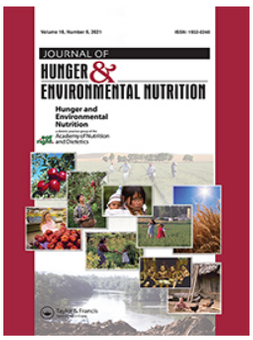

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Agricultural Production, Traditional Foods and Household Food Insecurity in Rural Kenya: Practice, Perception and Predictors

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ABSTRACT

Although rural households in Kenya rely on agricultural production for their livelihood, attaining food security is challenging in areas experiencing harsh agro-ecological conditions. We utilized mixed methods research to examine the effect of agricultural production, including that of traditional foods, on household food insecurity in Seme sub-County of Kenya. Study participants believed that traditional foods protected against hunger. However, production of these foods, with the exception of traditional vegetables, was low. Poultry-keeping; cereal/grain, any vegetable and traditional vegetable production; and crop diversity were significantly associated with lower household food insecurity. Vegetable production maintained statistical significance after controlling for other variables.

KEYWORDS

Household food insecurity; agricultural production; traditional foods; vegetable production; mixed-methods; focus group discussion; key-informant interviews; Kenya

Introduction

Although national estimates show that household food insecurity and global hunger rates have decreased in Kenya over the last ten years, they remain at levels of public health significance. The Global Hunger Index ranking was shown to be at a serious level for the 2012–2016 period, and it is estimated that 26.6% of the Kenyan population was food insecure in 2017, with a food gap of 271 kcal per day.[1,2] Despite concerns over the impact of climate change and political instability in Kenya, it is projected that food insecurity will significantly decrease in the next decade. However, tangible efforts are needed to make the projection a reality. Food and nutrition security exists when all people at all times have physical, social and economic access to food, consumed in sufficient quantity and quality to meet their dietary needs, requirements for growth, and food preferences; such security is supported by an environment of adequate sanitation, health services and caregiving.[3]

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About 75% of Kenyans derive all or part of their livelihoods from agriculture, which accounts for 18% of the gross domestic product (GDP).[4] Despite making up the backbone of the agricultural sector in Kenya, rural and small holder farmers suffer relatively high rates of food insecurity. A national survey identified 18% of rural smallholder farmers as being food poor, while studies in smaller communities have reported food insecurity prevalence as high as 74% across communities and seasons.[5–7] The problem of food insecurity in Kenya is linked to declining agricultural production in the country. Kenya has not achieved national food self-sufficiency over the last four decades partly due to an over reliance on rain fed agriculture, climate change, and fast human population growth amongst other factors including economic, agronomic, political, socio-cultural, and health factors.[8,9] Increased landownership, having a male household head, having at least secondary school education, participation in salaried employment, participation in output market, use of fertilizer, use of improved seeds, social support, crop diversity and increased maize yields have been associated with improved household food security among different rural communities in Kenya.[6,7,10,11]

Agricultural investment in Kenya has prioritized commercially-high value crops such as maize and dry common beans over traditional foods such as sorghum, millet, cassava, cowpeas and green grams. Maize and dry common beans are most preferred in Kenya.[12–19] However, such high value crops are less drought-resistant compared to traditional crops such as sorghum, millet, cowpeas and green grams.[14,19–22] Investment in the production of traditional foods is still in its infancy and little is known about their effect on household food security in Kenya.[4,8,17,23]

Attaining food security is especially difficult for individuals living in areas of harsh agro-ecological conditions such as those in Seme sub-County, a rural sub-county located along the shores of Lake Victoria in Kenya. The study area's marginal suitability to rain-fed agriculture, coupled with poor, sandy soils, limits the types of crops that can be produced without requiring high levels of investment, such as irrigation and commercial fertilizer. Only 17.6% of children 6–23 months old in Seme sub-County consume meals at the recommended minimum frequency, and food insecurity is a hindrance to recommended breastfeeding practices.[24,25] Seme sub-County's agricultural zones are classified as semi-humid to semi-arid, and traditional foods have the potential to reduce hunger and food insecurity.[26] Indigenous and traditional foods are foods that are native to a region or have been historically produced in a region.[13] For Seme sub-County these include sorghum, millet, cassava, cowpeas, green grams, and certain dark-green leafy vegetables such as amaranth, spider plant, African nightshade, cowpea leaves and jute mallow amongst others.[27,28] These foods are referred to as "traditional foods" in this manuscript. There is an increasing interest in the role of traditional foods in supporting food security in Kenya. The Kenya National Food and Nutrition

Security Policy Implementation Framework 2017–2022 recognizes the role of traditional high value crops in increasing diversified and affordable food production in Kenya.[8] We utilized mixed methods research to examine the effect of agricultural production including that of traditional foods on household food security in Seme sub-County of Kenya. The study examines the challenges to food security in Seme sub-County as emblematic of other similarly challenged locales and could help in defining sustainable strategies aimed at improving food and nutrition security in the area.

Materials and Methods

Study Area

Seme sub-County is a rural sub-county located along the shores of Lake Victoria in Kenya with a projected population of 124,872 in 2018.[29] Seme is one of the sub-counties in Kisumu County. Over 60% of households in Kisumu County depend on crop farming as a source of income with much of the agricultural activity practiced on small parcels of land that are approximately the size of 1 acre.[29,30] Higher temperatures, soil degradation, drying of water wells and rivers and reduced water volumes are some of the agricultural challenges reported in Seme.[31] Approximately 61% of the county's population is food poor and only 44% of young children receive a minimum acceptable diet according to WHO/UNICEF standards.[29] More than 80% of the children in Kisumu County consume a diet deficient of iron rich foods. About 18% of children less than five years old in Kisumu County are stunted, 6.6% are underweight and less than 1% are wasted.[32] We expect higher prevalence of malnutrition in Seme because of its rural location.

