

The Community Perceptions and Attitudes about Agroforestry and Impediments to on-farm Trees/shrubs Growing and Management in Rajaf County-South Sudan

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Abstract:- The fundamental elements in sustainable agroforestry management are the Community's perceptions and preference of those agroforestry practices that relates to impediments to grow and manage on-farms trees/shrubs. The study examined the varied dimensions of peoples' perceptions and preference to agroforestry values towards its benefits and impediments to on-farm tree/shrub growing and management in rural communities of Rajaf County. The data were collected from four identified villages with 332 households' respondents selected for interviews through simple random sampling. The data were then subjected to descriptive and analytical statistics. The results indicated respondents perceived AF practices as contributing fairly (41%) or poorly (29.5%) to food security and climate change. Household incomes (90.1%), need for food (87.0%), inadequate seedlings and seeds (75.3%), insecurity (74.4%) and sources of fire/fuelwood (64.5%) were expressed factors that highly influenced people's participation in tree/shrubs growing and management. The perceived challenges preventing them from on-farms tree growing activities were majorly insecurity (97.6%), lack of inputs (91.0%), lack of trainings (89.8%), prevalence of pests and diseases (82.8%) and lack of capital to start (60.8%). The rural farmers also expressed their concern for trainings and received of inputs such as improved seeds, seedlings and farming tools majorly provided by World Vision (97%), Caritas (73.70%), and CRS (61.9%). The on-farms material value (sources of income) ranked (1st to 5th) of agroforestry were perceived the most important while off-farm income sources were adjudged least important. Most of their expenditures were used for staple food, paying school fees and hire farm labour. Although these are said to be mere perceptions, the findings will help to enrich knowledge-base disorder to provide basis for decision and policy making for sustaining and managing on-farm trees/shrubs in any agroforestry. Integrating peoples' perceptions in sustainable agroforestry management will enhance strategy in commensuration of future agroforestry developments and challenges.

Keywords:- Agroforestry, Community/Farmers' Perceptions, Impediments/Constraints, On-Farm Trees/Shrubs, Agroforestry Extension Services, Rajaf County, South Sudan.

I. INTRODUCTION

Any sustainable on-farm tree growing and management in agroforestry systems requires direct integration of people's perceptions, attitudes and preferences on its uptake and impediments. According to [1] and [2], perception is a process where individuals organize and interpret their sensory impression in order to give meaning to their environment. Individual's characteristics such as attitudes, motives, interests, past experiences and expectations influence the perceiver's need [2]. This balances the social, economic, ecological, and cultural needs of present and future generations and to maintain and conserve forest resources besides offering the multiple uses [3].

The community decisions can increase the social acceptance of agroforestry and on-farm tree growing and management and to lessen differences among other agroforestry participants [4]. The community perceptions and attitudes about agroforestry practices values can assemble concepts about agroforestry whether of importance and desirables, or bad and undesirable [5]; [6]; [7].

These Agroforestry values are categorized into material and non-material. The material ones involved economic and life supporting while non-material values included socio-cultural, ethical, aesthetic and spiritual values. In most cases, they can also be referred to as intrinsic values that relate to agroforestry ecosystem services or conservative nature and instrumental values relates to satisfaction of human needs or wants such as in aesthetic, cultural, spiritual and ethical values. Communities' perceptions of these agroforestry values vary from region to region, culture to culture and over time [8];[9].

For a long-term sustainable management of agroforestry resources to be successful, peoples' perceptions and attitudes must be prioritized considering their needs, aspirations and to respect their opinions [10]. Once the community perceptions on agroforestry are favorable, assurance for agroforestry promotions and development become inevitable whereas

unfavorable attitudes and perceptions create an atmosphere of failure in adoption of agroforestry [6]; [8]. The attitudes influence human behaviors towards agroforestry acceptance and encouragement [11]. Agroforestry resources preference due to the community perceptions can likely be influenced by factors categorized as on-site such as household needs, local usage perspectives, livelihood dependency and off-site factors such as cottage industries, proximity to markets and transport services, *etc.* [12]; [13].

The communities' and people's perceptions and attitudes about agroforestry is fundamental to agroforestry planning, tree growing and management [14]. This is because people's knowledge can effectively support decision making in the management and preservation of tree-based forest systems [15]; [7]. Additionally, assessing people's perceptions and attitudes in agroforestry is also a key role in designing and implementing management policies (Sood *et al.*, 2008). Thus, a deeper knowledge of peoples' perceptions is imperative for structuring appropriate agroforestry policies on tree growing and management plans [15].

[16]observed that communities' perceptions on tree resources are changing from aesthetic to that of ecological and socio-economic benefits. This is because trees offer functions that are potential in addressing problems of poverty, energy base, shelter/habitat, pollution besides restoration of environment and improving microclimates. Although agroforestry systems and practices are advantageous as compared to conventional agriculture/forestry, its perceived usefulness is not widespread and adopted worldwide [17]. This is due to obstacles that constrained farmers from adopting such systems. Most agroforestry farmers have perceivably ranked several constraints to Agroforestry practices and management (from most critical to least critical) outlined as follows [17]:

- Lack/shortage of land as the main problem faced by farmers who are tenants and landless
- Lack of inputs such as quality seeds and seedlings and other agroforestry incentives
- Lack of awareness: most rural farmers lack trainings on agroforestry activities.
- Lack of financial assistance to boost agroforestry and motivate farmers
- Lack of time and labour including farming equipments: these factors of production coincides and conflicts with period of planting trees.
- Seedlings destruction by humans, animals, and pests and diseases [18].
- Perceived competition between the components (Trees for moisture/nutrients, crops for light, animals for fodder and shade.
- Lack of apparent profit potentials from agroforestry practices
- Long maturity period of trees discourages farmers from on-farm tree growing and management
- Lack of developed markets and unfamiliarity with alternative marketing approaches

- Unfamiliarity with most agroforestry technologies and its technical assistance

➤ *Community Perceptions about On-Farm Tree Growing and Management*

Communities' perceptions of on-farm tree growing and management programme is usually assessed by the importance they placed on planting trees on-farms in relation to other social and environmental services [19]. According to [20], communities' appreciation of tree planting is an important aspect in planning and developing agroforestry programmes. The positive perceptions of on-farm tree planting and management is mainly influenced by tree products, socio-economic, cultural, and environmental services provided by trees [21]; [19].

