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Farmer's Perceptions on Importance and Role of Agroforestry Species in Karago, Rwanda

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Abstract: Rwandan environment has been negatively impacted by agricultural activities. In many forest areas, trees have been cut down by surrounding people looking for cultivatable and grazing land. This study examined farmer's perceptions on importance and role of agroforestry species in land use system. A sample of 67 farmers were interviewed on agroforestry species available in their farms and their role ;preferences in regard to different agroforestry species; the reason and problems of growing different agroforestry trees; different products obtained in agroforestry systems and their contribution to household income. Therefore, the results of the study show that 100 % of the interviewers have the agroforestry species in their farms. The most agroforestry species planted are *Erythrina abyssinica* (100 %) followed by *Alnus acuminata (*64.2 %). Farmer's perception on agroforestry species in their farmland is that those species contribute in the considerable manner for the stability of the family income. This is proved by the NTFPs which generate incomes such as: fire wood, stakes fodder, fruits and building poles. Farmers also consider the role of agroforestry species in soil conservation in different manner such as soil erosion control, soil holding and increasing soil productivity. The major constraints to agroforestry practice include lack of access to agroforestry species seedlings; lack of capital, lack of labour supply and lack of knowledge about tree management. Considering these results indicate a strong role and importance of agroforestry species, hence the need to promote agroforestry technologies and practices in Karago sector.

Keywords: Agroforestry Species, Farmer's Perceptions, Species Preference, Role and Importance

Introduction

Trees provide considerable services such as mitigation of climate change, cultural rights, soil conservation, and demarcation of land; trees also provide product such as timber, fuel wood, fodder, stakes and construction materials (Masozera and Alavalapati, 2004).Mix of appropriate tree species and food crop in one agroforestry system provides an opportunity to reduce farmer's poverty, enhance food security, non timber forest products(NTFPs) and environment sustainability (Garrity, 2004) .

Throughout Rwanda, many people are depending on agricultural for their livelihood; the relationship between population growth, poor agriculture practice and shortage of land has driven to deforestation. To address these challenges; forest management and land agricultural management systems including agroforestry have been taken. Agroforestry practices have been promoted in Rwanda for their perceived benefits of not only improving soil quality, but also practice that can provide economic, social and environmental benefits.

Literature studies show the enormous benefits of trees on farms, despite little are known about farmer's perceptions and preferences. This study focused on describing farmer's perceptions on importance and role of agroforestry species and how they contributed to household income in Karago sector, Nyabihu district, western province in Rwanda.

Study area description

The study was carried out in Karago sector in Nyabihu district, Western province in Rwanda. The average monthly temperature of Karago sector ranges between 13 and 20^{o}c throughout the year. While the average annual rainfall in Karago sector is between 1600 and 1800mm per year. The average monthly rainfall shows that there are two prominent rainy seasons (February-May and October-November) and two dry seasons (June-September and December January). The soil of Karago sector is dominated by clay soil in different part. More than 90 % of total population of Karago sector are involved in agriculture .In this sector the following crops are grown: cash crops (tea); vegetables (cabbages and carrots); food crops (potatoes, bean, maize, and Irish potatoes). Practically, the fauna is composed by

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reared animals like cow, goats, sheep, etc. The forest is dominated by different trees such as *Eucalyptus spp*, *cypress spp*, *Grevillea robusta*, and *Alundinalia rupina*.

Sampling method

Karago sector has six cells; three cells out of these cells have beneficiated from agroforestry practices with different stakeholders. In order to obtain the information according to our objectives, the study was conducted on the three cells beneficiary of agroforestry practices which are Kadahenda, Cyamabuye and Gihirwa. Referring to the objectives of the study, data was collected with an aid of questionnaire and by making direct discussion with focus groups from the study area. This method was use to collect qualitative data of farmers perceptions on Agroforestry practices. The questions were administered in local language to household heads, and then translated to English language for good comprehension.

