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ASSESSING THE BENEFITS OF AGROFORESTRY BEYOND FOOD SECURITY AMONG HOUSEHOLDS IN ISINGIRO DISTRICT, SOUTH-WESTERN UGANDA

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ABSTRACT

Globally, agroforestry and its capacity to offer a high yielding system are well known as a pathway for providing multiple benefits of Sustainable Development Goals (SDGs) to the households. In Uganda, household farmers adopt on-farm trees for various benefits such as soil erosion prevention, maintaining soil fertility, provision of shade, windbreaks, and climate regulation among others beyond food security. The study aimed at assessing the benefits of agroforestry beyond food security in Isingiro District. The study used a cross-sectional survey design to obtain qualitative and quantitative data. The number of household participants was 284. Multiple Linear Regression to analyse the association between dependent variable and numerous independent variables were employed. The study used Chi-Square tests to find out the statistical value of variables and their effect on agroforestry adoption. The study also used Multiple Regression Model to determine the degree to which selected variables were accountable for influencing agroforestry benefits beyond food security. The results indicated that 41% households in Kabaare, 37.0% in Kikokwa, and 22.0% in Kigyendwa practiced agroforestry. These percentages mean that agroforestry adoption is below the average (50%). The low adoption is attributed to factors such as land shortage, limited financial capacity, poor attitudes and perceptions. Of all the agroforestry adopters, only 21% of the households indicated that they had benefited from on-farm trees. This implies that majority 79% of those who did not practice agroforestry realized no benefits. The socio-economic factors that were positive and insignificant with a positive influence on household agroforestry benefits were the main occupation and income (0.001) while the family size and land size (0.288), land acreage used for food production and household size (0.553), land acreage and marital status (0.182) were insignificant. The study recommends intensive studies on household attitude, and perceptions about agroforestry practice in relation to other factors. The local government needs to review land policy, and strengthen its support to households in utilising their resources productively through on-farm tree adoption to attain diversified benefits.

Key words: Agroforestry, Benefits, Food security, Governance, Livelihood, Policy review, Household

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INTRODUCTION

Since its creation in the mid-1970s, the International Council for Research in Agroforestry (ICRAF) has scaled up agroforestry research and development activities. The earlier study by Gopraju *et al.* [1] indicates that usage of such aspects of development can eradicate poverty, hunger and promote human well-being, good health, and other SDGs.

In Uganda, agroforestry systems promotion started in the 1990s in selected districts of the Lake Victoria Crescent and the western region, which later extended to other areas like the Kabaare district, Western Uganda [2]. There is an inventory of data on home gardens in the Greater Bushenyi, South-western region that presents 225 diverse plants. Besides 54% of these plants provide food, 15% are for economic purposes, and 11% for medicine [3]. Despite these benefits, the earlier study in Uganda by Zinngrebe *et al.* [4] shows little government support for agroforestry systems.

In Isingiro district, the importance of tree adoption on farmlands is a reality [5]. Despite the attempted efforts in enabling sustainable forest plantations, Isingiro District faces governance gaps affecting community enhancement of environmental conservation. These challenges include negative perceptions toward forest management, inadequate resources, and minimal political will, and inadequate adaptive capacity, which make households susceptible to climate-induced hazards [6].

The paper attempts to assess the benefits of agroforestry beyond food security in Isingiro district. Its contribution is the enlightenment of households to adapt and use a multi-dimensional approach to agroforestry practice and understand factors influencing it. The study tested the hypothesis, "There is a significant relationship between socio-economic factors and household agroforestry benefits in the study sites."

MATERIALS AND METHODS

The study was carried out in Isingiro district (Fig. 1), located in South-western Uganda 00◦ 50'S 3050'E [7], and selected because of high agrarian nature and irregular precipitation [8]. The district has a population of 486360, annual rainfall of 1200 mm. Its topographically; has steep hills, deep valleys, gentle slopes and low lands. The district has equatorial type of climate, and agriculture is limited by water shortage [8]. The study used a cross-sectional survey design to obtain qualitative and quantitative data on household benefits of agroforestry. The study targeted 26 respondents in each of the five villages per parish. The selection of the first household was done by systematic sampling. Households were contacted

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through the area local council chairpersons. The proportion of the respondents who agreed to be interviewed was 284. The sample size of 400 respondents was obtained through a formula by Yamane [9].