Study Design

A longitudinal study design was used to assess household food security status and agricultural production across two seasons (non-harvest and harvest seasons) within the year. The non-harvest season data was collected during the months of January and February 2017. Unlike previous years when short rains fell in the months of September and October, the short rains failed in 2016, leading to a lack of crop harvests in the following months, hence the term "non-harvest." The harvest season data was collected during the months of June and July 2017, following the year's long rainy season (March-May). Study inclusion criteria included reproductive age, non-pregnant mothers with singleton young children (1–3 yrs old) and with at least 2-year residency in the study area. Community Health Workers (CHWs) in the study area keep up-to-date records on the number of mothers with children less than five years old who reside within the area and were trained to recruit mothers-child pairs

into the study. All mothers who met the study's criteria and resided within West Othany and North Ratta administrative locations of Seme sub-County were approached by trained CHWs and requested to participate in the study. North Ratta is categorized as a semi-humid agro-ecological zone, while West Othany is semi-arid. CHWs approached a total of 220 mothers, and data was collected on 191 mother-child pairs during the non-harvest season (87% participation rate) and 182 mother-child pairs in the harvest season (83% participation rate). A total of 168 mother-child pairs participated in both seasons (76% participation rate). Six enumerators consisting of nutritionists and graduate nutrition students were trained to administer informed consent and study questionnaires. Study participants' informed written consent was obtained prior to administering any questionnaires. CHWs guided enumerators to participants' homes. Because CHWs work with mothers on a more regular basis, they were asked not to be present during the interviews to eliminate any potential participant bias. Ethical approval for the study was obtained from the Office of Research Subject Protections at George Mason University (#929857-3) and the Maseno University Ethics Review Committee (#MSU/DRPI/MUERC/00317/16).

Assessment of Household Food Security

The Household Food Insecurity Access Scale (HFIAS), a tool developed by the Food and Nutrition Technical Assistance (FANTA) project, was utilized to assess household food insecurity status with mothers as the primary respondents.[33] The HFIAS directly assesses households' lived experiences and has been shown to be positively associated with common proxies of household food security such as household wealth, income and assets, maternal education, dietary adequacy and diversity, and child nutritional status.[34] The HFIAS consists of nine occurrence questions that assess whether certain food-related conditions occurred in the past four weeks (yes = 1, no = 0) (Supplemental Table S1). Each occurrence question is followed by a frequency-of-occurrence question to assess how often the condition occurred (no = 0, rarely = 1, sometimes = 2, often = 3). An overall HFIAS score is developed by summing across all frequency-of-occurrence scores with a possible maximum score of 27 per household. The higher the HFIAS score, the more food insecurity the household experienced, and vice-versa.[33] The HFIAS has been shown to be valid and reliable in measuring household food insecurity in poor households in rural Africa.[34,35] Prevalence of household food insecurity was calculated using the formula provided in the HFIAS document.[33] The formula takes severity and frequency of food insecurity experiences into account and categorizes households into four levels: food secure household, mildly food insecure households, moderately food insecure households and severely food insecure households (Fig. 1). Households are

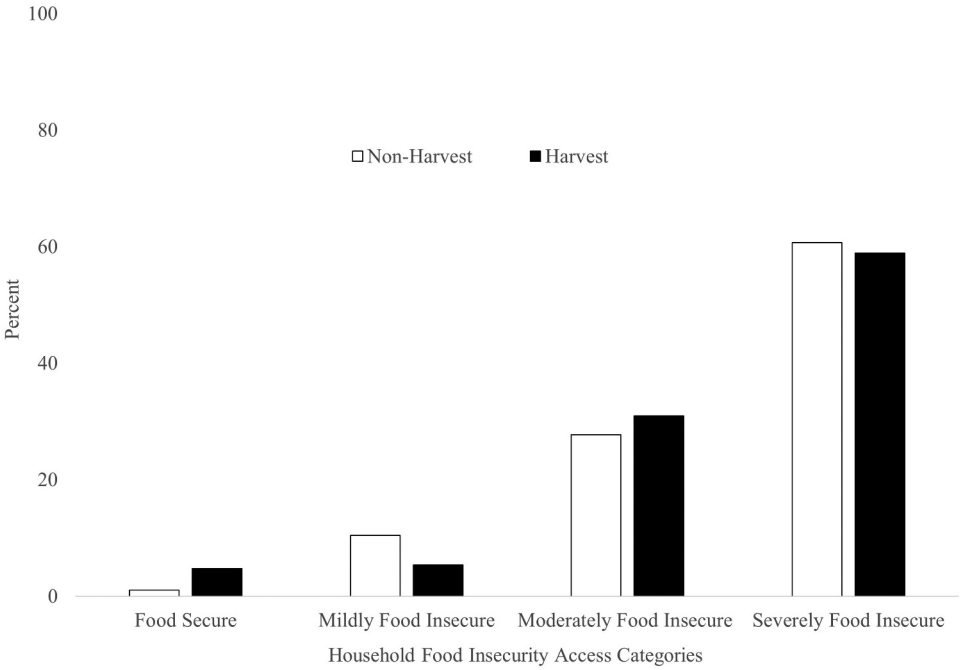

Figure 1. Household food insecurity access prevalence in the non-harvest and harvest seasons in seme sub-county1. 1 n = 191 in non-harvest season; n = 168 in harvest season

identified as increasingly food insecure as they experience more severe conditions or experience less severe conditions more frequently. A food secure household does not experience any food insecurity (access) conditions, or experiences worry, but rarely. A severely food insecure household cuts back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a - whole day and night without eating), at least rarely over the last 4 weeks. Mildly and moderately food insecure households fall in between these two extremes and the details are available in the HFIAS document.[33]

Observation of Agricultural Production

Enumerators conducted an observation of study participants' homes and farms and recorded types of cultivated crops, farm animals, and poultry owned by the households during the non-harvest and harvest seasons. Types of crops and animals observed are included in Table 1. Cereals & grains consisted of maize, millet, and sorghum. Starchy foods and tubers consisted of cooking bananas, sweet potatoes, arrowroots, yams and cassava. Legumes, nuts and seeds consisted of common beans, soybeans, groundnuts and green grams. Vegetables consisted of collard greens, tomatoes, onions, eggplants, cowpeas, slender leaf (crotalaria spp), jute mallow, pumpkins, spider plant,

Table 1. Types of crops cultivated and farm animals owned by study households.

