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Sustainability of farmer organizations in Uganda: the role of organizational and institutional factors

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Received: 5 May 2024 / Accepted: 6 August 2024
Published online: 11 September 2024

Abstract
In Uganda, despite government support, many farmer organizations are short-lived or exist solely to receive subsidies. Existing literature evaluates the sustainability of farming systems, technology impacts, and non-certified markets, yet a gap remains regarding the sustainability of farmer organizations. This study addresses this gap by determining a sustainability index and the effect of organizational and institutional factors on the sustainability of farmer organizations in central and northern Uganda. It highlights how regional disparities impact organizational sustainability. Using cross-sectional data from 272 farmer organizations across 12 randomly selected districts, a multilevel mixed-effects linear regression in Stata13 was employed. Results indicate that Ugandan farmer organizations have a low sustainability index of 36%, with central organizations slightly outperforming northern counterparts by 2%. Significant differences exist between northern and central organizations in terms of finances, resources, value addition, training, and leadership. Additionally, internal financial dependence, leadership committee size, farm management, and value addition training greatly enhance sustainability. Specifically, regional level variables contribute 21% to changes in the sustainability of farmer organizations in Uganda. To enhance sustainability, farmer organizations should engage in income-generating activities aligned with their economic, environmental, and social welfare objectives. The government should also intensify leadership, farm management, and value addition training.

Keywords Farmer organization · Sustainability dimensions · Multilevel mixed effects linear regression model · Sustainability index · Uganda

1 Introduction

Smallholder farmers face significant challenges transitioning from subsistence to commercial farming [36, 51, 54], even though their livelihoods depend entirely on agriculture. These challenges include poor infrastructure, unreliable market information, limited access to training, credit, extension services, and markets, an inability to meet strict safety standards, and difficulties in enforcing contracts [1, 23, 31, 36, 54, 62, 70, 83]. These constraints consequently hinder agricultural growth and sustainability [51, 54, 55]. To address these issues, governments and development partners have encouraged smallholder farmers to form farmer organizations, aiming to facilitate their transition from subsistence to commercially oriented farming.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43621-024-00403-2.

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Smallholder farmers can be efficiently and effectively supported by development partners and government policies through farmer organizations [5, 21, 104]. These organizations enable governments to support smallholder farmers at reduced costs compared to individual support [5]. Farmer organizations enhance smallholder farmers' access to advanced technologies, inputs, credit, information, and extension services, lower transaction costs, and improve bargaining power, among other benefits [5, 7, 21, 31, 61, 69, 104]. However, these organizations operate in diverse localities and face varying agro-ecological, socioeconomic, and political factors that may influence their sustainability [19, 22, 64]. These factors include access to institutional support, partnerships with government and development partners, member and government/development partner commitment, and capital to run the organizations [19, 23, 61, 62, 70, 82, 116]. Additionally, farmer organizations employ different business models, leadership styles, organizational structures, and focus on various agricultural commodities [19, 23, 61, 62, 65, 70, 82, 116].

In Uganda, farmer organizations have historically faced sustainability issues due to inadequate leadership structures and uncertain criteria for selecting both leaders and farmers when they were state-owned [14, 59, 61]. Currently, these organizations are member-owned, self-governing, and formed based on the common interests of farmers [14, 59, 61]. They operate as self-sustaining and profit-generating businesses [14, 61]. Membership is open and voluntary; members subscribe to be part of the organization, and leadership is mostly democratic [61]. Additionally, farmer organizations in Uganda receive support from government and non-governmental bodies in terms of extension services, inputs, and partnerships to integrate smallholder farmers into larger value chains and achieve agricultural transformation [61]. For example, in the northern region of Uganda, farmer organizations were established to lift farmers out of poverty caused by the Lord's Resistance Army war from the mid-1980s to 2006 [20, 47]. However, despite significant support and interventions, many farmer organizations have disintegrated, while others continue to exist solely to receive inputs and subsidies from the government and development partners, after which farmers go their own way. It is therefore necessary to determine the factors that can effectively and efficiently support the sustainability of farmer organizations. Thus, the objectives of this study were: (1) to determine the sustainability indices of farmer organizations in Uganda, (2) to identify differences among farmer organizations in central and northern Uganda, and (3) to assess the influence of organizational and institutional factors on the sustainability of farmer organizations in Uganda. This study contributes to the understanding of how regional differences manifest in the sustainability of farmer organizations in Uganda.

1.1 Literature review

Literature defines sustainability as the ability of any person or organization to achieve their present goals while preserving their capacity to meet the same goals in the future [13]. It involves meeting intended objectives while maintaining the quality of the environment and natural resources amidst changing conditions [97, 109, 110]. Scholars Rahman et al. [85] define organizational sustainability as a holistic strategy that enhances an organization's capacity to adapt to environmental, social, economic, and political or institutional changes. This is achieved through effective leadership, a skilled workforce, securing resources, and fostering organizational behavior and culture that address sustainability challenges and promote overall organizational sustainability. According to the Triple Bottom Line model, the sustainability of an organization relies on the competencies it gains from implementing social, economic, and environmental strategies [25]. Therefore, a farmer organization must balance the economic, social, and environmental dimensions to withstand changing conditions [9, 10, 25, 32, 60, 84, 97, 109, 110].

Among the sustainability studies conducted on farmer organizations is the work by Nji et al. [77], which examined the determinants of success and sustainability of farmer organizations in the north-west region of Cameroon. However, the study by Nji et al. [77] was qualitative in nature, measuring sustainability simply as "existence for a longer time." Additionally, Nji et al. [77] gathered factors that farmers believed could make their organizations last longer, without clarifying the basis of these perceptions. The findings were presented in terms of frequencies and percentages, leaving unclear how and to what extent the identified factors influence the success and sustainability of a farmer organization.

Scholars Msuya [74] also assessed the factors influencing the sustainability of the development of farmer cooperatives in Tanzania. However, like [77], the study was qualitative, relying on respondents' perceptions and understandings of the factors affecting the sustainability of farmer cooperatives. Sustainability was measured as long-term business success and the attainment of intended goals, but the study did not provide clear criteria for measuring "long-term."

Scholars Wanjiku and Kagiri [114] conducted a qualitative evaluation of factors affecting the sustainability of fish farming projects in public secondary schools in Kiambu County. However, they considered the continuity of operations as a measure of sustainability and based their findings on respondents' perceptions of how various factors influenced

sustainability. From their regression model, the measurement of "continuity" was unclear, making it difficult to determine the extent to which the listed variables impacted sustainability.

Sustainability studies conducted in Uganda have predominantly focused on areas other than the sustainability of farmer organizations. Ebanyat et al. [33] investigated the drivers of land use change and household determinants of sustainability in smallholder farming systems in eastern Uganda. However, scholars Ebanyat et al. [33] measured sustainability as farm nutrient balance, considering only the environmental dimension of sustainability while neglecting the social and economic dimensions. Additionally, Ebanyat et al. [33] focused on the determinants of sustainability in farming systems, not farmer organizations.

Scholars Jelliffe et al. [50] examined the sustainability of the impacts resulting from the adoption of high-yielding varieties (HYVs) of groundnut through a regional farmer-led dissemination and multiplication program, rather than sustainability of farmer groups. Additionally, sustainability was assessed by measuring the continuity of HYV adoption in terms of the percentage of groundnut farmland allocated to these high-yielding varieties.

Scholars Onyas et al. [79] explored the sustainability initiatives implemented in a non-certified market involving an indigenous Southern firm and smallholder coffee farmers in Uganda. They emphasized the importance of balancing the economic, social, and environmental dimensions of sustainability. However, the authors did not proceed to measure the sustainability of the farms.