[21] also argues that little is known about farmers' perceptions of trees, tree products and other related aspects as compared to their perceptions of agricultural practices. More recent findings have also shown that the level of literacy, level of participation in extension education, social interactions and attitude toward participatory activities positively correlate with the level of motivation of villagers' participation in activities such as tree planting and management [22]. By this measure the success of on-farm tree planting and management depend on community motivation based on a feeling of communal ownership.

[23] also pointed out that for the success of any rural development interventions that involve tree production on farms, it is essential to have a clear understanding of farmer's incentives and livelihood strategies within the socio-economic and policy environment they are operating. Most important role is the motivating factors in the tree planting activities by free supply of seedlings, food aid and free inputs like protective nursery materials such as cutlasses and boots. Most communities perceived that free provision of food aid, seedlings, and other farm requirements would motivate them from participating in on-farm tree planting and management.

According to [24], farmers with better and positive knowledge of benefits from trees will participate in tree planting and management programmes. They will allocate more acres of land for tree planting than farmers with inadequate information. Financial benefits from trees could also be one important motivating factor that influences communities' perception to participate in growing and management of tree on farms.

It is also imperative to consider the negative perceptions of communities towards their preference to on-farm trees growing and management. These include poor extension services, long maturity duration of trees to observe tangible outcomes, trees as hosts to pests and diseases, tree require intensive farm labor, effects of trees on crops, etc can also influence negative communities' participation. In such a case, according to [25]and[26], those farmers with better knowledge of afforestation and re-afforestation programmes can be better positioned to engage in planting trees on their farms while training those with limited agroforestry knowledge.

II. MATERIALS AND METHODS

➤ Study Area

The study was conducted in the four payams of Rajaf County, Jubek State-South Sudan. Rajaf County is located along the eastern and western banks of River Nile, southeast direction from Juba city at latitude ranges between 4° and 6° North and longitude ranges of 27° and 32° East respectively (Figure 2). It covers a total area of 3,204 Km² and hosts a total population of about 15,604 people in the proportion of 8,232 male and 7,372 females irrespective of age class [27]. The population of Rajaf County comprised mainly of the Bari tribe forming about 90% of the population according to 2008 census. The main economic activity of the communities is farming although some activities such as rearing of animals, fishing, and hunting are also done on a small scale. Rajaf County has become a very important site for fishing in Jubek state due to its proximity to the shores of River Nile. Even then, its fertile soils potential makes it favorable for agriculture and growth of agroforestry species and natural forests stands [28]; [29]. The main food crops grown are sorghum, cassava, maize, groundnuts, simsim, beans and sweet potatoes. Most green vegetables are sparingly grown for cash while goats, sheep, pigs, chicken, guinea fowl and cattle are their main domestic animals kept by many households.

The area is covered by open woodland and grasslands in the rich moist and tropical and highland ranges. The main trees and shrubs species include *Mahogany spp*, *Acacia seyal*, *Acacia mellifera*, *Balanites aegyptiaca*, *Acacia senegal*, *Hyphaene thebaica*, *Borassus aethiopum*, *Mangifera indica*, *Tamarindus indica*, *Azadirachta indica*, etc [30].

Temperatures in the area range between 30°C- 33°C in the dry season, and drops to an average temperature of 18°C in the wet season [31]; [32]. Rainfall intensity is more than 1200mm per annum that lasts from April to November. Its proximity to Nile River makes it accustomed to seasonal flooding and increased evaporation. Humidity usually exceeds 80% during the rainy season, and drops to below 50% in the dry season [33]; [34].

The topographical feature of the area that makes up the County is an integral part of the hills and mountains agro-ecological zone. The area is characterized by an alluvial geological formation consisting of vertic soils, which are interspersed by alfisols that vary along the lateral range of geological sites [35]. These alkaline soils are generally of low organic matter content, high salinity and a clay content ranging from 15 to 40 % with clay-loams. The soil is brownish in color typical of a combined green belt and hills and mountains agro-ecological zones of South Sudan befallen within Jubek state [36].

➤ Research Design

This study was a descriptive one involving household surveys. The Household surveys involved conducting interviews with household heads. Key informants' interviews

(KIIs) and Focused Group Discussions (FGDs) were also held with the communities [29].

➤ Sample Size and Sampling Procedures

Four payams of Rajaf County were purposefully selected for the study. From each selected payam, at least three villages called Bomas were surveyed. At least 25 households from each Boma were selected randomly and visited for interviews. This made up a total of at least 74 household respondents from each Payam. A list of households for each Boma that was retrieved from payam registry was used for random selection of Bomas and their respective households [29]. A total of 332 household respondents were randomly selected. That is a 5 % of the total of 2432 households found in the payam registry [37]; [38]. Twenty checklists were administered to key informants. People involved in key informant interviews were purposefully selected from relevant government institutions, community leaders, local agroforestry initiatives, extension workers, community-based organizations and NGOs to provide specific information that is relevant to the study [39]. Members of the Focused Group Discussions were got from two distinct groups (men & women) of varied age category (Plate 1) [35]. This was done with consultation and approval of concerned payam administrations and local leaders [29].



Plate 1: Focused Group Discussions held at Kolye East (R) and Kolye West (L) of Rajaf county

➤ Data Collection

Prior to data collection, a reconnaissance survey was conducted to give the overall baseline information of the area, different farmers /groups, key agroforestry practices, peoples' cultures, access roads and peoples' perceptions towards the survey [40].

Pre-testing of field questionnaires were done in order to evaluate its strength or weakness, for clarity checks and to improve its reliability. Where necessary adjustments on the questionnaires would be done and incorporated [29].

The household survey focused on household/farmers'/community and local farmers perceptions on use and impediments/constraints towards tree planting and agroforestry activities [19]; [29].

Household head or any of her willing representatives present was interviewed. Direct translation other than audio transcription was done since all interviews were conducted in local language including Arabic. This was for easy understanding of questions and filling of the questionnaires and to avoid misinterpretation of questions. The final responses were then recorded in English [35].

