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Food environment and dietary intake of female smallholder farmers in rural Uganda: the case of Mpigi district

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Abstract

Background Malnutrition remains persistent among female smallholder farmers who produce most of the food consumed in Uganda; yet, information on their food environment is limited. We tested the hypothesis that rural female smallholder farmers rely mostly on the food they produce for their dietary intake.

Methods A cross-sectional survey was conducted among 386 female smallholder farmers of reproductive in Mpigi district, Central Uganda. Dietary intake was assessed using a 24-hour recall, producing the Minimum Dietary Diversity for Women (MDD-W) score, and facets of the food environment were assessed using self-reported perceptions and a seven-day food frequency questionnaire. The cost, and sources of the consumed foods were also assessed. The food-environment predictors of MDD-W were analyzed using binary logistic regression in Stata 15.

Results Results revealed that less than half of the respondents, 43.3% ($n = 167$) met the MDD-W, whereas 56.7% ($n = 219$) did not. The respondents primarily depended on a bought food environment from which they obtained an average of 6.5 (± 2.9) food items compared to their own production 4.5 (± 2.4). Every household spent an average of United States Dollars (USD) 8.5 (± 7.9) to buy food in the seven days preceding the study. The odds that a woman met the MDD-W increased by 18% ($p = 0.00$) if they bought food, by 13% ($p = 0.01$) if they obtained food through their home-stead production, and by 4% ($p = 0.00$) if they had any positive or negative perceptions on physical access to food.

Conclusions Compared with their own production, female smallholder farmers in rural areas like Mpigi depend more on the bought food environment for their dietary intake. Innovations that enhance physical and economic access to diverse diets, promote both diverse production and purchase alongside social behavior change communication, are recommended to improve the dietary diversity of female smallholder farmers in Mpigi.

Keywords Food environment, Food access, Dietary diversity, Nutrition, Smallholder farmers, Rural female farmers, Malnutrition

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Background

Globally, 30% of women aged 20 to 49 years suffer from anemia, whereas 10% are underweight [1, 2]. In East and South Africa alone, 33% of women in the above-mentioned age group are anemic, and 10% are underweight [2]. Undernutrition remains prevalent amidst increasing overnutrition in Uganda, where 32% of women of reproductive age are anemic, 9% are underweight, and 24% are overweight or obese [3]. Malnutrition among women of reproductive age poses significant risks of death, disease, and disability not only for the women but also their children.

Over 90% of the world's small farms are located in low- and middle-income countries (LMICs) and are estimated to produce one-third of the world's food supply [4, 5]. Concurrently, the highest rates of malnutrition are in the same regions [1, 2, 6]. In Uganda, the 2022 Demographic and Health Survey (UDHS) revealed that women in rural areas were twice as underweight as their counterparts in urban settings [7]. Moreover, 71% of Ugandans reside in rural areas, where agriculture is the predominant economic activity [8]. From a food systems perspective, investigating the paradox of starvation and hunger among smallholder farmers who produce 70% of Uganda's food consumption is imperative [9].

The food environment is part of the broader food system and includes components such as access, availability, affordability, convenience, quality, and sustainability of foods. These factors operate across the wild, cultivated, and built food environments typologies [10, 11]. The food environment is shaped by broader influences such as sociocultural norms, political structures, and the surrounding ecosystems. Research has shown a significant relationship between food environments and dietary intake at the population level [12, 13]. However, there is limited evidence on food environments and their impact on dietary intake in LMICs [11], particularly among smallholder female farmers in rural sub-Saharan Africa. Relatedly, there is a scarcity of empirical evidence on the connection between crop production (cultivated food environment) and dietary diversity [14].

This study assessed dietary intake, examined the food environments, and explored the relationship between the two among female smallholder farmers. According to [11], the internal food environment relates to personal attributes/perceptions about food, while the external consists of systemic contexts within which the individual dwells. These two environments interact among themselves to shape food access and consumption at individual level.

The study area, Mpigi District, is located in Central Uganda, where 6.6% of women of reproductive age are underweight and 27.7% are anemic [3]. Mpigi district was chosen as a case study because 59.3% of the households

rely on subsistence farming as their source of livelihood. The main agricultural activities carried out include livestock farming, beans, maize, and sweet potatoes production in that order [15].

The findings of this study aim to guide the development of context-specific interventions to reduce malnutrition and food insecurity among female smallholder farmers in Mpigi District.

Methods

This cross-sectional descriptive study was conducted in Mpigi District in January 2022.