N= N/ (1+N (e)2 where N signifies sample size, e marginal error at 10% (0.05) and N the total population under study. Therefore, N = $\frac{486360}{1+486360\ (0.05)^2}$ = 400

A semi-structured questionnaire was used to interview household head per family in a face- to-face interview. Fifteen key informants (KIIs) constituting farmers and local leaders were purposively sampled based on their understanding of the study problem, and experience in farming. The study used focus group discussions (FGDs) through organizational discussion, comprising of 15 participants, who were purposively chosen, screened, and not part of the primary respondents. Qualitative data analysis was based on thematic areas. Quantitative data were coded, entered, cleaned, and condensed using descriptive statistics, frequencies and chi-square. The study used Chi-square to test the association between the variables, and to find out the significance level at a marginal error of 0.05. Multiple Regression Model was used to test for the strength, and direction of the effect of one variable on the other. The study used SPSS software version 16. Data were collected in Kabaare, Kikokwa, and Kigyendwa civil parishes, with a population of 4,810; 2,803, and 2880, respectively [8].

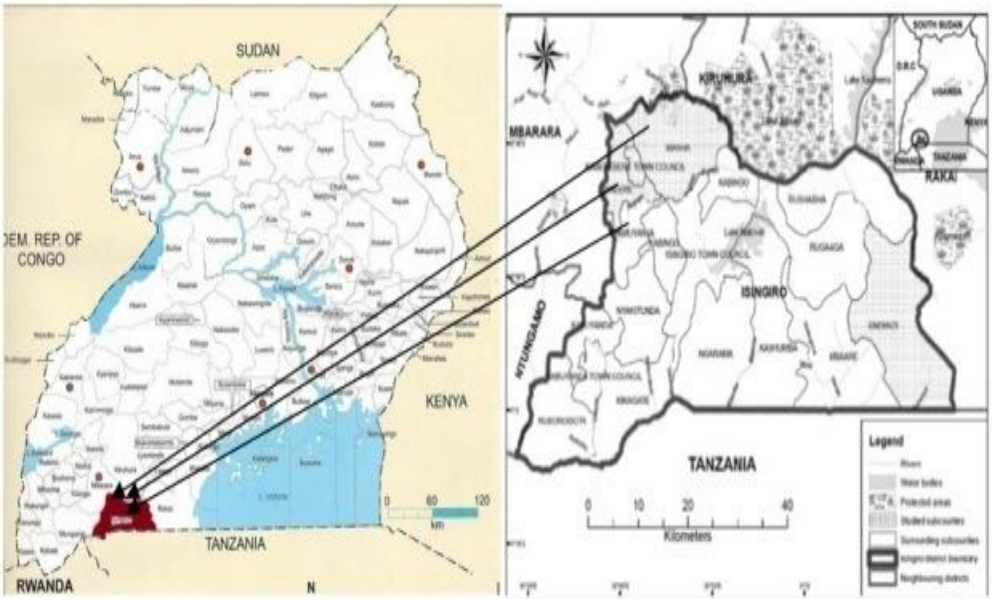

Figure 1: Location of the Study Site of Isingiro District, South-western Uganda

Source: https://www.google.com/url?sa=i&url=https%3A%2F

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Ethical approval

The Graduate School of the University of Nairobi; the Research Ethics Committee of the Mbarara University of Science and Technology, the National Council of Science and Technology; and Isingiro District Authority approved the study.

RESULTS AND DISCUSSION

Social-demographic characteristics

A summary of the social-demographic features of key household respondents is in table 1. The demographic characteristics of KII and FGD participants are in table 2.

