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Original Article

Classification and Socio-Economic Benefits of Agroforestry Systems in Soin Ward, Kericho County, Kenya

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Agroforestry System, Tree-Sugarcane, Socio-Economic, Classification, Constraints and Benefits.

ABSTRACT

Agroforestry Systems (AFS) are integrated land use systems involving trees, agricultural crops, and animals simultaneously or sequentially, with the objective of sustainably increasing their total productivity per unit area. Despite strong literature evidence describing the benefits of agroforestry to livelihoods in other parts of the world, there is little information as such in Soin Ward of Kericho County, where sugarcane competes with tea as a major cash crop. This study aimed at classifying agroforestry systems and evaluating their socio-economic benefits in Soin Ward, Kericho County, Kenya. The study adopted a qualitative research design through the administration of pretested questionnaires on types of agroforestry systems, the scale of production, land utilisation, preference of trees and sugar cane varieties and their interactions with 384 respondents in lower, upper, and midland parts of Soin Ward. Four (4) classes of agroforestry systems were identified that comprised (48.2% agrosilvopastoral, 31.6% agrosilvicultural, and 20.2% silvopastoral); (16.2% protective and 83.8% productive); (45.7% subsistence and 54.3% commercial), and integrated farm-based agroforestry 47.4%, homestead (6.8%), animal farm (31.4%), dairy farm (1.4%), and forest land (13%) respectively. The majority of the respondents (42.7%) preferred Grevillea tree species for blending with sugarcane in a tree-sugarcane agroforestry system in comparison with cypress (29.4%), eucalyptus (15.1%), casuarina (12.6%), and calliandra (0.2%) respectively. Sixty (61.7%) plant trees along the boundary, 24% as woodlot, hedge raw (8.9%), intercropping/mixed (3.1%), and alley cropping (2.3%). Direct benefits from the identified agroforestry systems include; income (67.6%), food (8.3%), and employment (24.1%). Indirect benefits include provision

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of biofuel (21.9%), enhanced soil fertility (21.1%), bio drainage (20.4%), biodiversity conservation (19.4%), carbon absorption (17.2%), improvement of social amenities such as roads (27.2%), markets (25.8%), hospitals (19.3%), schools (18.5% and electricity (9.2%).Constraints faced by the agroforestry systems include; long waiting payback (39.2%), limited possibilities to sell products (28.3%), labour intensive (27.8%), and knowledge and technology gap (4.7%). Such results are useful for policy-making decisions towards afforestation and improved livelihoods in Kenya.

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INTRODUCTION

Agroforestry Systems (AFS) are integrated land-use systems involving trees/shrubs and agricultural and/or animal crops, simultaneously or sequentially, with the objective of sustainably increasing the total productivity of plants and animals per unit area (Catacutan *et al.*, 2017). Similarly, agroforestry comprises land-use systems and technologies in which woody perennial plants (trees, shrubs, palms, or bamboo) and agricultural or animal crops are cultivated on the same plot organised in planned spatial and temporal arrangements (FAO and ICRAF, 2022). Such biodiverse and interactive production agroforestry systems provide social and ecological benefits to the communities and land users (Catacutan *et al.*, 2017).

Agroforestry systems (AFS) are further classified as silvoarable systems (combination of trees/shrubs with crops), silvopastoral (combination of trees with livestock), and agro-silvopastoral (combination of trees/shrubs with both crops and livestock), riparian buffer strips, and home gardens (Mosquera-Losada et al., 2018). Besides providing services such as food, fodder, fibre, and fuelwood production, AFS provide several other ecosystem services, including regulation of nutrient cycling, carbon sequestration, habitat for biodiversity, erosion control, fire and flood control, and recreational and cultural services (Mosquera-Losada et al.,

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2018). Similarly, AFS improve the resilience of smallholder farmers through more efficient water utilisation, improved microclimate, enhanced soil productivity, nutrient cycling, control of pests and diseases, improved farm productivity, diversified and increased farm income while at the same time sequestering carbon (Fagerholm et al., 2016).

