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Assessment of Sustainable Livelihoods of Small Holder Farmers in the Densely Populated Highlands of South-Western Uganda

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Abstract

The paper uses cross sectional data from 281 farm households collected through farmer interviews, focus group discussions and field observation from the densely populated highlands of southwestern Uganda. It is derived from a baseline study of a project aimed at developing agricultural intensification models for sustainable livelihoods in the study area. We assess livelihood activities and use the Sustainable livelihood framework, to assess livelihood vulnerability of the small holders focusing on the social and demographic profiles, livelihood strategies, social networks, financial capital and food. The details of the subcomponents for each of the major components are presented and discussed. Crop production is the major source of livelihood for 93.1% of the sampled households. The study shows that households in the study area have a relatively low livelihood vulnerability index of 0.33. Female headed households are more vulnerable with an index of 0.36 compared to male headed households with LVI of 0.32. About 19% of the sampled households are highly vulnerable with a LVI of 0.5. High vulnerability was recorded for social networks at 0.43 and the lowest recorded is 0.29 for food. Results indicate an average household dietary diversity score of 6, implying limited nutrients for some households. A more detailed study on food and nutrition security might be important to identify the gap in nutrient levels. Pests and diseases, unpredictable weather and low soil fertility are the major factors limiting production. Replication of this study including data on other key components specifically climate change might provide information about how the exposure, adaptive capacity, and sensitivity of the region will change as intensification adaptation practices are initiated.

Keywords: rural population, highlands, sustainable livelihoods, Uganda, food security and income

1. Introduction

Agriculture is an important sector for most countries in sub-Saharan Africa, where it remains the main source of livelihood for a majority of the rural population. A majority of the population continue to depend on agriculture for both income and food security. While crop and livestock production are the main sources of livelihood for a majority of rural households, their productivity is very low due to various factors including limited resources, limited knowledge and skills, unpredictable and harsh weather conditions and limited farm size (Belay et al., 2017). Agricultural land per household continues to shrink due to high population growth and as a result, the small land has been over cultivated leading to low soil fertility (Party et al., 2018).

Uganda has one of the highest population growth rate in the world at 3.0 percent with the current population at 48.58 million persons (UBOS, 2023) and projected to increase to 61 million in 2040 (National Population Council, 2018). Uganda's economy is predominantly rural, with more than 80% of its population and 95% of the poor living in rural areas (National Population Council, 2018). A majority of the population in Uganda, about 69 percent of the households depend on subsistence farming as their main source of income and food. The major concern is how to feed this population on limited land.

One potential pathway for increasing household food and nutrition security for rural households with limited resources especially land is through sustainable intensification (Mubiru et al., 2018). Sustainable intensification is about increasing productivity of the available resources while minimizing negative effects on the environment and

without conversion of non-agricultural land (Pretty et al., 2012). Traditionally, agricultural intensification has been defined in three ways: (1) increasing yields per hectare; (2) increasing cropping intensity (i.e. two or more crops) per unit of land or other inputs (water), or livestock intensity (e.g. faster maturing breeds); and (3) changing land use from low value crops or commodities to those that receive higher market prices or have better nutritional content (Pretty & Bharucha, 2014).

This paper provides a detailed assessment of the livelihoods of the rural population in the densely populated highlands of Kigezi. The paper is derived from a baseline study of a research project whose main objective is to explore different options and design a feasible, socioeconomic and technically acceptable model for guiding sustainable intensification in densely populated highlands. This will include integrating livestock in the crop dominated farming system and restoring nutrients in the degraded soils. Integrating crop farming and livestock has several benefits such as provision of organic fertilizer for the crops and feeds for the livestock, thus, allowing recycling of nutrients and efficient use of the limited resources in the farming system (Mubiru et al., 2018; Whitney et al., 2017; Nanyeenya et al., 2009). Integration of crop and livestock further creates alternative sources of income thus spreading the risks associated with depending on specific enterprises. Whereas, there are several options, it is important to identify combinations that will provide the farmer with optimal output both in terms of income and food security.

In Uganda, the average holding land size of the agricultural households was 1.3ha as per annual agricultural survey 2019 (UBOS, 2022). However, 67% of agricultural households had less than 1 ha and Southwestern Uganda had the smallest holding size of about 0.4 ha (UBOS, 2022). As the population continues to increase, productive land per capita is decreasing and therefore, the solutions to food insecurity must be holistic. The major challenge to achieving food and nutrition security is not only small land holdings but also low agricultural productivity. For example, the yield of potatoes a major crop in the region, has declined from 7.14mt / ha in 2010 (Mbowa & Mwesigye, 2016) to 4.2mt / ha in 2019 (UBOS, 2022). The underlying causes of low agricultural productivity are diverse, ranging from use of poor technologies and methods of farming to environmental degradation and associated impacts of climate change. Increased land degradation has been linked to various factors including; poverty and land fragmentation, increasing rural population densities with limited off farm income opportunities and poor markets for produce coupled with production of low value commodities that farmers have low incentives to invest in soil maintenance and management technologies (Olson & Berry, 2003; Nkonya, 2002). Other factors such as little farmer knowledge of improved agricultural technologies, insufficient agricultural research that takes into account the needs and resource constraints of farmers, and a lack of effective agricultural extension as well as inappropriate farming practices/ systems including deforestation and bush burning have equally contributed to low productivity and consequently food and nutrition insecurity (Olson & Berry, 2003). With the compelling need to feed the rapidly growing and urbanizing population, sustainable intensification of agricultural production is a must (Vanlauwe et al., 2014). Yet, not much effort has been made in developing sustainable agricultural intensification models necessary in guiding use of small land holdings in the densely populated highlands. This paper provides a baseline and insights about the heterogeneity of the smallholder farming systems in the densely populated southwestern highlands, it highlights the different sources of livelihood focusing on income and food security.

Hunger, malnutrition and poverty have remained serious challenges in sub-Saharan Africa. Productive resources have been heavily depleted rendering them unproductive for the future generation. Enhancing agricultural productivity needs to go hand in hand with the maintenance of other ecosystems services. Sustainable intensification is gaining momentum as a means to meet the increasing food demands for the increasing population. Intensification is the process of enhancing agricultural yields with minimal environmental impact (Loos et al., 2014). Sustainable intensification can promote transition from subsistence agriculture to commercial agriculture which in turn benefits progress in other sectors (Pretty et al., 2011). Rockström et al., (2017) propose for a paradigm shift towards sustainable intensification of agriculture, integrates the dual and interdependent goals of using sustainable practices to meet rising human needs while contributing to resilience and sustainability of the entire environmental ecological system.

