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ORIGINAL RESEARCH ARTICLE

Status of Food and Nutrition Security among Smallholder Farmers in Selected Districts of Eastern Uganda: A Cross-Sectional Study

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ABSTRACT

Food and Nutrition Security (FNS) remain critical concerns for smallholder farmers in Sub-Saharan Africa. This study looked at the food and nutrition situation of smallholder farmers in three selected districts of Kamuli, Buyende, and Pallisa in Eastern Uganda. A cross-sectional, mixed-methods approach was employed involving 647 smallholder households and 893 children aged 6–59 months. Food security was evaluated using four indicators: Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Individual Dietary Diversity Score (IDDS), and Minimum Dietary Diversity (MDD) for a subsample of 308 children aged 6–23 months. Data were collected through dietary recalls, food frequency questionnaires, anthropometric assessments (Mid Upper Arm Circumference [MUAC] and Weight for Height Z-Scores [WHZ]), and market-based food price analysis. Qualitative insights were obtained from focus group discussions and key informant interviews. Results showed that, among households, 75.9% consumed fewer than three meals daily, and 32.5% exhibited low dietary diversity. The mean FCS was 28.8, indicating borderline food consumption. Among all children, 56.9% had inadequate dietary diversity (IDDS < 4), while 60.3% of those aged 6–23 months failed to meet the MDD standard. Overall, 15% of children were acutely malnourished, with Buyende district reporting the highest burden. Cost-effectiveness analysis identified cassava, sweet potatoes, sim-sim, and silverfish (mukene) as affordable, nutrient-rich foods. Participation in farmer groups was associated with better dietary outcomes. Food insecurity in the three selected districts of Eastern Uganda is multidimensional, affecting both the quantity and quality of diets. Locally tailored, nutrition-sensitive agricultural strategies are essential for improving child health and household resilience.

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1. INTRODUCTION

Food and nutrition insecurity remain pressing global challenges, with more than 2.3 billion people lacking regular access to safe, nutritious, and sufficient food in 2023 (Food and Agriculture Organisation [FAO et al., 2023). Sub-Saharan Africa bears a disproportionate burden of this crisis due to structural poverty, limited resilience to climate change, underperforming food systems, and constrained access to nutrition services. Paradoxically, the most affected are often rural smallholder farmers—those responsible for producing the bulk of food consumed in the region, but who themselves remain highly vulnerable to food insecurity (Sibhatu & Qaim, 2017). Uganda exemplifies this paradox. With over 70% of the population engaged in small-scale farming, agriculture is central to livelihoods and food supply. However, systemic challenges—including seasonal food shortages, market volatility, land fragmentation, and inadequate nutrition education—continue to undermine food and nutrition security, particularly in Eastern Uganda (Uganda Bureau of Statistics [UBOS], 2020). Despite its agricultural potential, the region experiences persistently high rates of child undernutrition, limited dietary diversity, and recurrent food shortages, especially during dry seasons. Children under five remain the most vulnerable, with widespread stunting, wasting, and micronutrient deficiencies undermining their long-term growth and development.

National frameworks, such as the Agriculture Sector Strategic Plan (Ministry of Agriculture, Animal Industry and Fisheries [MAAIF], 2020) and the Uganda Nutrition Action Plan, attempt to address these issues through production-driven interventions. However, such efforts often fall short in addressing the *quality* and *affordability* of household diets. Moreover, the lack of disaggregated, district-level evidence limits the development of tailored, nutrition-sensitive interventions that respond to local realities. While national statistics provide aggregate data on food and nutrition security, there is limited empirical evidence on the status of these indicators among smallholder farmers at sub-regional or district level in Eastern Uganda. This study aims to address this gap by assessing the food security and nutrition outcomes in three high-risk districts—Kamuli, Buyende, and Pallisa—using four validated indicators: Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Individual Dietary Diversity Score (IDDS), and Minimum Dietary Diversity (MDD) for children aged 6–23 months. It also examines the cost-effectiveness of 35 locally available foods to identify affordable, nutrient-dense dietary options.

By combining quantitative and qualitative methods, the study offers robust, localized evidence to guide context-specific, nutrition-sensitive policies. The findings align with Uganda's development priorities and contribute to global targets, such as Sustainable Development Goals 2 and 3, which aim to end hunger and promote health and well-being.

2. METHODOLOGY

2.1 Study area

This study was conducted in three purposively selected districts of Kamuli, Buyende, and Pallisa in Eastern Uganda (**Figure 1**). These districts were chosen for their agricultural importance, high burden of food insecurity, and relevance to ongoing farmer-based interventions. Kamuli District was retained from the previous Post-Harvest Uganda (PHU) project (Tibagonzeka et al., 2018) and progress in postharvest handling (PHH), providing a valuable benchmark for measuring learning and scale-up. Buyende, despite being historically considered a regional food basket, suffers from high malnutrition and limited prior intervention coverage. Pallisa was chosen for its agroecological diversity and existing engagement in Farmer Research Networks (FRNs), providing a fertile ground for both learning and scaling out.

Within each district, four sub-counties were selected based on participatory consultations with local leaders, agricultural officers, and community-based organizations. The selection criteria included crop productivity, the presence of organized farmer groups, and levels of food insecurity and malnutrition. In Kamuli, the sub-counties included Butansi, Bugulumbya, Namasagali, and Mbulamuti. These areas are known for high maize and cassava production, with Namasagali also reporting significant gender-based vulnerabilities. In Buyende, the study was implemented in Bugaya, Buyende Town Council, Kagulu, and Nkondo, each of which was selected for its high production potential and nutritional vulnerability. In Pallisa, the selected sub-counties were Puti-Puti, Kasodo, Akisim, and Kameke—each characterized by diverse cropping systems and active farmer collectives.