Crop/animal	Types of crops and animals observed	Traditional foods
Cereals & grains	Maize, millet & sorghum	Millet & sorghum
Starchy foods and tubers	Cooking bananas, sweet potatoes, arrowroots, yams and cassava	Cassava
Legumes, nuts and seeds	Common beans, soybeans, groundnuts, green grams & cowpeas seeds	Groundnuts & green grams
Vegetables	Collard greens, tomatoes, onions, eggplants, cowpeas, slender leaf (crotalaria spp), jute mallow, pumpkins, spider plant, African nightshade & amaranth.	Cowpeas, slender leaf (crotalaria spp), jute mallow, pumpkins, spider plant, African nightshade & amaranth.
Fruits	Avocado, mangoes, papaya, passion fruits, oranges, apples, guavas, jackfruit, jamun tree (Java plum), lemons, loquats, pineapples, watermelons & white supote (*Casimora edulis*).	
Farm animals	Cattle, goats, sheep, rabbits and donkeys. Poultry included chickens, ducks, guinea fowls and doves	

African nightshade and amaranth. Fruits group consisted of avocado, mangoes, papaya, passion fruits, oranges, apples, guavas, jackfruit, jamun tree (Java plum), lemons, loquats, pineapples, watermelons, white supote (*Casimora edulis*). Millet, sorghum, cassava, groundnuts, green grams, cowpeas, slender leaf (crotalaria spp), jute mallow, pumpkins, spider plant, African nightshade and amaranth were identified as the study area's traditional foods. Farm animals and poultry included cattle, goats, sheep, rabbits, donkeys, chickens, ducks, guinea fowls and doves. A score of 1/0 (yes/no) was entered for observed crops, farm animals and poultry. All-crop, traditional food crops and animal-poultry diversity scores were calculated by summing up the scores for each type of crop, traditional food crops and animals/poultry, respectively.

Focus Group Discussions and Key-informant Interviews

Participants' understandings and perceptions of food security and the roles of traditional foods in Seme sub-County were probed using a mix of qualitative research methods including focus group discussions (FGDs) and key-informant interviews (KIIs). Study participants were purposively selected to allow for a range of perspectives and responses for each qualitative method. A total of 5 FGDs were conducted with young children's mothers to explore their perspectives on occurrence and determinants of food insecurity, and the role of traditional foods in the study area. Each FGD consisted of 7–9 participants. A total of five KIIs were conducted with government and non-government representatives within the agriculture, health and development sectors in Seme sub-County. Four of the five KII informants were male. The FGDs and KIIs were conducted by the first author. All FGD and KII proceedings were recorded using digital voice recorders.

All questionnaires and FGD questions were prepared in English and then translated into the local language, *Dholuo*. All questionnaires were pretested and modified before data collection commenced. Interviews and discussions were conducted in the local language.

Data Collection on Household Demographics and Socioeconomic Status

Information on household demographics and socioeconomic status (SES) was collected once at the beginning of the study. Household members' date of birth, marital status, religion, tribe, sex, number of completed school years, and income earning status were recorded. Household size, maternal education level, and maternal age were defined from demographic data. The SES questionnaire, which has been used among populations in rural Kenya, accounted for land use, animal ownership, income sources, household expenditures, household possessions, types of houses, types of fuel used in the household, parental literacy, and involvement of parents in leadership and community positions.[36,37] Different weightings were assigned to household possessions depending on their value. A composite SES score was then developed whereby a higher score represents a higher level of SES.

Data Analysis

Quantitative data analysis was performed using SAS version 9.4 (SAS Institute). Descriptive statistics were used to summarize each household's food security scores, household food security categories as well as traditional foods production, and socio-economic and demographic variables. Chi-square statistics were used to compare prevalence across seasons and paired t-tests were used to compare means across seasons. To account for the study's longitudinal design, mixed models with a compound symmetry (CS) covariance matrix structure were used to estimate the association between independent variables and HFIAS scores. *Proc mixed* was utilized to assess the association between independent variables and HFIAS scores. Bivariate analysis was conducted using *proc mixed* to estimate the association between socio-economic and demographic variables, and HFIAS score. Socio-economic and demographic variables that showed statistical significance were all included in the multivariate regression models. Season, location, household size, livestock and poultry production indicators were included in the multivariate regression models irrespective of statistical significance. The first multivariate model (Model MMI) included mother's age, mother's number of school years, mother's marital status, proportion of household members who earned, household SES and size, season, location, animal and poultry production indicators and crop production indicators. The second multivariate model (model MMII) included mother's age, mother's number of school

years, mother's marital status, proportion of household members who earned, household SES and size, season, location, animal and poultry production indicators and traditional crop production indicators. Results from multivariate regression models showed the effect of each independent variable on HFIAS score while controlling for other variables in the model. We tested for presence of interactions between each of the independent variables in model II and SES score. None of the interactions predicted HFIAS scores and were dropped from the analysis. Finally we assessed the relationship between each agricultural production diversity score (all-crop, traditional foods, animal-poultry) and HFIAS scores while controlling for mother's age, mother's number of school years, mother's marital status, proportion of household members who earned, household SES and size, season, and location. *Proc mixed* model fit was assessed using −2 Log Likelihood and AIC, AICC and BIC statistics.

Focus group discussions and KII recordings were translated into English by the first author and an independent consultant, both of whom discussed any differences until an agreement was reached. The translated recordings were independently transcribed verbatim and coded by three graduate student researchers using NVivo software (QSR International Pty Ltd, Melbourne, Australia). The coded variables represented themes, which were inductively identified, labeled, categorized, and linked as they reoccurred in the data. Data collection continued until theoretical saturation occurred. The codes were compared and discussed by the research assistants and agreements were reached. Furthermore, we conducted validity checks via three community feedback meetings. The meetings were attended by 53 people, seventy-five percent of whom had participated in the study. The remaining attendees included local community leaders and representatives (agriculture, health, religious, gender and youth, local administration).

Results

The average HFIAS score was significantly lower in the harvest season compared to the non-harvest season (10.87 ± 5.31 versus 9.41 ± 4.88, *p-value* = 0.0074). However, there were no significant differences in household food insecurity prevalence across the two seasons (Fig. 1).

