEPs) to end hunger. Conducting this study involved trials and tribulations owing to my positionality. I am a native of Kamuli, and I was a graduate research assistant with the CSRL engaged in monitoring and evaluating the LEPs from 2017 to 2022. I do appreciate my fears of interviewing my community people which could result in providing predetermined responses for social desirability that could result in biased responses. For this reason, we recruited and trained a team of research assistants who were conversant with the native language and data-collection procedures and who possessed valid National Institutes of Health certificates. The community-based NEC trainers guided us to our target households in the respective communities.

The whole research process followed principles prescribed in the IRB approval and guidance from the program of study committee. The committee was composed of four advisors, who are co-authors of this article and are accomplished researchers, constantly engaged in international research and development. The second co-author, Francis Owusu, doubled as my major advisor and guided the writing to avoid bias in the article; he has no direct connection with the program. The third co-author, Dorothy Masinde, was familiar with the research area and has worked in Uganda since 2003 with the program. The fourth and fifth co-authors are accomplished social scientists and international researchers who have written extensively about East Africa. The idea of reflecting on my positionality shaped my conduct, as reflection was very influential in presenting the findings while controlling for my preconceived perceptions.

Appendix B.

Table B1. Linear Regression Testing for Multicollinearity of the Study Variables

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.417[a]	0.174	0.155	0.584

ANOVA[a]

Model		S. Squares	df	Mean Square	F	Sig.
1	Regression	31.752	10	3.175	9.310	.000[b]
	Residual	151.085	443	.341		
	Total	182.837	453			

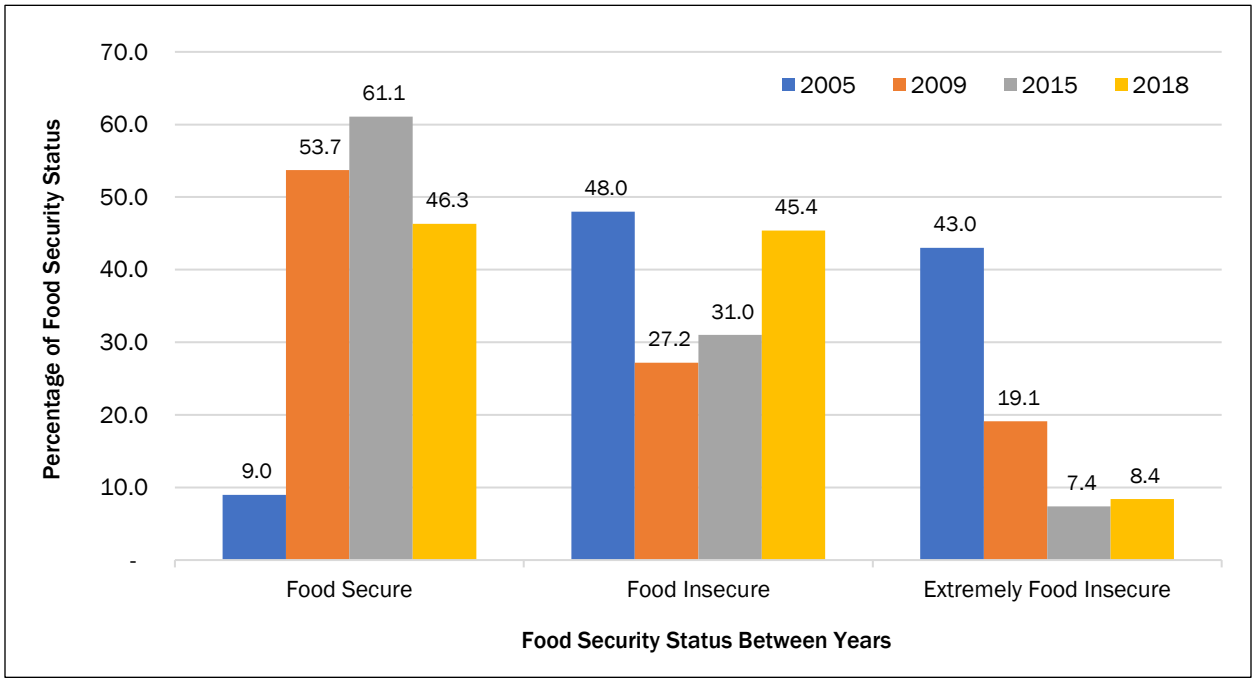
Coefficients[a]

