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Socio-Economic Determinants of Soil Fertility Management Practices among Small-Scale Farmers in Semi-Arid and Humid Subzones of South-Western Uganda

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Abstract

Uganda's consumption of mineral fertilizers is low and this is partly attributed to its high costs and lack of proper information among others. Alternative soil fertility management technologies such as the use of manure and integration of legumes in cropping systems provide plausible options, but their adoption by small-scale farmers is less investigated. The National Agricultural Research Organization with the financial support from the Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI), and Rural Development Administration of Korea implemented a project for enhancing agricultural productivity with improved use of legumes and manure in a smallholder farming system. A baseline study was conducted in two districts: Isingiro and Rubirizi in south-western Uganda to assess the socio-economic activities and use of existing soil fertility management practices at the household level. The major soil fertility management practices were the use of mixed organic manures, cow manure and compost. High input costs were the major limiting factor to the adoption of soil fertility management options, particularly mineral fertilizers. This led to a majority of households not using any soil fertility improving innovations for agricultural production.

Subject Areas

Agricultural Science

Keywords

Adoption, Farming, Innovations, Legumes, Manure, Soil Fertility

1. Background

Africa's consumption of modern agricultural inputs, particularly fertilizers, is very low compared to other continents [1]. It is predicted that the situation is not going to change much in the short run as Africa is expected to account for less than 7.7 million tonnes of fertilizer consumption by the end of 2050 [2]. Low use of improved inputs for agricultural production is attributed to the different socio-economic factors such as limited extension services, high costs of inputs and poor farmer-market access. Efficient agricultural input market systems are crucially important in order to deliver the right product, at the right time, in the right amounts, at a convenient place, and for an affordable price [3]. Therefore, access to agricultural input and output markets is a key precondition for the transformation of the agricultural sector from subsistence to commercial production. Linking smallholder farmers to reliable and profitable markets could be one of the avenues for sustainable agricultural production and rural livelihoods.

Smallholder farmers must be able to benefit more from extension services, efficient markets and local-level value-addition, and be more exposed to competition. It is reported that more than half of the population in most East African countries lives five hours or more from a market centre [4]. As a result of poor market access, the use of agricultural inputs is generally low among smallholder farmers. For instance, average application rates of fertilizer for arable crops in East African countries are estimated to be below 30 kg/ha/year, which is far less than the world average of 100 kg/ha/year [5]. In response to this low agricultural input use, African Union (AU) member states passed the Abuja declaration with resolutions to increase timely access and raise fertilizer use by farmers to an average of 50 kg/ha by 2015 [5]. The declaration intended to increase fertilizer access and usage through elimination of barriers to fertilizer access such as tariffs on fertilizers and fertilizer raw materials. Increased fertilizer use ought to increase agricultural productivity, reduce food insecurity and poverty levels among smallholder farmers [3]. The low use of fertilizer in Africa can be explained by demand side as well as supply side factors. Demand for fertilizer is often weak in Africa because incentives to use fertilizer are undermined by the low level and high variability of crop yields on the one hand and the high level of fertilizer prices relative to crop prices on the other [6].

Increased use of improved agricultural inputs (seeds, fertilizers and chemicals) alongside organic soil fertility enhancing practices is crucial in addressing the technical change needed for sustainable smallholder agricultural growth in Africa. In East Africa, there are problems related to food security because of decreasing per-capita food production majorly resulting from declining soil fertility [7]. Extreme poverty, widespread malnutrition and alarming environmental degradation are, in part, consequences of a farming environment that results in large-scale nutrient mining from generally old and inherently nutrient-poor soils. Nutrient mining in Uganda is among the highest in East Africa, with an estimated nutrient loss amounting to 87 kg/ha/yr of nutrients (NPK); in ratios of 38 kg of nitrogen; 17 kg of phosphorus and 32 kg of potassium [8]. These figures represent the bal-

ance between nutrient inputs as fertiliser, manure, atmospheric deposition, biological nitrogen fixation, and sedimentation, and nutrient outputs as harvested products, crop residue removals, leaching, gaseous losses, surface runoff and erosion. The figures, therefore, are evidence that nutrient inputs are limited, and the basis of argument that the future growth in agriculture in the country will depend primarily on improved land management practices. Uganda's soil fertility and nutritional value are reported to be gradually depreciating over the years, and according to the experts [8], this trend explains the shift in food-sourcing regions within the country, and eventually, it will lead to total extinction if nothing is done.