The average household size in Seme sub-County was below six (Table 2). A majority of the household heads were male, married and earned an income. Household heads had spent an average of 7.70 years in school. A majority of the mothers were married. Mothers reported a mean of 8 years of education with most mothers having primary school level education. Most of the mothers were married and about 60% of them earned an income at the time of the study. Fathers had a mean of 8 years of education with most fathers having primary school level of education. Over 90% of the fathers earned an

Table 2. Household demographic and socio-economic characteristics[1,2].

Characteristic	n	%	Mean	SD
Mothers:				
Mothers' age, years	191		27.58	6.30
Mothers' number of school years	186		7.97	2.21
Mothers' education level:				
None		2.69		
Primary school		77.42		
Secondary school		18.82		
Post-secondary		1.08		
Mother Married	189	84.13		
Mother Earns Income	189	58.20		
Fathers:				
Fathers' age, years	93		35.44	8.80
Fathers' number of school years	155		7.82	2.69
Fathers' education level:				
None		6.45		
Primary school		80.00		
Secondary school		10.32		
Post-secondary		3.23		
Father Earns Income	156	91.14		
Household:				
Head of household age, years	109		35.69	9.62
Head of household number of school years	183		7.66	2.99
Head of households' education level:				
None		8.74		
Primary school		77.60		
Secondary school		9.29		
Post-secondary		4.37		
Household Head Earns Income	188	89.89		
Household Head Married	188	89.89		
Female Household Head	189	11.64		
Proportion of household members earned income	187		0.30	0.14
Household size	190		5.71	1.95
Family owns home	191	90.05		
Household SES score	191		54.02	13.97
Location: West Othany	191	45.03		
Location: North Ratta	191	54.97		

[1]Demographic and socio-economic data collected during non-harvest season
[2]Percent provided for categorical variables and Mean (SD) provided for continous variables

income at the time of the study. No significant differences were noted in the socio-economic and demographic characteristics of households that participated in the study in non-harvest and harvest seasons. As expected, food production was higher in the harvest season (Fig. 2). The percentage of households engaged in producing traditional cereals & grains; legumes, nuts & seeds; and tubers/starchy foods was lower than those that produced the non-traditional counterparts with the largest difference in cereals and grain production. Only 5% of households produced traditional cereals and grains compared to the 49% that produced non-traditional cereals and grains in the non-harvest season. Only 39% of households produced traditional cereals/grains compared to the 79% that produced non-traditional counterparts in the harvest season. On the other hand, a larger percentage of households produced traditional vegetables compared to non-traditional vegetables. Over 25% of households produced traditional vegetables compared to the 9% that produced non-traditional vegetables in the non-harvest season, and 51% of households

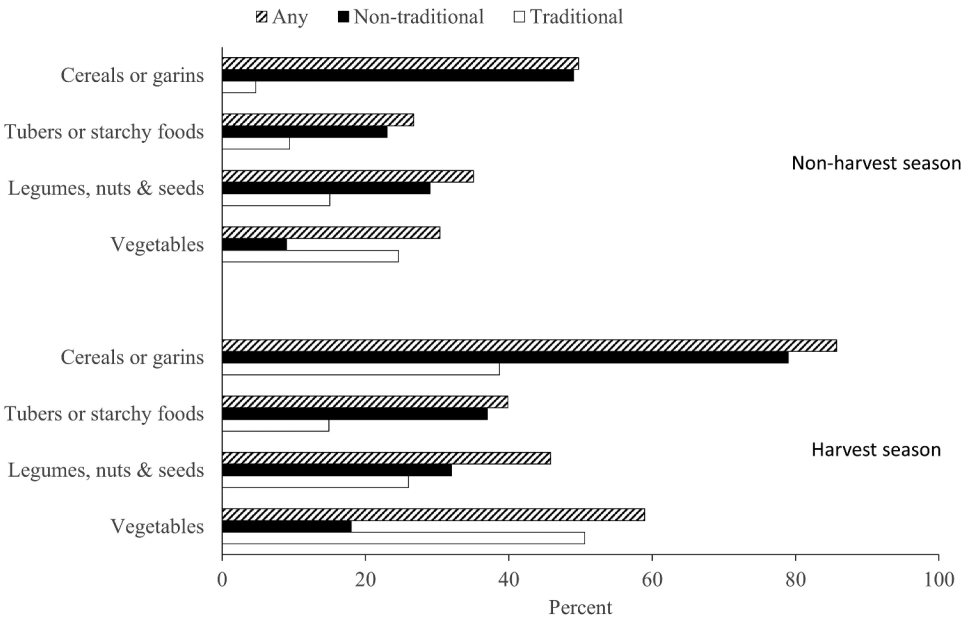

Figure 2. Percent of households engaged in crop production during non-harvest and harvest seasons1.

produced traditional vegetables compared to the 18% that produced non-traditional vegetables in the harvest season. All-crop diversity was higher in the harvest season compared to the non-harvest season (*3.90 ± 2.42, median = 4 versus 2.14 ± 2.10, median = 2, p-value<0.0001*). Traditional foods diversity was higher in the harvest season compared to the non-harvest season (*1.71 ± 1.59, median = 1 versus 0.69 ± 1.08, median = 0, p-value<0.0001*). Poultry keeping was quite common with 75–77% of households keeping poultry in each season. Chickens made up 97% of the poultry observed. Fifty-eight percent of households kept livestock in each season. Cattle, goats, and sheep made up 50%, 33% and 15% of farm animals observed. There were no differences in the percentages of households engaged in livestock and poultry keeping nor differences in animal-poultry diversity (1.61 ± 1.10, median = 2) across the two seasons. The HFIAS scores were significantly lower in households that produced vegetables compared to those that did not produce vegetables during the harvest season (Table 3). No significant differences were shown in mean HFIAS scores across the remaining agricultural production indicators.

Results from the bivariate analysis showed that season, mother's age, mother's school years, mother's marital status, proportion of household members who earned an income, and household SES score were each significantly associated with HFIAS scores (Table 4). Poultry keeping, production of cereal and grains, any vegetables, and traditional vegetables were

Table 3. Association between household agricultural production and HFIAS scores[1,2].