The aim was to investigate the food environment of female smallholder farmers of reproductive age to inform interventions to improve their dietary diversity and nutrition outcomes. We tested a hypothesis that rural female smallholder farmers rely mostly on the food they produce for dietary intake. This hypothesis was supported by findings from Ecuador [16] and Rwanda [17] showing that rural female smallholder farmers rely mostly on home-stead food production for dietary intake.

The study recruited female smallholder farmers aged 18 to 49 years who were permanent residents of the selected villages and who provided informed consent. Participants meeting these inclusion criteria were excluded if they were pregnant, in poor health, or if their spouses were unhappy for them to participate in the study.

Sample size determination

The sample size was calculated using Kish Leslie's formula [18] for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1 - p)}{d^2}$$

where:

n = required sample size.

Z = z-score corresponding to the desired confidence level (1.96 for 95% confidence)

p = estimated prevalence of the outcome (50% or 0.5, used here for maximum variability)

d = desired margin of error or standard error (0.05)

$$n = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2}$$

$$n = 384$$

From this number, a non-response rate of 5% was applied giving a total of 403 study participants. However, only 386 women were included in the final data set used for data analysis.

Power Calculation Assumptions:

Two-sided confidence level: 95% (alpha = 0.05)

Power: 80% (beta = 0.20)

Prevalence estimate (p): 50% to maximize sample size and ensure representativeness

Margin of error (d): 5%

Sampling procedure

Multistage cluster sampling with proportionate allocation was used to recruit participants. Two sub-counties (Kituntu and Buwama) of the seven in Mpigi district were randomly selected to take part in the study. Three parishes were also randomly selected per sub-county, and four villages were randomly selected per parish, resulting in a total of 24 villages for the study. Study participants were selected from sampling frames (lists of all female smallholder farmers) that were developed by village leaders. All the random selections were done using the simple random sampling approach at all levels.

Tools

Data were collected using a structured interviewer-administered, paper-based and pretested questionnaire. After the pretest, some questions were dropped while others were re-worded to improve clarity. The final tool that was used during data collection was administered in approximately one hour.

The questionnaire assessed demographic factors such as age, marital status, and household size, among others. Data on internal food environment included perceptions on desirability, affordability, accessibility, etc., and were collected using Likert-scales, while the external food environment investigated issues of food prices, vendors, and availability [11]. Dietary intake data were collected using the three-pass 24-hour recall without estimating portion sizes in a method described by Gibson and Ferguson 2008 [19]. A dietary diversity score was calculated, and participants who scored less than five were classified

as having low dietary diversity, whereas those who scored five or more met the MDD-W according to the Food and Agriculture Organization guidelines [20].

A seven-day food frequency questionnaire was used to assess the frequency of consumption of various food items within seven days preceding the study. This was developed following guidelines from the Food and Agriculture Organization [21]. The foods were categorized using the Household Dietary Diversity Score (HDDS) food groups according to the World Food Program guidance [22].

Using the food environment framework [11], internal and external food environment factors were assessed, and their relationships with the MMD-W were examined using binary logistic regression.

Statistical analysis

The data were analyzed using Stata Version 15. Univariate (descriptive statistics), bivariate, and multivariable analyses were conducted for each food environment factor against MMD-W (outcome). The MDD-W was grouped into two categories that made binary logistic regression analysis possible. Odds ratios are reported at the $p = 0.05$ level of significance.

Data on perceptions was collected using four-item Likert scales with scores one to four in increasing importance. These scores were allocated to all foods consumed in the seven-day recall period and later aggregated for all foods consumed by the respondent. A mean score and standard deviation were calculated for the entire sample for each perception on the food environment. The data are presented as means (\pm standard deviations), percentages (numbers) and odds ratios (p values).

Results

Individual and household demographic characteristics

Table 1 shows that almost half of the respondents were aged 25 to 34 years, whereas slightly less than a quarter were aged 35 to 49 years. Most women could read and only a few could neither read nor write. More than half of the women subscribed to monogamous male-headed households, followed by those in female-headed households, and only a few belonged to polygamous male-headed households. The mean household size was 5.54 (SD = \pm 2.028) members.

Women's dietary diversity

More than half of the respondents, 56.7% (219), consumed foods from fewer than five food groups in the 24 h preceding the study, whereas 43.3% (167) consumed foods from five food groups or more, and thus met the MDD-W.