According to the study, socio-demographic characteristics are influential regarding household benefits of agroforestry. Much as most households were male-headed across the parishes, the majority of the respondents were females (Fig. 2). These results mean that women were the majority found at home at the time of the interview. These findings match the previous study results in the Kapsaret sub-County, Kenya where cultural norms may have somehow evolved [10]. This outcome is commonly not what is expected culturally except in female-headed households. One would expect household male respondents to be the majority due to their cultural-based headship roles in a family. The reason is that women do most of the domestic work related to food production, tree caring, and looking after children, which increases chances of finding women at home.

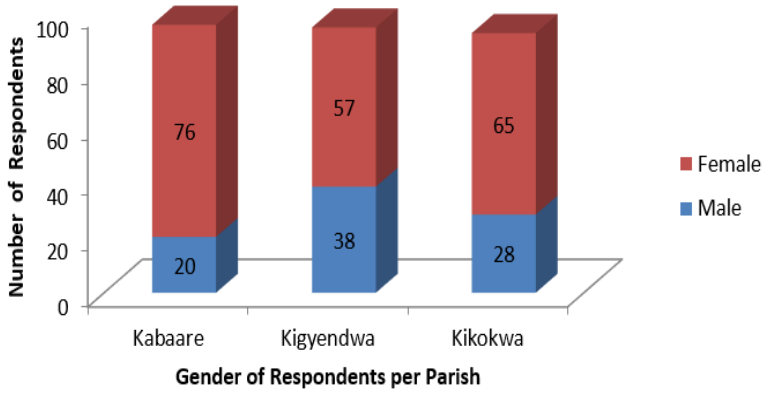

Figure 2: Gender of Respondents per Parish

Although women contribute significantly to farming than men, they generally have no equal say in decision-making over agroforestry practice. Women's less power means that men dominate intra-household decision-making pertaining to resources, which limits agroforestry benefits. This finding is similar to the earlier

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results in northwest Vietnam [11], where men dominated decision-making on crops, varieties, and tree species to plant. A lesser ratio of women (9%) reported their participation in deciding what tree or crop to plant. Women's less participation could be attributed to men's more access to modern farming information through membership in farmer cooperatives and better extension contacts. Women's limited exercise of equal rights to use household resources affects household capacity to enjoy agroforestry benefits beyond food security as shown by Rotich *et al.* [12] in Kapsaret sub–County, Kenya. Men's dominance implies that women's invisibility in household decision-making limits households' potential for tapping agroforestry benefits.

Education is an insignificant factor in influencing households to obtain value from on-farm tree adoption. The majority of the households practicing agroforestry had primary education (Fig. 3). Although the majority knew how to read and write, education level remains an insignificant factor. These results match past study findings in the Kapsaret sub-County, Kenya [10], and in Manafwa District, Uganda [12], showing that a low education level affects household advantages of agroforestry practice. The lower the level of education, the fewer households may be able to analyze, interpret and assimilate the available farming information. This finding does not match earlier study results in Malawi [13] and in the Southwest zone, Nigeria [14], where education significantly influences households' benefits from agroforestry. The implication is that unless household holders of primary education undergo refresher capacity-building courses in tree adoption, most of them may not be able to enjoy the advantages of tree adoption.