Available information indicates that on average, Uganda uses between 1.8 to 3 kg of fertilizer per acre which is far below the global average, and yet over 70% of the population is engaged in agricultural production [9]. Continued low use of fertilizers has affected the country's food security as yields continue to decrease since even the current food hub is also affected. Uganda being a largely agricultural country, its soil is overworked and needs to be re-energized with massive fertilization which is not the case at the moment. Soils in smallholder farming systems have been deliberately neglected, and not prioritized, irrespective of the country's 2006 commitment to use up to 50 kg/acre of fertilizers by 2015 [10]. Low use of fertilizers has led the country not fulfilling its agricultural export targets, and this trend is most likely to continue unless something is done about the ongoing soil degradation. It is the large-scale plantations like tea and sugar estates that mainly use mineral fertilizers, but the small-scale farmers barely do so, and that's what brings the national average down to the alarming levels. Further, organic nutrient imbalance in the country is very alarming. Most of farmers' fields under smallholder farming systems experience negative soil nutrient balances, meaning that what is gotten out of the soil is much more than what is put in, which leads to decline in crop yields [11]. To revert soil nutrient losses, there is need for sensitization of farming communities on improved soil fertility management and conservation practices needed for sustainable agricultural production and productivity.

National Agricultural Research organization (NARO) in partnership with Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI) implemeted a two-year pilot project on the optimizing productivity of crop-livestock System in Uganda while using nitrogen fixing legumes and livestock Manure. The pilot project was executed in two districts (Rubirizi and Isingiro) in south-western agro-ecological zone (SWAEZ) of Uganda. This paper describes baseline information with regard to the prevailing socio-economic drivers and barriers of soil fertility management in smallholder farming systems in SWAEZ in Uganda.

2. Materials and Methods

2.1. Study Area

The study was conducted in two districts: Isingiro and Rubirizi, representing the semi-arid and humid sub-zones of SWAEZ, respectively (**Figure 1**). The yearly temperature of Isingiro district is 22.0˚C, and it is 1.46% lower than Uganda's av-

erages [12]. Isingiro typically receives about 357.72 millimeters of precipitation annualy, and has 282.18 rainy days. The soils of Isingiro district are mainly of clay, laterite loam, and sandy in nature. The district is naturally endowed with waterfalls on River Kagera that are shared with the Republic of Tanzania. The natural vegetation of Isingiro district consists primarily of grassland savanna and woodland, with patches of natural forest (including swamp forest) found in valleys and on hillsides, as well as some agricultural land. On the other hand, Rubirizi district receives 1750 mm of rainfall annually, and the mean annual temperature is 21.3˚C, which is 5.3% lower than the country's average. The district is endowed with loamy fertile soils with varying proportions of sand and clay. It has tropical rain forest vegetation of Kalinzu, Imaramagambo, Kasyoha-Kitomi in the central and savannah woodlands, semi-arid vegetation in the north and wetland vegetation [13].

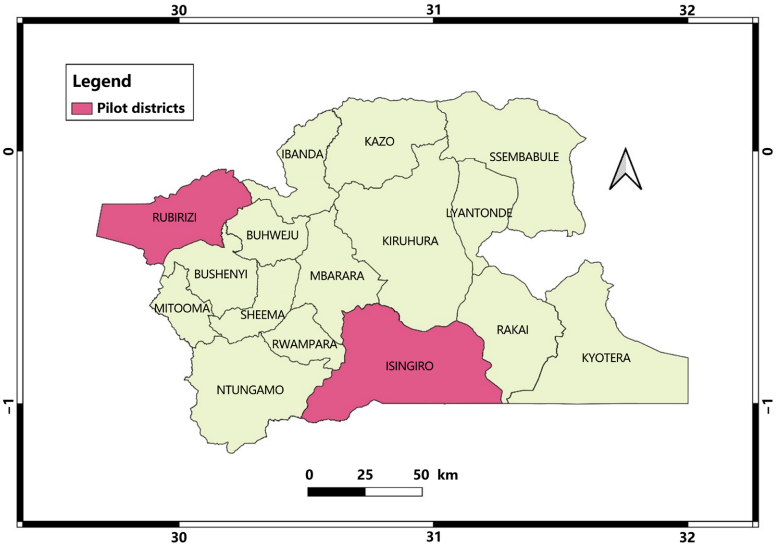

Figure 1. Study area located in south-western Uganda.

2.2. Study Population

Small-scale farmers in Rubirizi and Isingiro districts under the study with subsistence-orientation, and used low-input farming practices on fragmented plots were selected. These farmers owned less than two acres of land, practiced mixed farming, primarily relied on family labor, and faced major challenges such as vulnerability to climate change, limited market access, and financial constraints.

2.3. Sampling Size and Procedure

The data used in this study was obtained through farmer interviews conducted in 2024. Households from two pilot districts (Isingiro and Rubirizi), were purposively sampled targeting smallholder farmers. A total of 278 households from Isingiro (145) and Rubirizi (133) were sampled for the questionnaire survey. Simplified formular version was used to determine the sample size [14].

$$n = \frac{N}{1 + N.e^2} \quad (1)$$

where:

N: population size; *e*: level precision.

Multi-stage sampling procedure was used to identify five sub-counties and Town Councils from which farmers were selected through systematic random sampling. The household survey was conducted through a face-to-face administration of the pretested questionnaire to the household heads and responses filled in the Kobotool box application by the enumerators. The process of interviewing lasted an average of 30 minutes. Data collected include demographic, socio-economic, institutional profiles and soil fertility management practices (See Table 1).