Figure 1 shows that within 24 h preceding the study, the most consumed food groups were grains, white roots,

Table 1 Individual and household demographic characteristics of female smallholder farmers in Mpigi District, central Uganda ($n = 386$)

Parameter	%(n)
Age	
18- 24years	29.5% (114)
25-34 years	45.9% (117)
35-49 years	24.6% (95)
Whether the respondent was literate	
None	15.5% (60)
Only read	84.5% (326)
Household Structure	
Male-headed with a single wife	62.2% (240)
Male-headed with multiple wives	17.4% (67)
Female-headed	20.5% (79)
	Mean (\pm SD)
Household size	5.54 (2.03)

Women's consumption from the ten food groups within 24 hours preceding the study.

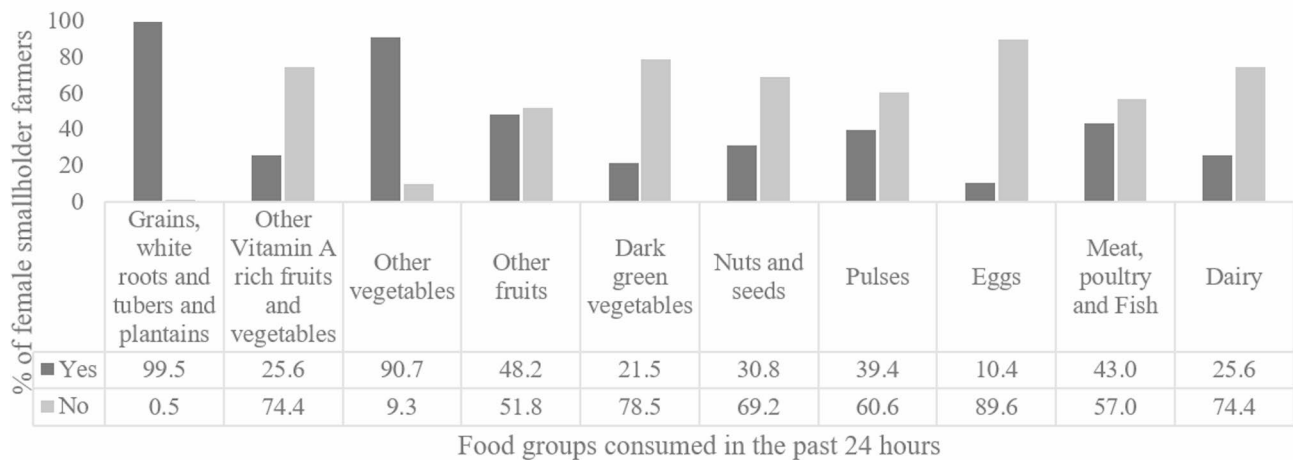


Fig. 1 The percentage of respondents who, in 24 h preceding the study, consumed or did not consume from the ten food groups

Table 2 The means and standard deviations of the scores of various food environment factors among respondents

Food environment perception	Mean (± SD)
Desirability	51.4 (± 6.4)
Healthy	50.8 (± 8.4)
Physical accessibility	43.5 (± 9.3)
Convenience	40.0 (± 5.8)
Affordability	29.9 (± 8.1)
Sources of food	
Food items from purchase	6.5 (± 2.9)
Food items from own production	4.5 (± 2.4)
Total number of sources of food	2.3 (± 0.6)
Food items as gifts	0.5 (± 0.9)
Food items from the wild	0.0 (± 0.1)
Food items picked from another's field	0.0 (± 0.2)
Food items from food aid	0.0 (± 0.0)
Food vendors	
Food items bought from permanent shops	4.9 (± 2.5)
Food items bought from wet markets	0.5 (± 0.9)
Food items bought from street vendors	0.4 (± 1.0)
Food items bought from mobile vendors	0.3 (± 0.8)
Cost of food	
Total amount spent on purchasing food	USD 8.5 (± 7.9)

The means and standard deviations of the scores of various food environment factors (perceptions, food sources, vendors and cost of food) among female smallholder farmers in Mpigi District, Central Uganda (n = 386)

tubers and plantain by 99.5% (384); and the other vegetables group by 90.7% (350) of the respondents. The least consumed food groups were dark green leafy vegetables and eggs, consumed by only 21.5% (83) and 10.5% (40) of the respondents, respectively.

Perceptions of the internal and external food environment, sources of food, food vendors and cost of food

From Table 2, the perception with the highest score among the surveyed households was desirability averaging a total of 51.4 (± 6.4), followed by the healthy perception. The lowest held perception was affordability for all food items consumed in the seven days preceding the study.