To ensure representativeness, three parishes were selected per sub-county using pairwise ranking exercises with farmer leaders and district officials. This resulted in 36 study parishes, including Bugeywa, Butansi, and Naluwoli in Butansi sub-county; Gumpi, Kitukiro, and Bugaya in Bugaya sub-county; and Mpogi, Boliso, and Puti-Puti in Puti-Puti sub-county, among others. This participatory approach not only enhanced local ownership and data quality but also ensured that selected parishes represented diverse agro-ecological and social settings. These sub-national geographies were central to understanding the spatial distribution of food and nutrition insecurity and informing the design of context-specific interventions.

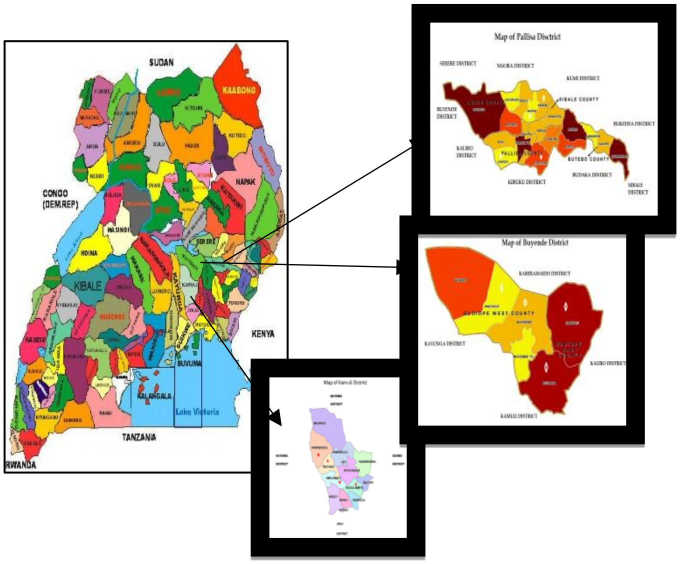

Fig. 1. Map of Uganda showing the Study Districts Location

2.2 Study design and period

The study was conducted in February 2021, during the dry season when food shortages are typically most severe. The timing provided a critical lens on food and nutrition insecurity during peak vulnerability. A cross-sectional, mixed-methods design was chosen to provide a snapshot of both quantitative trends and qualitative narratives. This design enabled methodological triangulation and reduced bias, ensuring a more nuanced interpretation of household food dynamics (Creswell & Plano Clark, 2011).

2.3 Study population and sampling

The study targeted smallholder farming households with at least one child aged 6–59 months, a demographic considered highly vulnerable to food and nutrition insecurity. Eligibility criteria included active involvement in subsistence farming and provision of verbal informed consent. A multi-stage sampling strategy was adopted to ensure representative coverage across districts, organized farmer groups, and unaffiliated community members.

At the first stage, three districts—Kamuli, Buyende, and Pallisa—were purposively selected based on historical participation in postharvest and nutrition programming, agricultural diversity, and observed disparities in child malnutrition indicators. Within each district, four sub-counties were purposively chosen in consultation with district leaders, guided by crop production levels, prevalence of food insecurity, and geographic distribution. Three parishes were then selected per sub-county using pairwise ranking exercises that involved community-based farmer organizations and agricultural officers, resulting in a total of 36 parishes. Villages within each selected parish were randomly listed, and one to two villages per parish were randomly sampled using a lottery method to serve as final study sites. The study applied a two-tiered household sampling approach. First, 36 registered farmer groups (12 per district) were identified with the help of local extension workers and partner NGOs. From these, 342 households were randomly selected using a systematic sampling technique. Membership lists served as sampling frames, and a sampling interval (k) was calculated by dividing the total number of eligible households by the number needed per group. For instance, if a group had 40 members and 10 were needed, every fourth household was selected.

To enhance external validity, an additional 305 households were selected from non-affiliated smallholder farmers within the same parishes. Lists of households with children under five were generated through village health teams and local leaders. Within each village, stratified random sampling was applied, with strata defined by village and district, and household selection guided by pre-established eligibility and availability on the day of data collection. The final sample comprised 647 households, distributed as 205 in Pallisa, 201 in Kamuli, and 241 in Buyende. Sample size was calculated using the Krejcie and Morgan (1970) formula, ensuring a 95% confidence level and a 5% margin of error. Although proportional allocation was not strictly applied across districts, the near-equitable sample sizes were designed to allow for district-level comparisons with balanced statistical power. From these households, 893 children aged 6–59 months were surveyed. Of these, a subsample of 308 children aged 6–23 months was identified based on age eligibility for the Minimum Dietary Diversity (MDD) indicator, as per WHO and FAO (2016) guidelines. This included 88 children from Pallisa, 107 from Kamuli, and 113 from Buyende. These were not randomly drawn but rather represented all eligible cases within the total child sample. The remaining 585 children aged 24–59 months (128 from Pallisa, 204 from Kamuli, and 253 from Buyende) were analyzed using age-appropriate indicators such as the Individual Dietary Diversity Score (IDDS) and Weight-for-Height Z-scores (WHZ). This stratification enabled targeted vulnerability assessments and enhanced the interpretability of age-specific findings.

2.4 Data collection and organization

Data were collected using a combination of quantitative and qualitative instruments designed to capture household-level food access, dietary diversity, and child nutrition outcomes. A structured household questionnaire was administered to collect demographic, agricultural, dietary, and health-related information. Dietary intake was assessed through a 24-hour dietary recall and a 7-day food frequency questionnaire (FFQ) adapted from Gibson and Ferguson (2008). These tools were tailored to reflect the local food environment by incorporating commonly consumed regional staples such as cassava, millet, sweet potatoes, and small fish. This contextual adaptation ensured that dietary diversity indicators reflected the actual consumption patterns of smallholder farming communities.