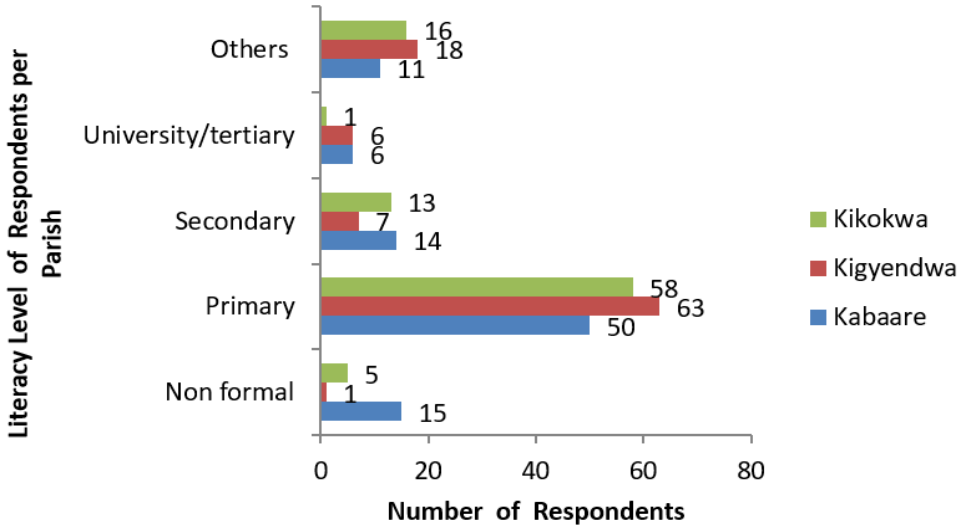

Figure 3: Literacy Level of Household Respondents per Parish

The majority of households across the parishes owned < one acre and <two acres of land (Fig. 4). This means households experienced land shortage. This finding

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resembles previous study results in Vihiga sub-County, Kenya according to Asena *et al.* [15]. This study shows that about 75.0%of the respondents had less than two acres, with 37.4% owning < 1 acre. Limited land, its inadequacy, fragmentation and over cultivation has made the resource most sensitive and may not motivate households to increase agroforestry benefits. Consequently, land scarcity results in resource conflict among the neighboring households due to trespass for survival. Agreeing with KIIs and FGDs, households having less land opt to use it for growing legumes, and cereals instead of integrating trees with crops. In one of the families, a key informant said, *"My husband planted coffee in our banana plantation against our will. We want to eliminate the coffee trees."* Such disagreement generates conflict as one party is determined to eliminate coffee on the basis that the land is too small and trees undermine banana trees.

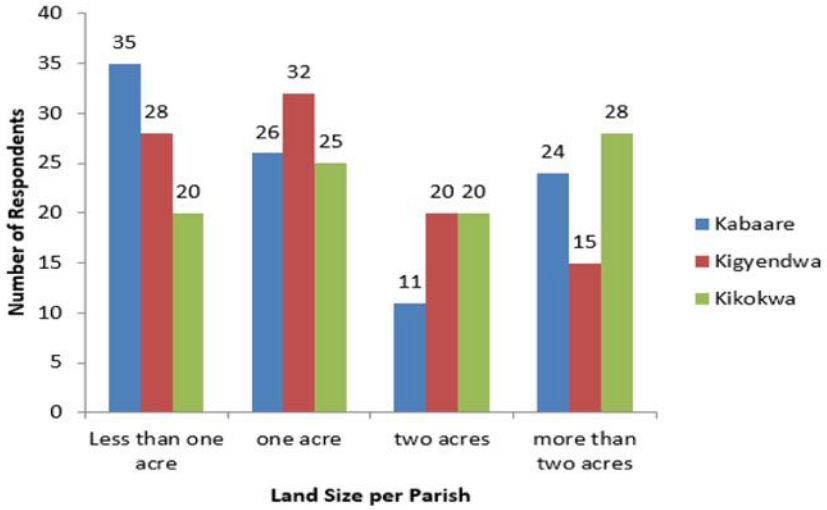

Figure 4: Land Size per Parish

Although respondents (79%) own one acre and above, they still believe that it is inadequate for meeting large household needs. The findings affirm that acreage is inadequate (Fig. 5). One FGD participant also asserted, *"Due to the land shortage we are facing, it is not good to plant trees on my small landholding since trees override other crops and fail them."* This factor is attributed to farmers' perception that their small landholdings cannot accommodate trees. This view echoes the earlier study in Kapsaret sub-County, Kenya [10], which reveals that when farm sizes are limited, farmers utilize them for subsistence farming and non-perennial cash crops such as wheat and maize, while side-lining tree planting.