On average, households obtained food from 2 (± 0.6) sources, with most items obtained from the built food environment, followed by their own production in the past seven days preceding the study. The least common sources of food items were food aid, other's fields, wild fields, and gifting.

Food groups and sources of the food items consumed

Table 3 indicates the instances of consumption of the different food groups, together with the food environment typology from which the food was obtained in the past seven days. Cereals were the most consumed, with 779 instances and majority of the time, they were bought. The second most consumed food group were vegetables which were also mostly bought. Eggs were the least consumed, and more than half of the times they were consumed, they were from own production. Another food group with a low instance of consumption was fish and seafood, where almost all the time, they were bought.

Own production contributed most to the consumption of fruits, white roots and tubers, and legumes, nuts and seeds.

Table 3 Sources of foods consumed per food group in the seven days preceding the study

Food Group	Total times consumed (N)	Own production % (n)	Bought % (n)	Wild % (n)	Gift % (n)	Other's garden % (n)	Food aid % (n)
Cereals	779	9.9% (77)	81.9% (638)	0.0% (0)	7.9% (62)	0.3% (2)	0.0% (0)
Tubers & roots	678	82.4% (559)	13.3% (90)	0.0% (0)	4.0% (27)	0.0% (0)	0.1% (1)
Vegetables	688	42.6% (293)	49.6% (341)	0.9% (6)	6.8% (47)	0.1% (1)	0.0% (0)
Fruits	354	85.0% (301)	8.5% (30)	0.6% (2)	5.9% (21)	0.0% (0)	0.0% (0)
Meat	228	11.8% (27)	85.5% (195)	0.0% (0)	2.6% (6)	0.0% (0)	0.0% (0)
Eggs	142	38.0% (54)	59.2% (84)	0.0% (0)	2.8% (4)	0.0% (0)	0.0% (0)
Fish	213	1.9% (4)	96.2% (205)	0.0% (0)	1.9% (4)	0.0% (0)	0.0% (0)
Legumes, nuts & seeds	604	57.5% (347)	38.7% (234)	0.0% (0)	3.5% (21)	0.3% (2)	0.0% (0)
Milk and milk products	221	21.3% (47)	73.3% (162)	0.0% (0)	5.4% (12)	0.0% (0)	0.0% (0)
Oils & fats	350	0.9% (3)	98.0% (343)	0.0% (0)	1.1% (4)	0.0% (0)	0.0% (0)
Sweets	176	1.7% (3)	96.0% (169)	0.0% (0)	2.3% (4)	0.0% (0)	0.0% (0)

Sources of foods consumed per food group in the seven days preceding the study; on the basis of the number of instances, certain foods in a food group were consumed by households of female smallholder farmers in Mpigi District, Central Uganda ($n=386$). N represents the total instances when the particular foods in the named food group were consumed in the seven days preceding the study

Table 4 Types of vendors from whom food was purchased by households of respondents

Food Group	Instances/times when the vendor used was known (N)	Permanent shop % (n)	Weekly/biweekly market % (n)	Mobile vendor % (n)	Street vendor % (n)
Cereals	635	92.1% (585)	1.7% (11)	0.8% (5)	5.4% (34)
White tubers and roots	56	42.9% (24)	28.6% (16)	12.5% (7)	16.1% (9)
Vegetables	329	54.1% (178)	20.4% (67)	12.2% (40)	13.4% (44)
Fruits	25	32.0% (8)	8.0% (2)	44.0% (11)	16.0% (4)
Meat	175	51.4% (90)	24.6% (43)	1.7% (3)	22.3% (39)
Eggs	83	95.2% (79)	1.2% (1)	0.0% (0)	3.6% (3)
Fish & other sea food	198	47.5% (94)	16.7% (33)	20.2% (40)	15.7% (31)
Legumes, nuts & seeds	228	98.7% (225)	0.4% (1)	0.9% (2)	0.0% (0)
Milk and milk products	110	55.5% (61)	0.9% (1)	40.0% (44)	3.6% (4)
Oils & fats	342	98.5% (337)	1.5% (5)	0.0% (0)	0.0% (0)
Sweets	171	100% (171)	0.0% (0)	0.0% (0)	0.0% (0)

Types of vendors from whom food was purchased by households of female smallholder farmers in Mpigi District, Central Uganda ($n=386$), in the seven days preceding the study. N represents the total times when a food item in the named food group was reported to have been bought

Food groups and vendors used for the food items consumed

Since most of the food items consumed were bought, the types of vendors used were further analyzed, and the results are summarized in Table 4. Permanent shops were the most common vendors used by the households, providing an average of 4.9 (± 2.5) food items, followed by weekly/biweekly markets, street vendors, and mobile vendors in the seven days preceding the study.