One of the key global agenda of vision 2030 is the achievement of the Sustainable Development Goals (SDGs) (Garrity et al., 2012). The goals promote the world's effort to eliminate poverty and hunger, improve access to health services, basic education, support women empowerment, and regenerate the global environment through conservation and agroforestry. If SDGs are fully attained and implemented, they will benefit everyone by contributing globally towards a greater economic abundance, peace, and security. Similarly, the achievement of SDGs will give ways of overcoming hunger and poverty in a thorough and comprehensive manner through the development of rural communities in developing world such as Kenya (Gennari & D'Orazio, 2020).

Efforts to increase forest cover worldwide have been gaining momentum over the years through climate change mitigation and adaptation measure. Kenya is among the countries putting up the effort through the development of different strategies such as agroforestry and land use management systems with the ultimate aim of achieving 10% forest cover by 2030 (Ongweno et al., 2009). This study aimed at classifying agroforestry systems and evaluating their socio-economic benefits and constraints in Soin Ward, Kericho County, Kenya. Information on the tree-sugarcane agroforestry combination was underpinned by this study.

MATERIALS AND METHOD

Study Site

This study was carried out in Soin Ward (longitude 35º 02' and 35º 40' East and latitude 0^0 23' South), Kericho County, Kenya. Kericho County has fertile soils and reliable rainfall with low annual evaporation rates thus suitable for agriculture (Okonya et al., 2013). The variation in altitude within the study site has contributed to gradual variations in weather and agro-ecological (Fig 1) patterns; temperatures range between 10 ºC and 29 ºC with an average temperature of 17 ºC (GoK, 2013) and rainfall range of about 2125 – 1400 mm. The long rains fall between April and June, while the short rains occur between October and December. January and February are usually the driest months in the county.

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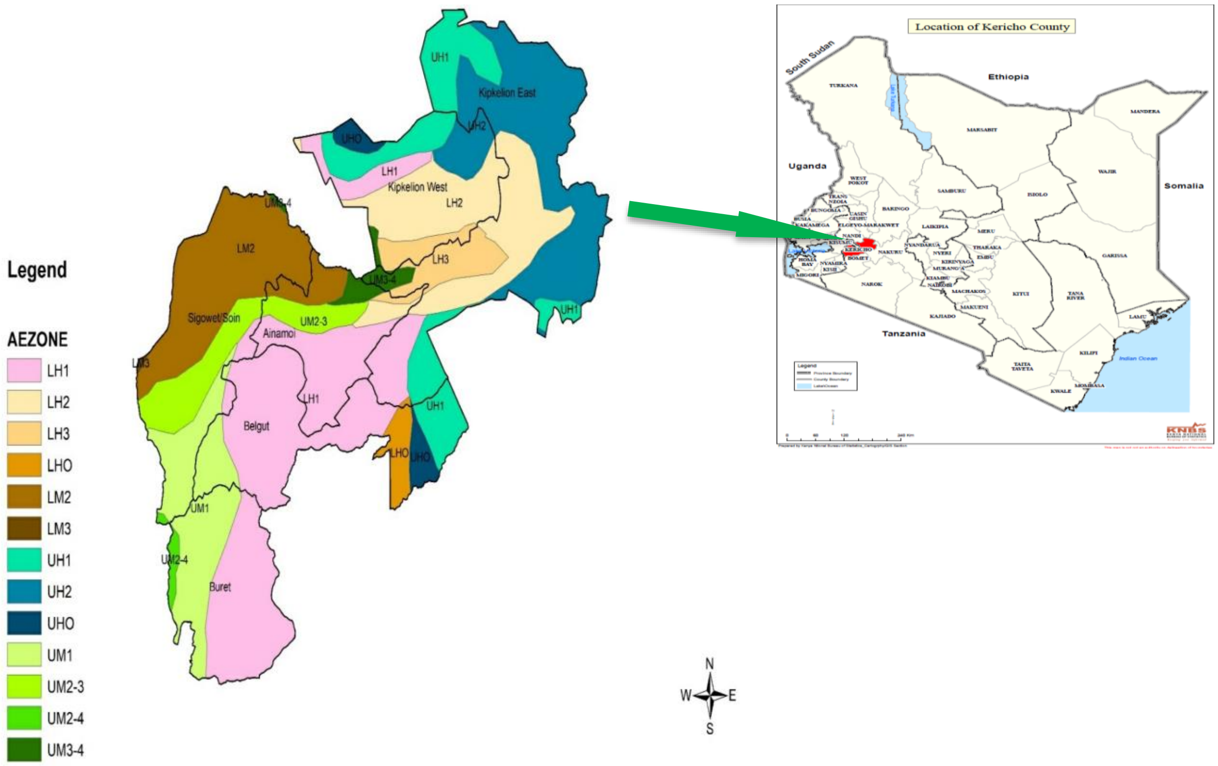
Figure 1: Map of Study Site