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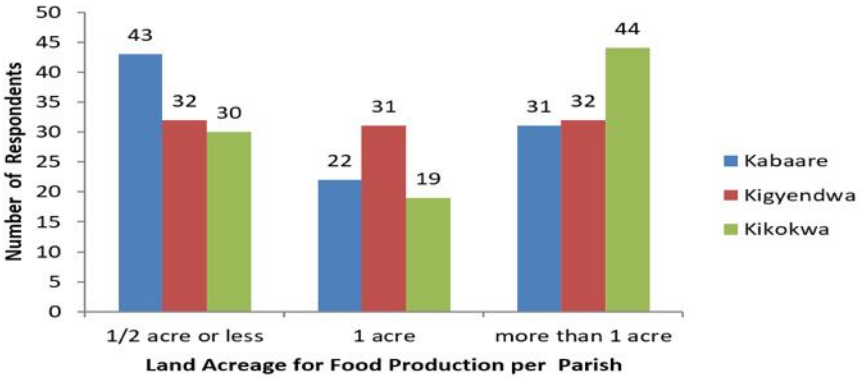

Figure 5: Land Acreage for Food Production per Parish

The land gap creates more challenges when the family size (Fig. 6) is not in congruence with the available land size.

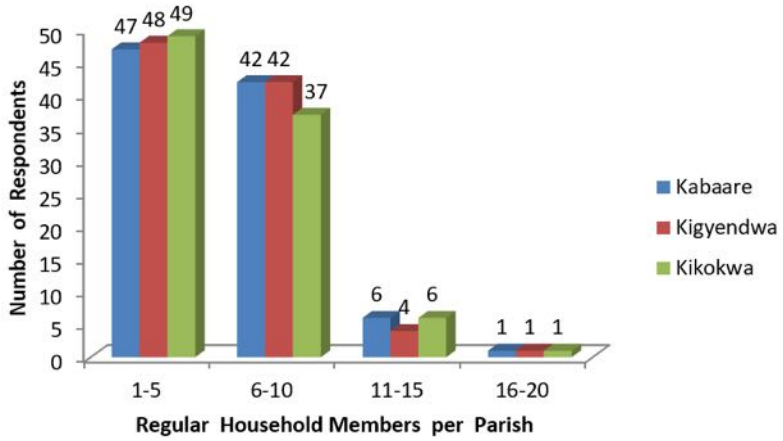

Figure 6: Family Size per Parish

The findings indicated that majority of the households engaged in food crop growing but not in on-farm trees (Fig. 7). This means that food growing was their main livelihood, and they mostly believed that trees would override other crops causing them starvation. However, they put less or no effort in agroforestry because of the mentality that small landholdings are not enough for accommodating trees.

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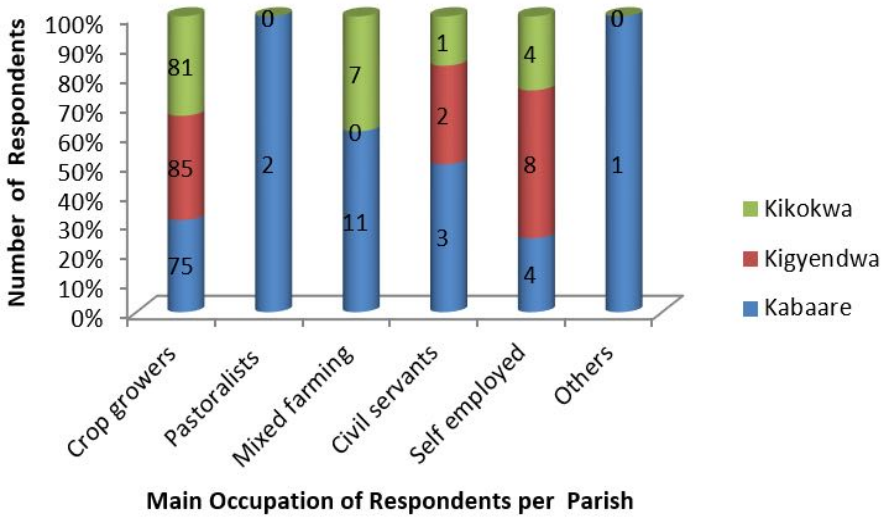

Figure 7: Main Occupation of Household Respondents per Parish

Association between household-farm factors and their influence on agroforestry benefits beyond food security

The study used Chi-Square analysis (Table 3) to test for the association between the variables: family size, land size, occupation, income, land acreage used for food production, and marital status.