Scholars in Ssebunya et al. [98] analyzed and compared the sustainability performance of certified and non-certified smallholder coffee farms in Uganda. While their study assessed sustainability using an index that encompassed social, governance, economic, and environmental dimensions, it focused on the sustainability of individual agricultural systems rather than that of farmer organizations.

Scholars in Tennhardt et al. [102] also employed a multidimensional approach to assess sustainability performance, but they concentrated on cocoa farming rather than farmer organizations. Additionally, their focus was on the socio-economic co-benefits of environmentally friendly cocoa farms. To date, there is a paucity of literature on the factors influencing the sustainability of farmer organizations in Uganda. Furthermore, it remains unclear whether there are differences in the sustainability of farmer organizations across various regions of operation.

In this study, a farmer organization refers to a group of farmers working together in either the production and/or marketing of any agricultural product(s), regardless of their registration status or size. Additionally, this study considers an organization a farmer organization if it operates independently and does not have any subordinate groups within it. A smallholder farmer in this study is defined as a farmer who cultivates no more than 2 hectares of farmland, has a low asset base, and relies predominantly on family labor. Sustainability is defined as the ability of a farmer organization to withstand a changing environment.

1.2 Theoretical framework

This study is based on the Proto Theory of Sustainability Management. Various scholars have proposed different theories to explain organizational sustainability. For example, scholars in refs. [53, 63] introduced the Behavioral Theory of Vision, which posits that an organization's performance is influenced by its vision. According to this theory, organizations must clearly communicate their visions to their followers to achieve a sustainable competitive advantage. A well-communicated vision guides organizational operations and behaviors [63] and drives followers' commitment [53], ultimately influencing sustainable competitive advantage and organizational performance. However, this theory mainly focuses on organizational performance and places little emphasis on the well-being of workers and the community.

To address the limitations of the Behavioral Theory of Vision, other scholars in refs. [24, 71] proposed the Institutional Theory. According to these scholars, organizations achieve sustainability by adapting to external environmental pressures. Organizations survive by responding to and undertaking operations that meet external demands. However, the Institutional Theory primarily focuses on the influence of the external environment on business sustainability.

As an improvement to the Institutional Theory, the scholar in Starik and Kanashiro [99] proposed the Proto Theory of Sustainability Management. This theory suggests that an organization's sustainability depends on the interaction between natural environmental and human socio-economic factors [99]. It assumes that sustainability management is influenced by political-economic systems, sociocultural systems, and natural systems. The theory emphasizes the role of human interactions in influencing long-term organizational sustainability [99]. Organizations must recognize the medium- and long-term effects of these factors to remain sustainable in a changing environment. The Proto Theory posits that social, economic, and environmental factors reinforce each other to support business sustainability [99]. It proposes that organizations consider various components related to social, economic, and environmental aspects, including

values, strategies, inputs, processes, outputs, feedback loops, links to other systems, resource flows, internal/external boundaries, and product and service choices that preserve and restore ecosystems and socioeconomic systems [99].

In this study, environmental factors are represented by institutional factors, business models, and characteristics of farmer organizations, while human socioeconomic factors are represented by organization leaders, leadership structure, member education, revenue, and costs.

2 Methods

2.1 Study area

The study was conducted in two contrasting regions of Uganda: the northern and central regions. The northern region has the highest number of farmer organizations, predominantly producing annual crops (cereals, legumes, pulses, and oilseed crops) due to its climate conditions, and has a history of political and civil unrest. In contrast, the central region has fewer farmer organizations [3, 75, 107], produces both annual and perennial crops (such as coffee, vanilla, and cocoa) due to its more favorable climate, and has enjoyed relative political stability. In terms of institutional support, the northern region receives relatively more assistance from both government and non-governmental organizations to alleviate poverty and food insecurity caused by political instability [3, 20, 75]. This enabled the study to obtain comparable findings about farmer organizations and institutional frameworks in the contrasting agro-ecological regions of Uganda.

2.2 Sampling procedure and sample size determination

The study applied a multi-stage sampling procedure. In the first stage, two out of five regions were purposively selected. In the second stage, 12 districts were randomly chosen: seven from the northern region and five from the central region. The seven districts from the northern region included Arua, Koboko, Yumbe, Gulu, Agago, Apac, and Amolatar, while the five districts from the central region included Nakasongola, Mityana, Gomba, Buikwe, and Kayunga. In the third and final stage of sampling, lists of farmer organizations per district were obtained, and from these lists, every fifth farmer organization was selected. The study used a cross-sectional survey to collect both quantitative and qualitative primary data [38, 93] from the chairpersons of the randomly selected farmer organizations between January and March 2021. In cases where the chairperson was unavailable, the secretary or vice-chairperson of the group was interviewed.

The sample size was determined using the formula provided by Cochran [28] for sample size determination, as shown in Eq. 1.

$$n = Z^2 \frac{P(1-P)}{e^2} \tag{1}$$

where n is the sample size, Z is the abscissa of the normal curve that cuts off an area at the tails, e is the desired level of precision, and P is the estimated proportion of an attribute that is present in the population. Z is 1.96, and e is 0.05. In this study, P was assumed to be 0.23 because a small number of farmer organizations survive in a changing environment and many just exist by name [6, 115]. Substituting 0.23 in the formula generated a sample size of 272 respondent farmer organizations. The 272 farmer organizations were distributed proportionately between the northern and the central regions (Eq. 2).

$$n_{gr} = \frac{F_r}{F_R} * N_g \tag{2}$$

n_{gr} represents the number of farmer organizations sampled per region, F_r represents the approximate number of farmer organizations per region, F_R represents the approximate total number of farmer organizations in the two regions, and N_g represents the total number of farmer organizations sampled for the entire study (272).

From Table 1, the northern region had approximately 18,644 farmer organizations, while the central region had 7177 farmer organizations [107]. In total, the two regions had approximately 25,821 farmer organizations (Table 1).

The differences reflected in Table 1 between the number sampled and the number interviewed were due to COVID-19 restrictions. Since it was challenging to access the sampled number in Northern Uganda, only 177 farmer organizations were interviewed from the region. However, the difference was compensated for in Central Uganda by interviewing 95 farmer organizations to achieve the intended sample size of 272.

Table 1 Total number of farmer organizations and those sampled per region

Region	Approximate organizations	Sampled organizations	Interviewed organizations	
Northern			District	Number
			Arua	51
			Yumbe	22
			Koboko	20
			Gulu	27
			Agago	25
			Apac	10
			Amolatar	22
Sub total	18,644	196	–	177
Central			District	Number
			Nakasongola	16
			Mityana	18
			Gomba	12
			Buikwe	23
			Kayunga	26
Sub total	7177	76	–	95
Grand Total	25,821	272		272

Source: Ref. [107]

The study obtained ethical clearance from an ethics committee for higher institutions and sought authorization from District Farmers Associations (DFAs) and community leaders before commencing the survey. In addition, informed consent was obtained from each respondent prior to the interviews. Researcher-administered questionnaires were used with the assistance of trained research assistants.