➤ *Data Analysis*

After raw data cleaning, the household survey data in the filled questionnaires were coded, entered and managed in statistical software programs known as Excel spreadsheet which were later exported to Minitab v.14. and/or SPSS v.23 for analysis. Initially, minimum, maximum, median, and frequencies and descriptive statistics were examined for each variable to check for entry errors. Corrections were then made upon verification with entries in the HH questionnaires. In some cases, data were plotted for verification purposes and preliminary analyses were done in descriptive statistics that include comparing their means, frequencies/percentages and standard deviations [41].

Thereafter, primary categorical data were analysed in inferential statistics including cross tabulation (Chi-Square) test of independence and some analysed using logistic regression to determine the level of significance [42]. This was to compare and explain the relationships of various factors with trailing agroforestry and its performances among the payams including communities' perceptions, and impediments towards tree planting and indigenous management knowledge, extension package and income levels [41].

To rank sources of each income priority, weights were assigned to each priority. The greatest priority was assigned a rank of 1 and the least priority ranked as 6. Those with no answer were ranked 0 [43]. The mean ranks were obtained by multiplying each assigned weight by its respective number of respondents for each named income sources (table 18). This was calculated by the formula below:

$$\text{Mean income Rank} = \frac{\sum (\text{Weights} \times \text{number of respondents for each weight (N)})}{\text{Total number of respondents for each weight (N)}}$$

III. RESULTS

➤ *Farmers' Perceptions of AF Practices to Enhancing FS and Resilience to CC*

Over 41% of the respondents perceived that AF practices as contributing fairly to food security and climate change while 29.5%, 17.5% and 3.6% of them perceived AF

practices as contributing poorly, good and very good to food security and resilience to climate change was very good (Figure 1).

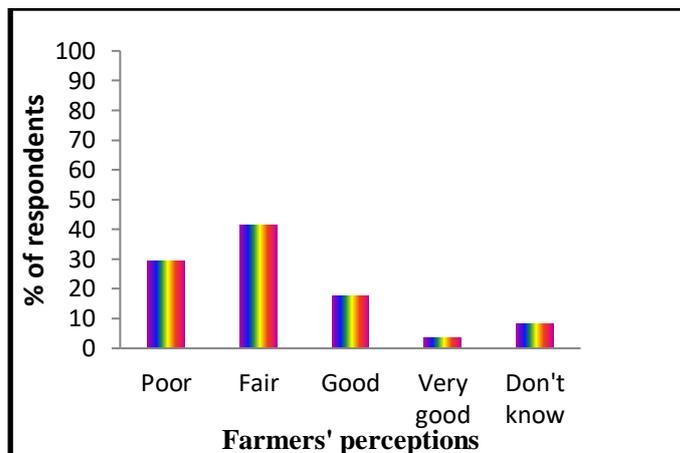


Fig 1: Farmers' perception on effectiveness of AF practices to FS and CC resilience

➤ *Perceived Factors Influencing Tree Growing and Management Activities*

Most household respondents reported that growing and management of trees on their farms were usually influenced by HH incomes (90.1%), need for food (87.0%), inadequate seedlings and seeds (75.3%), insecurity (74.4%), sources of fire/fuelwood (64.5%) and water constraints (53.0%) as reported by the respondents (Table 1)

Farmers Perceptions ^a	Frequency (N)	Percentage of cases
HH incomes	299	90.1
Sources of food	289	87.0
Inadequate seedlings and seeds(inputs)	250	75.3
Insecurity	247	74.4
Fire/Fuelwood	214	64.5
Water constraints	176	53.0
Climate change (Drought, flood, heavy winds)	164	49.4
Soil erosion/quality loss	147	44.3
Pests and diseases	144	43.4
Availability of pastures	126	38.0
Soil improvement	089	26.8

Table 1: Farmers Perceptions on factors influencing tree growing and management activities (N=332)

➤ *Perceived Impediments Preventing Households from Tree Growing and Management*

Chronologically perceived challenges preventing households from tree growing and managing them properly on-farms included insecurity, lack of inputs, lack of trainings, prevalence of pests and diseases, lack of capital to start, destruction from cattle and infertile soils reported by 97.6%, 91.0%, 89.8%, 82.8%, 60.8%, 57.5% and 44.3% respectively (Figure 2).

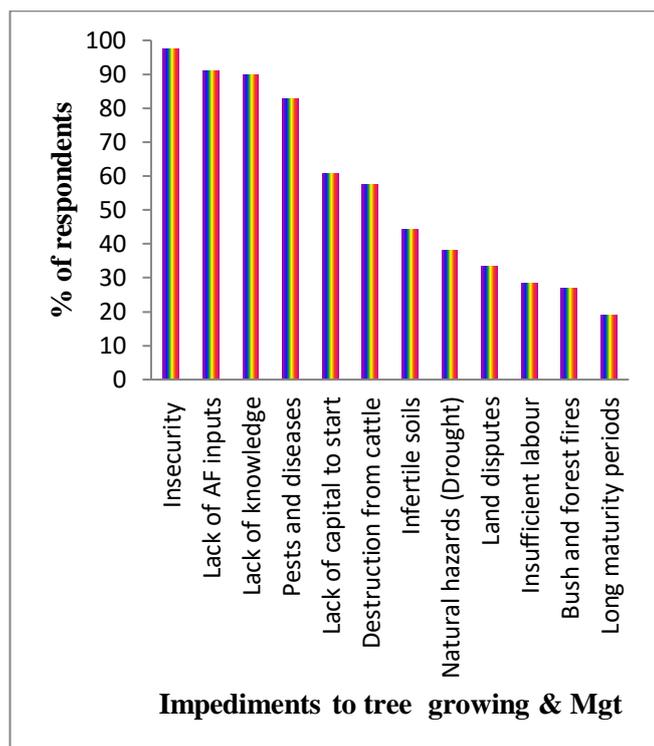


Fig 2: Reported impediments towards tree growing and management activities

➤ *Perceived Ways to Overcome the Impediments to Tree Growing and Management*

Suggested ways to overcome impediments preventing households from practicing agroforestry activities included the use of locally available seeds/seedlings, seeking for peaceful place to cultivate, purchased AF inputs or inputs provision, Fencing /guarding farmlands, Mixed cropping, cultivating within homestead, trainings and extension services and Avoid deforestation & fire setting reported by 93.4%, 92.2%, 91.6%, 74.4%, 72.9%, 70.8%, 57.8% and 50.6% of the respondents respectively (Figure 3).