The study measured multiple dimensions of food security. The Household Dietary Diversity Score (HDDS) and Individual Dietary Diversity Score (IDDS) were calculated using FAO (2011) guidelines, while the Minimum Dietary Diversity (MDD) indicator was applied to children aged 6–23 months in line with WHO and FAO (2016) standards. The Food Consumption Score (FCS) was computed using WFP (2024) protocols, integrating dietary frequency, diversity, and nutritional importance of food groups. Additionally, data on the number of meals consumed in the previous day were collected to assess dietary quantity. Households reporting fewer than three meals were flagged as food insecure by quantity. Anthropometric indicators included Mid-Upper Arm Circumference (MUAC), measured using UNICEF-provided, colour-coded, non-stretch MUAC tapes, and Weight-for-Height Z-scores (WHZ), calculated using the WHO Anthro software (version 3.2.2), which applies the WHO (2006) Child Growth Standards. Weight was measured using SECA 874 digital flat scales, which are portable and battery-powered. Height and length were measured using SECA portable stadiometers or length boards, depending on the child's age (standing height for children ≥24 months; recumbent length for <24 months), following WHO standard measurement protocols. All anthropometric indicators were stratified by district, child age group (6–23 vs. 24–59 months), and sex, enabling a nuanced analysis of nutritional status across population subgroups.

Although the data collection tools were not formally translated into local languages, the study employed enumerators fluent in Lusoga, Lugwere, and Ateso, ensuring real-time, culturally appropriate interpretation during interviews. This approach allowed for more nuanced clarification and enhanced engagement with respondents in their preferred languages. To further strengthen understanding, especially among low-literacy participants, visual Information, Education, and Communication (IEC) materials were used extensively. These included pictorial flipcharts and food group illustrations, which standardized how questions and prompts were presented across households and districts. The use of visual aids supported consistent data collection while facilitating respondent comprehension in settings where written translations would have been ineffective. All tools were pre-tested in a non-study village to evaluate clarity, cultural sensitivity, and operational feasibility. Adjustments were made to local food references, probe phrasing, and question sequencing based on pre-test findings.

A team of 12 enumerators underwent a three-day intensive training program covering research ethics, structured interviewing, anthropometric measurement, and dietary diversity protocols. The training sessions included mock interviews, role-plays, and inter-rater reliability checks, particularly for MUAC and weight-height assessments. Measurement consistency was validated by comparing results from multiple enumerators measuring the same child, with discrepancies addressed through retraining and supervision. Two field coordinators conducted daily field checks and random spot validations to uphold data quality standards. Qualitative data collection involved 18 focus group discussions (FGDs) and 9 key informant interviews (KIIs). FGDs were stratified by gender and location and facilitated in the local language to capture a wide range of household experiences, food access dynamics, and cultural feeding practices. KIIs were conducted with agricultural officers, community health workers, and local leaders to gather expert perspectives. The number of discussions and interviews was guided by the principle of thematic saturation (Guest, Bunce, & Johnson, 2006), with data collection concluding once no new insights emerged. All sessions were audio-recorded with consent, transcribed, and translated into English for thematic analysis.

2.5 Variables and indicators

To assess food security and child nutrition outcomes, the study employed a multidimensional framework that incorporated five core indicators: Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Individual Dietary Diversity Score (IDDS), Minimum Dietary Diversity (MDD), and daily meal frequency. Anthropometric assessment was based primarily on Weight-for-Height Z-scores (WHZ), which were derived from Mid-Upper Arm Circumference (MUAC) data, converted using WHO Anthro software to ensure standardized, age- and sex-adjusted nutritional classification. All indicators were stratified by child age group (6–23 and 24–59 months), sex, and district, allowing for targeted vulnerability analysis. HDDS was calculated using 24-hour dietary recall data aggregated across 12 FAO-defined food groups. Households were categorised according to dietary diversity as follows: low (1–3 food groups), medium (4–6 food groups), and high (7–9 or more food groups). Households scoring fewer than six food groups were flagged as nutritionally vulnerable, indicating likely deficiencies in micronutrient intake. This indicator served as a proxy for food access and dietary quality at the household level.

FCS was derived from a 7-day food frequency recall, covering eight food groups in line with World Food Programme (WFP, 2024) guidelines. Each food group was assigned a weight reflecting its relative nutritional importance, with higher weights given to protein-rich and micronutrient-dense foods. Specifically, staples such as cereals and tubers were weighted less heavily than animal-source foods and pulses. Meat, fish, milk, and dairy products were given the highest weights due to their contribution to protein and micronutrient intake, while foods such as sugar and oil received minimal weights. The FCS for each household was calculated by multiplying the number of days each group was consumed by its assigned weight and summing the results. Final scores were classified as poor (0–21), borderline (21.5–35), or acceptable (>35), enabling the

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categorization of households along a spectrum of dietary adequacy. IDDS was computed for all 893 children aged 6–59 months using 24-hour recall data, based on seven WHO-designated food groups appropriate for assessing infant and young child feeding. Children who consumed at least four of the seven food groups were considered to have adequate dietary diversity. This individual-level indicator captured variation in diet quality that may not be observable at the household level and provided insight into intra-household food allocation patterns.
Minimum Dietary Diversity (MDD) was calculated for a subsample of 308 children aged 6–23 months, drawn from the total sample of 893 children, as the indicator is explicitly validated for this critical age range. These children were identified based on age stratification during data processing. MDD was assessed according to the WHO and FAO (2016) standards, with four or more food groups indicating an adequate diet. This age-specific assessment enabled the evaluation of complementary feeding practices, which are vital for child growth and cognitive development during the weaning period.