However, for a lasting paradigm shift from the current agricultural practices of nutrient mining, Pretty et al., (2011) underscores the importance of policies and incentives necessary for the wider adoption of sustainable intensification practices. Policies however, must be guided by research because of the heterogeneity of the farming environment and socioeconomic differences across households (Ulukan et al., 2022; Simane et al., 2016). Most studies have not considered these differences and therefore, tend to provide general guidelines without considering various components of the farming systems. In Ethiopia for example, Simane et al., (2016) found that livelihood vulnerability index (LVI) varied systematically across agroecological systems where high elevation sloping lands and low elevation steep lands exhibited relatively low adaptive capacity to climate variability and high

vulnerability compared to the midland which had higher capacity and lower vulnerability. Sustainable intensification is also constrained by a number of barriers including; socioeconomic inequalities between gender for example in Kenya, male easily adopt minimum tillage and animal manure in crop production compared to women (Theriault et al.,2017; Ndiritu et al.,2014). In Bukina Faso women are less likely to adopt yield enhancing and soil restoring strategies (Theriault et al., 2017).

Moreover, sustainable intensification ought to take care of heterogeneity in small holders who are a diverse group depending on their socioeconomic conditions. Their diversity potentially generates a multitude of pathways from the current low productivity to sustainable production (Vanlauwe et al., 2014). For example, access to resources, equipment, land acreage, livestock ownership, value of non-farm income have been reported to affect adoption of sustainable intensification practices in cereal production in West Africa (Theriault et al., 2017). Understanding the categories of small holders is important in order to design the best options innovation for the various categories across household types. As for the southwestern highlands which are densely populated and highly degraded, intensification of agriculture with a crop-livestock intensification might be the best option without degrading the resource base (Vanlauwe et al.,2014). Addressing the challenge of low productivity requires adoption of new approaches to how research is formulated, managed and executed (Rockström et al., 2017). This research employs a rather unique approach where it is not just evaluating existing approaches but rather involving the community in finding appropriate and reliable solutions to own problems.

2. Methodology

2.1 Study Area

This research was conducted in the southwestern highlands of Uganda in greater Kabale (Figure 1). This area was chosen for the study because it is characterized by small land holdings, decreasing agricultural productivity as a result of land and soil degradation among others. South western highlands is one of the densely populated areas in Uganda with a population of about 528,231 persons with over 76.3% in the rural areas (Uganda Bureau of Statistics 2017). It has a land area of about 1,679.1 km2 (648.3 sq mi) with a population density of 296.8/km2 (769/sq mi (Uganda Bureau of Statistics 2017). A majority of the population is engaged in crop production especially potato and sorghum with only 25.9% engaged in livestock. The land is overcultivated and the soils are highly degraded (Muzira et al., 2018). This is manifested by low productivity of their main crops like sorghum yet it occupies a considerable big area (UBOS 2010). The area therefore needs a sustainable intervention to continue feeding its population.

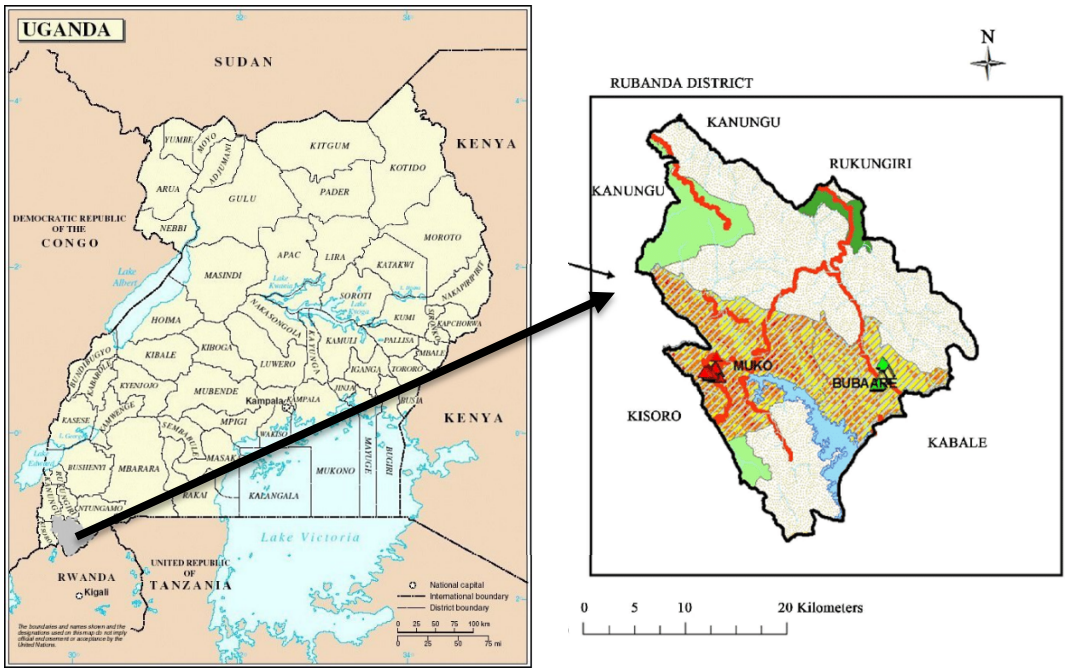

Figure 1. Map of Uganda showing the study area (grey shades)

Source: Mugaga, (2019)

2.2 Sample Selection

The study sample is from Rubanda district. Rubanda district was, purposively selected due to its proximity to other districts of Kisoro and Kanungu with similar challenges. In consultation with the district agriculture production officer two sub counties namely, Bubare and Hamurwa were purposively selected. These were selected because of the high population and their similarity to many other sub counties in the region. From each subcounty, a list of farmer groups was obtained from the community development officer and two farmer groups were randomly selected. Farmer groups were considered because they will be the training unit for the project during intervention. All members of the farmer groups were interviewed making a total of 281 respondents.

2.3 Data Collection and Type of Data

A mixed method approach was used to collect both secondary and primary data. Secondary data were collected through a review of literature and other relevant reports. Primary data were collected by conducting household interviews with selected farmers in each of the selected subcounty. The interviews were conducted by trained research assistants using a pretested semi-structured questionnaire. The questionnaire was pretested on 25 respondents (about 9% of the target sample). To augment household data, other data were collected at community level through focus group discussions that involved different members of the community purposively selected to represent various categories including men, women and the youth farmers. A total of 4 (2 per subcounty) focus group discussions were conducted. The type of data collected include demographic and social economic characteristics of sampled household, sources of income, household assets, livestock and crop production, yields and marketing. Other data were collected on household food and nutrition security specifically on food availability, access and dietary diversity.