Household acreage does not significantly differ among the study sites. The $\chi 2$ established no major association between household size, and land size ($p= 0.288>0.05$), and between household size and land acreage ($p= 0.553>0.05$). This finding does not match results of the previous study in Dale District, southern Ethiopia [16], where the family size and land size were significantly associated (<0.05). A combination of large families and household perception of the available land as being inadequate does not motivate households to engage in agroforestry practice. Large families that perceive their land as inadequate (Table 3) will less likely take advantage of gaining from on-farm tree practice but will opt for conventional farming over trees on farmyards. One of the participants stated, *"We are unable to embrace fruit trees on our limited plot of land because of our large numbers' after all our leadership is poor as it has never attempted to teach us about the possibility of adopting on-farm trees."*

Households facing land inadequacy and large household sizes focus more on the expenditure needs than making use of the accessible land industriously. According to the test of significance, there is no relationship between the land size, and land acreage at Phi Cramer's V= 0.195, P= 0.288 and 0.132, P=.553 respectively. This

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implies if large families experiencing land shortage increase, farmers are unable to save reasonable income due to many mouths to feed which affects household to invest in agroforestry.

There is a major association between occupation and income (p= 0.001) intensity in influencing household benefits of agroforestry. This means that household occupation has both a positive and significant effect on income at Phi Cramer's V= 0 .488, P = 0.001. This finding matches earlier results in Bungoma and Kakamega counties, Kenya [17], where farmers reported higher income from selling agroforestry yields and 14.0% higher cash value from fuel wood as a result of their farming occupation. It can be argued that families having occupational opportunities that provide them with reasonable income increase their chances of investing in agroforestry. This implies that an increase in the household income creates a higher likelihood for the family to practice agroforestry for diverse benefits.

According to multiple regression findings and the coefficient of determination (Adjusted R square) value in table 4 monthly income (0.103), and marital status (0.107) had no or less effect while family size (-.0.130), land size (-0.125), land acreage (-0.104), and main occupation (-0.063) had no influence on household income. This finding disagrees with the finding in southern Tigray Ethiopia [18], where variables such as family size, landholding, and marital status, had significant and positive ($p < 0.001$) effect on household agroforestry adoption. The earlier finding in Ndabibi, Nakuru County Kenya [19] supports the present study which indicated less or no effect of land size on agroforestry adoption. Households in the study sites are resource restrained and combined with other factors such as poverty, and low awareness, affects the level of agroforestry benefits. However, some households suggested measures of overcoming such challenges as training and sensitization programmes, and tree planting (Table 5). The study acknowledges that most variables had no or less effect on household agroforestry adoption. Therefore, the hypothesis, "There is a significant relationship between socio-economic factors and household agroforestry benefits in the study sites'' is rejected.

Livelihood benefits households derive from agroforestry practices

Agrisilviculture (Table 6) at 41.0% in Kabaare, 22.0% in Kigyendwa, and 37.0% in Kikokwa was the dominant agroforestry system. Households were interested in boundary cropping, intercropping, alley cropping, and woodlots. This finding matches earlier results in the Nyamagabo district, Rwanda [20], where alley cropping, boundary, and woodlots are adopted. The adopters of these practices

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find them easier to embrace, though majority people perceive them differently. The findings indicated that agroforestry benefits beyond food security included income, shade, manure, timber and windbreakers. However, most benefits fall below the average across the parishes. The implication is that unless government strengthens its support, the contribution of agroforestry will remain insignificant, hence limiting improvement of households' well-being.