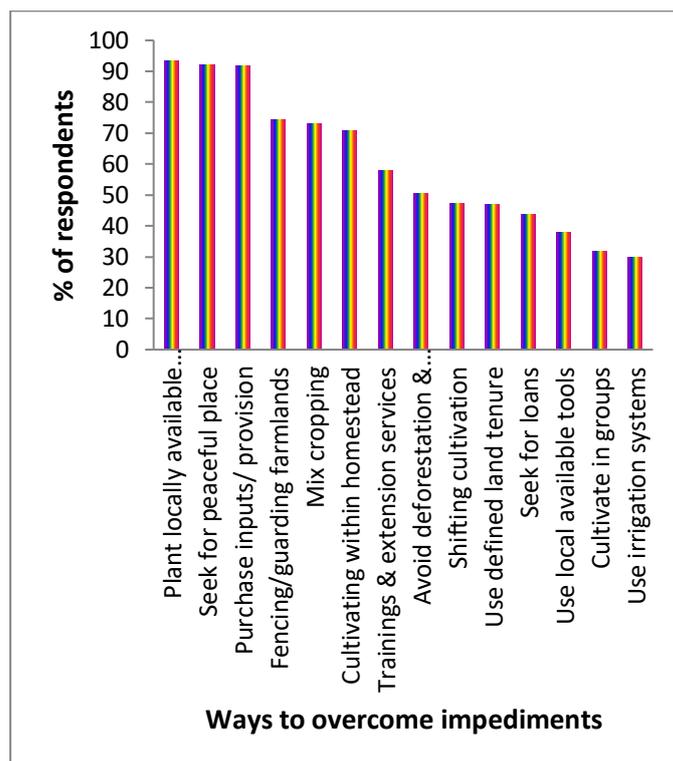


Fig 3: Ways to overcome the impediments to on-farms tree growing and management

➤ *Opportunities necessary for Promoting Tree Growing and AF Activities*

Several opportunities for promoting tree growing and AF activities were reported, namely; training of farmers in agroforestry activities, provision of credit and capital, availability and provision of low-cost inputs, defined land tenure system, and other extension services as reported by 81.9%, 78.5%, 68.3%, 60.7%, and 58.9% of the respondents respectively (Table 2).

Opportunities for Promoting Tree ^a	Frequency (N)	Percentage of cases
Need for trainings on AF activities	271	81.9
Provision of credit and capital	260	78.5
Availability of low-cost inputs	226	68.3
Defined land tenure systems	201	60.7
Extension services	195	58.9
Removal of regulatory and trade barriers	143	43.2
Clarity & ready markets	139	42.0
Private Sector involvement	088	26.6

Table 2: Opportunities for promoting tree growing and AF activities for FS and CC (N=332)

➤ *Access to Agroforestry Extension Services in Rajaf County*

Over 96% of the respondents reported that they knew of benefits from trees. While 66.2% of the respondents had been made aware of the benefits of incorporating trees on farms through extension services; 63.1% of them had received AF inputs from NGOs in form of seeds, seedlings, fertilizers, tools, etc. and 61.3% of them were given trainings on AF activities by either government or NGOs (Table 3).

Description	Frequency	Percentage of cases
Know benefits of incorporating trees in AF farms	319	96.4
Aware of incorporating trees in farms	219	66.2
Received inputs packages from extension worker/services	209	63.1
Trainings or workshops offered by government or NGOs	203	61.3
Grouped for extension services as Farmers group	198	59.8

Table 3: Access to Agroforestry Extension Services for Rajaf household farmers (N=332)

➤ *Organizations, Inputs and Groupings of Household Heads for Extension Services*

Over 97% of the respondents received extension services (trainings) from World Vision Other organizations that had been providing intrinsic extension services included Caritas, CRS, Accord-SS, and UNFAO provided the least extension services reported by 73.7.0%, 61.9%, 58.0% and 13.6% of the respondents respectively (Table 4). The main inputs provided by these organizations included improved seeds, seedlings, farming tools, fertilizers, pesticides and cash reported by 88.6%, 65.7%, 25.3%, 20.4%, 15.7%, and 6.8% of the respondents respectively (Table 4). Groupings of households for extension services included those ungrouped farmers, women farmers groups, agricultural Cooperative groups/societies, religious groups, cultural groups, men-farmers groups and social groups reported by 94.2%, 64.1%, 35.3%, 28.6%, 23.7%, 17.6 and 7.3% of the respondents respectively (Table 4).

Description	Variable	Frequency (N)	Percentage of Cases
Organizations that help to offer extension services such as trainings or workshops on benefits of incorporating trees in AF farms	World vision	323	97.6
	Caritas	244	73.7
	CRS	205	61.9
	Accord-SS	192	58.0
	From school	162	48.9
	Local initiatives (CBOs)	089	26.9
	Women Farmers Groups	052	15.7
	UNFAO	045	13.6
AF inputs received by HH farmers from the extension services	Improved seeds	287	88.6
	Seedlings	213	65.7
	Farming tools	082	25.3
	Fertilizers	066	20.4
	Pesticides	051	15.7
	Cash	022	06.8
HH farmers grouped for extension services	Not grouped	310	94.2
	W F G	211	64.1
	Cooperative societies	116	35.3
	Religious groups	094	28.6
	Cultural groups	078	23.7
	Men-Farmers groups	058	17.6
	Social groups	024	07.3

Table 4: Organizations, inputs and groupings of households for extension services (N=332)

➤ *Perceived Sources of Incomes from Agroforestry Practices in Rajaf County*

From the analysis, the major sources of incomes from the respondents ranking was livestock sale, poultry sale, tree crop sale and food crop sale respectively (Table 5)