Source: Kenya Metrological Department – Kericho Office, 2020).

Research Design

The study site was divided according to the three major agro-ecological zones (AEZ), namely: Upper Highlands (UH) and Midlands (ML), suitable for sheep, dairy farming, wheat and pyrethrum production and coffee, tea, maise, and sunflower respectively. Lower Lands (LL) is suitable for commercial sugarcane and cotton growing that is proximal to the Nyanza sugar belt of Kisumu County (KCSAP, 2022). The study site covers 517km^2 with a population of 126,500 (KNBS, 2019).

This study employed a descriptive survey design since it enabled the researcher to get information about a social system and give a description concerning a particular issue. It was used due to its versatility to accommodate various methods of data collection such as questionnaires, interviews, observation, focused group discussion as well as data analysis (qualitative and quantitative) in order to deeply understand the problem under investigation. This design enabled the researcher to obtain information that examines the classification and socio-economic benefits of agroforestry systems in Soin Ward, Kericho County, Kenya.

Target Population, Sample and Sampling Procedure

This study targeted 126,500 sugarcane farmers, households, farm workers, and beneficiaries within Soin Ward. Three hundred (384) respondents were sampled according to the

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Fischer formula described by Kothari and Garg (2014) as follows:

$$n=Z^2*(p)*(1-p)/C^2 \quad \text{Equation 1}$$

Where; n = sample size, Z = 1.96, the tabulated Z value for 95% confidence level, p = sample proportion expressed as a decimal (0.5 is the maximum that can yield at least the desired precision; c = degree of accuracy expressed as a decimal (0.05 because the estimate of the study should be within 5% of the true value.

Hence, n=1.96 2 0.5 x (1-0.5)/0.052

n= 384 respondents

The sample size (n) was then apportioned equally (128) in a simple random manner to the three major climatic zones (upper, mid, and lower lands) in the study site.

Data Collection Procedures

Data on the classification and socio-economic benefits of agroforestry systems were collected by using a pretested questionnaire. Pretesting of the questionnaire was carried out in the neighbouring Ward of Kipkelion West three months prior to the commencement of the study. In each climatic zone (upper, mid, and lower lands) within the study site, agroforestry farmers and households were identified and the pretested and structured questionnaire was administered. The questionnaire maintained the anonymity and honesty of respondents (Böhringer, 2003). Additional data captured through observation and photographs were recorded in a checklist.

Secondary data were obtained from various sources such as the internet and journals and entered into data extraction form. Key informant interviews were administered to the Ministry of Agriculture and Forestry employees working in the area, community leaders, and professionals who have first-hand knowledge about the issue being explored. These experts, with their particular knowledge and understanding, can provide insight into the nature of problems and give recommendations for solutions (Carter, 2014).