2.3 Sustainability index development

In this study, the sustainability of farmer organizations was measured using a sustainability index. The index was computed as the sum of the total scores from three dimensions: social, economic, and environmental. The index indicates the level of competency of a business or organization to withstand the changing business environment [10, 17, 25, 35, 84, 97, 98]. It was measured on a scale from zero to one hundred percent [84, 97, 98]. The three dimensions were weighted on a 100% scale, with each dimension weighted based on its importance [45, 84]. In this study, the highest weight (50%) was assigned to the economic dimension, while equal weights of 25% were assigned to the environmental and social dimensions. The economic dimension received the highest weight because it was considered more important than the social and environmental dimensions, as it facilitates all organizational activities, including social and environmental ones [45, 85]. Equal weights were given to the environmental and social dimensions because they were considered equally important, given that a farmer organization cannot operate without customers or products/services.

2.3.1 The social dimension

According to Rahman et al. [85], the social dimension involves special attention paid to the social aspects to ensure the wellbeing of stakeholders ranging from environmental to societal issues. These ensure the social viability of an organization [85, 86]. To obtain sub-scores for the social dimension, this study assessed a farmer organization on strategies that it applies to ensure inclusion and wellbeing of the society in which it operates as well as its farmers and employees if any [85, 86]. These included: 1-hygiene and sanitation trainings, 2-participation of members in other groups, 3-capacity development of members and employees if any, 4-offering some goods/services to the community, 5-offering internship/training places to the community, 6-paying same price to all organization members and 7-taking products closer to customers. Each social practice/strategy reported to be used by a farmer organization received a score of 1. Thus, this study socially assessed a farmer organization on 7 social practices. More details about this are in Table 5 in the appendix.

2.3.2 The economic dimension

The economic dimension focuses on the financial aspects of an organization to ensure the financial well-being of the organization and its stakeholders [85, 92]. This includes financial feasibility, advancements towards environmental and social sustainability, and other related factors [9, 80, 85]. To obtain sub-scores for the economic dimension, this study evaluated each farmer organization based on strategies used to ensure the financial well-being of both the organization and its farmers. The criteria included: (1) timely payment, (2) retained earnings, (3) training on financial management, (4) economic value given to farmers (price paid compared to the market price), (5) value of physical resources (UGX), and (6) level of patronage from members (volume of produce produced or marketed by members through the organization). Financial management training and timely payment practices received a score of 1 if reported to be practiced by the farmer organization, and a score of 0 if not. The economic value parameter received a score of 1 if the organization paid a higher price than the market price, or 0 if it paid the same price. Retained earnings, level of patronage from members, and value of physical resources received scores of 1 or -1 based on their growth rates [12]. A positive growth rate earned a score of 1, while a negative growth rate earned a score of -1. The growth rate was calculated as illustrated in Eq. 3 [12].

$$Growth\ rate = \left(\frac{current}{initial}\right)^{1/n} - 1 \tag{3}$$

where: Current = value of physical resources/retained earnings/patronage levels, initial = value of physical resources/retained earnings/patronage levels, n = number of years of existence of a farmer organization. This study, therefore, assessed the economic performance of a farmer organization based on six economic parameters. More details are provided in Table 5 in the appendix.

2.3.3 The environmental dimension

The environmental dimension, according to Rahman et al. [85], focuses on the environmental aspects to ensure the well-being of stakeholders, addressing both environmental and societal issues. To determine the sub-scores for the environmental dimension, this study assessed each farmer organization based on agricultural practices it implements, trains, and monitors its farmers on to ensure the maintenance of soil and water resources, as well as the quality and quantity of produce [35, 85]. Effective agricultural practices are crucial for both production and marketing, as poor maintenance of soil and water resources can lead to a decline in produce quality and quantity, potentially resulting in a loss of customers for the farmer organization.

The practices considered included: (1) tree planting, (2) terracing/ridges, (3) mulching/cover cropping, (4) organic agricultural practices, (5) rainwater harvesting/irrigation, (6) intercropping, (7) crop rotation, and (8) land fallowing. Each reported practice received a score of 1 if implemented and 0 if not. Thus, farmer organizations were assessed on 8 environmental practices. More details are provided in Table 5 in the appendix.

The sustainability index of a farmer organization was then computed as shown in Eq. 4.

$$FOSI = \sum_{i=1}^{3} U_i * Sub_i \tag{4}$$

where $FOSI$ = Farmer Organization Sustainability Index, Sub_i = Sub-scores of the three dimensions, i = dimensions (economic, social and environment), and U_i = Weights of the respective dimensions.

Sub-scores for the three dimensions (Sub_i) were computed as shown in Eq. 5.

$$Sub_i = \sum_{qi=1}^{n} \frac{S_a}{U_q} \tag{5}$$

qi = Practices asked under a given dimension, U_q = weight of number of practices asked for each dimension, and S_a = number of practices reported in an organization

A farmer organization would be considered highly sustainable if it achieved a sustainability index of 100%, or averagely sustainable if it attained a sustainability index of 50%. Sustainability indices below 50% would be considered low.

2.4 Data entry and analysis

The Statistical Package for Social Sciences (SPSS) was used for data entry, while STATA 13 software was employed for analysis. Prior to the actual survey, the questionnaire was piloted to ensure validity and reliability. To validate the data, experts in the field reviewed the questionnaire to ensure it covered all relevant questions and answers [41]. Additionally, the questionnaire was pretested to guarantee reliability. The collected data were tested for reliability, producing a Cronbach's alpha value of 0.8282, indicating good reliability and consistency [41]. All quantitative data were subjected to Q–Q plots to assess their distribution characteristics, and a few variables that were not normally distributed were transformed. A correlation matrix was generated for all variables included in the model, with an acceptable correlation coefficient of less than 0.5 set as the threshold to ensure the absence of multicollinearity. Qualitative data, such as leadership styles and sustainability strategies, were initially summarized using frequencies to identify the most frequently mentioned variables. These variables were then converted into quantitative data through coding and included in econometric models for further analysis [46]. T-tests and Chi-square statistics were used to characterize farmer organizations across the central and northern regions of Uganda.

To assess the influence of organizational and institutional factors on the sustainability of farmer organizations at both the organizational and regional levels, a Two-Level Mixed Effects Linear Regression Model was used due to the clustered nature of the data. This model provides more reliable results for nested data compared to regular regression [11, 43]. In this model, farmer organizations represented the first level, while regions represented the second level. The sustainability index of farmer organizations served as the dependent variable, and organizational and institutional factors were the independent variables, as described in Table 2. Empirically, the model was estimated as shown in Eq. 6:

$$Y_i = B_0 + B_{1o}X_{1o} + B_{1r}X_{1r} \ldots .. + B_{20o}X_{20o} + B_{8r}X_{8r} + u_r + e_{or} \quad (6)$$

where Y_i = sustainability of farmer organization (index), B_0= the intercept for organization, $B_{1o} - B_{20o}$= parameters estimated at the organization level, $B_{1r} - B_{8r}$= parameters estimated at the regional level, $X_{1o} - X_{20o}$= explanatory variables at the farmer organizational level, $X_{1r} - X_{8r}$= explanatory variables at the regional level,u_r= Sustainability variance at the regional level, and e_{or}= Residuals at the farmer organization level. All explanatory variables are detailed as in Table 2.