Table 1. Definition of the independent and dependent variables used in the analysis.

Variables	Definition and measurement
Independent variables	
District	Farm location (1 = Isingiro, 2 = Rubirizi)
Gender	Gender of the household head (0 = female, 1 = male)
Age	Age of household head (Continuous variable)
Education	Household head education level (0 = No formal education, 1 = Primary, 2 = Secondary, 3 = Tertiary
Nature of the main house	1 = Permanent, 2 = Semi-permanent
Primary activity	1 = Agriculture, 2 = Trade, 3 = Employed, 4 = Art work
Secondary activity	1 = Agriculture, 2 = Trade, 3 = Employed, 4 = Art work, 5= None
Sources of funding	1 = Credit from financial institutions, 2 = Development agency, 3 = Own funds, 4 = Remittances
Level of household income	1 = High, 2 = Middle, 3 = Low, 4 = Very low
Major soil types	1 = Heavy soils (Fine), 2 = Light (Sandy), 3 = Medium (Loamy)
Farming experience	Years in farming (Contuous variable)
Contact with extension	Contact with agricultural extension providers (0 = no, 1 = yes)
Major categories of crop varieties grown	1 = Improved, 2 = Local land races, 3 = Mixed, 4 = Do not know
Major soil amendments used	1 = Mineral fertilizers, 2 = Organic fertilizers
Major soil organic amendments used	0 = None, 1 = Cattle manure, 2 = Chicken manure, 3 = Pig manure, 4 = Compost manure, 5 = Mixed
Walking distance to nearest urban and village markets	Number of hours taken to the markets by foot
Access to soil information	Access to training on soil management (0 = no, 1 = yes)
Access to Soil analysis	Access to soil testing services (0 = no, 1 = yes)
Credit information	Farmer has ever received credit information (0 = no, 1 = yes)
Crop information	Farmer has ever received crop information (0 = no, 1 = yes)
Agribusiness information	Farmer has ever received agribusiness information (0 = no, 1 = yes)
Livestock	Own livestock (0 = no, 1 = yes)
Family size	Number of people in the family
Farm size	Total size of landholding cultivated by household (in acres)
Work force	Number of household members actively involved in farming
Tropical livestock units	Aggregated livestock assets

Continued

Dependent variables	
Farm animals	Major farm animals kept (1 = Cattle, 2 = poultry, 3 = Goats, 4 = Sheep, 5 = Piggery)
Stall feeding	When is stall feeding done (1 = Year round, 2 = Partly in dry season, 3 = Partly in wet season, 4 = Whole of wet season, 5 = Whole of dry season
Farmers purchase supplement for livestock	Response (0 = no, 1 = yes)
Major livestock product	1 = Animal manure, 2 = Eggs, 3 = Cow milk
Frequency of manure collection	1 = Once a day, 2 = Twice day, 3 = Every two days, 4 = Do not collect

The questionnaire was designed, entered into kobo toolbox and tested on community outside the study population, but with similar socioeconomic charcteristics. Further, the study population and the community used for the pre-tested questionnaire were operating in the similar biophysical environment. The questionnaire administration and interviews were carried out following the main ethical principles of social science research and an informed consent was obtained from the participants in each case.

2.4. Research Approach and Data Analysis

The District Agricultural Officer in each of the two districts was used to identify sub-counties with high concentration of small-scale farmers using less than 2 acres of land for farming. At the sub-county level, Agricultural Extension Officers were used to identify parishes with high population of households practicing mixed farming a small scale. At the parish level, community register was used to randomly select farm households to be administered with formal questionnaire to capture socio-economic conditions and soil fertility management practices used by the farming households. The collected data was later downloaded from kobo toolbox into excel spreadsheet for cleaning, managed and exported into R-statistical software for the analysis. Descriptive statistics were used to summarize and understand the basic feature of the study population.

3. Results and Discussion

3.1. Socio-Economic Status of Farm Households in Rubirizi and Isingiro Districts

The average age of farmers was 49.77 and 47.31 years in Rubirizi and Isingiro district, respectively (See **Table 2**). Further, average age for male and female farmers was 50.32 and 49.21 years in Rubirizi district and 47.28 and 47.34 years in Isingiro district, respectively. While Ugandan population engaged in agricultural production is aging, farmers in the two districts are younger than the national average of 54 years [15]. However, the average age of farmers in both districts was synonymous with what was reported in an annual agricultural report of 2019 indicating that agricultural household between 45 to 64 years old was the largest age group [16].

Average household size was 5.58 and 5.85 in Rubirizi and Isingiro district, respectively. This was well above the national average of 4.7 [17]. Rural households in Uganda have large families, that form a major source of farm labor [18]. None-

theless male headed households had more family members compared to the female headed households. Female headed households had limited family size because they were worse off compared to male-headed households in terms of both food security and welfare. Farming experience of male and female headed households in Rubirizi district was 25.87 and 28.75 year with the average of 27.31 years. Similarly, average farming experience of farmers in Isingiro district was 20.69 years with male and female households having spent 22.29 and 19.09 years in farming, respectively.