Sample size and sampling procedures

Determination of sample size at sector level

Purposive sampling procedure was used where a sample of **n** private households was selected by using KOTHAR formula:

$$n = \frac{z^2 \times p \times q \times N}{d^2(N-1) + z^2 \times p \times q}$$

Where: **n**= sample size; **N**= size of population (number of household); **Z**= coefficient normal distribution; **q**= probability of failure; **d**= margin error; and **p**= probability of success.

For KOTHAR, the margin error varies between 5 % and 10 %. The margin error of 10 % was used, and the confidence level of 90 %, the probability of success is p=0.5, failure probability of q=0.5, as Z0.25=1.65

The total household on these selected cells are 2942.

Then,

$$n = \frac{(1.65^2) \times 0.5^2 \times 2942}{(0.1^2) \times (2942-1) + (1.65^2) \times 0.5^2} = 66.54 \approx 67$$

Determination of sample size at cell level

For determining the sample size at cell level the following formula was used

$$ni = \frac{Ni \times n}{N}$$

Where: **ni**= the sample size proportion to be determined; **Ni**= the population proportion in the stratum; **n**= the sample size; and **N**= the total population.

The proportion of population in cells:

Kadahenda: 1171; Cyamabuye: 1013; and Gihirwa: 757

Thus we have:

Kadahenda: (1171x67): 2942=27; Cyamabuye: (1013x67):2942=23; and Gihirwa: (757X67):2942=17

Sampling intervals.

$$i = \frac{N}{n}$$

Where: **i**=sampling interval; **N**=Total number of household; and **n**=sample size at sector level

$$i = \frac{2942}{67} = 43.9 \approx 44$$

Data analyses

The statistical package for social science (SPSS) version 16 was used to analyze data achieving both descriptive and inferential statistics.

RESULTS

Table1: Household characteristics

Household characteristics	%
1.Gender	
Male	82
Female	18
2.Range of age	
18-35	51
36-60	42
≥61	
3.Educational level	
Illiterate	13.4
Informal	3
Primary	70.1
Secondary	11.9
University	1.5

Out of 67 interviewed households, 82% were male and 18% were female. In terms of household age composition, 51% were in the class of 18-35years, 42% in the 36-60 years age class, and 7% in the 61+ age class. The data suggests that the majority of the respondents were still in the active age class contributing to family labour force. The majority of the respondents did not have enough education to qualify them for white collar or formal jobs. Out of 67 household heads 70.1% had primary level, 3% had informal level and 13.4% of them had no educational level. Only 11.9% and 1.5% had secondary and university level respectively.

Household sources of income

The farmers give great importance to combination of two activities in order to gain more profits from combination of activities. Figure1 shows the integration of crop production with livestock activity occupying the first place in Karago sector. In the figure, 41.8% of respondents practice the agriculture and livestock rearing and it is the main source of income of many household in the study area. The importance of this combination is to increase soil fertility trough using animal manure as fertilizers hence improve soil productivity**.** Forest products are also livelihood sources providing 4.5% of household income of sampled households.