Despite the variations among agroforestry practitioners in the study sites, most benefits fall below the average, except where Kikokwa lead in timber, Kabaare in shade trees, and Kigyendwa in windbreaks. This finding means that households practicing agroforestry are still a few. This finding differs from the study in communities like Ayakomaso, Mantukwa, Dumasua, and Fiapre in Ghana, indicating that growers' responsiveness to familiarized tree adoption skills scaled from 26 to 90%, with nearly 76% involved in the agroforestry practices due to government support and training programs [21]. It is difficult for farmers to engage in any practice and significantly benefit from it due to their perceptions and other demotivating factors. Some respondents engaged in agroforestry adoption have not remained the same. FGD (100%) participants stated, *"We are enjoying benefits of agroforestry such as additional income. We have to plant more."* This finding echoes earlier results by Quandt *et al.* [22] in the two communities of Burat and Kinna in Isiolo County, Kenya, where agroforestry improved the overall quality of life for respondents by 25.8% and 41.0%. This change shows that agroforestry has the power to promote the well-being of households as indicated in the past results in Latin America [23].

Further, results revealed that the most common and highly ranked type of fruit trees households integrated with other crops were mango (*Mangifera indica*), pawpaw (*Carica papaya*), and avocado (*Persea Americana*), all of exotic origin (Table 7). The practice of these trees means that households are interested in fruit tree adoption for various purposes beyond food security. This finding matches the previous results in Tigray, Ethiopia [18], where the most numerous fruit species preferred by small farmers were mango (*Mangifera indica*), pawpaw (*Carica papaya*), and avocado (*Persea Americana*). Despite low adoption of trees on farm, the findings showed that fruit tree adoption is still low. Fruit tree species have a high value in providing other benefits beyond food security like income and crop shades. This view matches earlier results in Southwestern Ethiopia [24] on the role home gardens play in promoting livelihood. This understanding implies that diverse tree species provide alternative sources of livelihood to families.

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CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Socio-economic variables influence household agroforestry benefits. The study has rejected the hypothesis, "There is significant relationship between socioeconomic factors and household benefits of agroforestry". Isingiro District being a semi-arid zone faces several challenges such as unreliable rainfall and land shortage that affect tree adoption on farms. These factors demonstrate why majority of the households are non-beneficiaries of agroforestry. The study recommends intensive studies on household attitude, and perceptions about agroforestry practice in relation to other factors. The local government needs to review land policy, and strengthen its support to households in utilising their resources productively through on-farm tree adoption to attain diversified benefits.

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Disclosure statement

No potential competing interest was reported by the author(s).

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Table 1: Social Demographic Characteristics of Respondents

Name of Parish	Gender (%)		Age (%)	Marital Status (%)	Literacy Level	Family Size (%)	Main Occupation (%)	Land size (%)	Land Acreage (%)	Monthly Income (US $)
	Male	Female	Less than 20	Married (%)	Non-formal Education (%)	0-5 members	Crop growers	< 1 acre	less an acre	Us $ 28
Kabaare	7	27	67	36	71	33	31	42	41	34
Kikokwa	13	20	33	30	24	34	34	24	29	36
Kigyendwa	10	23		34	5	33	35	34	30	30
			20-29	Separated	Primary	6-10 members	Pastoralists	1 acre	1 acre	30.5-55.5
Kabaare			30	18	29	35	100	31	31	32 29 39
			30-39	Widowed	Secondary	11-15 members	Cropping & cattle keeping	2 acres	> 1 acre	58-83
Kabaare			36	35	41	37.5	61	22	29	50
Kikokwa			35	28	38	37.5	39	39	41	17
Kigyendwa			29	37	21	25		39	30	33
			40- 49	Single	University	16-20	Civil servants	> 2 acres	2 acres	86-111
Kabaare			29	25	46	33.3	50	36		33.3
Kikokwa			27	50	8	33.3	17	42		33.3
Kigyendwa			44	25	46	33.3	33	22		33.3
			50-59		Others		Self employed			114 & above
Kabaare			48		24		31			21
Kikokwa			26		36		8			21
Kigyendwa			26		40		61			58
			60-69				Non-occupation holders			
Kabaare			40				100			
Kikokwa			25							
Kigyendwa			35							
			70+							
Kabaare										
Kikokwa			57							
Kigyendwa			43							

Source: Field Data

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Table 2: Demographic Characteristic of FGD and KII participants