Table 2. Socioeconomic status of farm households in Rubirizi and Isingiro districts.

Parameter	Rubirizi			Isingiro		
	Male	Female	Average	Male	Female	Average
Age (years)	50.32	49.21	49.77	47.28	47.34	47.31
Family size	6.15	5.01	5.58	6.02	5.69	5.85
Farming experience (years)	25.87	28.75	27.31	22.29	19.09	20.69
Education levels (%)						
No formal education	5.38	27.55	16.75	23.08	28.13	25.00
Primary	50.54	55.10	52.88	51.92	50.00	51.19
Secondary	21.51	16.33	18.85	15.39	18.75	16.67
Tertiary	22.58	1.02	11.52	9.62	3.13	7.14
Nature of the main house (%)						
Permanent	65	71	59	40	31	37
Semi-permanent	36	29	42	60	69	63
Primary farmer's activity (%)						
Agriculture	73.12	93.88	83.77	92.31	96.88	94.05
Trade	13.93	0.00	9.43	5.77	3.13	4.76
Employed	7.53	1.02	4.19	1.92	0.00	1.19
Art work	5.38	5.10	2.62	0.00	0.00	0.00
Secondary activity (%)						
Agriculture	37.63	30.55	30.89	26.92	34.38	29.76
Trade	15.05	16.36	12.04	32.70	15.63	26.19
Employed	13.98	6.18	6.80	5.77	3.13	4.76
Art work	8.60	6.18	7.32	1.92	6.25	3.57
None	24.73	40.73	42.93	32.70	40.63	35.71
Sources of funding (%)						
Credit from financial institutions	4.3	6.1	5.2	5.8	3.1	47.60
Development agency	7.5	1.0	4.2	5.8	0.0	3.60
Own funds	87.1	87.8	87.4	88.5	93.8	90.5
Remittances	1.1	5.1	3.1	0.0	3.1	1.2
Level of household income (%)						
High	6.5	0.0	3.1	5.8	5.8	3.6
Middle	52.7	17.4	34.6	40.4	40.4	56.6
Low	35.5	76.5	56.6	34.6	34.6	34.6
Very low	5.4	6.1	5.8	19.2	19.2	27.4

Majority of farmers had primary education as observed with the average of 52.88% and 51.19% in Rubirizi and Isingiro districts, respectively. Majority of female (55.10%) and male farmers (51.92%) had primary education in Rubirizi and Isingiro districts, respectively. This was in agreement with the National Agricultural survey findings that indicated a majority of the agricultural household heads (56.9%) having a primary education as the highest level attained [16].

The proportions of permanent (59%) and semi-permanent (63%) households was higher in Rubirizi and Isingiro districts, respectively. This was well above the national average of 11% and 18% for the semi-permanent and permanent dwelling structures [19], respectively. It was observed that it was female headed households that had higher proportions of permanent (71%) and semi-permanent (69%) houses in Rubirizi and Isingiro districts, respectively. This was because the male spouses in Rubirizi district had off-farm jobs working in businesses in the neighboring districts, leaving much of the responsibilities to female spouses. Further, the highly fragmented land in Rubirizi district was not sufficient to sustain household welfare, leading men to search for job opportunities elsewhere. On the other hand, wealth endowed households in Isingiro district had livestock that required labor, leading men to keep working on family farms.

Majority of households considered agriculture as either their primary or secondary activity for food and income security, and this was followed by trade. Households engaged in agricultural production as primary or secondary activity was much higher than the national average of 64% [17]. On average, 42.93% and 35.71% of the households in Rubirizi and Isingiro districts had no secondary activity that could be alternative source of income, respectively. Over 67% of the Ugandan population depends on agriculture for the livelihoods [17]. Majority of the households in Rubirizi (87.4%) and Isingiro (90.5%) mostly relied on their own saving as source of funding with higher proportions being observed among female headed households. Household saving is often done through sales of agricultural produce, which is the major source of income [16]. Majority of farmers in Rubirizi (56.6%) and Isingiro (56.6%) districts perceived their household income to be low and moderate, respectively. Majority of the female headed households (76.5%) in Rubirizi district had low incomes, and this was attributed lack of reliable sources of income. More than 70% of Ugandan population work in agriculture, and tragically, it is the population that most often suffer from hunger and living below the poverty line of 1.25 dollar per day [20].

3.2. Major Soil Types and Soil Fertility Management Practices

Most of farmers' fields had medium or loamy textured soils. However, majority of farmers' fields (>60%) had loamy textured soils with the highest proportion found in Rubirizi district (**Figure 2**). The soils in Rubirizi district had more developed structure with moderately high-water holding. On the other hand, approximately 50% of farms located in Isingiro district had soils majorly composed that were light (sandy), and prone to drought. These soils had poor or weak structure with low water holding capacity.