Table 2 Variables in a multilevel regression to assess influence of organizational and institutional factors on sustainability of farmer organizations

Variable	Measurement	Expected sign	References
Dependent variable: sustainability (index)			
Independent variables			
Farmer organization level variable			
Leaders sex	(0 = female, 1 = male	±	[105, 121]
Internal finances	(USD)	±	[48, 80, 99, 106]
Proportion of male members	(%)	±	[55, 99, 106]
Average members' age	(years)	±	[15, 74, 77, 88, 99]
Leadership style	(0 = only democratic, 1 = both democratic and autocratic)	±	[65, 74, 77, 99]
Organizational departments	(number)	±	[74, 77, 99]
Organizational business activities	(number)	±	[74, 77, 99]
Leadership committee tenure	(years)	±	[74, 77, 99]
Average members' farm sizes	(acres)	±	[88, 89, 99]
Average secondary incomes	(number)	±	[56, 99, 105]
Leadership committee size	(number)	±	[48, 99]
Frequency of meetings	(number)	±	[48]
Leader's other income sources	(number)	±	[56, 77, 105]
Leader's expertise	(number)	±	[77, 121]
Organizational Age	(Years)	±	[48, 119]
Products traded	(number)	±	[119, 121]

Table 2: (continued)

Variable	Measurement	Expected sign	References
Value proposition	(number),	±	[117, 119]
Use farm gate distribution	(0 = No, 1 = Yes)	±	[117, 121]
Savings and loan scheme	(0 = No, 1 = Yes)	±	[97, 105]
Customer relationships strategies	(number)	±	[40, 105]
Tertiary value addition	(0 = No, 1 = Yes)	±	[37, 48]
Organization physical resources	(USD)	±	[80, 97]
Organization costs	(USD)	±	[97, 105]
Leadership passion	(0 = not passionate, 1 = passionate)	±	[65, 74, 77, 99]
Organization size	(number)	±	[88, 105, 117]
Regional level variable			
Value addition trainings	(0 = No, 1 = Yes)	±	[112, 117, 118]
Management and leadership trainings	(0 = No, 1 = Yes)	±	[77, 97, 99]
Farm management trainings	(0 = No, 1 = Yes)	±	[44, 99, 110]
Mode of establishment	(0 = external agencies, 1 = farmers)	±	[73, 91, 99]
Registration status	(1 = registered, 0 = not registered)	±	[99, 117]
Receipt of inputs	(0 = No, 1 = Yes)	±	[73, 97, 99]

To compute the difference in sustainability of farmer organizations across the two regions, the regional-level variance estimates from Model 1 and Model 5 were used, as shown in Eq. 7 [11, 43].

$$Regional\ sustainability\ variations = \left(\frac{Var_{M1}(cons) - Var_{M5}(cons)}{Var_{M1}(cons)}\right) * 100 \quad (7)$$

where: $Var_{M1}(cons)$= regional level variance estimates for Model 1, and $Var_{M5}(cons)$= regional level variance estimates for Model 5.

3 Results and discussions

3.1 Descriptive statistics: characteristics of farmer organizations in central and northern Uganda

3.1.1 Chi-square results for categorical characteristics

Table 3a shows that most farmer organizations in both the central and northern regions of Uganda were formed by the farmers themselves. However, it also indicates that many of these organizations did not engage in tertiary value addition, such as further processing flour into products like cakes, flavored porridge, scones, bread, bathing soap, wine, and coffee. Additionally, Table 3a reveals that most organizations in both regions had male leaders, although the central region had more female leaders compared to the northern region (Table 3a).

The following relationships were observed between the characteristics of farmer organizations and their region of operation. The mode of formation of farmer organizations was significantly ($P \leq 0.05$) related to the region of operation (Table 3a). Many organizations formed by external agencies were in the central region of Uganda. This suggests that the government is applying similar strategies to promote and stimulate the formation of farmer groups in central Uganda as were used in the northern region. Most of the population in central Uganda tends to shy away from agriculture, opting instead for more lucrative opportunities in urban areas [90]. Consequently, forming and supporting farmer organizations in the region by both government and non-government agencies is seen to renew interest in agriculture for food security, agro-industrialization, and poverty reduction, like the outcomes observed in the northern region [27, 73, 75, 91, 95].

Table 3a: Comparison of categorical characteristics of farmer organizations by region of operation

Variable	Category	Percent	Region		Pearson χ^2
			Central (n = 95)	Northern (n = 177)	
Mode of formation	By farmers	66.54	56.84	71.75	6.17**
	By external agencies	33.46	43.16	28.25	
Tertiary value addition	No	95.6	90.53	98.87	11.09***
	Yes	4.04	9.47	1.13	
Leader's gender	Female	42.28	57.89	33.90	14.59***
	Male	57.72	42.11	66.10	
Leadership style	Only democratic	40.44	32.63	44.63	3.70*
	Both democratic and autocratic	59.56	67.37	55.37	
Receipt of Inputs	No	83.09	86.32	81.36	1.08
	Yes	16.91	13.68	18.64	

***, ** and * are significance levels at 1%, 5% and 10% respectively

Tertiary level value addition (processing into final products) was significantly ($P \leq 0.01$) associated with the region of operation (Table 3a). Farmer organizations in the central region of Uganda excelled in adding value to their produce at the tertiary processing level, creating final products such as bathing soap, wine, cakes, scones, yogurt, ghee, cheese, flavored porridge flour, and ready-to-eat foods. This finding suggests that the environment in the central region is more conducive to tertiary value addition compared to the northern region. According to Okello et al. [78], farmer organizations in northern Uganda engage less in tertiary value addition, likely due to constraints related to limited exposure, market access, and market size.

The sex of the leader had a significant ($P \leq 0.01$) relationship with the region of operation of farmer organizations (Table 3a). Most farmer organizations in northern Uganda had male leaders compared to those in central Uganda. This disparity may be attributed to government and non-government interventions that initially provided direct support to farmer organizations in the central region. According to Uddin and Belal [106], many farmer organizations that received direct support from the government also benefited from extensive training, including leadership and management training, gender balance training, financial management training, and other programs designed to facilitate the smooth operation of the organizations and maintain strong relationships with supporting agencies (both government and non-government).

3.1.2 T-test results for continuous characteristics of farmer organizations in Uganda

Table 3b shows that, on average, farmer organizations had a low sustainability index of 36%. It also indicates that, on average, 33% of their members were male and that the committee size comprised 6 members. Additionally, farmer organizations typically required members to own at least 0.367 acres of farmland and have at least one other source of income before enrollment (Table 3b). On average, leaders also had at least one other source of income (Table 3b). Furthermore, farmer organizations, on average, implemented one customer relationship strategy, such as follow-up calls, after-sales services, or offering discounts (Table 3b).

The sustainability index was significantly ($P \leq 0.05$) different between farmer organizations across the two regions (Table 3b). Organizations in the central region were found to have a higher sustainability index compared to their counterparts in the northern region. This difference could be attributed to factors such as the nature of commodities traded, agro-ecological variations, relative political stability, and the degree of reliance on external support. According to Tirado-Soto and Zamberlan [103], dependency on external finances can undermine the reliability and capability of a farmer organization. This dependency restricts the organization's ability to engage in additional income-generating activities, which negatively affects its overall operations.

The proportion of male to female members in the organization was significantly ($P \leq 0.05$) different between farmer organizations across the two regions (Table 3b). Farmer organizations in northern Uganda had a higher proportion of male to female members compared to those in central Uganda. This difference could be attributed to the partnerships these organizations have with government and non-government entities [47]. According to Hill and Scarborough [47],

the Project for Restoration of Livelihoods in Northern Uganda (PRELNOR) and the International Fund for Agricultural Development (IFAD) work to raise awareness about gender equality among farmer organizations in northern Uganda.

The number of departments in the organizations varied significantly ($P \leq 0.01$) across the two regions (Table 3b). Farmer organizations in northern Uganda had more departments compared to those in the central region. This finding may be because many farmer organizations in northern Uganda pursue multiple objectives, such as production, marketing, and resource mobilization, which necessitate having several specialized units and diverse expertise to ensure efficiency and effectiveness. According to Ugoani [108], departmentalization enhances organizational performance by allowing members to focus on specialized tasks.