2.4 Data Analysis

Livelihood sustainability

We applied the Livelihood Vulnerability Index (LVI) analysis to identify the levels of livelihood sustainability of the small holder farmers in the densely populated highlands. This is further supported by descriptives statistics and correlation analysis. The sustainable livelihood framework based on DFID (1999) was used to analyze livelihood vulnerability of the households in the densely populated highlands and the factors affecting sustainability in agricultural livelihoods. The livelihood vulnerability Index (LVI) includes seven major components including sociodemographic profile, livelihood strategies, social networks, food, water and natural hazard induced disasters (Hahn et al., (2009). In this paper, the original framework was adjusted to make it suitable for our context. The LVI was calculated based on five components due to lack of data on subcomponents for water and natural hazard induced disasters. The original framework was adjusted based on previous studies (Tran et al., 2021; Thao et al., 2019) and available data. The five key components were classified into indicators or subcomponents as follows;

Social demographic variable comprises dependency ratio, percent of female-headed households, average age of female head of household and percent of households where head of household has not attended school. Under social capital, we considered the average borrow-save ratio, percent of households that have been members of savings and credit associations in the past 12 months and percent of households that have been members of a farmers' association in the past 12 months before the survey. Financial capital comprises annual household income and access to loans. Livelihood strategies comprise the percent of households dependent solely on agriculture as a source of income. average livelihood diversification index and agricultural acreage. The food component comprises the percent of households dependent solely on family farm for food, average number of months households struggle to find food, average crop diversity index, percentage of households that do not save crops and percent of households that do not use improved seed.

Whereas, each of the component was measured using appropriate scale in different units, the subcomponents were standardized to become an index following Hahn et al (2009).

$$\mathrm{Index}_{S_i} = \frac{S_i - S_{min}}{S_{max} - S_{min}}$$

Where S_i is one of the subcomponents and S_{max} and S_{min} are the maximum and minimum values respectively. After the subcomponents are standardized, their average is computed to calculate the value of each key component using the equation below;

$$M_i = \frac{\sum_{i=1}^{n} \mathrm{Index}_{S_i}}{n}$$

M_i is one of the main components, index S_i shows the subcomponents recorded with indicators i and n is the

number of subcomponents in each main component. When the value of the key component is determined, livelihood vulnerability index is calculated as follows;

$$\text{LVI} = \frac{\sum_{i=1}^{5} w_{M_i} M_i}{\sum_{i=1}^{5} w_{M_i}}$$

LVI is the livelihood sustainable index for the study area, corresponding to the weighted average of all 5 main components. The weight of each main component, w_{M_i} is determined by the number of subcomponents contributing to the main components. The LVI values range from 0 to 1(the lowest to the highest vulnerability).

Household Dietary diversity score (HDDS)

The study further, assessed food security in respect of food access by measuring the dietary diversity score. Dietary diversity score is a qualitative measure of food consumption that reflects household access to a variety of foods and it is a proxy for nutrient adequacy of the diet (Hoddinott & Yohannes, 2002; Kenedy et al., 2011). Different foods are grouped into eleven categories including cereals, root and stem tubers, vegetables, fruits, meat, eggs, fish milk and milk products, pulses, cooking oil and sweeteners. If the household consumed any of the foods in the period of 7 days before the interview, it scores 1 and 0 otherwise. The sum of all categories is the household's dietary diversity score (HDDS).

3. Results and Discussions

3.1 Demographic and Social Economic Characteristics of the Sampled Households

It is important to understand the demographic and social economic characteristics of the sampled households as these characteristics may influence livelihoods. Table 1 presents a summary of the key characteristics considered. Findings indicate that most households are male headed (70%) with an average age of 51 years slightly higher than that of their spouses with an average age of 43 years. A majority of farmers have primary level education with an average of 6-7 years of schooling. About 82% of farmers interviewed are married with an average household size of 5 persons. This is close to 4.8 persons for rural households reported by Uganda Bureau of Statistics (UBOS) (2021). For most households (89.2%), crop farming is their main occupation, followed by non-farm business (3.5%) and livestock production (3.2%). Livestock production is a secondary occupation for most households (38.9%) followed by Non-farm business (21.2%). Notably, 16.5% have no secondary occupation and therefore rely on one source of livelihood. Findings indicate that most households are small holders with an average land size of 1.6 acres which is mainly used for crop production (1.5 acres).

Table 1. Socio-economic and demographic characteristics of sampled farmers

Characteristic	Category (n = 2821)	Percentage /average (std deviation)
Average age of the farmer (years)	household head	51(15.5)
	household head's spouse	43 (17.8)
Farmer's Gender:	Male	69.7
	Female	30.2
Level of education of the farmer (years of schooling	Household head	7 (4.0)
	Spouse of the household head	6 (3.6)
Marital status	Married	82
	Single	2
	Widowed	16
Household size		5 (2.1)
Main Occupation	Crop production	89.2
	Nonfarm business	3.5
	Livestock production	3.2
	Government/NGO job	1.4
	Others	2.4
Secondary occupation	Livestock production	38.9
	Non-farm business	21.2
	None	16.5
	Crop production	10.6
	Government/NGO job	4.8
Average Land size owned (acres)		1.6 (1.2)
	Land under crop production	1.5 (1.4)
	Average Land under fallow	0.2
	lease	0.1
Annual household income (million UGX)		2,269,545
		(2,342,589)

Note: Standard deviation in parenthesis

Household sources of income and savings

The average annual household income is about UGX 2,269,545 (USD 609) (Note 1). The major source of income for households is production and sale of crops (93.1%) followed by production and sale of livestock (38.2%), hiring out labour (25.6%) and trading (23.8%) (Figure 2). Apart from farming, 52% of the households have other sources of income with an average monthly income of UGX 173,583.