	Unstd Coeff.		Std Coeff.	t	Sig.	95% C.I for B		Collinearity Statistics	
Model Variables	B	SE	Beta			LB	UB	TV	VIF
(Constant)	2.76	.14		20.448	.000	2.49	3.04		
Participation in LEPs	−0.11	0.06	−0.08	−1.751	0.081	−0.23	0.01	0.968	1.033
Age of household head	0.07	0.06	0.05	1.121	0.263	−0.05	0.19	0.943	1.061
Education of household head	−0.02	0.06	−0.01	−0.267	0.790	−0.13	0.10	0.971	1.03
Land ownership in acreage	−0.12	0.06	−0.09	−1.924	0.055	−0.23	0.02	0.898	1.114
Household keep livestock	−0.20	0.07	−0.13	−2.849	0.005	−0.34	−0.06	0.949	1.053
Time to collect water for round trip	−0.15	0.06	−0.11	−2.589	0.010	−0.26	−0.04	0.978	1.022
WASH facilities condition	−0.13	0.06	−0.10	−2.277	0.023	−0.24	−0.02	0.938	1.066
Days of illness of most adult male	−0.33	0.08	−0.18	−4.082	0.000	−0.49	−0.17	0.966	1.036
Number of meals eaten in scarcity	−0.41	0.30	−0.19	−4.338	0.000	−0.60	−0.23	0.954	1.048
Membership to burial/ festivals	−0.15	0.06	−0.12	−2.571	0.010	−0.26	−0.04	0.931	1.074

a. Dependent Variable: Food Security Status
Unstd Coeff.: Unstandardized Coefficients.

Appendix C.

Figure C1. Food Security Statuses in Center for Sustainable Rural Livelihoods Operational Areas in Kamuli, Uganda, Since 2004/2005–2018/2019



Sources: Sseguya et al. (2018) – 2004/2005 & 2008/2009 under CSRL/VEDCO; and Ikendi (2019) – 2015/2016 & 2018/2019 under CSRL/ISU-UP partnership.

Appendix D.

Table D1. Percentage Frequency of Occurrence of Food Insecurity Situation, Baseline in 2015 and Endline in 2018 in Center for Sustainable Rural Livelihoods Operational Areas, Kamuli, Uganda

Household Food Insecurity Access Scale for Developing Countries to Determine Food Access	Percentage Frequency of Occurrence							
	None		Rarely		Sometimes		Often	
	2015	2018	2015	2018	2015	2018	2015	2018
1. Did you worry that your household would not have enough food?	36.2	28.9	25.2	16.3	30.6	46.7	8.1	8.1
2. Were you or any household member not able to eat the kinds of foods you preferred?	27.6	17.6	27.2	24.7	34.6	45.6	10.6	12.1
3. Did you or any household member have to eat a limited variety of foods?	29.4	26.0	25.8	22.2	34.2	40.3	10.6	11.5
4. Did you or any household member have to eat some foods that you really did not want to eat?	27.6	18.5	25.8	22.9	37.8	49.3	8.8	9.3
5. Did you or any household member have to eat a smaller meal than you felt you needed?	43.4	33.9	21.3	17.2	29.7	39.2	7.6	9.7
6. Did you or any other household member have to eat fewer meals in a day?	42.7	37.4	22.5	16.1	27.2	38.3	7.6	8.1
7. Was there ever no food to eat of any kind in your household?	64.7	58.8	13.3	11.0	17.5	24.2	4.5	5.9
8. Did you or any household member go to sleep at night hungry because there was not enough food?	65.8	74.7	18.0	10.1	14.4	12.6	1.8	2.6
9. Did you or any household member go a whole day and night without eating anything because there was not enough food?	75.5	83.0	12.4	7.5	11.5	7.0	0.7	2.4

* The frequency of Occurrence codes: None = No occurrence; Rarely = Once or twice in the past four weeks; Sometimes = Three to 10 times in the past four weeks; and Often = More than 10 times in the past four weeks before the survey (Coates et al., 2007, p. 4).