The number of business activities conducted by the organizations differed significantly ($P \leq 0.05$) across the two regions (Table 3b). Farmer organizations in northern Uganda engaged in more activities compared to those in central Uganda. This disparity is likely because many organizations in northern Uganda serve both internal and external customers and offer a wider range of products and services than their counterparts in central Uganda. Different customer bases and diverse products and services necessitate various tasks and business activities, such as employee and customer training, processing, branding, marketing, follow-up calls, and after-sales services, to effectively address customer needs [58].

The committee tenure of the organizations differed significantly ($P \leq 0.05$) across the two regions (Table 3b). Farmer organizations in northern Uganda had longer tenures compared to those in central Uganda. This longer tenure could be a strategy for nurturing successors [29]. Additionally, it may be that farmer organizations in northern Uganda use longer-serving committees to save on costs associated with the replacement process and to enhance performance, as indicated by the findings. According to Tennhardt et al. [101], longer committee tenures can help reduce organizational costs and improve performance by allowing committee members to gain more expertise and better assess and improve organizational activities.

The size of the leadership committee in farmer organizations differed significantly ($P \leq 0.05$) across the two regions (Table 3b). Farmer organizations in the northern region had larger leadership committees compared to those in the central region. This difference may be attributed to the broader geographical coverage, numerous business activities, and diverse products and services that farmer organizations in northern Uganda are involved in Table 3b. According to refs. [94, 100], larger committee sizes facilitate the timely completion of business activities by allowing for shared responsibilities.

The average farm size of members differed significantly ($P \leq 0.01$) across the two regions (Table 3b). Farmer organizations in northern Uganda required larger farm sizes from members before enrollment compared to those in central Uganda. This finding is likely because average land sizes are generally larger in the northern region compared to the central region of Uganda [6]. Additionally, differences in farming and cropping systems between the two regions may also account for the variations in farm size requirements for farmer organizations.

Table 3b Comparison of continuous characteristics of farmer organizations by region of operation

Variable	Mean			t-value
	Combined	Central	Northern	
Social dimension	0.49 (0.01)	0.51 (0.01)	0.48 (0.01)	1.41
Economic dimension	0.34 (0.01)	0.35 (0.01)	33 (0.01)	1.49
Environmental dimension	0.28 (0.01)	0.29 (0.02)	0.28 (0.01)	0.889
Sustainability index	0.36 (0.01)	0.38 (0.01)	0.36 (0.01)	2.02**
Organization size males	0.33 (0.01)	0.30 (0.02)	0.35 (0.01)	− 2.00**
Departments	2.39 (0.05)	2.17 (0.09)	2.51 (0.05)	− 3.50***
Business activities	3.32 (0.05)	3.14 (0.08)	3.41 (0.07)	− 2.52**
Committee tenure	2.10 (0.07)	1.88 (0.10)	2.21 (0.09)	− 2.39**
Committee size	6.11 (0.17)	5.54 (0.19)	6.42 (0.24)	− 2.49**
Average farm size	0.37 (0.034)	0.15 (0.02)	0.48 (0.05)	− 4.86***
Leader's other sources of income	1.22 (0.04)	1.36 (0.07)	1.14 (0.05)	2.48**
Organization customer relationship strategies	1.29 (0.03)	1.18 (0.05)	1.35 (0.04)	− 2.57**
Organization costs (USD@ 3700)	240.54 (46.65)	405.41 (137.84)	159.46 (15.41)	2.30**

Standard errors are in parentheses

***, ** and * are significance levels at 1%, 5% and 10% respectively

The number of additional income sources for leaders differed significantly ($P \leq 0.05$) between the two regions (Table 3b). Farmer organizations in central Uganda had leaders with more supplementary income sources compared to those in northern Uganda. This finding suggests that having multiple income sources is important for being elected as a leader of a farmer organization in central Uganda. It is possible that members of farmer organizations in central Uganda view leaders' additional income sources as a safeguard for their savings and earnings within the organization [122].

Customer relationship strategies differed significantly ($P \leq 0.05$) between the two regions (Table 3b). Farmer organizations in northern Uganda employed more customer relationship strategies compared to those in central Uganda. This difference may be attributed to variations in the length and complexity of the value chains in which these farmer organizations are involved. Additionally, farmer organizations in northern Uganda had more educated members than those in the central region. Internal and external customers have different needs and thus require distinct strategies that can improve information sharing and eventually value [8, 18, 26]. Furthermore, education enhances members' understanding of various strategies and implementation techniques [113]. According to Wang and Feng [18, 26, 113], customer-oriented organizations implement a range of customer relationship strategies to achieve effective performance.

Organizational costs differed significantly ($P \leq 0.05$) between the two regions (Table 3b). Farmer organizations in the central region incurred higher costs compared to those in northern Uganda. This discrepancy may be attributed to differences in value chains, commodities, and strategies employed [39].

3.2 Multilevel mixed-effects linear regression results for factors influencing regional sustainability of farmer organizations

Table 4 presents estimates for the two-level mixed effects linear regression for the final model M5. Estimates were derived using the restricted maximum likelihood (REML) criterion to obtain unbiased variance estimates, given that the Level 2 variable (region) consisted of only two units/groups [66]. The first level was at the farmer organization level, while the second level was at the regional level. Five models (M1, M2, M3, M4, and M5) were fitted to achieve the best and most robust model fit to the data. Model 1, the null model, was used to test for significant data clustering. The results of this null model were significant ($P \leq 0.05$), confirming adequate data clustering around the Level 2 variable (region) (Table 4). This validated the use of a multilevel mixed effects linear regression model. Models M2 to M5 were then fitted to identify the best model fit, evaluated using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) [34] as shown in Table 4.

We ran Model 2 without estimating the variance for Level 2 (regional level). However, the AIC and BIC values for Model 2 did not show an improvement in fit compared to those for Model 1 (Table 4). In Model 3, which included only Level 1 (farmer organization) variables and the variance for Level 2, the results were significant ($P \leq 0.01$) (Table 4), and its AIC and BIC values indicated a better fit than those for Model 2, as they were lower (Table 4).

For Model 4, we included only Level 2 variables while estimating the variance for Level 2. The results were not significant, and its AIC and BIC values were higher than those for Model 3 (Table 4), indicating that Model 4 did not improve fit. Finally, in Model 5, we estimated the Level 2 variance while including both Level 1 (organizational) and Level 2 (regional) variables. The results were significant ($P \leq 0.01$) (Table 4), and the AIC and BIC values were lower than those for Models 1 to 4, reflecting an improvement in model fit [34]. Thus, Model 5 represented the best multilevel model fit compared to Models 1 to 4 (Table 4). This also indicated that including regional-level factors enhanced the model's ability to explain the variation in the sustainability of farmer organizations across the two regions.

In the random section of Table 4, Var(cons) represents regional-level variance estimates, while Var(residuals) denotes variance estimates at the farmer organization level with respect to residuals. To compute the difference in sustainability of farmer organizations across the two regions, we used the regional-level variance estimates from Model 1 and Model 5 as described in Eq. 7.

$$Regional\ sustainability\ variations = \left(\frac{Var_{M1}(cons) - Var_{M5}(cons)}{Var_{M1}(cons)}\right) * 100 \tag{8}$$

where $Var_{M1}(cons)$= regional level variance estimates for Model 1, and $Var_{M5}(cons)$= regional level variance estimates for Model 5. Var_M1 (cons) is 0.000211, and Var_M5 (cons) is 0.0007111 (Table 4). Substituting these values into Eq. 7 yields a result of 237%. This means that 237% of the regional variations in the sustainability of farmer organizations is accounted for by the explanatory variables. However, this 237% contribution includes all explanatory variables, both regional and organizational.