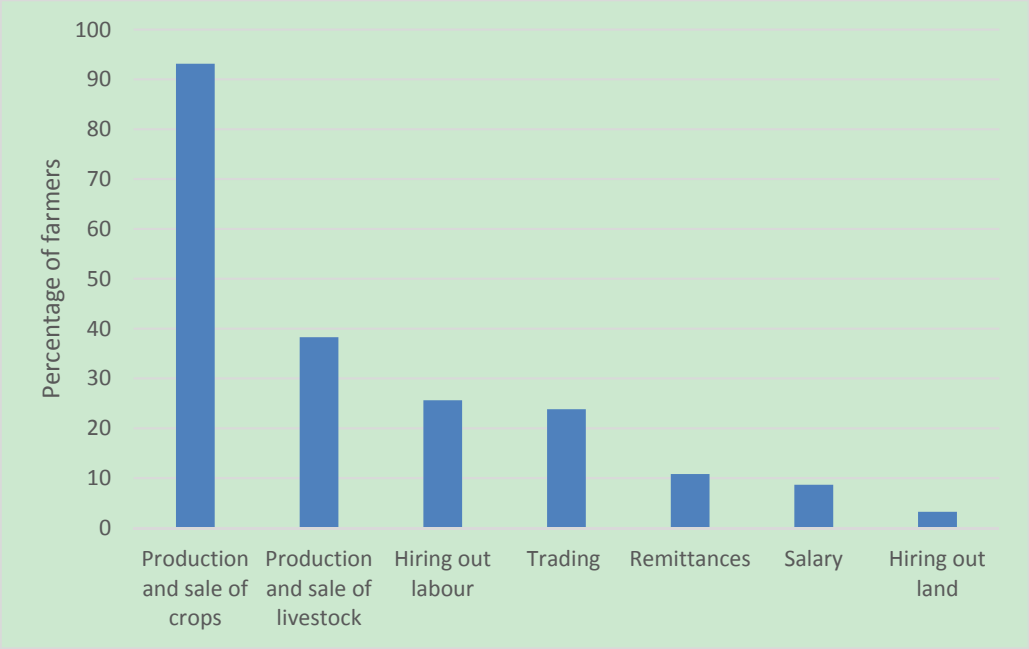

Figure 2. Major sources of income

With regards to savings, about 70% of the respondents are members of a savings and loans association. These are mainly village and savings loan associations (VSLA) with an average of about 30 members. Members save on a weekly basis and findings indicate that every respondent saves on average UGX 26,334 per month. The study assessed farmers savings' resilience to shocks such as COVID -19 and results indicate that 20% of the farmers who were saving on a weekly basis were not able to continue saving during COVID -19 pandemic. About 26% of the respondents borrowed money during lockdown to take care of their basic needs. Similar results were reported by Mahmud & Riley (2021) who found that rural households used nearly 50% of their savings and borrowed post the lockdown.

Household expenditure

Figure 3 displays the average annual household expenditure of sampled households. The highest expenditure was reported on school fees to an average of UGX 1,179,584 annually. This is closely followed by food with an average of UGX 1,167,425, alcohol (UGX 485,500), medical care (UGX 442,049) and transport and communication (UGX 342,661). Interesting to note is the high expenditure on food yet one would expect that farmers mainly consume what they produce. This might be attributed to very small land holdings that farmers are not able to produce enough. Moreover, they purchase what they do not produce especially livestock products. These results corroborate with national statistics which show that rural households spend 48% of their income on food (UBOS, 2020).

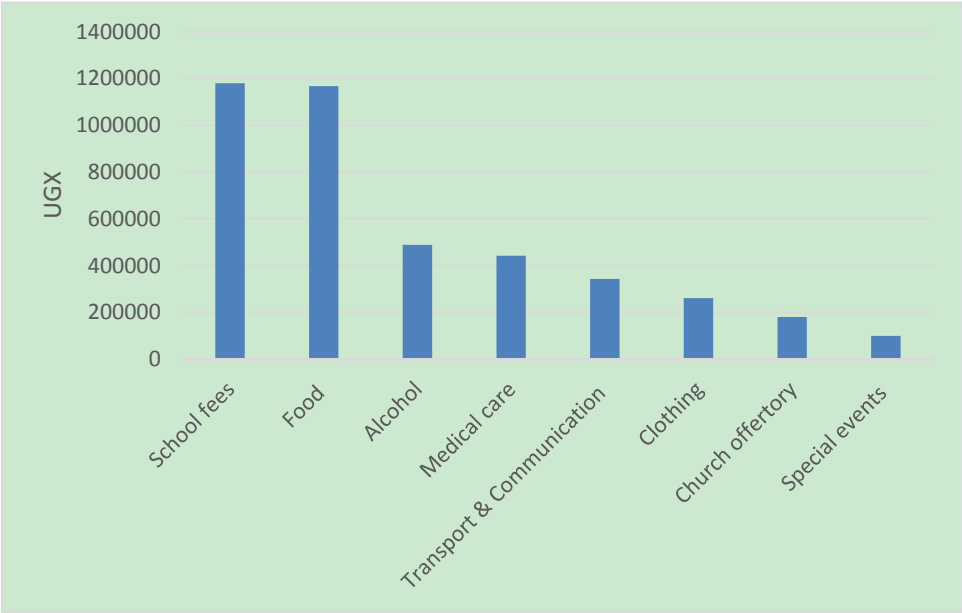

Figure 3. Household annual expenditure

3.2 Livelihood Vulnerability of Sampled Household

Vulnerability assessment in this paper focusses on quantifying the strength of farmers' livelihood and agricultural systems and the capacity of communities to adapt and cope in response to shocks. The study considered five key elements to assess livelihood vulnerability of sampled households and the results are presented in Table 2. Overall, the households in the study area have a livelihood vulnerability index of 0.33 which is relatively low. The highest vulnerability index recorded is 0.43 for social network while the lowest is 0.29 for food. The households have a social demographic index of 0.31 which is rather low. Only 30 % of the households are female headed and they are of middle age. A majority of household heads attended school thus making their households less vulnerable. The main challenge is a relatively high dependency ratio with an index of 0.5. considering the limited resources of the households they are likely to be vulnerable to shocks.

Results indicate a livelihood strategy index of 0.3 which is low. This is explained by a high percentage (48%) of households that solely depend on agriculture for income, yet with small land holdings with an index of 0.2. Moreover, the Average livelihood diversification index is equally low (0.22), hence most households have low capacity to adapt in case of shocks. As reported by Khan & Morrissey (2023), diversification specifically off farm income has become increasingly beneficial for welfare over time in rural areas. Most households have a relatively low financial capital with an index of 0.38. While the annual household income is very low with an index of 0.16, most households (61%) can access loans especially from village savings and loans association (VSLAs). To some extent, this helps most households to adapt.

The social networks are quite moderate, with an index of 0.43. This is attributed to a high percentage (70%) of households being members of savings and credit associations. However, membership to farmers association is still low at 25%. This area requires improvement since most households depend on farming. As observed by Sujakhu et al., (2018) strengthening human, natural and financial capital is one of the best means of managing risk and reducing vulnerability in farming communities.

The overall food vulnerability score is at 0.29. This is attributed to a high percentage (48%) households solely depending on farm for food. Given that most households have very small land holdings coupled with low yields, they become more vulnerable to food insecurity. It is not surprising that almost half of the year households struggle to find enough food. This is mainly during the growing period within the season. Further, we observe a very low Average crop diversity index at 0.11 implying that most households are able to grow few crops. This is expected given small land holdings and it makes households more vulnerable (Makate et al., 2016; McCord et al., 2014). The study also revealed that 17% of the households are not able to save crops, they consume all they harvest. This makes them rather vulnerable as they may not be able to get food incase of crop failure.