In addition to dietary quality, the study assessed dietary quantity through meal frequency. Households that consumed fewer than three meals in the preceding 24 hours were categorized as food insecure by quantity, complementing the qualitative dimensions captured by HDDS and FCS. This simple but powerful measure provided an indicator of food availability and energy sufficiency. To assess nutritional status, MUAC was measured for all children but interpreted through adjusted Weight-for-Height Z-scores (WHZ) to ensure standardization. MUAC readings were processed using WHO Anthro software, which adjusts for age and sex, providing a consistent classification of wasting. WHZ scores were interpreted according to WHO (2009) criteria: children with Z-scores greater than or equal to –2 standard deviations (SD) were considered normal; those between –2 and –3 SD were classified as moderately wasted; and those below –3 SD were identified as severely wasted **(Table 1).** By translating MUAC measurements into WHZ scores, the analysis aligned with international standards, improving the reliability and comparability of findings across global datasets.

2.6 Data quality and enumerator training

Twelve enumerators were trained over three days in research ethics, anthropometry, and standardized tool administration. Training included mock interviews and inter-rater reliability exercises. Data quality was assured through field supervision, random back-checks, and double data entry. Consistency checks and cross-tabulations were conducted using SPSS Version 28.

2.7 Data analysis

Quantitative data were analyzed using SPSS Version 28. Descriptive statistics (means, proportions, standard deviations) were used to summarize household and child-level characteristics. Associations between categorical variables, such as dietary diversity and group affiliation, were assessed using Chi-square tests, while one-way ANOVA was employed to compare outcomes across districts. For all inferential statistics, a 95% confidence interval (CI) was applied, and a p-value threshold of <0.05 was considered statistically significant. Market price data on 35 locally available foods were used to evaluate the affordability and cost-effectiveness of nutrient-rich diets for young children. Qualitative data from focus group discussions (FGDs) and key informant interviews (KIIs) were transcribed verbatim, coded using inductive methods, and thematically analyzed. These qualitative findings were used to triangulate the quantitative results and enhance contextual interpretation

Table 1. Food Security and Nutrition Indicators, Classifications, and Thresholds

Indicator	Measurement Method	Threshold / Cut-off	Classification	Reference
HDDS	24-hour dietary recall across 12 food groups	<6 food groups consumed	Low (<6), Medium (6–8), High (≥9)	Kennedy, Ballard, & Dop, 2011)
FCS	7-day food group frequency weighted by nutritional importance	≤21, 21.5–35, >35	Poor (≤21), Borderline (21.5–35), Acceptable (>35)	WFP, 2024
IDDS	24-hour recall for children (7 WHO groups)	<4 food groups	Inadequate (<4), Adequate (≥4)	WHO, 2010
MDD (6–23 months)	Subsample of 308 children, 24-hour recall	<4 food groups	Did not meet MDD (<4), Met MDD (≥4)	WHO & FAO, 2016
Meal Frequency	Number of meals in The prior 24 hours	<3 meals	Food insecure (<3), Food secure (≥3)	Adapted from WFP (2020)
WHZ (Wasting)	Adjusted from MUAC via WHO Anthro software	>–2 SD, –2 to –3 SD, ≤–3 SD	Normal (≥–2), Moderate (–2 to –3), Severe (≤–3)	WHO, 2009

2.8 Ethical considerations

This study adhered to ethical guidelines outlined by the Uganda National Council for Science and Technology (UNCST). Verbal informed consent was obtained from all participants, who were

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informed of their rights, the voluntary nature of participation, and the confidentiality of their responses. Community entry procedures were followed, and permissions were obtained from district and village authorities.

2.9 Study limitation

This study has several limitations. The cross-sectional design restricts causal inference and captures only seasonal conditions prevalent in the dry season. Dietary data, based on recall, may be subject to memory bias or social desirability effects. Market data were collected in a single cycle and may not reflect interannual price fluctuations or climate-related variability. Additionally, the findings are context-specific to Kamuli, Buyende, and Pallisa and may not generalize to the broader Eastern Uganda region. Despite these constraints, the use of validated indicators, stratified sampling, and data triangulation enhances the robustness, credibility, and policy relevance of the findings.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic characteristics of respondents

The socio-demographic profile of households **(Table 2)** provides a foundational context for understanding the drivers of food and nutrition insecurity. A total of 647 households participated in the study, with the majority of respondents being female (56.3%). Most were aged between 18 and 49 years (90.9%) and married (91.2%). Education levels were relatively high, with over 90% having completed primary education. Household size varied, with 45.3% of households having eight or more members. Income data revealed that 98.7% of households earned less than UGX 1,500,000 per year

These socio-demographic features reflect a labour-intensive, low-income agrarian population with high dependency ratios, which constrain household spending on diverse foods and health care. These patterns mirror findings from Uganda's national household surveys (UBOS, 2020) and reinforce the need for tailored interventions that address household vulnerability and build food resilience.

3.2 Food security status

Household food insecurity emerged as both widespread and chronic across the study districts, posing a significant barrier to achieving adequate nutrition and health outcomes. Seasonal food shortages, limited dietary diversity, and low meal frequency **(Figure 2)** contribute to a fragile food security environment, particularly for vulnerable populations such as young children, pregnant women, and low-income households. This section presents evidence on household food consumption patterns and underlying risk factors, helping to contextualize the nutritional challenges and inform targeted, location-specific interventions.