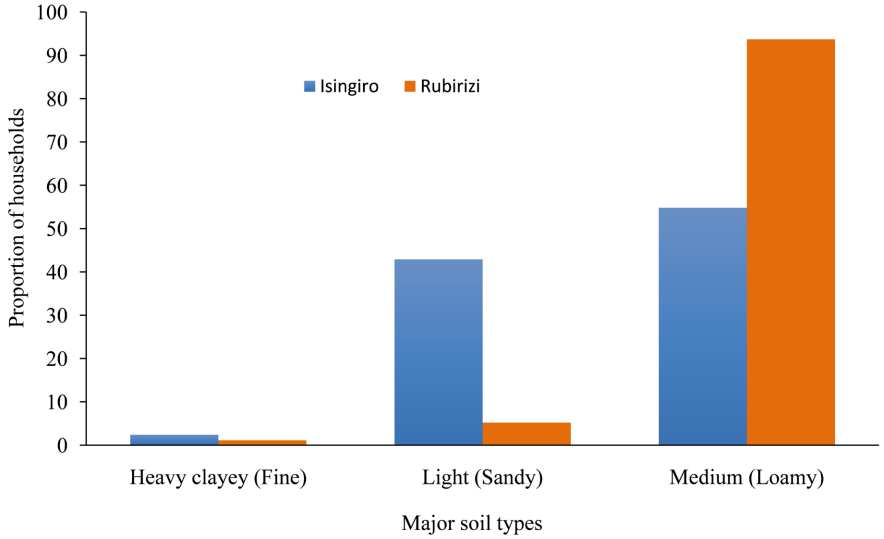

Figure 2. Major soil types in study sites.

Use of organic soil amendments was more popular compared to inorganic fertilizers among farmers (**Figure 3**). Horticultural production was majorly practiced in Rubirizi district that had favorable climate for cultivation of vegetable, and here farmers often used mineral fertilizers and organic amendments in its production.

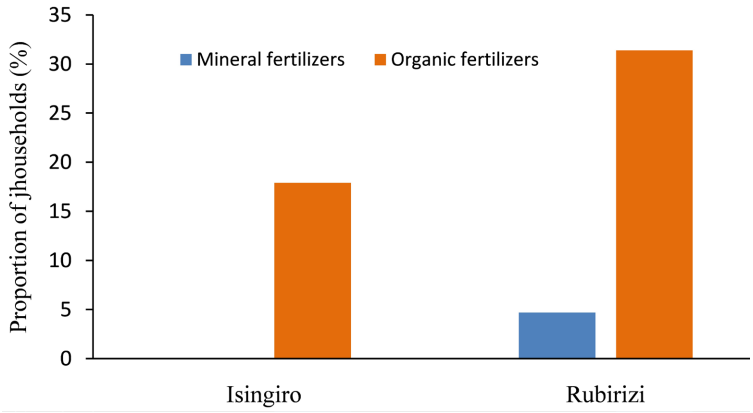

Figure 3. Distribution of households using inorganic and organic fertilizers on-farm.

Use of soil organic amendments was higher among the male headed households in Rubirizi district compared to their counterparts in Isingiro district (**Figure 4**). This was attributed to the higher importance attached to banana sold as desserts in Rubirizi district compared to Isingiro district (**Figure 5** and **Figure 6**). Banana is both food and cash crop, and it is considered a man's crop, and therefore men give much priority to banana production by applying organic manure. In Isingiro district, banana monoculture has long been the norm, where bananas are a key cash crop for many farming households. However, this approach has led to declining productivity due to soil nutrient depletion, increased pest and disease incidences, and vulnerability to extreme weather conditions, such as droughts and

heatwaves [21]. These pests have made some households to switch to annual crops such as common beans, Irish potato, cassava and finger millet that do not require intensive use of soil amendments and more tolerant to effects of climate change.

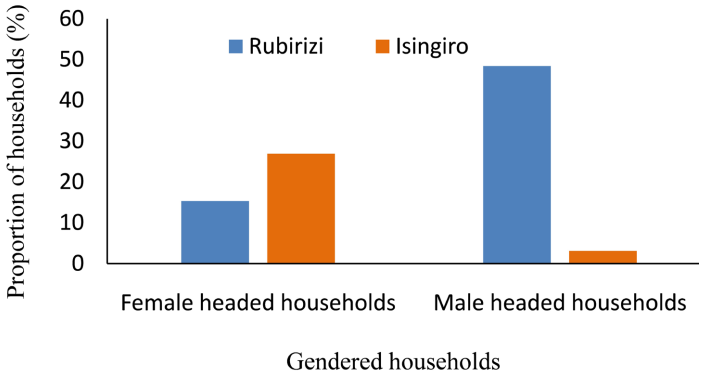

Figure 4. Proportion of households using organic amendments.