Classification of Agroforestry Systems

Data relating to the classification of agroforestry systems were collected through the administration of questionnaires, interviews, surveys, and observation. These involved gathering data on types of traditional agroforestry (agrisilviculture, silvopastoral, agrosilvopastoral); functional agroforestry (productive and protective); the scale of practice (subsistence or commercial); land utilisation (homestead, forested land, dairy farm, animal farm, and integrated farm); ecological classification (tree species preference, planting arrangement, and sugarcane species).

Classification Characteristics of the Tree-Sugarcane Agroforestry

Data relating to the characteristics of the tree-sugarcane agroforestry system were collected through the administration of questionnaires, interviews, and observation. These data include the types and preferences of trees, types and preferences of sugarcane, planting arrangements of trees and sugarcane within the farm such as hedge raw, intercropping, boundary, woodlot, and alley cropping.

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Assessing Socio-Economic Benefits of Agroforestry Systems

Data relating to the socio-economic benefits of the agroforestry system were collected through the administration of questionnaires, observation, and interviews. Data on types of benefits {biodiversity conservation, bio drainage, soil fertility, carbon absorption, and biofuel, income, social amenities improvement and employment were captured}, data on demographic information of respondents and households, sex, age, education level and marital status of household heads were also collected, and contribution of agroforestry to social amenities within the study area was underpinned to this study.

Examining Socio-Economic Constraints of Agroforestry Systems

The data relating to the socio-economic constraints of the agroforestry systems were collected through the administration of questionnaires, observations, and interviews. Constraints in terms of labour intensity, payback periods, market accessibility, technology and knowledge were captured. The questionnaire and observation checklist maintained the anonymity and honesty of respondents (Kasomo, 2007). Additional data relating to the socio-economics of the tree-sugarcane agroforestry system was obtained from various secondary sources such as the internet and journals.

Data Analysis and Presentation

Data were analysed using descriptive and inferential statistics such as means and percentages and presented by the use of frequency distribution tables.

RESULTS AND DISCUSSION

DEMOGRAPHIC INFORMATION OF THE HOUSEHOLDS

Table 1 reports the mean demographic distribution of respondents in Soin Ward. Sixty-eight (68.1%) of the respondents were males, while females were a minority (31.9%). In Kenya's population census of 2019, the total population of Soin Ward was 21,072 heads, with the ratio for males to females standing at 49.05% and 50.05%, respectively.

Table 1: Mean Demographic Information of Respondents in Soin Ward

Item	Description	% Response	Item	Description	% Response
Gender	Male	68.1	Marital status	Single	12.1
	Female	31.9		Married	55.5
				Widowed	26.8
				Divorced	5.6
Household size	≤5	30.2	Primary occupation	Formal employment	21.7
	6-10	65.7			
	11-14	3.8		Informal employment	78.3
	>15	0.3			

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Item	Description	% Response	Item	Description	% Response
Age bracket	≤35	13.9	Land Sizes (Acres)	<1	16.0
	36-50	49.4		1.5-3	30.5
	>51	36.7		3.1-5	34.8
				5.1-7	14.0
				>7	4.7
Education levels	None	13.7	Marital status	Married	55.5
	Primary	25.9		Single	30.3
	Secondary	28.9		Divorced	5.6
	College	26.2		Widow	8.6
	Adult Education	5.3			

The majority of the respondents undertaking agroforestry were of the age group range of 36 – 50 years (49.4%); those above 51 years (36.7%) formed the second largest group, while those below 35 years (13.9%) were the minority. Twenty-eight (28.9%) of the respondents had attained a secondary level of education, followed by college graduates (26.2%), primary (25.9%), none (13.7%), while the minority had adult education (5.3%). These results are not significantly different from the findings of the Kenya population census 2019 (KNBS, 2019).