Table 2. Major components, indexed subcomponents and overall LVI for Rubanda District, Southwestern Uganda

Main component	subcomponent	Units	Mean values	Maximum value	Minimum value	Index	LVI
Socio-demographic profile	Dependency ratio	ratio	0.5	1	0	0.5	0.31
	Percent of female-headed households	Percentage	30.3	100	0	0.30	
	Average age of female head of household	1/years	0.02	0.04	0.01	0.33	
	Percent of households where head of household has not attended school	Percentage	12	100	0	0.12	
Livelihood strategies	Percent of households dependent solely on agriculture as a source of income	Percentage	48	100	0	0.48	0.30
	Average livelihood diversification index	1/number of economic activities	0.3	1	0.1	0.22	
	Agricultural acreage	acres	1.6	8	0	0.2	
Financial capital	Annual household income	UGX	2,269,545	14,000,000	70,000	0.16	0.38
	Access to loans	percentage	61	100	0	0.61	
Social networks	Average borrow-save money ratio	ratio	1.0	2	0.5	0.33	0.43
	Percent of households that have been members of savings and credit associations in the past 12 months	percentage	70	100	0	0.7	
	Percent of households that have been members of a farmers associations in the past 12 months	Percentage	25	100	0	0.25	
Food	Percent of households dependent sorely on family farm for food	percentage	48	100	0	0.48	O.29
	Average number of months households struggle to find food	months	6	12	0	0.5	
	Average crop diversity index	1/number of crops	0.2	1	0.1	0.11	
	Percentage of households that do not save crops	percentage	17	100	0	0.17	
	Percent of households that do not use improved seed	Percentage	18	100	0	0.18	
Overall LVI			**0.33**				

Crop production and productivity

Crop production is the main source of livelihood for the farmers in the southwestern highlands of Uganda. Figure

4 displays the major crops grown by most farmers. The major crops grown include beans by 97.8%, followed by sweet potatoes (86.8%), sorghum (82.8%) and potatoes (66%). Some crops are grown mainly for income while others are grown mainly for home consumption (Figure 5). The major income crop is sorghum reported by 70% of the farmers interviewed followed by beans reported by 57% of the respondents. These are followed by potato reported by 39.2%. Others include cabbage, tobacco and sweet potatoes. The major food security crops are sweet potatoes reported by 87 % followed by beans (51.6%) and potato (34.9%). Important to note is that beans and potato remain the 2nd and 3rd important crops respectively for both income and food security. Crop diversification is one strategy that small holder farmers employ to reduce their vulnerability when dealing with unpredictable agricultural environment specifically climate variability and associated effects. As reported by other studies such as McCord et al., (2014), crop diversification motivated by household income, field size and exposure to agricultural extension tend to reduce household vulnerability.

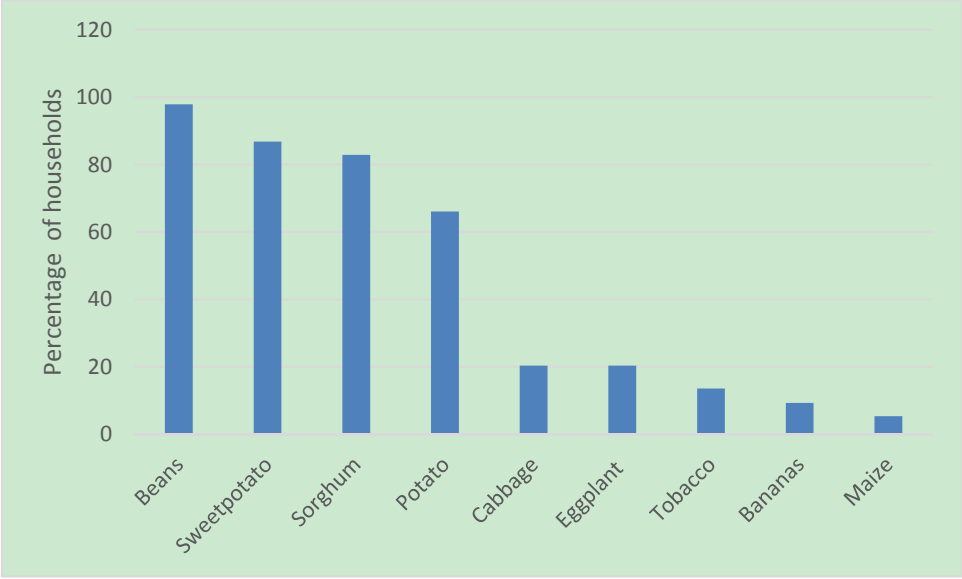

Figure 4. Major crops grown by households

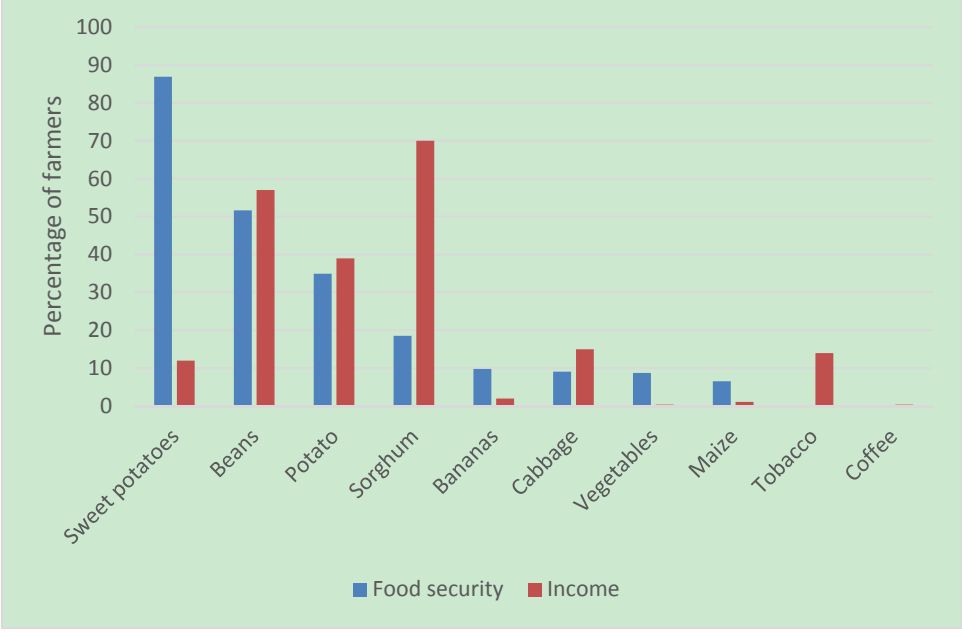

Figure 5. Crops grown for food security and income

The study assessed yields of major crops and the results are summarized in Table 3. A majority (92%) of farmers

grow local sorghum varieties and the average yield is 526kg/acre far below potential yield of 3.6 tons per acre. Despite most farmers growing improved varieties of beans (70%) and potatoes (77%), we observed low yields for these major crops in the study area. The average yield for beans is 389kg/acre which is very low compared to the potential yield of 700 – 1500kg/acre depending on the variety. Potato average yield per acre is 1,188kg equally very low compared to the potential yield of 6 tons per acre. Farmers reported that both production and productivity have been decreasing over the past five years. These results can be explained by various factors including high incidence of pests and diseases especially on beans and potatoes. About 50% and 31% of respondents reported pest damage on beans and potatoes respectively (Figure 6). Yet, potatoes are more prone to diseases as reported by 45% compared to beans where the disease burden was reported by 34% of the respondents (Figure 6). Other factors include; unpredictable weather conditions, exhausted soils, inadequate labour and limited access to extension services (discussed under factors affecting production).