Income sources	Weights assigned to each ranking							Mean \bar{x}	Mean rank*
	Gt 1	Gr 2	G 3	L 4	Lr 5	Lt 6	Ne 0		
Tree crop sale (N) %	52	63	77	77	34	24	5	3.11	(3)
	15.7	19.0	23.2	23.2	10.2	7.2	1.5		
Food crop sale (N) %	105	24	36	71	69	25	2	3.13	(4)
	31.6	7.2	10.8	21.4	20.8	7.5	0.6		
Cash crop sale (N) %	52	59	29	42	50	80	20	3.48	(5)
	15.7	17.8	8.7	12.7	15.1	24.1	6.0		
Livestock sale (N) %	28	42	40	19	38	33	134	2.10	(1)
	8.4	12.7	12.0	5.7	11.4	9.9	39.8		
Poultry sale (N)	11	24	60	32	32	35	139	2.22	(2)

%	3.3	7.2	18.1	9.6	9.6	10.5	41.6		
HH business (N)	8	20	64	53	53	79	55	3.59	(6)
%	2.4	6	19.3	16.0	16.0	23.8	16.6		
Off-farm sources (N)	2	6	26	64	67	86	81	3.61	(7)
%	6.0	1.8	7.8	19.3	20.2	25.9	24.4		

Table 5: Ranking HH main sources of income from agroforestry practices (N=332)

NB: N=number of HH heads, Weights assigned to each ranking: Gt=1=greatest, Gr=2=greater, G=3=great, L=4=low, Lr=5=lower, Lt=6=lowest, Ne=0=none. *=the average mean ranking of incomes from each income source.

➤ *Perceived Expenditures from Agroforestry Activities in Rajaf County*

Most Households’ expenditures from agroforestry practices included those on staple foods, pay school fees for their children, hire either tractor or manual labour, and used to purchase farm inputs reported by 98.5%, 93.7%, 84.3%, and 75.0% of households’ respondents respectively. Other reported expenditures on AF outputs included those used to buy fuelwood, animals’ feeds, veterinary services and for future saving that accounted for 63.3%, 46.7%, 28.6% and 9.6% of HH respondents respectively (Figure 4).

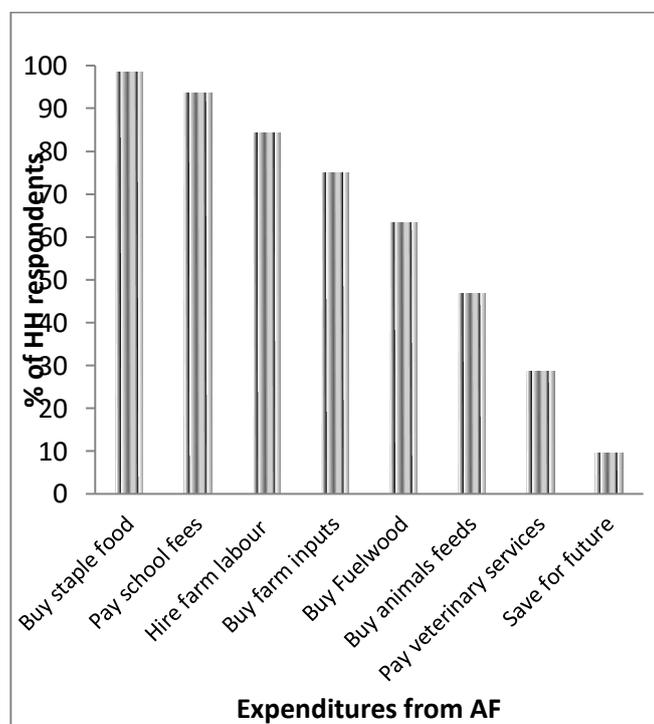


Fig 4: HH expenditures from agroforestry activities

IV. DISCUSSION

➤ *Farmers’ Perceptions of AF Practices in Enhancing FS and Resilience to CC*

Most households perceived that performance of AF was seemingly fairly or poorly contributing to food security and climate change resilience(Figure 1). There is a relative participation of people in AF activities since most communities still collect AF products for food, fruits, cooking energy (firewood), building poles, manures (composts or farmyard) from the available natural range of forest ecosystem and as free goods for household livelihoods. The results also show that local farmers lack knowledge on importance of AF practices as it provides a major source of

climate change reservoir of carbon stocks and atmospheric gaseous sinks through green plants preferably woody perennials. This finding is in contrast to the information acquired from [44] that there is a growing interest in the role of different land use systems in stabilizing carbon dioxide in the atmosphere.

➤ *Perceived Factors Influencing Tree Growing and Management Activities*

Perceptions on tree planting and management activities are varied among many households and play important roles in the development of tree planting programmes. [45] also noted that little is known about farmers’ perceptions of trees, tree products, their management and other related aspects as compared to what is known of their perceptions on agricultural crops and practices. This is due to their perceived benefits they obtained from agricultural crops for their immediate human welfare as compared to the long duration awaiting to realize outputs from tree products [19].

However, the most important factors that can serve as incentives and motivating farmers to participate in tree planting and management activities were households’ sources of incomes, need for fuelwood, need for food, soil fertilization, demand for timber and poles, pasture needs, free seedlings and other inputs (Table 1), etc [21]. Level of education and farm size also has high influence on tree planting and management on-farms. Motivated farmers with better knowledge of tree benefits will invest and participate more in tree planting and management programmes allocating more of their farmland acres to it than those with limited and inadequate information [24].

➤ *Perceived Impediments Preventing HHs from Tree Growing and Management*

From the results in Figure 2, many barriers were found to prevent uptake and management of AF practices. These constraints to participation in tree planting and management programmes were observed at both the community and individual levels. It was observed that insecurity issues and lack of knowledge were the predominant constraints outlined to influence participation[17]. They appeared to be the major threats and significant factors for predicting adoption decision of agroforestry by most households.

Agroforestry was not well known to most farmers in the County and so the lack of knowledge on arrangements and managements could pose a significant threat to the local populations’ food accessibility and availability and their ability to alleviate climate resilience. However, trainings as part of extension services have provided substantial

awareness to the communities especially the grouped farmers such as women groups, etc.