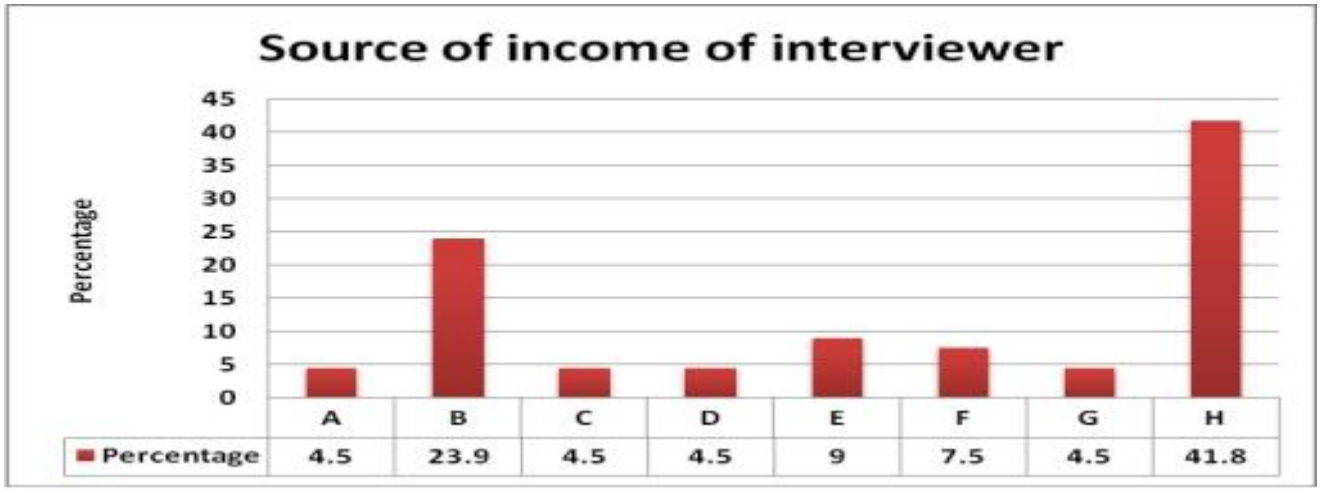

Figure1: Source of income

A: Regular employment; **B**: Crop production; **C:** Forest product form agroforestry; **D**: Brick layer; **E:** Integration of commerce and crop production; **F**: Regular employment and crop production; **G**: Integration of crop production, livestock and commerce and **H**: Integration of crop production and livestock

Agroforestry species planted in the farms

Many agroforestry species are planted in the farms of interviewees; *Erytrina abyssinica* occupy the first place with 100 %. Fruit trees like *Cyphomandra betacea* and *Persea americana* are planted to the lower percentage of 14.9 % and 7.5 % this indicate the problem of lack of fruits trees in the region**.**

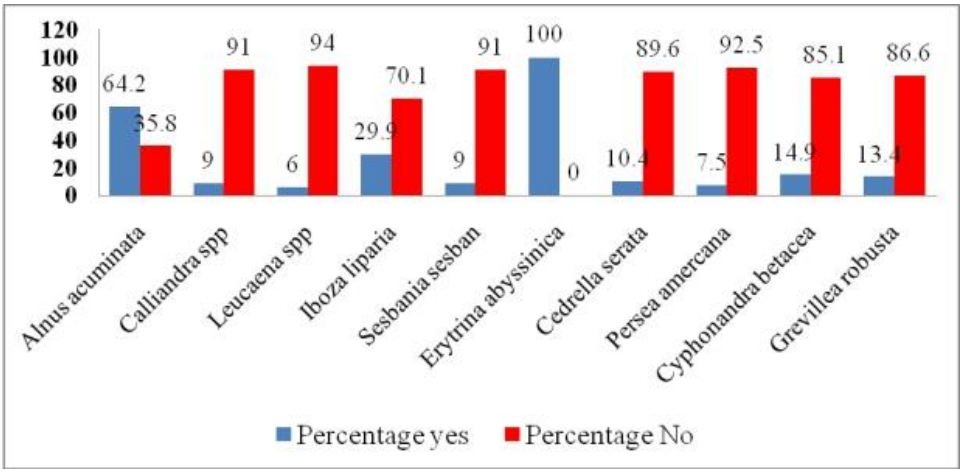

Figure2: Agroforestry species planted in the farms

Farmers Preference on Agroforestry species

Farmers' levels of preferences of agroforestry species are different due to their expected outcomes and needs and to agroforestry species adaptability. *Alnus acuminata* is highly preferred (100 %) followed by *Erythrina abyssinica* (86.4 %), that is due to its adaptability and its different uses in the region.