Household Characteristics of Agroforestry Farmers

Fifty-five (55.5%) of the households practising agroforestry were married, single (30.3%), or widowed (8.6%), while the minority were separated or divorced (5.6%). The highest number of household members among the respondents were 6 - 10 (65.7%), below 5 were 30.2%, those between 11 -14 members were 3.8%, and those with above 15 members were 0.3%. According to the Kenya Population Census of 2019, an average household size of four (4) was reported for Kericho County (KNBS, 2019). The current results from Soin Ward do not vary significantly from those reported for Kericho County in the 2019 population census.

The primary occupation for the majority of respondents (78.3%) was informal employment with those in formal employment at 21.7%. As of 2009, Kericho County's labour force stood at 405,034, the majority being males. This was projected to increase to 532,060 in 2018 and to rise further to 608,019 by 2022 (Kericho CIDP, 2018). Land sizes within Soin ward ranged from <1 acre (16.0%), 1.5 to 3 acres (30.5%), 3.1 to 5 acres (34.8%), 5.1 to 7 acres (14.0%) and >7 acres (4.7%). These results corroborate those reported in Kericho CIDP 2018 that put the average land holding size at 2.5 acres for smallholder farmers.

Classification of Agroforestry Systems in Soin Ward

Classification of agroforestry systems in Soin Ward was based on five thematic areas, namely: Traditional, functionality, socio-economics, ecological, and land utilisation. Results for each thematic area are presented in relation to land sizes.

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Traditional Classification of Agroforestry Systems

Table 2 shows the traditional classification of agroforestry systems in Soin Ward against the size of land owned. Three types of agroforestry systems were identified, namely; agrisilviculture, silvopastoral, and agrosilvopastoral.

Table 2: Traditional Classification of Agroforestry in Soin Ward

Thematic area of classification	Land size (acres)	Type of agroforestry system	Number of farmers	% Response
Traditional	<1	Agrisilviculture	21	5.5
	1.1-3		33	8.6
	3.1-5		49	12.8
	5.1-7		12	3.1
	>7		6	1.6
	Total		121	31.6
	<1	Silvopastoral	7	1.8
	1.1-3		19	4.9
	3.1-5		22	5.6
	5.1-7		24	6.1
	>7		7	1.8
	Total		79	20.2
	<1	Agrosilvopastoral	33	8.6
	1.1-3		64	17.0
	3.1-5		62	16.1
	5.1-7		21	5.5
	>7		4	1.0
	Total		184	48.2

Thirty-one (31.6%) of respondents practised agrisilvicultural system of agroforestry that involved planting food crops such as maise, sugarcane and trees in the same land in terms of alley cropping or home gardens. Twenty (20.2%) practiced a silvopastoral system that was characterised by grazing of domestic animals such as cows on Napier grass pastures. The majority (48.2%) of the respondents practiced an agrosilvopastoral system that involved planting cypress and eucalyptus trees, rearing animals and crops combined. This was characterised by home gardens, domestic animals, and scattered trees on croplands. The growth, development, and arrangement of different types of trees and crops such as sugarcane in the same area assume the existence of dynamic system interactions and change over time (FAO, 2015). This is especially true in areas where there are three components due to continued growth in height, crown projection, and leaf area of tree species. Land sizes and the adopted agroforestry system affect the distribution of existing resources,

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which in turn can cause a constant change in the productivity of species in a system (Jose, 2009; Peace Corps, 2021).

Functional Classification of Agroforestry Systems

Table 3 shows the functional classification of agroforestry systems in Soin Ward against the size of land owned. Two types of agroforestry systems were identified namely, protective and productive agroforestry.