		Non-Harvest			Harvest		
Agricultural production Indicator	Status	n	Mean	SD	n	Mean	SD
Crop production	Yes	127	10.49	5.27	151	9.40	4.87
	No	64	11.66	5.35	17	9.53	5.11
Livestock keeping	Yes	110	10.27	5.28	99	9.12	4.94
	No	81	11.70	5.27	69	9.83	4.80
Poultry keeping	Yes	144	10.67	5.45	130	9.13	4.85
	No	47	11.53	4.86	38	10.37	4.95
Cereals & grain production	Yes	95	10.84	5.32	144	9.49	4.84
	No	96	10.92	5.32	24	8.96	5.20
Tubers production	Yes	51	11.37	5.41	67	9.01	4.57
	No	140	10.70	5.28	101	9.67	5.09
Legumes, nuts & seeds production	Yes	67	10.84	5.28	77	9.91	4.80
	No	124	10.90	5.35	91	8.99	4.94
Vegetables production	Yes	58	9.91	5.25	99	8.76*	4.65
	No	133	11.30	5.30	69	10.35	5.09
Fruit production	Yes	41	11.17	5.40	37	9.19	4.92
	No	150	10.80	5.30	131	9.47	4.89
Traditional food production	Yes	71	10.30	5.30	124	9.35	4.76
	No	120	11.23	5.30	44	9.59	5.28
Traditional cereals & grains production	Yes	9	10.89	5.33	65	9.08	4.55
	No	182	10.88	5.32	103	9.62	5.09
Traditional tubers production	Yes	18	11.50	5.78	25	9.12	5.29
	No	173	10.82	5.27	143	9.46	4.83
Traditional legumes, nuts & seeds production	Yes	56	10.82	5.02	93	8.95	4.35
	No	135	10.90	5.44	75	9.99	5.45
Traditional vegetables production	Yes	47	10.11	5.23	85	8.86	4.47
	No	144	11.13	5.33	83	9.98	5.24

[1]HFIAS: Household Food Insecurity Access Scale
[2]One sample t-test utilized to compare HFIA scores between producers and non-producers in each season: *$P < 0.05$

each associated with significantly lower HFIAS scores. Poultry keeping was associated with a 1.22-point reduction in the HFIAS score, production of cereal and grains was associated with 1.15-point reduction, and production of vegetables was associated with a 1.80-point reduction in HFIAS. Production of traditional vegetables was associated with a 1.54-point reduction in HFIAS. Poultry keeping, production of cereal and grains, and production of traditional vegetables lost statistical significance when included with other independent variables in the multivariate models (models MMI and MMII). While controlling for other variables, households that produced any vegetables in comparison to those who did not were associated with a 1.25-point reduction in HFIAS scores. Production of any vegetables can be considered protective against household food insecurity. There were no statistically significant associations between the remaining agricultural production indicators included in the regression models and HFIAS scores.

Results from the bivariate analysis showed that all-crop diversity score (*Estimate = −0.22, SE = 0.105, p-value = 0.0359*) and traditional foods diversity score (*Estimate = −0.45, SE = 0.172, p-value = 0.0097*) were each associated with significantly lower HFIAS scores. However, they lost statistical significance when

Table 4. Relationship between socio-economic, demographic and agricultural production variables, and HFIAS score[1,2,3,4].

	Bivariate analysis[2]		Model MMI[3]		Model MMII[4]	
	Estimate	SE	Estimate	SE	Estimate	SE
Harvest season (ref = non-harvest season)	−1.47***	0.406	−1.15*	0.483	−1.38**	0.482
Mothers:						
Mothers' age, years	0.24****	0.048	0.18**	0.055	0.18**	0.055
Mothers' number of school years	−0.31*	0.147	0.06	0.150	0.039	0.156
Mother married (ref = not married)	1.99*	0.888	2.07*	0.923	2.09*	0.921
Household:						
Proportion of household members earned income	−7.84***	2.326	−5.42#	2.831	−5.07#	2.828
Household SES score	−0.08***	0.023	−0.06*	0.026	−0.06*	0.026
Household size	0.29	0.164	0.10	0.205	0.08	0.207
West Othany sub-location (ref = North Ratta)	−0.49	0.646	0.86	0.706	0.77	0.614
Agricultural production:						
Livestock keeping, yes (ref = no)	−0.70	0.545	0.14	0.551	0.11	0.551
Poultry keeping, yes (ref = no)	−1.22*	0.608	−0.85	0.624	−0.98	0.613
Cereals & grain production, yes (ref = no)	−1.15*	0.526	−0.59	0.693		
Tubers production, yes (ref = no)	−0.53	0.543	−0.09	0.569		
Legumes, nuts or seeds production, yes (ref = no)	0.19	0.530	0.41	0.600		
Vegetables production, yes (ref = no)	−1.80***		−1.25*	0.539		
Fruit production, yes (ref = no)	0.01	0.619	0.11	0.639		
Traditional cereals/grains production, yes (ref = no)	−1.40#	0.586			−0.20	0.673
Traditional tubers production, yes (ref = no)	0.06	0.797			0.77	0.779
Traditional legumes, nuts or seeds production, yes (ref = no)	−0.90	0.625			−0.23	0.638
Traditional vegetables production, yes (ref = no)	−1.54**	0.511			−0.96#	0.548

[1]HFIAS: household food insecurity access scale; SES: socio-economic status

[2]Bivariate analysis column shows the association between individual independent variable and household food insecurity access score

[3]Model MMI is a multivariate model that includes season, location, mother's age, mother's school years, mother's marital status, household size, proportion of household members earn income, household SES score, livestock keeping indicator, poultry keeping indicator and crop production indicators.

[4]Model MMII is a multivariate model that includes season, location, mother's age, mother's school years, mother's marital status, household size, proportion of household members earn income, household SES score, livestock keeping indicator, poultry keeping indicator and traditional crop production indicators.

#$P < 0.10$, *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.0001$

included with other independent variables in multivariate models (*Estimate = −0.11, SE = 0.122, p-value = 0.3685 for all-crop diversity score; and Estimate = −0.21, SE = 0.185, p-value = 0.2584 for traditional foods diversity score*).