Table 4 Organizational and institutional factors influencing sustainability of farmer organizations (Observations = 272, Groups = 2)

Dependent variable: sustainability of a farmer organization (Index)	
Fixed effects	
Independent variable	Coef
Leader's sex	− 0.010 (0.010)
Proportion of male members	0.016 (0.026)
Average age of members	0.003 (0.003)
Leadership style	− 0.003 (0.010)
Organizational departments	− 0.005 (0.006)
Organizational business activities	− 0.007 (0.006)
Mode of establishment of the organization	0.001 (0.009)
Leadership committee tenure	− 0.005 (0.004)
Organization age	0.0003 (0.001)
Savings and loan scheme	0.011 (0.016)
Internal financial dependence	0.029 (0.005)***
Average farm size of members	0.017 (0.008)**
Average of members' other sources of income	0.054 (0.049)
Leadership committee size	0.005 (0.002)***
Frequency of group meetings annually	0.0001 (0.000)***
Value of organizational physical resources	0.002 (0.001)*
Annual organizational total costs	0.004 (0.003)*
Leadership passion	0.017 (0.010)*
Organizational customer relationship strategies	0.013 (0.009)
Farmgate distribution of goods	0.017 (0.012)
Organizational value proposition	0.018 (0.008)**
Organizational products and services	0.007 (0.002)***
Leader's expertise	0.015 (0.008)*
Leader's other sources of income	0.005 (0.007)
Tertiary value addition	− 0.038 (0.025)
Group size	− 0.018 (0.010)
Registration status	0.016 (0.013)
Farm management trainings	0.052 (0.013)***
Value addition trainings	0.026 (0.011)**
Management and leadership trainings	0.022 (0.013)*
Receipt of inputs	− 0.015 (0.012)
_cons	− 0.405 (0.104)
Wald chi^2 (31)	270.35
Prob > chi^2	0.0000
Log restricted-likelihood	229.50
Random-effects parameters	
Region: Identity	
Var_M5(_cons)	0.0007111 (0.0010793)
Var_M5_s(Residual)	0.0045023 (0.0004119)
Var_M1(_cons)	0.000211 (0.0003957)
Var_M3(_cons)	0.0006658 (0.0010205)
Prob ≥ $chibar^2$	0.0006

Tests of goodness of model fit

Model	Obs	ll(null)	ll(model)	Df	AIC	BIC
Model 1 (null model)	272	.	257.921	3	− 509.84	− 499.02
Model 2	272	.	257.097	2	− 510.19	− 502.98
Model 3	272	.	235.276	23	− 415.19	− 314.22
Model 4	272	.	263.74	9	− 509.49	− 477.04
Model 5	272	.	229.77	35	− 390.99	− 268.40

Standard errors are in parentheses

***, ** and * are significance levels at 1%, 5% and 10% respectively

To determine the actual contribution of regional-level variables to sustainability, we compared the contribution of all variables with that of only organizational variables as derived from Model 3. Substituting Var_M3 (cons) from Model 3, which is 0.0006658. Substituting this value into Eq. 7 yields 216%. This means that organizational variables account for a 216% change in the sustainability of farmer organizations. Comparing this organizational-level contribution (216%) with the overall contribution of all explanatory variables (237%), it is evident that regional-level factors, including the mode of establishment of a farmer organization, registration status, farm management training, management and leadership training, and receiving inputs, contribute 21% to the changes in sustainability at the regional level.

From Table 4, internal financial dependence of a farmer organization had a significant ($P \leq 0.01$) and positive influence on the organization's sustainability. This indicates that reliance on internal finances effectively and reliably supports the sustainability of an organization. Adequate internal finances facilitate proper and timely planning, implementation, and management of sustainability-supporting activities compared to reliance on uncertain external funding [103, 111]. This, in turn, enhances their competence in the market. Data collection revealed that farmer organizations relying primarily on external finances were often uncertain about when to implement desired business activities due to unpredictable financial support. This finding aligns with Siman et al. [96], which also suggests that organizations must improve their internal financial resources to optimize and sustain their operations and compete effectively in the market.

From Table 4, the average farm size owned by organization members significantly ($P \leq 0.05$) and positively influenced the sustainability of farmer organizations. This suggests that larger farms are more sustainable than smaller ones. Larger farms enable farmers to implement ecologically responsive production systems, such as crop rotation, land fallowing and land furrows, which support regenerative agriculture [42, 88]. Additionally, larger farms tend to incur lower long-term costs compared to smaller farms [88]. For instance, farmer organizations with larger farms may benefit from economies of scale in tractor operations and experience reduced pest and weed pressure, unlike those with smaller farms. This, in turn, contributes to both economic and environmental sustainability. Smaller farm sizes, on the other hand, may lead to continuous cultivation on the same land, resulting in nutrient depletion and soil degradation [2]. Conversely, farmer organizations with larger farms can afford to employ environmentally friendly techniques such as crop rotation, rotational grazing, organic farming, cover cropping, and integrated pest management, which enhance their environmental sustainability [42, 57]. Our findings align with Ren et al. [89], who reported that an increase in farm size improves sustainability by positively impacting both economic and environmental dimensions.

The size of the leadership committee of farmer organizations was found to have a significant ($P \leq 0.01$) positive effect on the sustainability of the organizations (Table 4). Larger committees can reduce the leader's workload, supporting the timely completion of multiple sustainability-related tasks [83, 100]. These tasks may include mobilizing for farm management training, executing demonstration activities, organizing and conducting on-farm visits for members, arranging financial management training, and engaging the community in sustainability management. Having more committee members responsible for different tasks facilitates the timely achievement of organizational goals, fosters closer relationships among members, and increases their engagement in organizational management, thereby improving their commitment to organizational activities [83, 100]. Our findings align with refs. [30, 76], who suggest that larger committees bring diverse capabilities and support the coordination of organizational activities, reducing costs incurred by the organizations and thus contributing to economic sustainability.

The frequency of organization meetings significantly ($P \leq 0.01$) and positively influenced the sustainability of farmer organizations (Table 4). This implies that meetings play a crucial role in enforcing sustainability-related activities within an organization. Meetings help reinforce organizational intentions and goals to members [72]. They provide a platform for members and leaders to monitor progress, discuss encountered challenges, and brainstorm on solutions. This keeps the organization on track, facilitates accountability, and helps avoid costs that could arise from unaddressed issues [67]. Additionally, meetings bring members together, build trust between members and leaders, and enhance member commitment, thereby improving the social sustainability of the organization. Our findings align with Madsen [68], who also posits that regular meetings improve the sustainability of organizations by enhancing knowledge sharing, personal relationships, and flexibility and efficiency within the organization.

The number of value propositions offered by a farmer organization to customers had a significant ($P \leq 0.05$) and positive influence on the organization's sustainability (Table 4). This suggests that businesses aiming for long-term sustainability should focus on developing and offering multiple value propositions to their customers. By providing a variety of value propositions, an organization can address a broader range of customer needs and preferences, driving innovation, enhancing customer satisfaction and loyalty, and ensuring sustained revenue streams. This, in turn, contributes to long-term sustainability [120]. This finding aligns with Ilyas and Osiyevskyy [49], who also posits that value propositions positively affect a business's performance.