Table 3. Production trend and yield of major crops

Crop	Variety	Yield/acre (kg)	Production trends
Beans	Improved	389	Decreasing
Sorghum	Local	526	Decreasing
Potatoes	Improved	1,188	Decreasing

Figure 6. Proportion of farmers who reported pests and diseases on key crops

Livestock production

Livestock production is a secondary occupation for 39% of the small holder farmers in the study area**.** A majority rear goats (49%) followed by local cattle (39%), indigenous chicken (35%), pigs (35%) and rabbits (27%) (Figure 7). The small numbers of farmers engaged in livestock are due to limited land for most households. Livestock enterprises such as dairy, poultry and others are known to provide regular income which is important for sustainable livelihoods. Based on our findings, it means that most farmers rely on seasonal income from crops and that makes them more vulnerable with low resilience to effects of seasonal /climate change.

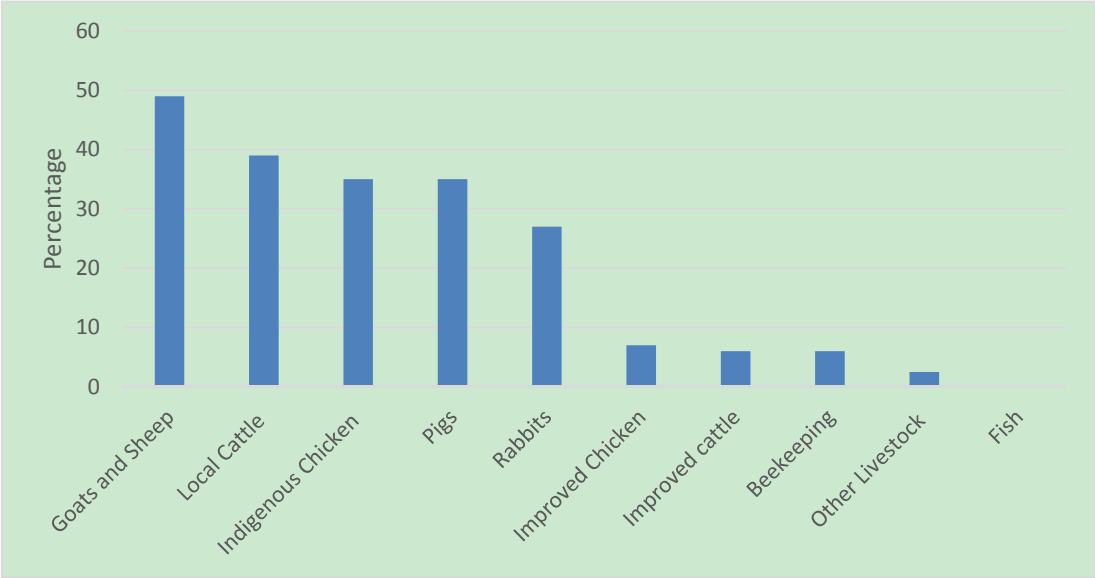

Figure 7. Proportion of farmers who rear different types of livestock

3.3 Factors Limiting Crop Production

Figure 8 depicts the various factors affecting production in the study area. The key challenge faced by farmers is high incidence of pests and diseases reported by 71% of the respondents. This affects yields and increases cost of production as farmers have to incur costs on pesticides. The most affected crops are potatoes and beans where 38 % and 21% of the respondents respectively apply pesticides. Crop production is further affected by unpredictable weather and climate change. Crop production is heavily dependent on nature, yet it is increasingly becoming difficult for farmers to predict the start and end of rains. This affects planting time and the water available for crops and consequently yields. Similar effects have been reported in many other studies as reviewed by Neenu et al., (2013). There is need to promote adaptation practices in order to minimize the impacts to a great extent. The other key factor affecting crop production is low soil fertility. Southwestern highlands are densely populated with very small land holdings per household. As a result, the soils are frequently used and have been exhausted. Thus, yields for most crops are much below potential yield. Despite the challenge of low soil fertility, results indicate that only 29% of farmers use inorganic fertilizer on potatoes, 8% use inorganic fertilizer on beans. A relatively higher proportion (55%) apply organic manure on beans and 13% apply organic manure on potatoes. There is need for farmers to increase use of organic manure to improve soil productivity. A study by Ma et al., (2023) indicates that increasing soil organic carbon beyond current technology to optimum levels can increase production of staple crops by at least 4.3%.

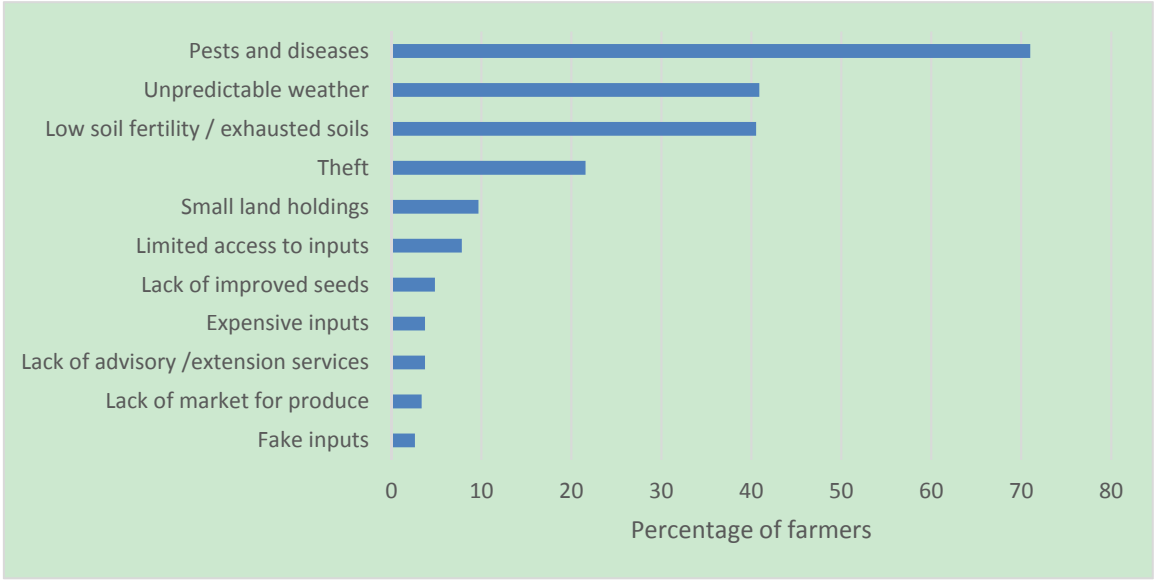

Figure 8. Factors limiting production

The study also assessed farmers' access to services such as extension, credit and market information, which support farmers in production. About 58% have access to extension services leaving the 42% not able to access extension services. The main source of agricultural information is from government extension workers (43.2%) fellow farmers (29%) and NAADS (10.9%) (Figure 9). A majority (47%) access extension service seasonally (Figure 10). Remarkably, 23% of the respondents access extension services by chance for example occasionally when there is training. Yet, 63% of farmers interviewed had not received any training in the past 12 months. This limited access to extension services partly explains low yields recorded for major crops. Access to credit is another important factor for production. Findings indicate that about 61% of the farmers belong to groups that provide financial support. These are mainly village savings and loans associations (VSLAs).