Moreso, problem of land tenure systems is one major factor as poor farmers are only confined to small portion of land parcel not permitting large scale production and growth of diverse agroforestry components. Land, forest and tree tenure and local regulatory systems including bylaws governing control and management of tree resources have been widely cited as crucial constraints to adoption of agroforestry [29]; [46]. On the other hand, [29] also revealed that land shortage was one reason why farmers do not adopt agroforestry practices. Other such barriers include, lack of inputs, prevalence of pests and diseases, and lack of capital.

➤ *Ways to Overcome the Impediments to Tree Growing and Management*

The results on different measures that, if undertaken might improve in the performance of agroforestry practices to food security and climate change are presented in figure 3. These different strategies ranges from but not limited to farmers purchasing their own AF inputs or inputs provision by NGOs and other agroforestry stakeholders, involvement in trainings and extension services, and advocate for peace to prevent insecurity on one hand. On the other hand, use of bylaws to protect trees on farms coupled with the use and reinforcement of indigenous knowledge for sustainable adoption of agroforestry practices would require community participation to solve problems of tree growing and management [47].

The use of indigenous knowledge as one strategy was found useful as it helps in providing information on endangered species and thereby assisting in regeneration, reforestation and conservation, and management strategies [29]. Other strategies adopted by the local communities in the county included: practising mixed cropping/crop rotation, cultivating within homestead, seeking for loans to increase and supplement production and use/planting locally available seeds. To many households, other strategies were invisibly constant.

➤ *Opportunities Necessary for Promoting Tree Growing and AF Activities*

Although the literature of this study indicates severe declines in agricultural production, the decline exposes the population in Rajaf county and South Sudan in general to chronic food insecurity, hunger and death. This food insecurity crisis in South Sudan is compounded by lack of productive resources and high rates of poverty [48]. To promote AF activities and to salvage this situation, an array of approaches is undertaken by UN agencies, bilateral donors and NGOs to increase food production support and to embark on reconciliation strategies [35].

These approaches firstly need to embark on knowledge transfer to local farmers on AF activities so they can obtain enough knowledge of various on-farm practices. Secondly, provision of credit and capital to start once they acquired the trainings. Thirdly, availability of improved low-cost inputs.

Removal of regulatory and trade barriers/policies; and clarity and ready markets were yet another opportunity for promoting agroforestry activities [49]. However, defined land tenure system and AF extension services were reported viable opportunities too. Nonetheless private sector involvement was not considered important in the area notwithstanding offsetting the effects of climate change [35]; [48].

➤ *Access to Agroforestry Extension Services in Rajaf County*

The research study revealed that most households had attended some forms of trainings or workshops on AF activities offered by government or NGOs. This means they are made aware of benefits of incorporating trees in their farms. These trainings were coupled by provision of extension inputs such as improved seeds, seedlings, fertilizers, tools, to mention a few (Table 3). Evidence indicates that adoption of traditional AF provides a sustainable approach to achieving food security. However, against this background, it can clearly be noted that NGOS are increasingly supporting agroforestry technologies projects in Rajaf county. This augment is in conformity with GOSS indecision in 2010 to allocate 70 % of donors support to the natural resource funding towards agroforestry programs [50]; [35].

➤ *Organizations, Inputs and Groupings of Household Heads for Extension Services*

From the statistics, it is apparent that World vision provided most extension services including trainings to over 90% household farmers in Rajaf county. These trainings, workshops and communications create awareness on the given technology and practices before farmers adopt them (Table 4). The finding is well supported by [51] and [52] who reiterated that to have effective adoption of any form of agroforestry, farmers requires education and knowledge that exposes general information on the technology or practice. It is eminent that after such trainings, about 88% households were mainly provided with improved seeds.

Additionally, farmers were grouped to receive these extension services as support with ungrouped individuals and women farmers group being highly supported (Table 4). Owing to this support either financially or materially, media reports suggests that these women groups floods the markets with vegetable [53]. Since farmers are provided with improved seeds, it is inevitable to backup with drying equipments so that farmers could dry seeds for the next season. This finding is supported by the [54] report during the launching of its \$54million support to farmers and farmers groups in South Sudan.

➤ *Households' Sources of Income and Expenditure from Agroforestry Practices*

It is prominent that most households obtained their incomes largely from on-farms AF activities. These households usually get it hard but it become essential that each household obtain its own sources of income whatsoever it needs for living. The ranking of incomes according to priorities depicted livestock and poultry as the high-income

production items although trees and food crops also show good contribution (Table 5). Moreover, household incomes from business and off-farm employments were minor contributor to agroforestry activities [49]; [55].

This shows that farmers value animals more than crop and tree production although they obtained no support for livestock production. This is also in line with [49] who reported that agroforestry practices hold more components resulting into more diversified incomes i.e in case of failure of one component, there is always a secured next component as an alternative source. The findings were also supported elsewhere by [56]. The greatest HH expenditures accrues to purchase of staple food and for paying school fees, hired farm labour (tractor or manual), and at least few HH spent their AF incomes to buy fuelwood because most of it is still fetched from natural forests as free goods in many rural areas [55].

V. CONCLUSIONS

Household respondents perceived that over 90% sources of their tree planting materials come from individual struggles either through private purchase or by collecting available planting materials, although some NGOs such as World vision offer to subsidize for other vulnerable HHs and farmers' groups such as women farmers group by providing improved seeds and seedlings of high-quality tree crop and food crop respectively. The majorly perceived food crop of HHs in the area includes sorghum/dura, cassava, beans, simsim and groundnuts grown on larger scale harvested mainly for subsistence use. Others like maize, okra, tomatoes, egg plants, etc are regarded cash crops of small-scale farmers and sparingly grown for market to supplement household incomes. Although most HH respondents perceived and ranked income sources from livestock highly as compared to other income sources, they kept very few animals and poultry. The reduction in livestock number could be attributed to high rates of cattle raiding and insecurity within the area. The insecurity issues also highly affected farmers in participating on tree planting and agroforestry activities at both community and individual farm levels.

CONFLICTS OF INTEREST

From this study, the authors enormously declared that there were neither irregularities nor conflicts of interest found.