The products and services offered by farmer organizations were found to have a significant ($P \leq 0.01$) and positive relationship with the sustainability of the organizations (Table 4). This implies that offering multiple products to the market supports an organization's sustainability by expanding its market share, customer loyalty, visibility, and credibility, which ultimately enhances organization earnings [40, 118]. This, in turn, contributes to the economic sustainability of the organization and overall organizational sustainability. This finding is supported by ref. [4], which suggests that firms offering a wide range of products usually perform well financially.

Receiving farm management training significantly ($P \leq 0.01$) and positively influenced the sustainability of farmer organizations (Table 4). This implies that farm management training is a key contributor to sustainability. Farm management training strengthens the environmental conservation strategies implemented by a farmer organization [15, 94]. Proper environmental stewardship enhances productivity and improves livelihoods, which in turn boosts economic, social, and environmental sustainability. This finding is supported by refs. [16, 52], which also infer that sustainability is greatly influenced by the extent of farm management training.

Receiving value addition training had a significant ($P \leq 0.05$) and positive effect on the sustainability of farmer organizations. This finding implies that value addition training is crucial for enhancing business sustainability. Such training improves product quality and market competitiveness, increases revenue and profit margins, enhances skills and knowledge, creates jobs, and encourages diversification [81, 112], all of which contribute to the overall sustainability of an organization. Reference number 36 also emphasizes the collective contribution of value addition training to the long-term sustainability of businesses.

4 Conclusion, recommendations and lessons learned

4.1 Conclusion

This study determined the sustainability index of farmer organizations and assessed the influence of organizational and institutional factors on their sustainability in Uganda. While there are studies that have assessed sustainability in Uganda, these have concentrated on the sustainability of farming systems, the performance of different farming systems, and the impacts of new technology adoption. Therefore, assessing the sustainability of farmer organizations at both the organizational and regional levels contributes to an understanding of the sustainability indices of farmer organizations in Uganda and how interregional differences manifest in their sustainability.

Our findings indicate that internal financial dependence, leadership committee size, frequency of group meetings, number of products and services offered, farm management training, and value addition training are key drivers of sustainability across regions. Results also revealed significant regional differences in several factors: the proportion of male to female members, number of organizational departments, number of business activities conducted, leadership committee tenure, farm size required for enrollment, leaders' other sources of income, number of customer relationship strategies, annual total costs, and leaders' gender. Additionally, farmer organizations in central and northern Uganda on average, have a low sustainability index of 36%, which is below the average level of 50% sustainability. Farmer organizations in the central region had a slightly higher sustainability index (by 2%) than those in northern Uganda.

Specifically, regional-level variables, including the mode of establishment, registration status, farm management training, management and leadership training, and receipt of inputs, contribute 21% of the variation in the sustainability of farmer organizations in Uganda. Furthermore, internal financial dependence, the farm size owned by members, leadership committee size, frequency of organizational meetings, number of organizational value propositions, number of products and services offered, farm management training, and value addition training enhance the sustainability of farmer organizations.

4.2 Recommendations

4.2.1 Recommendations for farmer organizations

Farmer organizations should strengthen internal financial management to reduce dependence on external financial sources. This includes maintaining proper bookkeeping, financial planning, and securing diverse revenue streams. Additionally, farmer organizations should have an effective and appropriately sized leadership committee to enhance the efficiency and effectiveness of the organizations.

Regular meetings are essential for better communication, cohesive planning, effective problem-solving, and improved engagement and coordination among members. Farmer organizations should diversify the range of products and services

they offer to mitigate risks and cater to broader market needs. This can be achieved by identifying new opportunities for value addition and diversifying their product lines to enhance sustainability.

Finally, farmer organizations should encourage and facilitate member participation in training programs to improve farming practices, product quality, and marketability.

4.2.2 Policy recommendations

The government and development partners should provide supportive policies and financial assistance aimed at strengthening farmer organizations based on their unique needs in different regions. These can include grants, subsidies, and low-interest loans to support training programs and infrastructural development.

Government and development partners should intensify training programs aimed at addressing gender balance issues and enhancing farm management, financial management, leadership skills, and governance practices for better decision-making and organizational sustainability.

The government should simplify the registration process and provide legal recognition to farmer organizations across the country to enhance their operational capacity and access to resources.

Additionally, the government and development partners should intensify market linkage programs to help farmer organizations access local and international markets.

4.2.3 Recommendations for future research

Future research should focus on the long-term impact of various factors on the sustainability of farmer organizations to provide more comprehensive insights and inform better policy and practice.

Future research may also consider assessing commodity-specific sustainability within farmer organizations to develop more targeted policies and practices.

4.3 Lessons learned

Diversification in products, services, and income sources is crucial for the sustainability of farmer organizations, as it helps mitigate risks and stabilize income.

Continuous training and education in farm management and value addition are key drivers of sustainability. These initiatives equip members with the skills needed to enhance productivity and marketability.

Strong and effective leadership is essential for guiding farmer organizations toward sustainable practices. Leadership training and well-defined governance structures can significantly enhance organizational effectiveness.

The structure and size of leadership committees, as well as the frequency of organizational meetings, significantly influence the sustainability of farmer organizations. A well-organized structure and regular communication are critical for effective operations.

4.4 Study limitations

The concept of sustainability is dynamic and subject to change over time. For instance, farmer organizations handle agricultural produce that is highly sensitive to climatic changes. Additionally, these organizations are affected by the prevailing economic environment, and fluctuations in this environment can significantly impact their sustainability. Therefore, the findings of this study are specific to the year 2021, when the data was collected.

Acknowledgements This article is based on a larger PhD study funded by the Centre of Excellence for Sustainable Agriculture and Agribusiness Management project at Egerton University, supported by the World Bank, to which the authors are grateful. We also acknowledge the Uganda National Farmers' Federation for connecting us with the District Farmer Associations, from which we identified the farmer organizations. Additionally, we extend our gratitude to all the leaders of farmer organizations across the districts and to the research assistants who contributed to this study.

Author contributions R.N: conceptualization; data curation; formal analysis; investigation; methodology; Project administration; writing—original draft; writing—review and editing. P.M. M: guided and supervised the whole process from inception, guided the development of data collection tools and tirelessly read and guided the development of the paper. B. M: guided and supervised the whole process from inception, guided the development of data collection tools, guided and supervised data collection and tirelessly read and guided the development of the paper.

Data availability Data sharing may not be applicable for this manuscript since it is just part of a bigger study. However, upon publication of all findings in the bigger study, data may be available on reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate The protocol was approved by the Gulu University Research Ethics Committee (GUREC) in accordance with the guidelines and regulations set by the Uganda National Council for Science and Technology (UNCST). Informed consents to participate and publish were obtained from each respondent.

Competing interests The authors declare no competing interests.

Appendix 1

See Tables 3a, 3b and 5.