3.2.1 Food consumption score (FCS)

The Food Consumption Score (FCS) was used to evaluate household-level food security, revealing that most households fall within the borderline food consumption category **(Table 3)**, indicating a fragile nutritional status. The mean FCS for the study sample was 28.8 (SE = 0.231), aligning with WFP's borderline threshold (21.5–35). Households reported frequent consumption of staples, such as maize flour and cassava (averaging 5.2 days per week), while vegetables and fruits were consumed approximately 3.8 and 3.9 days per week, respectively. In contrast, animal-source foods were rarely consumed—meat (0.7 days), milk (0.1 days), and pulses (1.6 days)—revealing significant gaps in nutritional diversity. District-wise, Kamuli had the highest mean FCS (31.2), followed by Buyende (28.9) and Pallisa (26.1). Furthermore, 75.9% of households consumed fewer than three meals per day, with Pallisa exhibiting the most severe reduction in meals.

These findings indicate a diet dominated by energy-dense but micronutrient-poor staples, which increases the risk of protein-energy malnutrition and hidden hunger, particularly among vulnerable populations such as children and women. The disparity across districts highlights localized vulnerabilities, with Pallisa showing consistent food access challenges. These patterns are supported by Herforth et al (2020) and WHO (2020), who noted similar dietary monotony in rural settings. Sibhatu & Qaim (2017) also linked poor dietary diversity to undernutrition in Sub-Saharan Africa. A significant association was found between household size and food access, with households having fewer than six members exhibiting higher FCS scores ($F(2, 644) = 6.12$, $p < 0.01$). However, no significant gender-based differences were observed ($\chi^2 = 1.84$, $p = 0.17$).

To address these chronic food security issues, especially in underperforming areas like Pallisa, targeted interventions are needed. These include Seasonal food assistance programs, Community-managed grain banks, and Agricultural extension efforts that promote the cultivation of nutrient-dense crops. Such strategies can improve both short-term food access and long-term dietary quality, building resilience among vulnerable households.

Table 2. Socio-demographic characteristics of respondents (n=647)

Social demographic characteristic	Option	Percentage			
		Pallisa	Kamuli	Buyende	Overall
Sex	Male	48.8	39.8	42.7	43.7
	Female	51.2	60.2	57.3	56.3
Age (years)	<18	2.44	1.49	2.49	2.16
	18-49	88.8	89.6	93.8	90.9
	>49	8.78	8.96	3.73	6.96
Marital status	Single	1.0	0	2.1	1.1
	Married	92.2	90.6	90.9	91.2
	Cohabiting	2.0	0.5	0.8	1.1
	Separated	3.4	4.5	4.6	4.2
	Widowed	1.5	4.5	1.7	2.5
Education level attained	None	8.29	10.94	8.71	9.27
	Primary	64.88	59.2	57.26	60.28
	Secondary	23.9	28.86	31.95	28.13
	Tertiary	2.93	1.99	2.07	2.32
Household size	≤ 4, small	19.5	15.9	18.7	18.1
	5-7, moderate	28.3	41.3	39.8	36.6
	8-10, big	25.9	25.9	29.5	27.2
	>10, extremely big	26.3	16.9	12.0	18.1
Farmer group membership	Member	65.4	45.8	62.2	58.1
	Non member	34.6	54.2	37.8	41.9
Caretaker relationship with the child	**Mother**	**39.5**	**48.8**	**82.7**	**57.1**
	Grandmother	10.2	11.4	9.5	10.4
	Sister	1.0	0.5	6.1	2.5
	Stepmother	0.5	0	0	0.2
	Father	48.8	39.3	1.7	29.8
Farmer income	**UGX below 500,000 per year (very low-income earners)**	**0**	**0**	**0**	**0**
	UGX 500,000-1,500,000 per year (Low-income farmers)	98.2	97.8	100	98.7
	UGX above 1,500,000 per year (Medium/High-income earners)	1.8	2.2	0	1.3
Vulnerability status	Pregnant mother	8.29	10.94	8.71	9.27
	Lactating mother	3.4	4.5	4.6	4.2
	Elderly	10.2	11.4	89.5	8.8
	Has a child under 5 years	64.88	59.2	57.26	60.28

Table 3. Weekly consumption of food groups in Pallisa, Kamuli, and Buyende

	FOOD GROUPS (FREQUENCY OF WEEKLY CONSUMPTION)								Mean FCS
District	**Staples**	**Pulses**	**Vegetables**	**Fruits**	**Meat**	**Milk**	**Sugar**	**Oil**	
Pallisa	5.2	1.4	4	4.8	0.6	0.02	1.9	1.8	27.7
Kamuli	5	2.1	3.8	3.4	0.7	0.1	2.8	3	29.6
Buyende	5.3	1.3	3.6	3.6	0.7	0.04	3.3	3.2	27.9
Mean	5.2	1.6	3.8	3.9	0.7	0.1	2.7	2.7	28.8