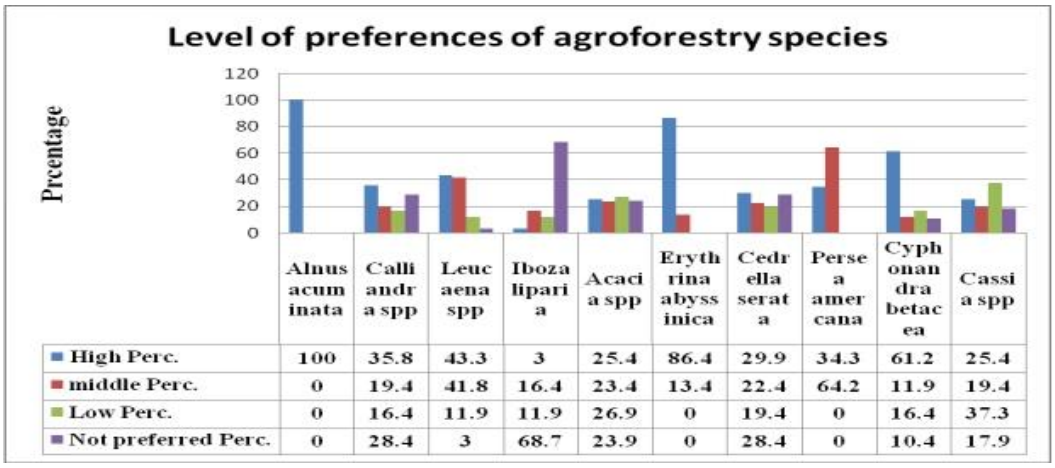

Figure3: Agroforestry species preferred by the farmers

Table2: Statistics test of farmers' perceptions on role of agroforestry species

Null hypothesis: the farmers of Karago sector have different knowledge or views on importance and role of agroforestry species in soil conservation like soil erosion control, soil holding and increasing soil productivity according to the age.

Role of agroforestry species in soil conservation	Chi-Square Value	Df	Asymp.sig. (2-sided)
Soil erosion control	4.597	2	.100
Soil holding	-	-	-
Increasing soil productivity	4.995	2	.082

According to the chi-square test, the chi-square observed is less than chi-square table ($\chi 2$ (df =2) at 5 % is 5.991) for this we conclude that the farmers in study area have different perceptions on importance and role of agroforestry species in soil conservation according to the age.

NTFPs harvested in the farms

Farmers in Karago sector produce climbing beans; the agroforestry species are used for stakes (100 %). The fire wood products occupy the second place with 91 %; the charcoal is the last with 0% this is due to the use of forestry tees in charcoal production.

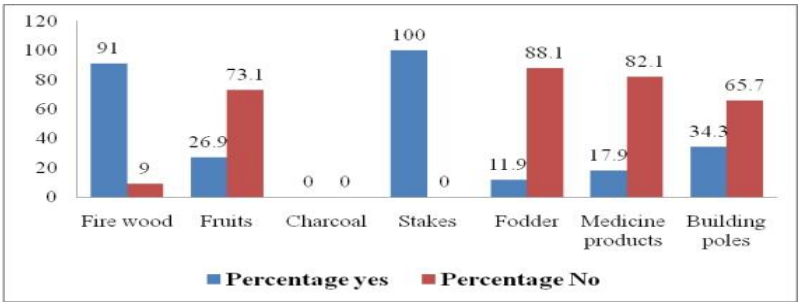

Figure4: NTFPs harvested from agroforestry species

Table3: Contribution of forest products from agroforestry species to the household's income

Null hypothesis: Fire wood and stakes are the only agroforestry products which generate income to the households of Karago sector.

Chi-square tests

Forest product	Chi-square value	Df	Asymp. Sig. (2-sided)
Fire wood	3.351(a)	6	.764
Building pole	3.519(a)	9	.940
Fruits	11.495(a)	10	.320
Stakes	13.879(a)	14	.459
Fodder	9.555(a)	7	.215

According to the above chi-square test, the chi-square observed are high than chi-square table ($\chi 2$ (df =6) at 95 % is 1.635) for fire wood and the chi-square observed is high than chi-square table, for stakes products ($\chi 2$ (df =14) at 95 % is 6.571), the null hypothesis is therefore, rejected. For that, the firewood and stakes are not only agroforestry products which generate income to the households of Karago sector but also there is significant contribution of income by other products.