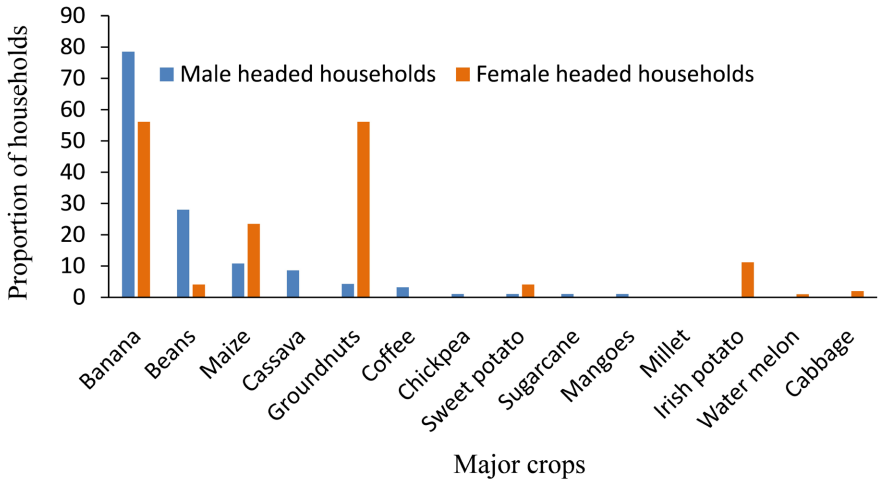

Figure 5. Proportion of households (%) by gender growing different crops in Rubirizi district.

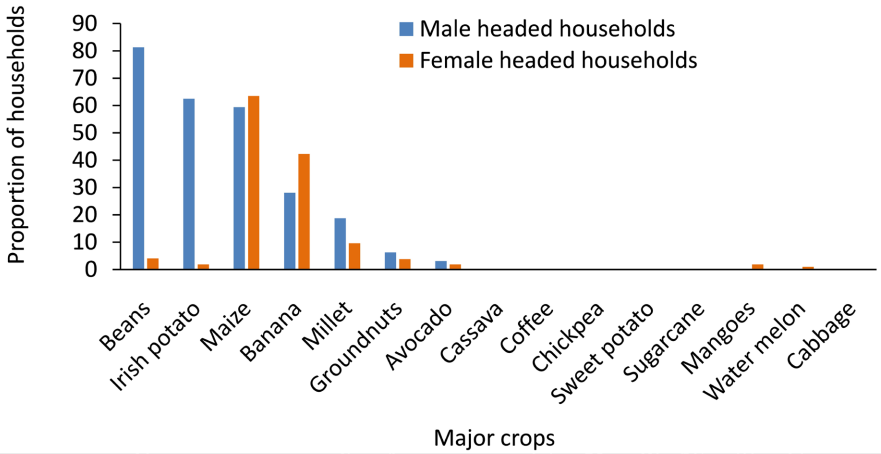

Figure 6. Distribution (%) of major crops by gendered households in Isingiro district.

The main agricultural related challenge facing farmers in Isingiro district is the severe and prolonged droughts leading to poor banana productivity. This becomes a disincentive to farmers in using soil fertility improving innovations. The repeats and prolonged severe droughts is often associated with declining crop yields, in turn leading to reduced farm incomes, and increased food shortages and malnutrition. The drought increases the risks for food security, illness, and reduced drinking water sources.

In both communities however, there was still large population of households that do not use organic fertilizers. This was attributed to several factors such as low availability of organic materials, limited animals to provide adequate manure, high costs of manure, and high land fragmentation leading to increased costs of using organic inputs. Due to limited organic inputs farmers most often used mixture of materials that included animal wastes and crop residues as soil amendments (Figure 7).

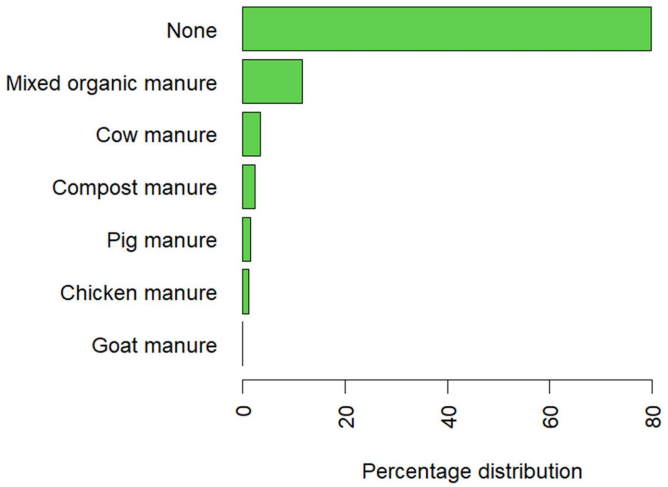

Figure 7. Proportion of households using different types of organic amendments.