Standard error = 0.231

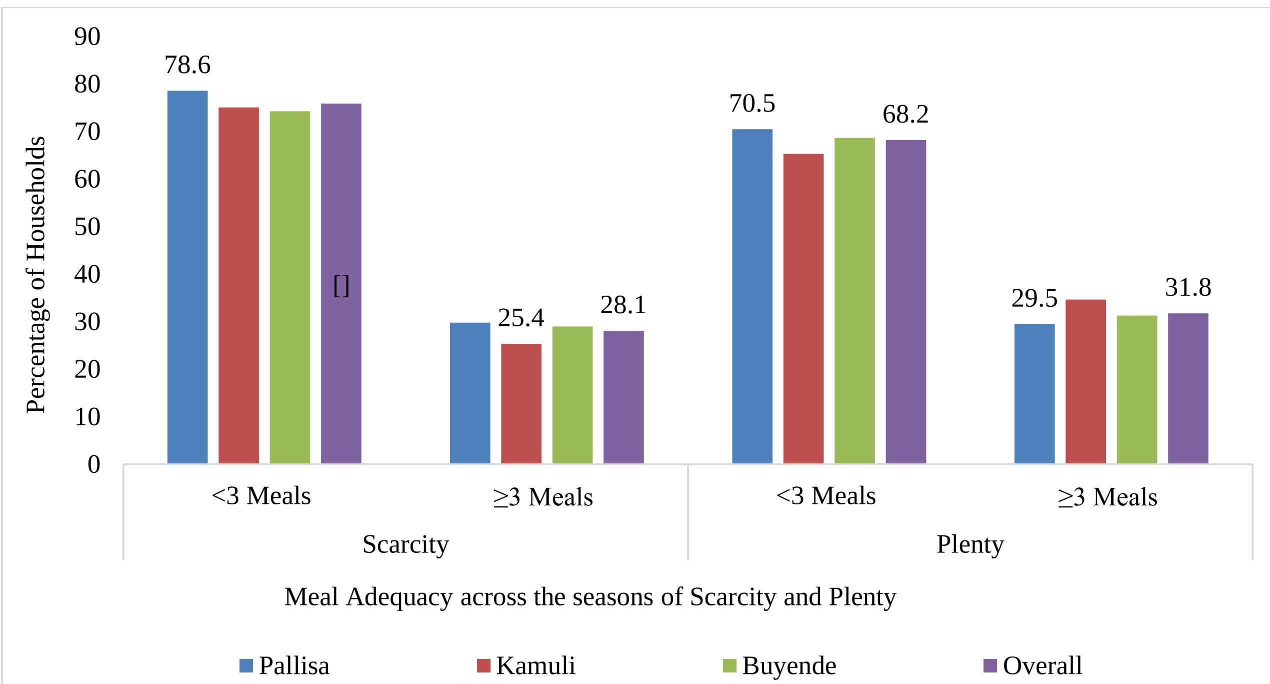

Fig.2 Percentage of households that consume less than the recommended 3 times a day

3.3 Dietary diversity of households and children

Among the households surveyed, 32.5% (Table 4) reported consuming fewer than six food groups per day, indicating low dietary diversity. The highest prevalence of poor dietary diversity was observed in Pallisa district (45.9%), while Kamuli had the lowest (22.9%). The mean HDDS values were 6.70 for Pallisa, 7.80 for Kamuli, and 7.59 for Buyende.

At the individual level, the Individual Dietary Diversity Score (IDDS) for children aged 6–59 months revealed that 56.9% **(Table 5)** did not meet the minimum threshold of consuming at least four food groups per day. The district with the worst performance was Pallisa (68.5%), while Buyende performed the best (43.8%). Among children aged 6–23 months (n = 308), 60.3% failed to meet the WHO-recommended Minimum Dietary Diversity (MDD) (WHO, 2010).

Table 4. Household dietary diversity in Pallisa, Kamuli, and Buyende districts (n=647)

No. of food groups	Percentage			
	Pallisa	**Kamuli**	**Buyende**	**Overall**
1 to 3 groups (Low diversity)	13.7	3	1.7	5.9
4 to 6 groups (Medium diversity)	32.2	19.9	27.4	26.6
7 to 9 groups (High diversity)	54.1	77.1	71	67.5
≤ 6 groups	45.9	22.9	29	32.5
> 6 groups	54.1	77.1	71	67.5

Footnote: "Dietary diversity classification is based on the number of food groups consumed in the previous 24 hours: 1–3 groups = Low dietary diversity, 4–6 groups = Medium dietary diversity, and 7–9 groups = High dietary diversity, consistent with FANTA guidelines (FANTA, 2016)."

This lack of dietary diversity increases risks for stunting, anaemia, and developmental impairments (FANTA 2016; Agbadi et al., 2017). It also mirrors trends observed in other Ugandan studies (Nabuuma et al., 2021; Nahalomo et al., 2023), where market inaccessibility and maternal education were key determinants of low IDDS.

3.4 Child Nutritional Status Assessment

To evaluate the nutritional well-being of children aged 6–59 months across the study districts, three key indicators were used: Mid-Upper Arm Circumference (MUAC), weight-for-height Z-scores (WHZ), and morbidity records. These indicators offer a comprehensive picture of acute malnutrition and child health outcomes. MUAC was employed as a rapid screening tool to detect undernutrition, while WHZ scores provided standardised anthropometric measures of wasting based on the WHO (2009) growth references. Additionally, recent illness episodes were recorded to explore the relationship between nutritional status and morbidity. The results from these assessments are outlined in the following subsections.

3.4.1 MUAC Assessment

Mid-Upper Arm Circumference (MUAC) assessment was conducted among 893 children aged 6–59 months to evaluate their nutritional status. Of the total sample, 308 children were aged 6–23 months, and 585 children were aged 24–59 months. The results revealed that 15% of the children were either malnourished or at risk of malnutrition, based on WHO-recommended MUAC-for-age Z-score classifications. Specifically, 0.7% of the children exhibited Severe Acute Malnutrition (SAM), defined as MUAC-for-age below -3 standard deviations (SD). Moderate Acute Malnutrition (MAM), corresponding to MUAC-for-age between -3 SD and -2 SD, was observed in 4.7% of the children. Additionally, 9.9% were classified as being at mild or potential nutritional risk, with MUAC-for-age between –2 SD and –1 SD. The majority—85% of children—fell within the normal nutritional range (MUAC-for-age ≥ –1 SD). Among the three study districts, Buyende reported the highest prevalence of severe acute malnutrition.