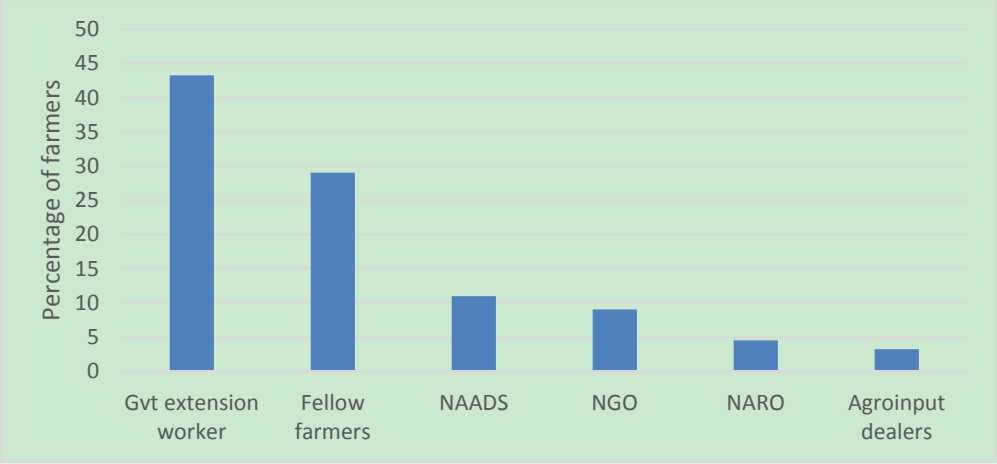

Figure 9. Source of extension services/ agricultural information

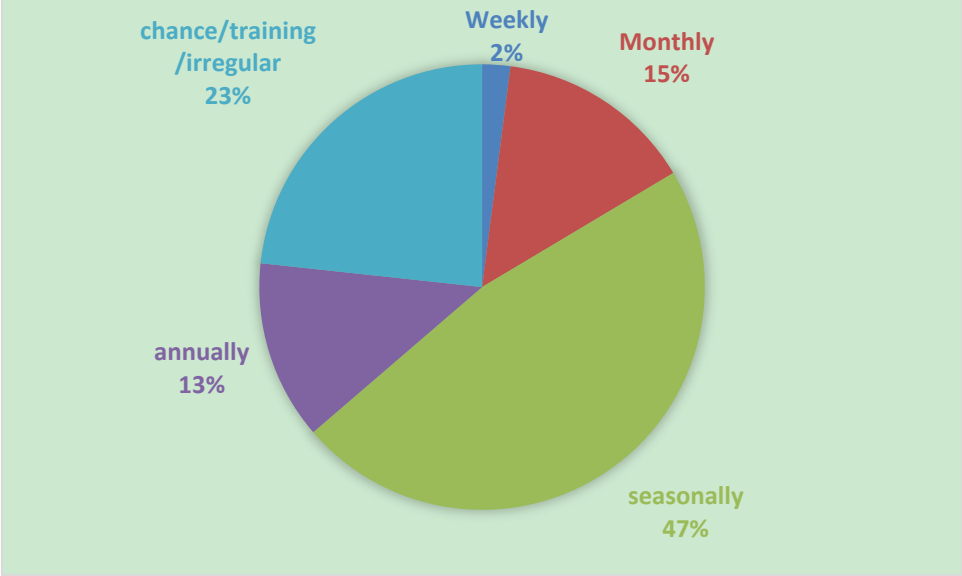

Figure 10. Access to extension services

Access to market information

Findings indicate that most farmers have limited access to market information. About 47% of the farmers interviewed get market information from traders, 37% from fellow farmers, 8% from the radio and 4% from extension workers (Figure 11). Since traders are the main source of market information, it means that traders can only give farmers the price they are willing to pay. This is further compounded by the fact that most (85%) farmers market their produce individually.