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REFERENCES

- [1]. Robbins, M. L., Levesque, D. A., Redding, C. A., Johnson, J. L., Prochaska, J. O., Rohr, M. S., & Peters, T. G. (2001). Assessing family members' motivational readiness and decision making for consenting to cadaveric organ donation. *Journal of Health Psychology*, 6(5), 523-535.
- [2]. Nzilu, W. B. (2015). *Farmers' perception And Its Impacts on Food Security* (Doctoral Dissertation, Kenyatta University).
- [3]. Roy, M. M., & Tiwari, J. C. (2012). Agroforestry for climate resilient agriculture and livelihood in arid region of India. *Indian J. of Agroforestry*, 14(1), 49-59.
- [4]. Dagar, J. C. (2012). Utilization of degraded lands/habitats and poor-quality water for livelihood security and mitigating climate change. *Indian J Agrofor*, 14(1), 1-16.
- [5]. Paletto, A., De Meo, I., Cantiani, M. G., & Maino, F. (2013). Social perceptions and forest management strategies in an Italian Alpine community. *Mountain Research and Development*, 33(2), 152-160.
- [6]. Khandagale, A. S., Taide, Y. B., Deshmukh, H. K., & Thigale, M. B. (2012). Constraints faced by growers in adoption of recommended practices of teak. *Indian J. of Agroforestry*, 14(1), 45-48.
- [7]. Banyal, R., Masoodi, N. A., Masoodi, T. H., Sharma, L. K., & Gangoo, S. A. (2011). Knowledge and attitude of farmers towards agroforestry practices in north Kashmir-a case study. *Indian Forester*, 137(12), 1377-1381.
- [8]. Ratsimbazafy, C. L., Harada, K., & Yamamura, M. (2012). Forest resources use, attitude, and perception of local residents towards community-based forest management: Case of the Makira Reducing Emissions from Deforestation and Forest Degradation (REDD) Project, Madagascar. *Journal of Ecology and the natural Environment*, 4(13), 321-332.
- [9]. Bijalwan, A., Mohan Sharma, C., & Kediya, V. K. (2011). Socioeconomic status and livelihood support through traditional agroforestry systems in hill and mountain agro- ecosystems of Garhwal Himalaya, India. *Indian Forester*, 137(12), 1423.
- [10]. Macura, B., Zorondo-Rodríguez, F., Grau-Satorras, M., Demps, K., Laval, M., Garcia, C. A., & Reyes-García, V. (2011). Local community attitudes toward forests outside protected areas in India. Impact of legal awareness, trust, and participation. *Ecology and society*, 16(3).
- [11]. Pant, N. (2011). Motivational factors in activities of agroforestry – a case study. *The Indian For.*, 137(3): 363-569.
- [12]. Mushtaq, T., Sood, K. K., & Raina, N. S. (2012). Species preferences for fuel wood in Shiwalik Himalayas-Implications for agroforestry plantations. *Indian Journal of Hill Farming*, 25(2), 18-21.
- [13]. Edwards, D. M., Jay, M., Jensen, F. S., Lucas, B., Marzano, M., Montagné, C., ...& Weiss, G. (2012). Public preferences across Europe for different forest stand types as sites for recreation. *Ecology and Society*, 17(1).

- [14]. Islam, M. A., Masoodi, T. H., Gangoo, S. A., Sofi, P. A., Bhat, G. M., Wani, A. A., ... & Malik, A. R. (2015). Perceptions, attitudes and preferences in agroforestry among rural societies of Kashmir, India. *Journal of Applied and Natural Science*, 7(2), 976-983.
- [15]. Reddy, E.V. (2011). Constraints in marketing of agroforestry produce in India. *The Indian For.*, 137(6): 669-677.
- [16]. FAO (2011). The state of the World's land and water resources for food and agriculture - Managing systems at risk. Rome and Earth scan, London.
- [17]. Jacobson, M., & Kar, S. (2013). Extent of agroforestry extension programs in the United States. *Journal of Extension*, 51(4), Article-4RIB4.
- [18]. [Aladi, S. F., & John, O. O. (2014). Farmers Perception of Opportunities Preferences and Obstacles of Growing Multipurpose Trees on Farmland in Kogi State. *European Scientific Journal, ESJ*, 10(14).
- [19]. Obiri. B. D., Agyeman. V. K., Kyereh. B., _utakor. E., Obeng. E. A., Agyeman. A and Britwum.S (2011). Perception and participation of local communities in tree planting initiatives.
- [20]. Akbar, G., Baig, M. B., & Asif, M. (2000). Social aspects in launching successful agroforestry projects in developing countries. *Science Vision*, 5, 52-58.
- [21]. Rahman, S. A. (2017). *Incorporation of Trees in Smallholder Land Use Systems: Farm Characteristics, Rates of Return and Policy Issues Influencing Farmer Adoption* (Doctoral dissertation, University of Copenhagen, Faculty of Science, Department of Food and Resource Economics).
- [22]. Faham, E., Rezvanfar, A., & Shamekhi, T. (2008). Analysis of factors influencing motivation of villagers' participation in activities of social Forestry (The Case Study of West Mazandaran). *American Journal of Agricultural and Biological Science*.
- [23]. Ewnetu, Z., & Bliss, J. C. (2010, June). Tree growing by small holder farmers in the Ethiopian Highlands. In *Small scale forestry in changing world: Opportunities and challenges and the role of extension and technology transfer IUFRO conference* (Vol. 3).
- [24]. Kinuthia, E. K., Owuor, G., Nguyo, W., Kalio, A. M., & Kinambuga, D. (2011). Factors Influencing Participation and Acreage Allocation in Tree Planting Program: A Case of Nyeri District, Kenya. *Agric. Sci. Res. J*, 1(6), 129-133.
- [25]. Ryan, M. (2016). *The economics of farm afforestation in Ireland* (Doctoral dissertation).
- [26]. Collier, P., Dorgan, J., & Bell, P. (2002). Factors Influencing farmer participation in forestry.
- [27]. Sudan Population & Housing Census, 2008.
- [28]. Mbwiga, J. (2016). *Classification of chagga agroforestry homegardens and their contributions to food, income and wood energy to communities of Rombo District, Tanzania* (Doctoral dissertation, Sokoine University of Agriculture).
- [29]. Shilabu, M. D. T. (2008). *The contribution of agroforestry to household food security and income generation in Maswa District, Shinyanga region* (Doctoral dissertation, Sokoine University of Agriculture (SUA)).
- [30]. Sulieman, H. M. (2007). Mapping and modelling of vegetation changes in the southern Gadarif region, Sudan, using remote sensing.
- [31]. Donat, M. G., Peterson, T. C., Brunet, M., King, A. D., Almazroui, M., Kolli, R. K., ...& Nada, T. A. A. (2014). Changes in extreme temperature and precipitation in the Arab region: long-term trends and variability related to ENSO and NAO. *International Journal of Climatology*, 34(3), 581-592.
- [32]. Mohamed, M., Stankosky, M., & Murray, A. (2006). Knowledge management and information technology: can they work in perfect harmony? *Journal of knowledge management*, 10(3), 103-116.
- [33]. Alrajoula, M. T., Al Zayed, I. S., Elagib, N. A., & Hamdi, M. R. (2016). Hydrological, socio-economic and reservoir alterations of ErRoseires Dam in Sudan. *Science of the Total Environment*, 566, 938-948.
- [34]. Mohamed, Yagoub Abdalla, PhD., editor. February 2007. National Environment Action Plan. GoNU and GoSS.
- [35]. [Wel, P. (2012). The Potential of Agroforestry for Peacebuilding the case of Jonglei, South Sudan (Doctoral dissertation).
- [36]. Williams, M. A., Usai, D., Salvatori, S., Williams, F. M., Zerboni, A., Maritan, L., & Linseele, V. (2015). Late Quaternary environments and prehistoric occupation in the lower White Nile valley, central Sudan. *Quaternary Science Reviews*, 130, 72-88.
- [37]. Bartlett, J.E., Kotlik, J.W., and Higgins, C.C. (2001). "Organizational Research: Determining Appropriate sample Size in Survey Research".
- [38]. Humphreys, J., & Ahern, A. (2017). Is travel based residential self-selection a significant influence in modal choice and household location decisions? *Transport Policy*.
- [39]. Ayinde, I. A. (2004). Socio-economic and Health Effects of Pesticide Use in Cowpea-based Production Systems in Kano and Ogun States, Nigeria. *Draft PhD Dissertation*.
- [40]. Kwiyege, J. L. (2015). *Role of community-based institutions, partnerships and practices in enhancing climate change adaptation in Mwanga district, Kilimanjaro, Tanzania* (Doctoral dissertation, Sokoine University of Agriculture).
- [41]. Kabwe, G., Bigsby, H. R., & Cullen, R. (2009). Factors influencing adoption of agroforestry among smallholder farmers in Zambia.
- [42]. Bryman, A., & Cramer, D. (2009). *Quantitative data analysis with SPSS 14, 15 and 16: A guide for social scientists*. Routledge.
- [43]. Okullo, J. B. L., Obua, J., Kaboggoza, J. R., & Aluma, J. R. (2003). Traditional agroforestry systems, tree uses and management in northern Uganda. *Uganda Journal of Agricultural Sciences*, 8, 5-12.