Table 3: Functional Classification of Agroforestry in Soin Ward

Thematic area of classification	Land size (acres)	Type of agroforestry system	Number of farmers	% response
Functionality	<1	Productive	47	12.3
	1.1-3		105	27.3
	3.1-5		121	31.5
	5.1-7		37	9.6
	>7		12	3.1
	Total		322	83.8
	<1	Protective	14	3.7
	1.1-3		11	2.9
	3.1-5		12	3.1
	5.1-7		20	5.2
	>7		5	1.3
	Total		62	16.2

Sixteen (16.2%) of respondents practised protective agroforestry that aimed at providing functions such as a windbreak, shelterbelt, soil conservation, moisture conservation, soil improvement, and shade for crops and animals. The majority (83.8%) of the respondents practised productive agroforestry that aimed at the production of essential commodities such as food, fodder, and fuel wood. A protective agroforestry system is designed to protect the land, improve climate, reduce wind, and water erosion, improve soil fertility, provide shelter, and other benefits (Kericho County Government, 2021). On the other hand, a productive agroforestry system aims at the production of essential commodities such as food, fodder, and fuel wood required to meet society's basic needs. It includes intercropping of trees, home gardens, plantation of trees in and around the crop field, and production of animals and fishes associated with trees (Kebebew & Urgessa, 2011).

Socio-Economic Classification of Agroforestry Systems

Table 4 shows the socio-economic classification of agroforestry systems in Soin Ward against the size of the land owned. Two types of agroforestry systems were identified,

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namely; subsistence and commercial agroforestry.

Table 4: Socio-economic classification of agroforestry systems in Soin Ward

Thematic area of classification	Land size (acres)	Type of agroforestry system	Number of farmers	% Response
Socio-Economics	<1	Subsistence	54	14.1
	1.1-3		62	16.1
	3.1-5		56	14.5
	5.1-7		3	0.8
	>7		1	0.2
	Total		176	45.7
	<1	Commercial	7	1.8
	1.1-3		54	14.1
	3.1-5		77	20.1
	5.1-7		54	14.1
	>7		16	4.2
	Total		208	54.3

Forty-five (45.7%) of the respondents practised subsistence agroforestry in comparison to 54.3% who preferred the commercial type of agroforestry system. Subsistence agroforestry is defined as self-sufficient farming in which farmers focus on cultivating sufficient quantities of trees and sugarcane for their families. It aims at the basic needs of a small family having less land holding and very little capacity for investment. In Soin Ward, this was characterised by marginal surplus production for sales like shifting cultivation and scattered trees in the farms and homesteads. A commercial agroforestry system is a large-scale production on a commercial basis, and the main consideration is to sell the products such as tea or sugarcane or coffee. Seventy (77%) of the farmers have less than five acres of practised commercial agroforestry in Soin Ward. Due to the statistical insignificance observed between the two types (commercial and subsistence agroforestry), it is suggested that an intermediate agroforestry system (intermediate between commercial and subsistence systems) is practised on the small and medium-sized farms with the aim to produce items that are not only enough to meet the needs of the family but also earn money from the surplus that can be sold, (Kebebew & Urgessa, 2011).

Classification of Agroforestry System Based on Utilisation of Land

Table 5 shows the classification of agroforestry systems in Soin Ward based on land utilisation. Five types of land utilisation agroforestry systems were identified, namely, homestead, forest land, dairy farm, animal farm, and integrated farm.

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Table 5: Classification of agroforestry system based on utilisation of land

Thematic area of classification	Land size (acres)	Type of agroforestry system	Number of farmers	% response
Land Utilisation	<1	Homestead	13	3.4
	1.1-3		10	2.6
	3.1-5		3	0.8
	5.1-7		0	0
	>7		0	0
	Total		26	6.8
	<1	Forest land	4	1.0
	1.1-3		10	2.6
	3.1-5		15	3.9
	5.1-7		16	4.2
	>7		5	1.3
	Total		50	13
	<1	Dairy farm	3	0.8
	1.1-3		2	0.6
	3.1-5		0	0
	5.1-7		0	0
	>7		0	0
	Total		5	1.4
	<1	Animal farm	3	0.8
	1.1-3		39	10.1
	3.1-5		56	14.6
	5.1-7		19	4.9
	>7		4	1.0
	Total		121	31.4
	<1	Integrated farm	38	9.9
	1.1-3		55	14.3
	3.1-5		59	15.4
	5.1-7		22	5.7
	>7		8	2.1
	Total		182	47.4