From permanent shops, households mainly obtained sweets, pulses, oils and fat, eggs, and cereals, whereas from the weekly/bi-weekly markets, respondents mostly obtained white tubers and roots. Mobile vendors mostly provided fruits and milk, while from the street vendors, respondents mostly bought meats.

On average, each household spent USD 8.5 (± 7.9) to buy food in the seven days preceding the study.

Relationship between dietary intake and the food environment

Five food environment factors were significantly related to MDD-W at the bivariate level: perception of physical accessibility of food, sourcing food from own production, buying food, purchasing from permanent shops, and the total amount spent on food.

Two variables were excluded from the multivariable model: 1) the total amount spent on food was highly correlated with buying food from permanent shops ($r=0.45$) and had a low association (OR = 1.00) with MDD-W compared to buying food from permanent shops (OR = 1.19); 2) buying food from permanent shops was highly correlated with obtaining food from the built food environment ($r=0.80$), but since it is a subset of obtaining food through purchase, it was not included in the multivariable model.

In the multivariable model, the odds of a woman meeting MDD-W increased by 18% ($p=0.0$) if she bought

Table 5 Adjusted and unadjusted odds ratios of food environment facets

Food environment factor	Unadjusted Odds Ratio	p value	Adjusted Odds Ratio	p value
Perception				
Affordability	1.01	0.63		
Healthy	1.00	0.84		
Convenience	1.01	0.74		
Desirability	1.01	0.76		
Accessibility	1.05	0.00*	1.04	0.00*
Food environment typology				
Total number of sources of food	0.90	0.57		
Own production (Cultivated)	1.09	0.05*	1.13	0.01*
Purchase (Built)	1.16	0.00*	1.18	0.00*
Wild	0.43	0.31		
Gifts	0.87	0.20		
Picking from another's field	0.93	0.91		
Food vendors				
Permanent shops	1.19	0.00*		
Wet markets	0.97	0.80		
Mobile vendors	1.04	0.77		
Street vendors	1	0.92		
Cost of food				
Total amount spent on purchasing food	1	0.00*		

Adjusted and unadjusted odds ratios of food environment factors (perceptions, sources of food, vendors, and amount of food) that influence the dietary intake of female smallholder farmers in Mpigi District, Central Uganda (n=386)

*p < 0.05

food, by 13% ($p=0.01$) if she sourced food from her own production, and by 4% ($p=0.00$) for women with positive or negative perceptions of physical access to food, controlling for other factors as shown in Table 5. The analysis could however not distinguish whether the increase in MDD-W was driven by positive or negative perceptions of physical access to food.

Discussion

The purpose of this study was to assess the relationship between the dietary intake of women of reproductive age and self-reported dimensions of their food environment. The results revealed that the odds that a woman met the MDD-W increased by 18% ($p=0.000$) if they bought food, by 13% ($p=0.011$) if they obtained food through their own production, and by 4% ($p=0.000$) for women who held any perceptions on physical access to food, controlling for other factors. Compared to their own production, female smallholder farmers in rural Mpigi relied more on food purchases for their dietary intake, leading us to reject our initial hypothesis. The MDD-W is a food consumption indicator, and this study shows that, in a rural community in Uganda, its greatest food environment predictors are related to food access.

We discuss food access as it relates to how easy or hard it is for individuals to obtain the foods available in their food environment [23]. In the literature, physical aspects of access, including mobility, transportation and location, were considered [23]; however, economic access has only recently been emphasized [24]. That said, an account of both dimensions of food access is provided below since both were found to be significant in the multivariable logistic regression model.

Studies have demonstrated that physical access to food affects the dietary intake of individuals. For example, both perceived and objective measures of food access had a significant effect on the intake of fruits and vegetables among elderly individuals in rural Texas in the United States of America [25]. Additionally, various aspects of food access, such as mobility and location, affect food access in Canada [26] and Lesotho [27]. From a geographical point of view, rural farming communities in Uganda are located in hard-to-reach areas with poor road networks, coupled with long distances from trading centers. For example, the total road network coverage in Mpigi district is 288.7 km [28] on an area of 3,606 square kilometers of land [29]. Additionally, land fragmentation [30] has perpetuated land rentals [31], of which the rented land is usually located some distance away from the farmer's home. These issues create difficulty in physical access to foods available to communities, affecting their dietary diversity. Another study on the other hand, reported that mobility was not as important a factor for dietary diversity as were the choices provided by the food source [32]. However, compared with our rural context, this study was conducted in an urban area in Burkina Faso. Since perceived physical access to food is an important factor in our study, innovations to bring nutrient-dense foods closer to the farmers should be promoted.