All FGD participants and key-informants overwhelmingly agreed that Seme sub-County is an area of high food insecurity. Key-informants estimated that between 40 and 90% of households in the county are food insecure depending on the season and location within the study area. Food insecurity was perceived to be higher in semi-arid agro-ecological zones in the county compared to semi-humid zones. According to study participants, high levels of hunger were experienced six months in the year, with only three months identified as periods of low hunger levels in the year (Table 5). According to key-informants, consequences of food insecurity in the sub-county include reliance on more expensive foods from outside the sub-county, higher rates of school absenteeism, deteriorating health status evidenced by higher frequency of fainting incidences

Table 5. Perceived occurrence and levels of food insecurity as reported by focus group discussion participants.

Month	Perceived levels of food insecurity	General Conditions
January	High	Dry and hot. Short-rain maize harvests may still be available. Vegetables generally lacking. School-related expenses.
February	High	Dry and hot. Short rain maize harvests may still be available. Vegetable are lacking
March	High	Land preparation begins. Some individuals have started planting. Short-rain maize harvests not available, maize flour lacking. Might find some vegetables.
April	High	Long rains begin. Some individuals have planted. Maize flour lacking. Might find some vegetables.
May	High	Green beans available for early planters. Maize flour lacking. Some vegetables are available.
June	Medium	Maize flour lacking. Green maize may be available. More vegetables are available. Start harvesting beans.
July	Low	Long rain harvests continue. Green maize available.
August	Low	Long rain harvests continue. Dry maize available, maize flour available.
September	Low	Long rain harvests available
October	Medium	Some long rain harvest still available for some households. Food stocks low for some households.
November	High	Short rains begin. Long rain harvests not available.
December	Medium	Dry and hot. Short rain harvests begin. Some beans and vegetables available.

among school children, increased incidences of stealing within the community, and elderly community members actively seeking assistance from the local administration.

Hunger coping strategies included the sale of products such as firewood, the provision of manual labor to earn some money, seeking food credit from local traders, and dietary modifications. Diet-related modifications included the reduction of portion sizes and the reduction of eating frequency, including skipping meals. Most FGD participants reported that they made efforts to protect young children from hunger. Such protective efforts were not extended to adults.

> *"Adults can go without food because they can recover but the children, you have to try even if it is only a small amount of food. Sometimes, you deny yourself as the mother as long as the children get something to eat, even if it is small".*

FGD participants noted that they did not have any social support systems beyond their immediate families that could help them survive the lean seasons. Close relatives such as individual's mothers and sisters helped through money transfers and some food aid. Most mothers did not feel comfortable approaching individuals outside their immediate family circles for assistance.

> *"A relative is better. Sometimes you tell your neighbor and the neighbor can share this information with somebody else and so word starts spreading in the village. They sometimes twist and add their own details. That is my problem with neighbors".*

Key-informants and FGD participants overwhelmingly agreed that although a variety of foods could be produced in Seme sub-County, households were not producing adequate amounts of food. Study participants noted that long-rain harvests last 2–3 months and the short-rain harvests last for about one month. Study participants identified a number of factors that they perceived influenced crop production and contributed to food insecurity in the study area as discussed below.

Small farm sizes: Study participants indicated that most households owned small pieces of land ranging from 0.25 to 0.50 acres, thus limiting the amount of crops that they can produce.

Inadequate and unreliable rainfall: Most of the study participants indicated that their farming activities are fully dependent on rain. In view of this, most noted that rainfall amounts have decreased substantially and become unpredictable over the years. Farmers have resorted to waiting for rains to start before preparing their lands, leading to delayed planting and inadequate harvests. It is important to note that a few households that reside close to Lake Victoria utilize the lake's water to irrigate their vegetable farms.

Poor soils: Focus group participants and some key-informants reported that the sandy and loamy soil found around the lake region is not conducive to crop production. Additionally, study participants indicated that the soil, irrespective of location, has been over-used, is degraded, and does not provide a high yield of crop production. Some of the participants mentioned that this is further exacerbated by deforestation and the lack of trees in the Seme sub-County area.

Limited/lack of access to appropriate farm inputs: Reliance on hand-held hoes to prepare their farms was associated with delayed planting. Additionally, study participants noted that they could not afford or did not have access to improved seeds and fertilizers.

"Farm inputs are not available. Hybrids and improved seeds are not readily available like in other regions. If you go to the shop, they are also expensive. People are struggling with the seeds that they have been having for a long time and they are not properly kept. And the seeds take as long as 5-6 months to mature. In this region it does not rain for 5-6 months. It rains for 1.5 months, for the long rains".

Lack of agricultural extension services: Study participants and key-informants reported that agricultural extension services were generally lacking. The Ministry of Agriculture office had resorted to "demand-driven" extension services due to the limited number of staff members. However, it was revealed that most community members did not understand the demand-driven concept. As reported by one male KII informant:

"The extension policy was changed to demand-driven which entails that it is upon those who are in need of the extension officers to invite the officers and tell them their problem. This policy has not gone well to the residents. They do not understand that if they have a problem, they can be in a group and invite the expert to advise them on what to do. That

is why you may find that within agriculture or forest or other government departments, the officers who are supposed to assist the residents are just seated in the offices waiting for people to call them. And you may find that as an agricultural officer within a period of 12 months, only three groups or one or none has come for your help".

It was also reported that the area's local administrator occasionally invited extension officers to advise area residents at public meetings, locally known as *barazas*. However, most *baraza* attendees were elderly individuals who were neither engaged in farming nor capable of implementing the lesson content shared at the meetings.

Crop damage by livestock and wild animals: Study participants reported that they lost crops to free-roaming livestock and sometimes to wild monkeys. It was noted that although there is a policy to prevent such destruction, most farmers were not aware of the policy or did not want to report crop damage incidences to the local government officers for fear of upsetting their neighbors and relatives. Additionally, some study participants reported that government officers were not responsive to farmers' complaints even if they were reported.

Over-reliance on few foods: FGD participants and key-informants reported that households relied heavily on planting maize and beans despite poor yields, especially in the semi-arid ecological zones.