Table 5. Child food insecurity by dietary diversity, IDDS (n = 893) and MDD (n = 308) across districts

District	Age in months	Category	Sex	Percentage	% of under 5s with ≤ 4 groups (food insecure)
Pallisa	6 to 23	≤ 4 groups	Female	13.4	68.5
			Male	12	
			Total	**25.4**	
		> 4 groups	Female	9.3	
			Male	6	
			Total	15.3	
	24 to 59	≤ 4 groups	Female	21.8	
			Male	21.3	
			Total	**43.1**	
		> 4 groups	Female	7.9	
			Male	8.3	
			Total	16.2	
Kamuli	6 to 23	≤ 4 groups	Female	13.8	58.6
			Male	7.1	
			Total	**20.9**	
		> 4 groups	Female	8.7	
			Male	4.8	
			Total	13.5	
	24 to 59	≤ 4 groups	Female	20.3	
			Male	17.4	
			Total	**37.7**	
		> 4 groups	Female	16.4	
			Male	11.6	
			Total	28	
Buyende	6 to 23	≤ 4 groups	Female	7.4	43.8
			Male	6.6	
			Total	**14**	
		> 4 groups	Female	7.9	
			Male	9	
			Total	16.9	
	24 to 59	≤ 4 groups	Female	15.6	
			Male	14.2	
			Total	**29.8**	
		> 4 groups	Female	22.1	
			Male	17.2	
			Total	39.3	
Overall	6 to 59	≤ 4 groups	Total	**56.9**	56.9

3.4.2 Weight-for-height Z-scores

Using WHO (2009) child growth standards, 17% of children were found to be wasted (WHZ < -2), indicating moderate acute malnutrition and surpassing the WHO emergency threshold of 15%. The highest prevalence was observed in Pallisa, with Buyende and Kamuli showing similarly concerning levels. These findings highlight the risks of acute undernutrition in the surveyed districts.

3.4.3 Morbidity and nutrition correlation

Morbidity data revealed that 4.7% of children had experienced illness, with a strong positive correlation between morbidity and malnutrition ($r = 0.85$, $p < 0.001$). This statistically significant relationship supports the bidirectional association between infection and undernutrition, as established by the World Health Organization (WHO, 2009) and reaffirmed by Elolu et al. (2021) in their study of rural Ugandan communities.

3.4.4 Summary and implications

These findings highlight systemic challenges in child health and nutrition across the districts. The co-occurrence of undernutrition and morbidity indicates critical gaps in caregiver feeding practices, disease prevention, and health system outreach. To address these challenges, integrated community-based strategies are recommended, including caregiver training on nutrition, timely illness detection and treatment, and mobile nutrition surveillance services.

3.5 Cost-effectiveness of candidate foods

Access to nutritious food is often constrained by cost, particularly among smallholder farming communities with limited income. Identifying affordable, nutrient-rich local foods is therefore essential for designing sustainable nutrition interventions. This section evaluates the cost-effectiveness of 35 commonly consumed local foods by analysing their nutrient density relative to price, with a focus on identifying optimal options for addressing malnutrition while minimising household food expenditure. The findings inform both household decision-making and policy-level strategies for improving the food system.

3.5.1 Affordable and nutrient-dense local foods

A cost-effectiveness analysis of 35 commonly consumed local foods identified several options that are both nutrient-dense and affordable, offering promising avenues to enhance dietary quality in a financially sustainable way. The foods highlighted include sweet potatoes, cassava, beans, sim-sim, mukene (silverfish), and orange-fleshed sweet potatoes, all of which provide a valuable mix of energy, protein, and essential micronutrients.

3.5.2 Nutrient and cost comparison

Seasonal price monitoring revealed that sweet potatoes and cassava maintained relatively stable prices throughout the year, making them reliable staples. In contrast, mukene and sim-sim experienced price spikes during lean seasons, potentially limiting access when nutritional needs are highest. Cassava offered the lowest cost per 100 kcal at UGX 27, making it an efficient energy source. "Mukene" (silverfish) had the highest protein density, costing UGX 41 per 10 grams of protein. These results echo findings by Fanzo et al. (2013) and Gatica-Dominguez et al. (2021), who advocate for food-based strategies that utilise local biodiversity to promote affordable and sustainable nutrition.

3.5.3 Implications for food system resilience

The identification of cost-effective foods has both nutritional and economic implications. Promoting the cultivation and storage of these resilient crops can help smooth seasonal food access and enhance household dietary diversity. Their affordability makes them particularly suitable for low-income households, while their nutrient profiles help address both macronutrient and micronutrient gaps. The volatility in prices of mukene and sim-sim, however, underscores the need for improved storage and market access to reduce seasonal shortages and cost surges.

3.5.4 Integration into agricultural and nutrition programs

To scale the impact of these findings, there is a need to integrate these foods into district-level agricultural value chains, school feeding programs, and community nutrition education campaigns. Such interventions can reduce nutritional deficiencies while promoting economic resilience among smallholder farmers. The findings strongly support multi-sectoral collaboration between the agriculture, health, and education sectors to operationalize local food-based solutions for chronic malnutrition.

This study reveals notable disparities in food and nutrition security across Eastern Uganda, with Pallisa district consistently recording the poorest outcomes. The results emphasise the interplay between socioeconomic barriers, dietary monotony, and child health risks, while also highlighting feasible, cost-effective dietary solutions rooted in local food systems. By leveraging these insights, integrated strategies can be tailored to regional contexts to combat chronic malnutrition and strengthen food security resilience.