Table 3a Comparison of categorical characteristics of farmer organizations by region of operation

Variable	Category	Percent	Region		Pearson χ^2
			Central (n = 95)	Northern (n = 177)	
Registration status	Registered	84.56	84.21	84.75	0.01
	Not-registered	15.44	15.79	15.25	
Mode of formation	By farmers	66.54	56.84	71.75	6.17**
	By external agencies	33.46	43.16	28.25	
Tertiary value addition	No	95.6	90.53	98.87	11.09***
	Yes	4.04	9.47	1.13	
Have saving and loan scheme	No	9.93	8.42	10.73	0.370
	Yes	90.07	91.58	89.27	
Leader's gender	Female	42.28	57.89	33.90	14.59***
	Male	57.72	42.11	66.10	
Leadership style	Only democratic	40.44	32.63	44.63	3.70*
	Both democratic and autocratic	59.56	67.37	55.37	
Leadership passion	Not passionate	42.65	37.89	45.20	1.35
	passionate	57.35	62.11	54.80	
Farm gate distribution	No	20.96	17.89	22.60	0.83
	Yes	79.04	82.11	77.40	
Use door-to-door distribution	No	99.63	98.95	100.00	1.87
	Yes	0.37	1.05	0.00	
Value addition trainings	No	75.00	76.84	74.01	0.26
	Yes	25.00	23.16	25.99	
Farm management trainings	No	15.07	16.84	14.12	0.37
	Yes	84.93	83.16	85.88	
Management and leadership trainings	No	15.44	12.63	16.95	0.88
	Yes	84.56	87.37	83.05	
Receipt of inputs	No	83.09	86.32	81.36	1.08
	Yes	16.91	13.68	18.64	

***, ** and * are significance levels at 1%, 5% and 10% respectively

Table 3b Comparison of continuous characteristics of farmer organizations by region of operation

Variable	Mean			t-value
	Combined	Central	Northern	
Social dimension	0.49 (0.01)	0.51 (0.01)	0.48 (0.01)	1.41
Economic dimension	0.34 (0.01)	0.35 (0.01)	33 (0.01)	1.49
Environmental dimension	0.28 (0.01)	0.29 (0.02)	0.28 (0.01)	0.889
Sustainability index	0.36 (0.01)	0.38 (0.01)	0.36 (0.01)	2.02**
Organization size males	0.33 (0.01)	0.30 (0.02)	0.35 (0.01)	− 2.00**
Members' average age	18.03 (0.08)	17.92 (0.061)	18.08 (0.12)	− 1.03
Departments	2.39 (0.05)	2.17 (0.09)	2.51 (0.05)	− 3.50***
Business activities	3.32 (0.05)	3.14 (0.08)	3.41 (0.07)	− 2.52**
Committee tenure	2.10 (0.07)	1.88 (0.10)	2.21 (0.09)	− 2.39**
Organizational age	7.24 (0.32)	7.55 (0.51)	7.07 (0.41)	0.70
Organizational size	32.94 (1.64)	36.60 (4.27)	30.97 (1.03)	1.64
Committee size	6.11 (0.17)	5.54 (0.19)	6.42 (0.24)	− 2.49**
Internal financial dependency	2,500,000.00 (260,000.00)	2,700,000.00 (650,000.00)	2,400,000.00 (210,000.00)	0.54
Frequency of organization meetings	15.03 (1.18)	15.97 (1.93)	14.52 (1.50)	0.58
Average farm size	0.37 (0.034)	0.15 (0.02)	0.48 (0.05)	− 4.86***
Other sources of income	1.00 (0.01)	1.00 (0.00)	1.00 (0.01)	0.00
Leader's other sources of income	1.22 (0.04)	1.36 (0.07)	1.14 (0.05)	2.48**
Leader's expertise	1.95 (0.04)	2.02 (0.06)	1.90 (0.04)	1.52
Organization products and services	4.77 (0.12)	4.64 (0.27)	4.84 (0.12)	− 0.78
Organization value proposition	1.63 (0.04)	1.66 (0.06)	1.61 (0.05)	0.80
Organization customer relationship strategies	1.29 (0.03)	1.18 (0.05)	1.35 (0.04)	− 2.57**
Organization physical resources	4,400,000.00 (800,000.00)	4,500,000.00 (17,000,000.00)	4,300,000.00 (810,000.00)	0.10
Organization costs	890, 000.00 (180,000.00)	1,500,000.00 (510,000.00)	590,000.00 (57,000.00)	2.30**
Organization size	32.94 (1.64)	36.6 (4.27)	30.97 (1.084)	1.64

Standard errors are in parentheses

***, ** and * are significance levels at 1%, 5% and 10% respectively

Table 5 Description of sustainability dimensions and their indicators

Sustainability of a farmer organizations (Index_0–100%)				[17, 25, 34, 75, 85, 87, 88]
Dimensions	Indicators	Description	Measurement	Source
Social dimension: special attention paid to the social aspects to ensure the wellbeing of stakeholders ranging from environmental to societal issues. These ensure social viability of an organization, and they may include job security, accommodation, health and safety, and capacity building, equity and accessibility among others [85]				
	Hygiene and sanitation	Whether the farmer organization trains and urges members and the community to maintain good sanitation practices	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Members' participation in other groups	Whether the farmer organization allows it members to participate in other development projects in their communities	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Capacity development of members	Whether a farmer organization builds members capabilities in accessing new markets, marketing strategies, understanding market demands, pricing strategies, negotiation strategies, networking with potential buyers, post-harvest handling techniques and conflict resolution	(0 = no, 1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Offering good/services to the community	Whether the organization donates some goods like food to the needy in their community or participates in community cleaning activities	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Offering internship/training places to the community	Whether the organizations allows students to come and practice on their members' farms	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Paying uniform price to members	Whether the organization pays a uniform price per kilo of produce to all members	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Taking products closer to customers	Whether the organizations takes its products/services closer to customer to improve access	(0 = no,1 = yes)	[17, 25, 34, 75, 87, 88]
Economic dimension: special attention paid to the economic aspects to ensure the financial wellbeing of the organization and stakeholders. These may include financial feasibility, developments towards environmental and social sustainability, among others [85]				
	Timely payment	Whether the organization pays its members in time	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Trainings on financial management	Whether the organizations train their members on record keeping (tracking expenses and revenues)	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Economic value given to members	Price the organizations pays members for their products (market price/higher than the market price)	(0 = market price,1 = higher than market price)	[17, 25, 34, 75, 85, 87, 88]
	Retained earnings	Nature of growth rate of an organization's retaining earnings since establishment	(– 1 = negative growth, 1 = positive growth)	[17, 25, 34, 75, 85, 87, 88]
	Value of physical resources	Nature of growth rate of an organization's physical resources since establishment	(– 1 = negative growth, 1 = positive growth)	[17, 25, 34, 75, 85, 87, 88]
	Level of patronage from members	Nature of the growth rate of members' quantity sold or produced through the group	(– 1 = negative growth, 1 = positive growth)	[17, 25, 34, 75, 85, 87, 88]

Table 5 (continued)

Sustainability of a farmer organizations (Index_0–100%)				[17, 25, 34, 75, 85, 87, 88]
Dimensions	Indicators	Description	Measurement	Source
Environmental dimension: special attention paid to the environmental aspects to ensure the wellbeing of stakeholders ranging from environmental to societal issues. These include all practices that maintain the quality of products, natural resources and human life [85]				
	Tree planting	Whether the organization urges and monitors its members to plant trees on their farms	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Terracing/ridges	Whether the organization urges and monitors its members to make terraces/ridges on their farmers	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Mulching/cover cropping	Whether the organization urges and monitors its members to mulch their gardens or using cover crops	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Organic agricultural practices	Whether the organization trains, urges and monitors its members to make and use organic manure and pesticides	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Rainwater harvesting/irrigation	Whether the organization encourages and monitors its members to harvest rainwater for irrigation during dry seasons	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Intercropping	Whether the organization urges and monitors its members to practice intercropping on their farms	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Crop rotation	Whether the organization urges and monitors its members to practice crop rotation on their farms	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]
	Land fallowing	Whether the organization urges and monitors its members to practice land fallowing on their farms	(0 = no,1 = yes)	[17, 25, 34, 75, 85, 87, 88]

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