"We just plant beans but it does not do well. You harvest very little yet you sowed a large area and a lot of seed. You just try because it is raining. It does well only if there is enough rain. Maize is similar to beans".

Traditional foods such as sorghum and cassava were less preferred (Table 6). Such an attitude did not seem to extend toward dark-green leafy vegetables, green grams, cowpeas and groundnuts. FGD participants noted that sorghum, cowpeas, groundnuts and traditional DGLVs performed better in the drier / low rainfall parts of the study area when compared to contemporary crops, maize, beans and collard greens. Mothers identified cassavas as long-lasting crops, sorghum as a healthy crop, sweet potatoes as fast maturing, and traditional vegetables as the preferred vegetables. Sorghum, cassavas, sweet potatoes and groundnuts were identified as foods that helped prevent hunger.

Cultural restrictions: Study participants discussed a number of cultural restrictions that often led to delayed planting or lack of planting within the study area. A number of study participants reported that married women had to wait for their husbands to be present before they could plant any seeds. Additionally, women could only sow seeds or plant crops after the mother-in-law had done so. For those in polygamous marriages, they could only plant after the senior co-wife had done so. Such a practice is referred to as "first-sowing."

Limited opportunity for income: The high dependence on agriculture and limited opportunity for other sources of income was mentioned as a major challenge when it comes to mitigating the effect of drought on the residents.

Table 6. Study participants' perceptions toward different crops as reported by focus group discussion participants.

Crops	Advantages	Limitations
Maize	Preferred grain.	Does not help prevent hunger. Requires a lot of rainAffected by striga weeds especially in the drier areas. High amounts of investment compared to amount of harvest.
Sorghum	Prevents hunger. Recognized as a healthier crop. Does better than maize especially in drier areas.	Has been neglected by the community. Less preferred when compared to maize. High amounts of investment compared to amount of harvest. Sorghum sales are not as fast as maize sales.
Cassavas	Does well. Lasts longer compared to maize and sorghum. Helps prevent hunger.	Do not like planting it. Crop destroyed by livestock. Takes too long to mature.
Sweet potatoes	Tubers can help prevent hunger. Fast-maturing compared to cassavas.	Crop destroyed by livestock. Requires more rainfall.
Kidney beans	Preferred legume.	Requires more rainfallDoes not do well.
Green grams		Does not do well. Requires more rainfall. Leaves destroyed by antelopes. Birds feed on the crop.
Cowpeas	Helps prevent hunger. Requires less rainfallCowpeas seeds consumed.	
Groundnuts	Does better than maize especially in drier areas. Groundnuts can be bartered for maize at post-harvest. Fetches a good price at the market. Requires low amounts of rainfall. Does well in sandy soils.	
Collard greens	Preferred vegetable.	Requires more rainfall.
Indigenous and traditional vegetables	Preferred vegetables. Grow wildly. Available even in low rainfall.	

Participants of the focus group discussion said that they did not have enough money to buy food and were often forced to sell some of their harvests to cater for household expenses including education and medical care.

Discussion

As part of the inquiry, we examined the prevalence and determinants of household food insecurity among households with mothers and young children in Seme sub-County, Kenya. The HFIAS scores were generally high with about 30% being moderately food insecure and 60% being severely food insecure in the non-harvest and harvest seasons. Results from our study showed that HFIAS scores were significantly lower during the harvest season. However, there was only a slight increase in the percentage of households identified as food secure in the harvest season and a slight decrease in the percentage of food insecure households. The high prevalence of food insecurity was further corroborated by mothers and key-informants' reports which indicated that harvests are generally low, lasting only 3–4 months of the year. Harvest season data was collected during the first half of the harvest season when only part of crops had been harvested. Such timing may explain the minimal differences in household food security prevalence noted in our study. It is also possible that households did not produce enough food to significantly shift the overall household food security prevalence in the study area. It is also possible that households may have adjusted their expectations and practices across different seasons.

The prevalence of household food insecurity reported in the current study is higher than the most recent national average of 12.7%.[2] A review of the literature revealed different approaches used to estimate household food security, thus making comparisons of prevalence rates across studies difficult. A study conducted in Tharaka South District, a district that is located within the arid and semi-arid lands (ASAL) in Kenya, reported that 43% of small-scale farmers' households were vulnerable to food insecurity while 45% were food insecure.[5] Another study reported that 85% of households in Wote, an area located within the ASAL regions of Kenya, were food insecure.[10] Although the tools and summary scores used in these studies are different, the reported household food insecurity levels are similar to household food insecurity estimates in the current study. When compared to studies that have utilized similar tools and summary scores, the prevalence of moderate and severe food insecurity in the non-harvest season in Seme sub-County was similar to that reported during the dry season in Meru District in Kenya.[38] However, harvest season household food insecurity prevalence was higher in Seme sub-County compared to Meru District. The prevalence of severe food insecurity in Seme sub-County is similar to the food poverty prevalence

reported in Kisumu County.[29] Reported hunger coping strategies were similar to those reported in other communities with mothers reporting that they protected young children's dietary needs over those of adults.[5,39]

Our bivariate analysis showed the negative association between poultry keeping and HFIAS score. Thus, poultry keeping was protective of household food security in Seme sub-County. However, this association lost significance in the multivariate regression models. Chickens were the most predominant type of poultry kept in the study households. Most households in Seme keep a small number of local scavenging chickens for food and as a source of income. Unlike larger livestock, poultry have short production cycles and households are more likely to decide to slaughter or sell poultry in times of need.[40,41]

Mothers believed that an over-reliance on a small number of crops contributed to hunger in the study area. The negative association that was shown between crop diversity and HFIAS scores supported this belief. Low levels of crop diversity may account for the loss of statistical significance in the multivariate regression models as our results show that households planted a median of 2–4 crops across seasons. Crop diversity was shown to be a strong predictor of increased food security in other studies in Kenya, Tanzania and Uganda.[10] When looking at specific crops, the bivariate analysis showed the negative association between cereal/grain production and HFIAS score. However, this association lost significance in the multivariate regression models. Maize was the most common type of crop cultivated in study households. The study's FGD respondents noted that maize was a more preferred cereal. However, they did not perceive maize as the type of crop that could help prevent hunger in the study area. Despite this perception, our analysis showed that households that produced cereal/grains were likely to experience less food insecurity. As the main staple food, production of maize is likely to lead to increased food availability and source of income. Higher maize yields have been shown to be associated with increased household food security.[10] Results from the quantitative data analysis did not support mothers' belief that traditional grains and tubers (millet, sorghum and cassava) could help prevent hunger in the study area. It is possible that households did not produce enough of the traditional grains to influence household food security. Only one-tenth of the households that produced cereals/grains in the non-harvest season had planted sorghum or millet, and less than half households that produced cereals/grains in the harvest season had planted sorghum or millet. Such low levels of production of sorghum in Seme could be attributed to a lack of preference as reported by the FGD respondents, among other factors.