- [44]. IPCC: Summary for policymakers, in: Climate Change 2014. Mitigation of Climate Change, contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlomer, S., von Stechow, C., Zwickel, T., and Minx, J. C., Cambridge University Press, Cambridge, UK and New York, NY, USA.
- [45]. Arnold, J. M., & Dewees, P. A. (2014). *Farms Trees and farmers: Responses to agricultural intensification*. Routledge.
- [46]. Njoku, E. C. M. (2005). Land Management through Agroforestry for Sustainable Agriculture in South-eastern Nigeria. *International Journal of Agriculture and Rural Development*. 6(2):81 – 91
- [47]. Sanou, L., Savadogo, P., Ezebilo, E. E., & Thiombiano, A. (2017). Drivers of farmers' decisions to adopt agroforestry: Evidence from the Sudanian savanna zone, Burkina Faso. *Renewable Agriculture and Food Systems*, 1-18.
- [48]. FAO (2010). The State of Food Security in the World: Addressing food insecurity in protracted crises. Accessed March 20, 2011 at: (<http://www.fao.org/publications/sofi/en/>).
- [49]. Chija, M. N. (2013). Adoption status and management of agroforestry systems and technologies by communities: a case study of Kasulu district, Kigoma, Tanzania (Doctoral dissertation).
- [50]. GoSS, (2011). The Government of South Sudan; Report Presented by Betty AchanOgwaro, minister of Agriculture and Forestry RSS, at the AgroBusiness Forum, 19th 158 October 2011. Johannesburg, South Africa. Accessed December, 2010 from: (http://www.oaklandinstitute.org/sites/oaklandinstitute.org/files/SouthSudanAgribusinessPotential_Oct2011.pdf)
- [51]. Matata, P. Z., Ajay, O. C., Oduol, P. A., & Agumya, A. (2010). Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania. *African journal of agricultural research*, 5(9), 818-823.
- [52]. Buyinza, M., Abwoli, Y., Nabanoga, G., & Ntakimanye, A. (2008). Farmers' adoption of rotational woodlot Technology in Kigoroba sub-County of Hoima District, Western Uganda.
- [53]. Sudan Vision, (2010) \News report: Jonglei Farmers Receive Cash for Norwegian People Aid (<http://www.sudanvisiondaily.com/modules.php?name=News&file=print&sid=5740>)
- [54]. USAID (2011). Press Release: USAID Funds Program to Reduce Food Insecurity in South Sudan. Accessed on November 2011 from: (<http://www.usaid.gov/press/releases/2011/pr111013.html>)
- [55]. Holtland, G. (2007). Eroded consensus: How ever-changing policy narratives distort the interpretation of livelihood systems. *Centre for international development issues, Nijmegen: Radbound University*.
- [56]. Zeleke, A. W. (2009). Status of traditional agroforestry and its future potential development as buffer zone agroforestry for the natural forest conservation in Burkutu Peasant Association, Oromia, Ethiopia (Doctoral dissertation, M. Sc. Thesis, Hawassa University, Ethiopia).

APPENDICES:





Plate 2: Data collection team (Top left), interview with farm owner (Top right) & Focused Group Discussion (Bottom) in Rajaf County, Jubeq State-South Sudan