In Soin Ward, an integrated farm-based agroforestry system was the most preferred by (47.4%) of the respondents in comparison with homestead (6.8%), animal farm (31.4%), dairy farm (1.4%), and forest land (13%). The Homestead agroforestry system focused on the production of fruit trees, selected multipurpose trees having less canopy and decorative trees/shrubs and vegetables, spices, and many shade-loving crops. The Forest land

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agroforestry system focuses on the production of crops in the vacant spaces of the forest; the crop farm forestry system focuses on the production of crops and trees in the cropland. Animal farm forestry was characterised by farming poultry birds and trees. Dairy farm forestry was characterised by farming milk and beef cattle and goats within the same land. Integrated farm forestry was characterised by the production of crops, animals, fishes along with trees and roadside agroforestry, the production of deep-rooted tall trees with narrow canopies and soil building grasses or crops along the sides of roads, highways, railways, and embankment (Kebebew & Urgessa, 2011).

Ecological Classification of Agroforestry in Soin Ward

Table 6 shows the classification of agroforestry systems in Soin Ward based on ecology. Three types of ecological classification in terms of tree species, planting arrangement, and sugar cane species preference were identified. Majorities (34.9%) of the farmers participate in a tree-sugarcane agroforestry system in a planting arrangement with sugar cane (33.6%) and tree species (31.5%), respectively.

Table 6: Ecological classification of agroforestry system in Soin Ward

Thematic area of classification	Land size (acres)	Type of agroforestry system	Number of farmers	% response
Ecological	<1	Tree species preference	18	4.7
	1.1-3		36	9.4
	3.1-5		45	11.7
	5.1-7		15	3.9
	>7		7	1.8
	Total		121	31.5
	<1	Planting arrangement	12	3.1
	1.1-3		51	13.3
	3.1-5		54	14.1
	5.1-7		11	2.9
	>7		6	1.6
	Total		134	34.9
	<1	Sugar cane species preference	13	3.4
	1.1-3		41	10.7
	3.1-5		57	14.8
	5.1-7		12	3.1
	>7		6	1.6
	Total		129	33.6

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Paquette and Messier (2020) and Ellison *et al.* (2016) have demonstrated the viability of sugarcane in agroforestry systems in Brazil. Several studies in Brazil and around the world demonstrate the viability of using annual crops such as maise, soybeans, wheat, oat, and ryegrass in ecological agroforestry systems (Ellison *et al.*, 2016).

Characteristics of Tree-Sugarcane Agroforestry System in Soin Ward

Studies were carried out to understand tree and sugarcane species preferences in Soin Ward and their planting arrangements in an agroforestry system.

Tree Species Preferences and Planting Arrangement in Soin Ward

The majority (42.7%) of the respondents preferred *Grevillea* tree species for blending with sugarcane in a tree-sugarcane agroforestry system. The other tree species in order of preference were c*ypress* (29.4%), e*ucalyptus* (15.1%), *casuarina* (12.6%), and *calliandra* (0.2%). This is different from Uganda, especially in Bunya County, where *Eucalyptus spp.*, *Senna siamea, and Senna spectabilis* tree species have been prioritised based on computed use values and acceptance to be grown by over 30% of farmers now and in future (Obua, 2010).

Trees were planted by (61.7%) of the farmers along the sugarcane farms as a boundary crop, as woodlot (24.0%), hedge row (8.9%), intercropping/mixed (3.1%), and alley cropping (2.3%). The adoption of hedgerows seems to be the best solution to soil conservation with annual crops (Young, 2020).