Production of vegetables (any vegetable type and traditional vegetables) was significantly associated with lower risks of household food insecurity. The association between production of any vegetable and HFIAS scores maintained significance in the multivariate regression analysis. Similar findings

were reported in South Africa where growing vegetables was shown to significantly contribute toward household food security.[42,43] Production of fruits and vegetables by smallholder farmers in rural Uganda was associated with significantly higher household food security within smallholder farmer households, and higher consumption of fruits and vegetables, and hemoglobin values among adult female household members.[44] Thus, vegetable production has the potential to improve household food security and the nutritional status of household members. A larger percentage of households in the current study produced traditional vegetables compared to non-traditional vegetables. Over 81% and 85% of households that had vegetables in their farms in the non-harvest and harvest seasons, respectively, had planted traditional vegetables. While it is clear that more households in the current study planted traditional vegetables compared to non-traditional vegetables, identifying the proportional mix of traditional and non-traditional vegetables associated with higher household food security is beyond the study's scope. Compared to vegetables such as kales and collard greens, traditional vegetables like cowpea leaves, spider plant, African nightshade and jute mallow would be better adapted to the harsh agro-ecological conditions in Seme sub-County. A recent study showed that distance to water point and number of rainy days were significant factors in households adopting a government-sponsored home gardening program in Ethiopia.[45] Traditional vegetables like cowpea leaves, spider plant, African nightshade and jute mallow require less water to thrive in the Seme sub-County's predominantly semi-arid agricultural zone.[22,26,31] They also provide nutritional benefits and are rich sources of beta carotene, folates, vitamins C and E, calcium, iron, dietary fiber in addition to antioxidant activity.[13,16]

Study participants' beliefs on the role traditional foods in preventing hunger in Seme sub-County were partially supported by the quantitative results across board. Traditional vegetable production and traditional crop diversity were associated with lower risks of household food insecurity. However, the current analysis did not show presence of any significant association between production of other individual traditional foods and household food insecurity. The percentage of households that cultivated traditional foods remained low. Traditional crops were less preferred compared to their non-traditional counterparts with the exception of vegetables. We acknowledge that the current study is limited by its observational nature and that an experimental study would help clarify the effects of traditional food production on household food security in the study area. Both the National Food and Nutrition Security Policy Implementation Framework 2011–2017 and the Food Security Bill recognize the importance of diverse foods including traditional crops in supporting food security among Kenyans.[8,46] However, there is need for stronger empirical evidence to support such policy in Seme sub-County.

Focus group participants identified presence of cultural restrictions that may contribute to household food insecurity. The Luo society is patriarchal. Men own the land and make decisions on land transactions, including buying, selling or gifting land.[47,48] Women can cultivate land owned by their husband's patrilineage, and make decisions on land use and deployment of land resources (eg. what crop to plant). However, agricultural practices such as "first sowing" are still guided by seniority where married women are expected to wait on their husband's, in-laws' or senior co-wife's lead to initiate planting.[48] Such a requirement may lead to delayed planting, a critical factor to consider when relying on rain-fed agriculture. Efforts aimed at addressing food insecurity in Seme sub-County should examine the role of cultural restrictions on timely planting, and explore strategies that bring family members together to work toward achieving household food security.

The current study has limitations. The FGD study participants were predominantly female. Thus, the FGD results reflect the views of young children's mothers and not that of the fathers. Despite multiple attempts, we were not successful in including fathers in the FGDs. Future studies should explore ways to include the male perspective when discussing household food security in Seme. Our use of a single food security metric, the HFIAS, may not provide for a robust assessment of the household food security situation in Seme. The HFIAS is an experience-based approach shown to be a valid measure of household food security status in multiple low-income nations.[34] However, one's experience is influenced by multiple factors including one's culture, personal values, expectations, and adjustments to the norm. Additionally, respondents may not accurately recall events over the relatively long reference period of 30 days. The seasonal differences in the HFIAS scores and the association between HFIAS scores and household SES in the current study were in the expected direction, giving us confidence in the metric's assessment of household food security in the study area.

Conclusion

Our research documents a high prevalence of household food insecurity in Seme sub-County across multiple seasons. Vegetable production (any type and traditional vegetables), maize production, crop diversity (all-crop and traditional food crops) and poultry keeping were protective of household food security in Seme sub-County, with vegetable production's protective effect persisting after controlling for socio-economic and other agricultural production variables. Future research should help identify the mix of vegetables needed to sustainably support household food security in the study area. In addition, strategies to enhance policy and programming to support vegetable production in the study area are needed. Such mechanisms might include promoting private/public partnerships to support access to farm inputs and

extension services, the development and maintenance of farmer groups or cooperatives, incorporation of peer-to-peer farmer training, and working with communities to address cultural restrictions that may hinder households from achieving food security. While study participants acknowledged the potential of traditional foods in supporting household food security, research that is more robust is needed to clarify the effect of traditional crops on household food security in Seme sub-County.

Author Contribution

CA Gewa. formulated the study, designed and conducted the research, analyzed the quantitative data and FGD content and wrote the paper.
B Stabile formulated the study and wrote the paper.
P Thomas formulated the study and wrote the paper.
AC Onyango facilitated the field activities, conducted the research and edited the paper.
FO Angano facilitated the field activities, conducted the research and edited the paper.

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