3.3. Farmers' Perception on the Crop Varieties Grown in the Community

While few households grow a mixture of crop varieties on the piece of land, more than 70% of the households grow land races of crops and less than 20% grow improved crop varieties in both study sites (Figure 8). Likewise, over 70% female and male headed households grow crop landraces in both study sites (Figure 9 & 10). Cultivation of local landraces provided economic benefits and resistance to climate shocks in smallholder farming system. Farmers were still attached to landraces because of cultural values, taste and demand in the local market. This has kept crop diversity amidst to pursuance of the farmers to adopt modern varieties. Local farmers do not practice agricultural intensification that may require adoption of moder crop varieties. Further new crop varieties require good soil quality endowment and yet under smallholder farming systems, farmers hardly used improved soil fertility innovations.

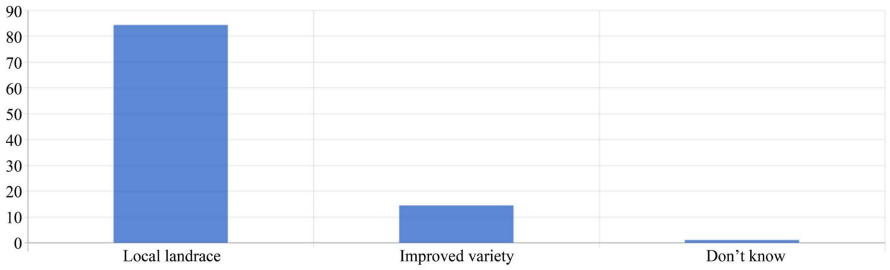

Figure 8. Proportion (%) farmers using different seed types.

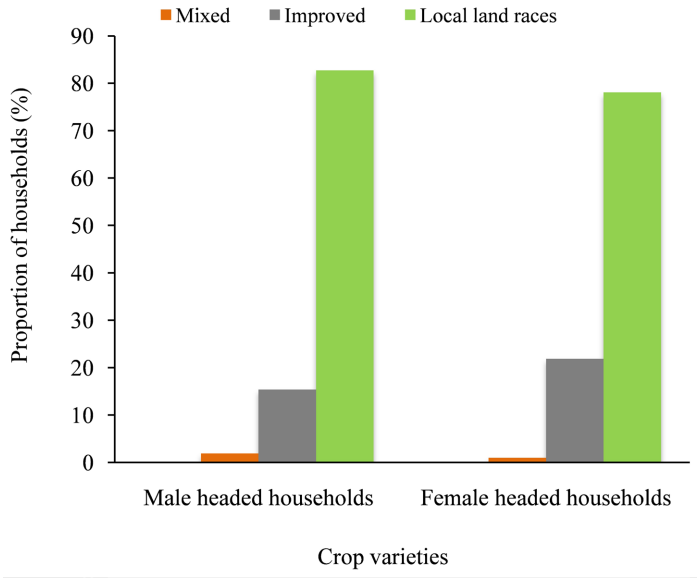

Figure 9. Distribution of gendered households with major kinds of crops grown in Rubirizi district.

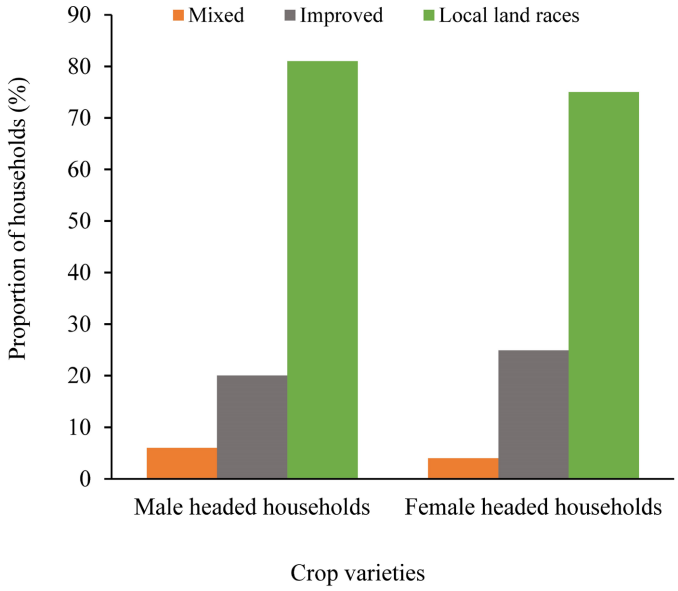

Figure 10. Distribution of gendered households with major kinds of crops grown in Isingiro district.

4. Conclusion

While agriculture is the primary rural activity, farmers in south western Uganda depend heavily on their own saving to fund its production. This limits the widespread adoption of agricultural technologies due to the low ability of farmers to invest in agricultural production as a viable business. Majority of farmers do not apply any soil fertility improving innovation to enhance agricultural productivity, making farm productivity stagnantly low.

Recommendations

There is need to leverage the use of organic amendments using locally available organic materials in the farming communities. Further, as farmers integrate legumes such as beans in the farming system, there is need to promote nitrogen fixing bacteria in form of rhizobium inoculants to enhance legume productivity.