Table4: Farmer's perceptions on the reasons and problems of growing agroforestry species

Factors	%
1.Shortage of land	
Land size	
<0.5ha	55.2
0.5-1ha	38.8
>1ha	6
2. Location of land	
On dawn slope	15
On middle slope	64.7
Up slop	20.3
3.Access to agroforestry species seedling	
Have access	33
No access	67
4.Location of agroforestry species nurseries	
<0.5km	11.9
0.5-1km	35.8
>1km	52.3
5. Lack of knowledge	
Yes	73.1
No	26.9
6.Lack of manpower	
Yes	76.1
No	23.9
7.Lack of capital	
Yes	76.1
No	23.9

It has been seen that the major number of respondents have a problem of land shortage where the 55.3 % of respondents have less than 0.5 hectare. The majority of respondents have land on middle slope (64.7%).Many farmers there have the problem of access to seedlings where 67% of the respondents have no access to agroforestry species seedlings; this has negative impact on agroforestry practice. Most of respondent (70.10%) are far from the nurseries, only 11.9 % are near nursery sites . so the farmers view it as big problem for planting agroforestry species. 73.1 % have a problem of lack of technical advice;

76.1 % have a problem of lack of capital and 76.1 % have a problem lack of man power

Table5: Test statistics on influence of location of agroforestry species nurseries and possession of agroforestry species on farm

Null hypothesis: The location of agroforestry species nurseries affects the possession of agroforestry species on farm.

Chi-square test

Agroforestry species planted on farms	Value	Df	Asymp. Sig. (2-sided)
Alnus acuminata	1.061(a)	2	.588
Iboza liparia	4.463(a)	2	.107
Sesbania sp	2.417(a)	2	.299
Erythrina abyssinica	1.191(a)	2	.551
Cyphonandra betacea	1.808(a)	2	.405
Grevillea robusta	3.032(a)	2	.220
Cedrela serrata	3.132(a)	2	.209
Calliandra sp	2.301(a)	2	.316
Leucaena sp	3.808(a)	2	.149

According to the above chi-square test, the chi-square observed are high than chi-square table ($\chi 2$ (df =2) at 95 % is .103) the null hypothesis is rejected. For that the location of agroforestry species nurseries has not affect the possession of agroforestry species on farm.

Discussion

The result indicated clearly that the respondents in the study area were very positive on practicing agroforestry in their croplands and homesteads. They viewed agroforestry as a profitable land use system which provided them with many benefits such as: improving income, soil erosion control, soil holding, increasing soil productivity, production of agricultural crops, etc. Their attitude and perception on agroforestry practice were very supportive to promote and upscale agroforestry in the study area.

Choice of agroforestry species

Agroforestry system is defined as a system that aim to get agricultural crops, trees products and/or livestock altogether from the same unit of land (Lundgren and Raintree, 1982).

Taking this into consideration, farmers of this region freely choose *Alnus acuminata* (100 %) due to the adaptability, rapid growth and different product (stakes, fire wood etc.) generated by this species. For integrating trees on farms, farmers apply a number of criteria, including fast growth, utility, compatibility, harvested products.

Other researchers have revealed that Adaptability and providing needed forest products are determining factors for selecting the right agroforestry species (Cerdánet al., 2012). However, the farmers also preferred the fruit trees but they do not have access to its seedlings. The other agroforestry species that the households preferred were *Erythrina abyssinica* , *Calliandra spp, Leucaena spp, Iboza liparia, Acacia spp, Cedrella serata, Persea amercana, Cyphonandra betacea; Cassia spp.*

Perceived importance and role of agroforestry species

The respondents perceived the importance of the agroforestry species tress positively after practicing agroforestry in their farms. They perceived the importance of agroforestry species both for its (different NTFPs and their income) and its benefits in soil conservation. (Glover et al., 2007) found that Introducing agroforestry species in the agricultural fields had grown more awareness to the farmers for its diversified benefits. This study which was done in Europe has shown that, growing trees and crops in agroforestry systems offers a higher value of ecosystem services than growing them separately.

It was very interesting that even they have the small land (55.2% have the land <0.5ha) they were interested to practice agroforestry to get more benefits from this mixed system. They had a positive attitude on agroforestry practice and they perceived to get better return from it than mono-cropping/agricultural practice. Farmers find agroforestry practice as a practice that can be used to minimize the problems related to the shortage of land, because the agroforestry species provides NTFPs, improve soil fertility hence increase soil productivity. Contrarily (Busienei, 1991) found that when farm sizes are small, farmers prefer to use their farms for subsistence farming and non-perennial cash crops when farm sizes are large, farmers easily adopt agroforestry system.