Previous studies [33–36] have shown that economic access and economic empowerment affect the dietary intake of both women and the general population. Food purchase is highly associated with greater dietary diversity because farmers cannot produce all the foods they need to consume, so they need to purchase some [37]. However, the low scale and high cost of production mean that income from the agricultural activities (livelihoods) of the named population is insufficient to offset the cost of adequate diets, in addition to other costs of living. Other scholars have reported that production diversity as well is strongly associated with dietary diversity at the population level [38].

Similar to our findings, however, another study reported that both diverse production and food purchases are associated with the dietary diversity of rural women in India [39]. Therefore, it is imperative to implement interventions that promote both diverse production and food purchases compared with current practices

which focus mostly on diverse production in rural Africa [37].

However, the increasing trends in non-communicable diseases, with the greatest burden in sub-Saharan Africa [40], are worth noting in encouraging food purchase. Since most food items consumed by our respondents were sourced from permanent shops, they are likely mostly processed. Therefore, communities should be educated through social behavior change communication on healthy food options to inform their choices. Food regulatory authorities also should ensure that the quality, safety, and nutritional value of the foods sold promote good health.

Strengths and limitations of the study

A key strength of this study is its examination of multiple dimensions of the rural food environment covering both economic and physical access rather than focusing narrowly on isolated factors like food prices, marketing, or availability. This comprehensive approach offered a deeper understanding of the contextual factors influencing dietary diversity in rural Uganda, where limited analyses have been conducted. Additionally, including both own-production and purchased food sources provided nuanced insights into the interplay between subsistence farming and market reliance. However, reliance on self-reported dietary data from a single 24-hour recall and a 7-day FFQ introduces recall and social desirability biases, while self-reported perceptions of the food environment are subjective and may not reflect actual conditions. The single 24-hour recall also fails to capture seasonal variations, and the relatively small sample limits statistical power and generalizability. Future research should address these issues by combining self-reported tools with objective measures such as market audits, GPS mapping, price monitoring, conducting repeated recalls across seasons, increasing sample sizes, and using mixed-method approaches to validate perceptions and better understand contextual influences on dietary diversity.

Conclusion

This study found that female smallholder farmers in Mpigi primarily obtained their food through purchases, which increased their chances of meeting the Minimum Dietary Diversity for Women (MDD-W) by 18%, compared to a 13% increase from their own production. These results indicate that while homestead food production is important, improving dietary diversity for women in rural Uganda requires equal emphasis on enhancing their purchasing power. To achieve this, policymakers and practitioners must urgently integrate agricultural diversification, women's economic empowerment, and improvements to the food environment into existing frameworks. Utilizing the Uganda Nutrition Action Plan

II (UNAP II) and the Parish Development Model (PDM) offers a strategic pathway. By strengthening women's participation in PDM value chains, promoting year-round production of nutrient-rich foods, and investing in rural infrastructure to improve market access, government and development partners can address significant structural and economic barriers to nutritious diets.

Abbreviations

HDDS	Household Dietary Diversity Score
LMICs	Low- and middle-income countries
MDD	W-Minimum Dietary Diversity for Women
OR	Odds ratio
PDM	Parish Development Model
UDHS	Demographic and Health Survey
UNAP II	Uganda Nutrition Action Plan II
WRA	Women of Reproductive Age

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s40795-025-01198-9>.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Not applicable.

Authors' contributions

JN conceptualized and mobilized the resources for the study. SK analyzed the data and drafted the manuscript; LNN took part in the investigation and administration of the study; MM supervised the data collection and analysis; WM collected the data; DA supervised the data collection and analysis. TLB, JK and VN analyzed the data. All authors reviewed the manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearances for this study were obtained from the Clarke International University Research and Ethics Committee (Reference No. CLARKE-2021-122), and the Uganda National Council for Science and Technology (UNCST) (Reference No. A146ES). For each respondent, informed consent to participate in the study was obtained. All study participants were 18 years and above so assent and consent from parents or guardians were not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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