Limitations of the Study

The findings of the study are restricted only to the study community, and cannot be used to the general population of farming community in Uganda. This is because of the highly diversified socioeconomic characteristics of farmers and biophysical environment in which they operate. Further, this study was conducted only in one planting season and yet farming activities and practices widely vary with seasons.

Acknowledgements

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Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Mwangi, W.M. (1996) Low Use of Fertilizers and Low Productivity in Sub-Saharan Africa. *Nutrient Cycling in Agroecosystems*, **47**, 134-147.

[2] Food and Agriculture Organization of the United Nations (2017) The Future of Food and Agriculture: Trends and Challenges. Food and Agriculture Organization of the United Nations.

[3] Landry, S. (2018) Africa's Consumer Market Potential: Trends, Drivers, Opportunities, and Strategies. Africa Growth Initiative, 38.

[4] Muoni, T. (2019) Integrating Legumes in Mixed-Livestock Systems in East Africa: Farmers' Perceptions, Ecosystem Services and Support for Decision Making. *Acta Universitatis Agriculturae Suiciae*, **58**, 90.

[5] Boniphace, N.S., Fengying, N. and Chen, F. (2015) An Analysis of Smallholder Farmers' Socio-Economic Determinants for Inputs Use: A Case of Major Rice Producing Regions in Tanzania. *Russian Journal of Agricultural and Socio-Economic Sciences*, **38**, 41-55. https://doi.org/10.18551/rjoas.2015-02.05

[6] Twikirize, J. and Spitzer, H. (2022) Community Counts: Rural Social Work in East Africa. *World*, **3**, 1053-1066. https://doi.org/10.3390/world3040060

[7] Onyutha, C. (2018) African Food Insecurity in a Changing Climate: The Roles of Science and Policy. *Food and Energy Security*, **8**, e00160. https://doi.org/10.1002/fes3.160

[8] Nabyonga, L., Basamba, T.A., Nyakoojo, C. and Ssenku, J.E. (2022) Impediments to Agricultural Production in Uganda and Measures to Enhance Soil Fertility Utilizing Organic Soil Amendments: A Review. *Cogent Food & Agriculture*, **8**, Article ID: 2113051. https://doi.org/10.1080/23311932.2022.2113051

[9] Roberto, A.T.J. and Maxmillian, T. (2023) Characterising Agricultural Holdings in Uganda: Inputs to Improving Policy Formulation. *Journal of Development and Agricultural Economics*, **15**, 11-25. https://doi.org/10.5897/jdae2022.1368

[10] Abate, G.T., Abay, K.A. and Spielman, D.J. (2020) Fertilizer Policies and Implications for African Agriculture. International Food Policy Research Institute.

[11] Esubalew, T., Amare, T. and Molla, E. (2023) Quantification of Soil Nutrient Balance and Stock on Smallholder Farms at Agew Mariam Watershed in Northern Ethiopia. *Heliyon*, **9**, e14832. https://doi.org/10.1016/j.heliyon.2023.e14832

[12] Aturihaihi, C., Opio, F., Tumwesigye, W. and Beyihayo, G.A. (2023) Smallholder Farmers' Coping Strategies to Perceived Climate Change and Variability in Isingiro District, South Western Uganda. *African Journal of Climate Change and Resource Sustainability*, **2**, 51-67. https://doi.org/10.37284/ajccrs.2.1.1203

[13] Aturihaihi, C., Tumwesigye, W., Opio, F. and Beyihayo, G.A. (2023) Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda. *East African Journal of Agriculture and Biotechnology*, **6**, 82-97. https://doi.org/10.37284/eajab.6.1.1154

[14] Yamane, T. (1967) Statistics: An Introductory Analysis. 2nd Edition, Harper and Row.

[15] Thompson, T. (2020) How Uganda's Tech-Savvy 'Generation Z' Is Transforming Its Agriculture. World Bank Blog.

[16] UBOS (Uganda Bureau of Statistics) (2020) Uganda Annual Agricultural Survey 2018. Uganda Bureau of Statistics.

[17] UBOS (Uganda Bureau of Statistics) (2014) National Population and Housing Census 2014. https://www.ubos.org

[18] NPC (National Population Council) (2022) The State of Uganda Population Report 2022 Accelerate Demographic Transition: Refocus Investments to Attain a Favorable Population Age Structure for Sustainable Development.

[19] MLHUD (Ministry of Lands, Housing and Urban Development) (2010) Statistical Abstract, Land Transfer Forms, Land Amendment Act 2010. https://www.mlhud.go.ug

[20] Siens, R. and van Hintum, H. (2023) The Smallholder Farmers of Uganda. Resilience Food Stories.

[21] Fatumah, N., Tilahun, S.A. and Mohammed, S. (2021) Water Use Efficiency, Grain Yield, and Economic Benefits of Common Beans (*Phaseolus vulgaris* L.) under Four Soil Tillage Systems in Mukono District, Uganda. *Heliyon*, **7**, e06308. https://doi.org/10.1016/j.heliyon.2021.e06308