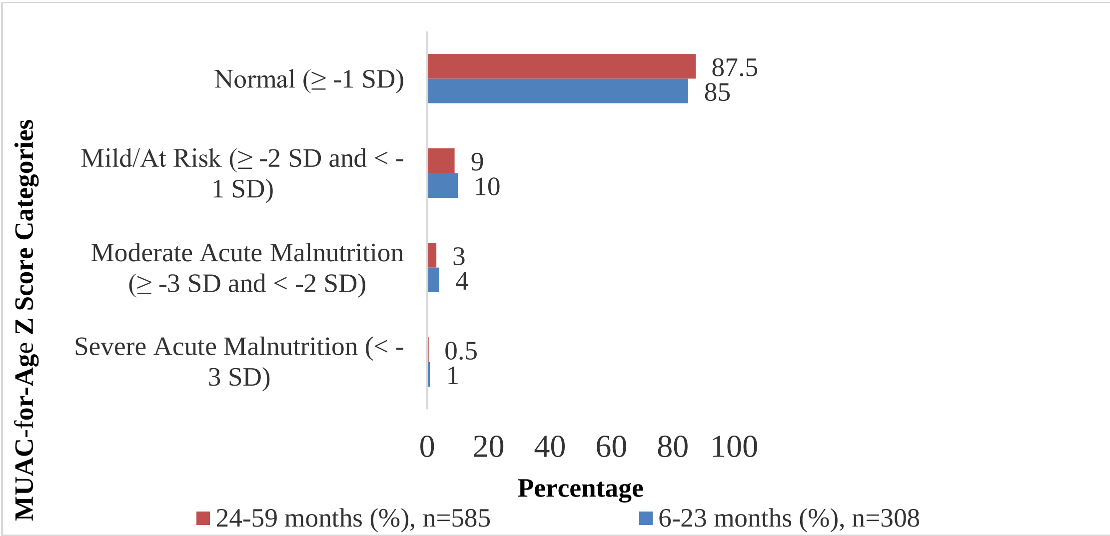

Fig. 3. MUAC-for-Age Z Score Distribution by Age Group, N=893 Children (6-59 Months)

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

This study examined the state of household food security, dietary diversity, and child nutritional status across Kamuli, Buyende, and Pallisa districts in Eastern Uganda using a mixed-methods approach. Findings reveal that smallholder farming households continue to face significant food access and utilization challenges, with widespread low dietary diversity, suboptimal child feeding practices, and high prevalence of acute malnutrition among children aged 6–59 months. These conditions were particularly severe in Buyende district, where both the Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) were lowest, and anthropometric indicators such as Mid-Upper Arm Circumference (MUAC) and Weight-for-Height Z-scores (WHZ) showed elevated levels of wasting.

Stratified data analysis further underscored the vulnerability of younger children, especially those aged 6–23 months, who consistently demonstrated lower dietary adequacy and higher rates of malnutrition compared to older cohorts. Children from households unaffiliated with farmer groups also exhibited poorer outcomes, highlighting the potential protective effect of participation in agricultural networks. While Kamuli showed modest improvement, likely attributable to its engagement in the Post-Harvest Uganda project, and Pallisa benefited from its integration in the Cereals Project and Farmer Research Networks, these programmatic gains have not fully translated into household-level nutritional resilience.

The triangulation of qualitative data reinforced these patterns, revealing that barriers to food security are not solely about production but include market inaccessibility, seasonal food shortages, gendered control over food resources, and limited knowledge about nutritious diets. Collectively, the findings highlight the multifaceted nature of undernutrition and emphasize the need for multi-pronged interventions that combine food systems strengthening with social and behavioral change.

4.2 Recommendations

In light of these findings, it is essential to establish ongoing monitoring systems that track dietary diversity and child malnutrition through disaggregated indicators such as MUAC and WHZ by age and sex. Monitoring should be integrated into community health platforms and agricultural extension services, allowing for real-time detection of food insecurity and early intervention. Emphasis should also be placed on tracking the participation and impact of farmer groups, given their apparent influence on household-level dietary and nutrition outcomes.

Evaluation of nutrition-sensitive agriculture interventions must be prioritized. Programmes that aim to improve food availability should be assessed not only for yield outcomes but also for their contribution to dietary quality and child health. For instance, while Pallisa's involvement in the Cereals Project suggests a pathway to improved food security, formal evaluation is needed to determine how effectively these gains reach nutritionally vulnerable populations such as young children and lactating women.

Adaptation is necessary to ensure that interventions are context-specific and responsive to the distinct needs of each district. In

Buyende, where the situation is most critical, immediate adaptation is needed through the implementation of short-term safety nets such as supplementary feeding, mobile health outreach, and subsidized food distribution. At the same time, long-term agricultural and market reforms should focus on reducing food price volatility and improving access to nutrient-rich foods.

Learning from this study points to the importance of gender-sensitive and age-targeted approaches. Nutrition programming should build on the structure of the existing 36 farmer groups by embedding gender-responsive, community-based learning modules focused on complementary feeding, maternal nutrition, and low-cost food preparation strategies. In households where women are the primary caregivers, learning initiatives must empower them with decision-making authority, agricultural training, and access to nutrition information.

Finally, multi-sectoral collaboration is critical for sustaining food and nutrition security. Ministries of Health, Agriculture, and Gender must work in tandem with local government and civil society actors to deliver integrated services. Community-level platforms such as Farmer Research Networks should be leveraged as vehicles for coordinated service delivery, linking agricultural innovation with health and nutrition education. A culture of continuous learning, feedback, and evidence use should be cultivated to ensure that interventions remain adaptive, accountable, and impactful.

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ETHICAL COMPLIANCE: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

CONFLICT OF INTEREST

The authors declare no conflict of interest

DATA AVAILABILITY STATEMENT

The data used in this study is available upon request from the author.

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