Plate 1: Characteristics of Tree-Sugarcane Agroforestry in Soin Ward

a. Boundary arrangement

b. Alley cropping

c. Hedge row

Benefits Accrued from Agroforestry Systems

Socio-economic Benefits of Agroforestry Systems

Direct benefits from tree-sugarcane agroforestry systems include income (67.6%) and employment (24.1%). (21.9%) of the farmers benefit from biofuel extraction, soil fertility enhancement (21.1%), bio drainage (20.4%), biodiversity conservation (19.4%), and carbon absorption (17.2%). In terms of its potential to mitigate climate impact and improve soil quality, agroforestry can offer significant economic and social impact,

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especially for smallholder farmers in developing countries such as Kenya (Ngugen, 2013). Improved soil quality could help farmers produce more crops, while introducing trees in traditional agricultural systems can allow more efficient nutrient cycling, meaning farm output can be substantive and reliable (Ngugen, 2013). Crops and products derived from introducing trees in agricultural systems drive positive social and economic change (Tumwebaze & Byakagaba, 2016). A low-cost and sustainable technique to transform any degraded landscapes and improve livelihoods among communities is through agroforestry (Ngugen, 2013).

The adoption of agroforestry in Soin Ward has changed the standards of living among the residents through the construction of new and repairing of roads, schools, hospitals and markets. In the study area, the following social amenities were improved; roads (27.2%), markets (25.8%), hospitals (19.3%), schools (18.5%), and electricity (9.2%). Literature review showed that farmers derive direct revenue from harvested cane while indirect revenue comes from opportunities created by the sugarcane industry such as business investments mostly in the form of retail and wholesale shops, transport services (both motorbikes and motor vehicles) and reinvestment in the food crop industry (Ngugen, 2013).

Socio-Economic Constraints of Agroforestry Systems

Trees integrate with sugarcane to improve yields, diversify products, increase economic resilience, and improve farm viability and sustainability in the long term. When choosing a tree species for a particular purpose, it is important to consider the multiple uses and functions it can provide (Wilson & Lovell, 2016). In the current study, the majority of respondents (90.3%) reported that land size was the major constraint to the tree and sugarcane agroforestry system. Other constraints include; long waiting payback (39.2%), limited possibilities to sell products (28.3%), labour intensive (27.8%), and knowledge and technology gap (4.7%). A rapid increase in the human population in the world has led to the widening of the market gap in the supply of various farm produce, especially in the forestry and agriculture sectors (UN, 2016). The gap has forced farmers to encroach on nearby forests in search of more space for settlement and expansion of agricultural fields (FAO, 2016; Melusi, 2012).

CONCLUSIONS

Four (4) classes of agroforestry systems were identified in Soin Ward that comprised; (48.2% agrosilvopastoral and 31.6% agrosilvicultural and 20.2% silvopastoral); (16.2% protective and 83.8% productive); (45.7% subsistence and 54.3% commercial) and Integrated farm-based agroforestry 47.4%, homestead (6.8%), animal farm (31.4%), dairy farm (1.4%) and forest land (13%) respectively. The majority of the respondents (42.7%) preferred *Grevillea* tree species for blending with sugarcane in a tree-sugarcane agroforestry system in comparison with *cypress* (29.4%), e*ucalyptus* (15.1%), *casuarina* (12.6%) and c*alliandra* (0.2%) respectively. Sixty (61.7%) plant trees along the boundary, such as woodlot (24.0%), hedge raw (8.9%), intercropping/mixed (3.1%) and as alley cropping (2.3%). Direct benefits from the identified agroforestry systems include; income (67.6%), food (8.3%) and employment

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(24.1%). Indirect benefits include provision of biofuel (21.9%), enhanced soil fertility (21.1%), bio drainage (20.4%), biodiversity conservation (19.4%) and carbon absorption (17.2%), improvement of social amenities such as roads (27.2%), markets (25.8%), hospitals (19.3%), schools (18.5% and electricity (9.2%). Constraints faced by the agroforestry systems include; long waiting payback (39.2%), limited possibilities to sell products (28.3%), labour intensive (27.8%) and knowledge and technology gap (4.7%).

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