	FGD Participants		KII Participants	
Variable	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Gender				
Females	10	67	6	40
Males	5	33	9	60
Age				
20-39	1	7	1	7
40-59	9	60	5	33
60-70	5	33	9	60
Marital Status				
Married	11	73	13	86.6
Widowed	2	13	1	6.6
Separated	1	7	0	0
Single	1	7	1	6.6
Education				
Non-formal	0		0	0
Primary level	8	53	3	20
Secondary level	4	27	8	53
University /tertiary	3	20	4	27
Main Occupation				
Famer	10	67	12	80
Civil servant	5	33	3	20

Source: Field Data

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Table 3: Association of Variables and Effect on Agroforestry Practices

Pearson Chi-Square Tests				
		Value	Df	Asymp. Sig. (2-sided)
Family size and land size		10.825[a]	9	0.288
Family size and land acreage		4.932[a]	6	0.553
Marital status and land acreage		8.860[a]	6	0.182
Main occupation and monthly income		67.458[a]	20	0.001
Impact of each variable on agroforestry practice				
Land size		7.860	3	0.049
Land acreage		6.098	2	0.049
Family size		6.846	3	0.077
Occupation		19.139	5	0,002
Income		1.467	4	0.832
Marital status		2.024	3	0.568

Table 4: Multiple Linear Regression Results and Coefficients of Determination Value

Coefficients[a]							Multiple Liner Regression: Adjusted R Square
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	0.062
		B	Std. Error	Beta			
1	(Constant)	1.820	.140		12.998	.000	
	Family size	-.097	.043	-.130	-2.241	.026	
	Land size in acres	-.053	.054	-.125	-.994	.321	
	Land acreage	-.058	.071	-.104	-.816	.415	
	Main occupation	-.027	.026	-.063	-1.055	.292	
	Monthly income	.042	.025	.103	1.686	.093	
	Marital status	.082	.045	.107	1.841	.067	
a. Dependent Variable: Income generated in US $							

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Table 5: Challenges faced in enhancing Agroforestry and Adopted measures

Challenges	Kabaare	Kigyendwa	Kikokwa
Poverty	57%	10%	33%
Agricultural inputs	30.70%	7.60%	61.50%
Pests & diseases	37.50%	25%	37.50%
Limited knowledge & skills	32%	44%	24%
Household suggested ways of overcoming the above challenges			
Training & sensitization programs	36%	28%	36%
Extension services	38%	38%	24%
Provision of seedlings	36%	9%	55%
Favorable market creation	75%	25%	0%

Source: Field Data

Table 6: Main type of Agroforestry System adopted and Household Benefits

Dominant Type	**Kabaare**	**Kigyendwa**	**Kikokwa**
Agrosilverculture	41%	22%	37%
Household benefits beyond food security			
Income	39%	25%	36%
Shade	43%	0%	57%
Manure	0%	20%	80%
Timber	33%	0%	67%
Windbreaks	11%	11%	11%

Source: Field Data

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Table 7: Elementary tree species households grow

No.		Kabaare Parish		Kigyendwa Parish		Kikokwa Parish	
	Tree specie	Frequency	%	Frequency	%	Frequency	%
1	Mango	36	22	15	16.6	28	18.0
2	Avacado	40	24.5	18	20	35	22.4
3	Pawpaw	31	19	21	23.3	33	21.1
4	Jackfurit	27	16.5	15	16.6	25	16.0
5	Casta oil	6	3.6	5	5.5	4	2.5
6	African satin wood	3	1.8	1	1.1	4	2.5
7	Guava	11	6.7	6	6.6	19	12.1
8	Markhamia lutea	0	0	1	1.1	2	1.2
9	Erythrina abyssinica	1	0.6	1	1.1	1	0.6
10	Diospyros abyssinica	1	0.6	0	0	0	0
11	Cordia africa	0	0	0	0	1	0.6
12	Coffee	6	3.6	7	7.7	3	1.9
13	Ficus exesperata	1	0.6	0	0	1	0.6
	Total	163	100	90	100	156	100

Source: Field Data

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