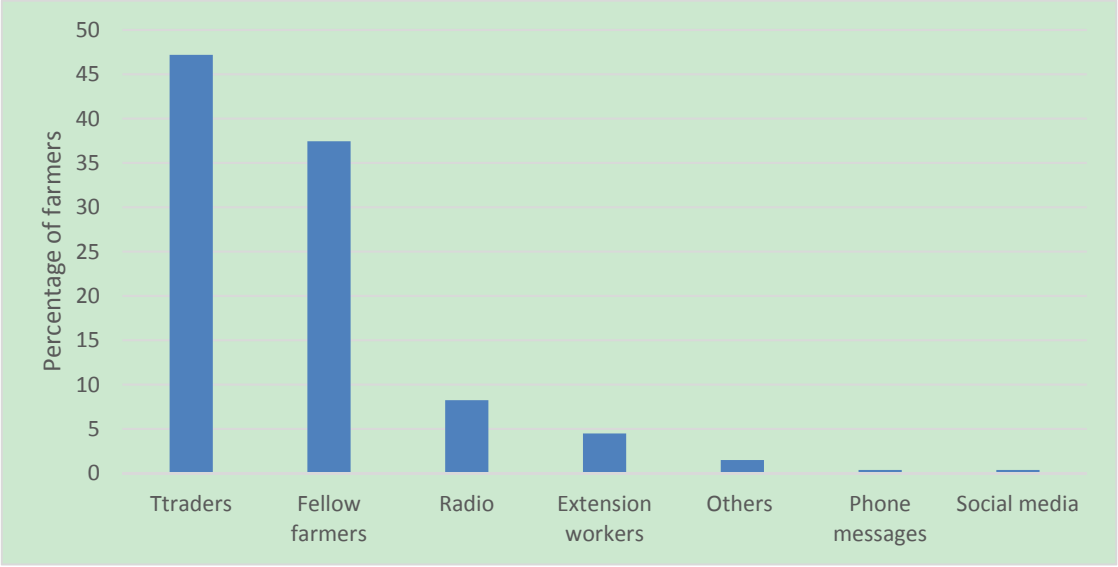

Figure 11. Source of market information

3.4 Food Diversity and Household Food Security

Food and nutrition security is a key element of sustainable livelihoods. The study attempted to assess the food and nutrition security of the households in the densely populated highlands by considering dietary diversity and food availability as well as access. Dietary diversity reflects household access to a variety of foods and it is a proxy for nutrient adequacy of the diet. Results indicate an average household dietary diversity score of 6. This means that majority of the households consume at least 6 out of 11 food categories. Figure 12 presents the foods consumed by the households in a recall period of 7 days. Root tubers, vegetables, cereals and pulses dominate the diet of most households. Root tubers specifically sweet potatoes and potatoes provide the major source of energy for all the households. About 81% had consumed a cereal especially sorghum, 98% of households had consumed vegetables while 96% had consumed pulses specifically beans. Fruits are also fairy consumed by 72% of the households. It was noted that most households did not consume animal products in a period of 7 days for example meat was consumed by only 21% and fish by 7% which is very low. Low consumption of animal proteins raises concern about nutrition security. Low consumption of animal proteins is explained by the fact that very few (42%) households keep livestock and this has been persistent over the years considering reports from previous studies such as Nanyeenya et al., (2009). Consistent with previous studies such as Ntakyo & Berg, (2019), we find that most households are not able to purchase the animal-based proteins due to low incomes.

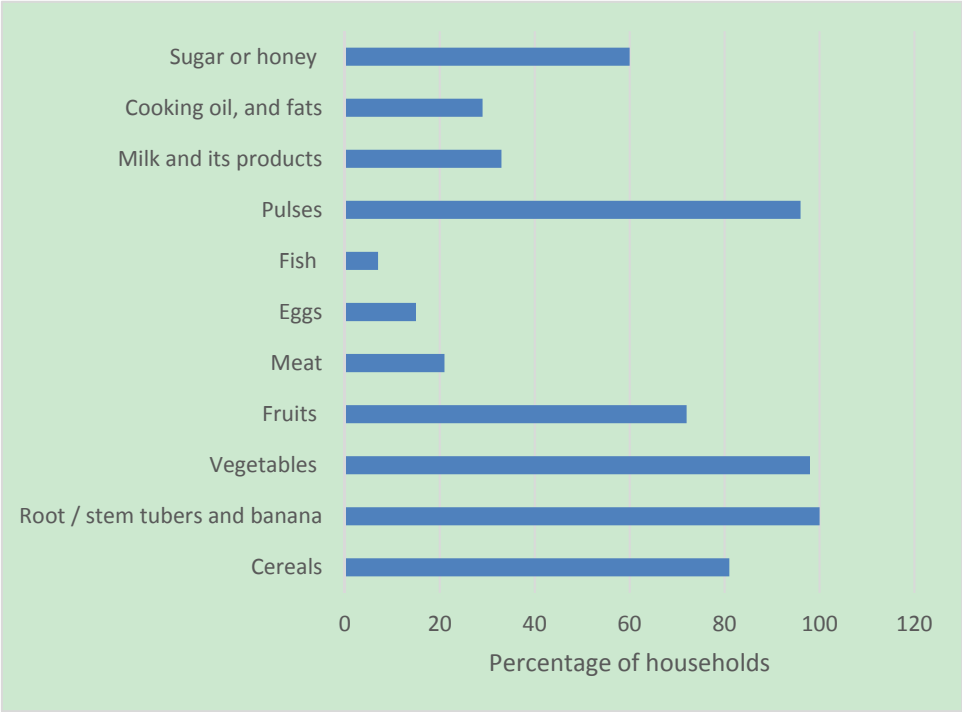

Figure 12. Proportion of households consuming food from different food groups in a 7-day recall period

The study further assessed food insufficiency as a measure of food adequacy. A majority of farmers (57%) ate 2 meals a day against the recommended 3 meals. Of more concern is, about 6% of the sampled households that ate 1 meal a day. This is an indicator of severe food insecurity. Findings further revealed that 48% of the households did not have enough food for home consumption in the past 12 months. About 60% of the households did not have enough money to buy the food requirements for the household in the past 12 months. A considerable proportion (40%) of households spent at least a day in a week without food due to lack of food or cash. The study revealed that 43% of the respondents sometimes do not have enough to eat, 33% do have enough to eat but not the kind of food they want and 6% often do not have enough to eat. The main reason for inadequate food is lack of money (70.8%) and too little harvest to last a season (46%). These findings correlate with low crop yields which explains lack of enough money to buy food since crop farming is the major source of income. Respondents were asked what they do when there is not enough food. They mentioned various options including; - borrowing money (31%), selling livestock (27%), hiring out labour (16%) and borrowing food (13%).

4. Conclusions

This paper provides an assessment of the livelihoods of the rural population in the densely populated highlands of Kigezi. It is based on cross-sectional primary data from 281 small holder households, collected to provide a baseline for a project aimed at designing a feasible, socioeconomic and technically acceptable model for guiding sustainable intensification in densely populated highlands. The paper adopted the sustainable livelihood framework which was modified to analyze livelihood vulnerability of the households in order to get insights on farmers livelihood sustainability strategies. We also provide a detailed analysis of the various components considered in assessing the vulnerability index. Overall, the households in the study area have a livelihood vulnerability index of 0.33 which is relatively low. The highest vulnerability index recorded is 0.43 for social network while the lowest is 0.29 for food. Female headed households are more vulnerable with an index of 0.36 compared to male headed households with LVI of 0.32. About 19% of the sampled households are highly vulnerable with a LVI of 0.5.

Results suggest that with an intervention most households may be able to adapt and cope in case of social economic shocks. The average annual household income is UGX 2,269,545 (USD 609) and crop production is the major source of livelihood for most households. Overall, the most important crop is beans which is grown for both income and food security. The most important food security crop is sweet potato while sorghum ranks highest for income. Production trend for all the crops is decreasing. Results indicate an average household dietary diversity score of 6.

This means that members in most households may be lacking some nutrients especially from animal products. A more detailed study on food and nutrition security might be important to identify the gap in nutrient levels. An inquiry on gender participation in production revealed that in most households, decisions on land use are mainly done by household heads. There is need to promote intrahousehold joint decision making for livelihood sustainability. The major factors limiting production include pests and diseases, unpredictable weather and low soil fertility. Replication of this study including data on other key components specifically climate change might provide information about how the exposure, adaptive capacity, and sensitivity of the region will change as intensification adaptation practices are initiated. The study recommends promoting adaptation practices that mitigate climate change effects and increase crop yields on small land holdings. Adapting intensification interventions such as rearing small livestock species like rabbits, chicken and piggery which can be raised on small land, yet provide food, income and organic manure might reduce vulnerability of small holders. These can also be easily kept by women and youth who do not own land.

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Note

Note 1. Exchange rate: USD 1 = UGX 3,728

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Authors contributions

Dr. Proscovia Renzaho Ntakyo drafted the manuscript and all authors read, edited and approved it. All the authors participated in data collection and Mr. John Bosco Muhumuza was in charge of data processing while Proscovia did the analysis.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.