The majority of respondents have land on middle slope (64.2 %); so they found agroforestry species as a solution for soil erosion control, depends upon the

location of farms. Another research done by (Phiri et al., 2003) has shown that Agroforestry species can reduce water runoff and soil erosion and thus contribute to reduction of the effects of soil dryness.

As most of famers depend on crop production, most of farms are used for crop production. The soil has been under intensive cultivation and this lead to the problems of soil infertility and reduction of crop production. So farmers view the agroforestry systems as the solutions to not only for provision of needed forest products but also for increasing crop production by increasing soil fertility. Reviewed research has shown that Integrating trees on farms facilitate a high nutrient cycling compared to monoculture systems and improve soil nutrients and organic matter (Lehmann et al., 1998).

Constraints and problems of Agroforestry Systems

In the study area, agroforestry practice is bedeviled with some factors. The following factors are enumerated by the farmers:

- **Lack of knowledge on tree management**

It was noticed that some of the respondents lacked adequate knowledge on tree management and that affected the health of trees on their farms and that led to low production of forest products. Comparative to other agriculture activities, Training and information for agroforestry are essential to farmers, (Busienei, 1991).

- **Lack of seedlings**

Lack of seedlings serves as another constraint to the possession of agroforestry species in the study area. Some Farmers (33%) are therefore interested in the planting of agroforestry species on their farms but do not have access to seedlings. Outside ownership issue and lack of land, Lack of a tree planting culture and knowledge of which species to grow and how to grow them and Lack of seedling are the main motives to farmer for planting agroforestry species, (Amanor, 1996).

Other researchers (Kwesiga et al., 2003) found that lack of planting materials (seed and seedlings) is also affecting the adoption of agroforestry system.

- **Lack of capital and labour supply**

Farmers in the study area have a low living standard it is indicated by their low estimated income per year; as 80% of farmers had income lower than the national average per capita income of 450 USD per year, farmers indicated that credit facilities were not also available for the purchase of farm inputs. Another research done (Ajayi et al., 2006) has shown that factors like lack of labour supply, and the degree of innovativeness of farmers can disturb the adoption of agroforestry practices. Expensive inputs like fertilizers also can affect the adoption of agroforestry practices (Gladwin et al., 2002).

Agroforestry species in household income

The result of this research shows that most of respondents have gained different agroforestry products from their farm at different level or quantity. Stakes is the first product which is harvested by the farmers this is due to the production of climbing beans in region.

This shows the importance of agroforestry products on household income. Likewise other researchers (Nguyen et al., 2013) found that multipurpose tree and integrated method use, can improve the productivity of agroforestry, trees can provide fodder, and fodder can be converted in organic manure. (Neufeldt et al., 2012,) and (Assogbadjo et al., 2012) also found that Integration of trees on farms can provide diverse NTFPs that provide alternative food and incomes to the rural communities.

Conclusions

The study found that *Erytrina abyssinica* was the most dominant and *Alnus acuminata* was the most preferred species due to its diverse products and it adaptability in the area. Trees on farm improve forest cover, co-exist with food crops and are utilized for fodder, stakes, fuel wood, and soil fertility improvement. However, Farmers perceptions on agroforestry practice were very supportive to encourage and upscale agroforestry in the study area. The farmers of Karago sector know the importance and role of agroforestry species in land use system at different level where some mentioned their importance in soil erosion control and others mentioned their role in increasing soil productivity. Different agroforestry products are gained by farmers and the quantity gained is still low due to the poor agroforestry species management, lack of seedlings, lack of capital and lack of labour supply. The result of this research show the impact of the agroforestry species in income generation where fire wood and stakes generate more income respectively.

In this regard there is need to improve farmer's knowledge on trees management, provide seedling and provide loans to the farmers in order to build capacity of agroforestry practices in the area. It is imperative that the government of Rwanda pay increased attention to agroforestry as a feasible strategy to restore soil productivity, increase forest cover and social economic benefits of farmers.

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