Assessing the Impact of reforestation on household income in Gatsibo District, Rwanda

Alphonse Nahayo[1,*], Francine Usabye

Higher Institute of Agriculture and Animal Husbandry (ISAE);Department of Forestry and Nature Conservation; P.O.Box 210 Musanze, Rwanda; Email:nahayo1@yahoo.fr

Abstract: This study was conducted in Kiramuruzi sector, Gatsibo district, in Eastern Province of Rwanda from July to October 2011. Its main purpose was to assess the impact of reforestation on household income. This area is subject to the deterioration of tree resources, poor conditions of living and reduced income in households. Therefore, this study is an attempt to investigate this situation. Data collection was done through the use of a survey questionnaire containing open and closed-ended questions. The formal and informal interviews were conducted with 67 household's heads including the farmers participating in reforestation. Data were analyzed using the Microsoft Excel and SPSS 16.0 Windows program and statistical tests such as Friedman and Paired samples T-test were used. The results showed that different forms of tree growing through reforestation provide many products and services. The wood for cooking is the main forest product with the low mean rank of 1.01. Concerning the impact of reforestation on the increase of household income, there is a relationship between the increase of crop production, animal breeding and annual profit from forest products after reforestation than before where the p-value $(0.00) < \alpha$ (0.05). The main challenges faced by farmers in reforestation include the shortage of land (86.5%), pest and diseases (89.6%), poverty (70%), poor management practices of existing forest resources (67%) and insufficiency of seedlings (40.3%). The reforestation is very important source of income for farmers and it contributes to the improvement of people's conditions of living. Estimating the economic input of forest products at district level is recommended.

Key words: Reforestation, household income, Gatsibo district, Rwanda

1. Introduction

Forests generate direct monetary income for households, public entities and the country in general. In Rwanda, the used energy sources are generally wood and agricultural wastes. Researches show that this source of energy occupies 96 % of the total energy used in Rwanda, for cooking food. The rural households use firewood but the urban households use charcoal. Furthermore, forests are a key component of the life-support system in view of both the products and services they provide. This is particularly in Rwanda where forests protect watersheds for making agriculture viable, and meet the energy needs of the bulk of population (MINIFOM, 2010). Forest encroachment through various human activities is a threat to Rwandan forests. These activities included illegal logging, charcoal production, human settlement, bush fires, etc. The national forest inventory in 2007 identified illegal tree cutting (78.3%), farming activities (1.9 %), livestock grazing (4.9%), bush fires (2.5 %), debarking (1.9 %), mining (0.6%) and beekeeping (0.5 %) as the main threats (MINITERE, 2007). Forest encroachment is not a new phenomenon; It was occurred in years that followed independence in 1962, and during the war and post-war period (1990-1994 and 1995-1996) (ORTPN, 2004). However, Rwandan forests have suffered from degradation of forest resources. The main cause are the overexploitation of forests, the poor management of existing resources and the lack of knowledge on available resources. The Government of Rwanda has set a target to increase the national forest cover from the present 10 per cent to 30 per cent of the national territory by the year 2020. In order to attain this target, there is a need to combine efforts to increase the number of existing protected forests and to add to the number of tree plantations. Another solution is the careful management of forest resources by eliminating clear-cutting to ensure that the environment stays intact and planting trees to replace the fallen ones (MINIFOM, 2010). The practice of reforestation is viewed to offer the solutions to the recovering of degraded forest resources.

After 1994, the deforestation in Eastern province of Rwanda was a critical issue due to overgrazing (UNEP, 2009). Therefore, the analysis of rainfall trends shows that rainy seasons become shorter with higher intensity of sun. This tendency has led to the decrease in agricultural production and events such as droughts often responsible for famine, food shortages, a reduction in plant and animal species and displacement of people in search of food and pasture.

Nowadays, the efforts to restore the degraded forests are on-going and the results are encouraging in agriculture and animal grazing. In 2005, the forest coverage was 122.5 km^2 in Eastern province and in 2010 the forest cover was 149.5 km^2. This means that there was an increase of.18% of forest plantation. Therefore, this study aimed at providing the information on how planting trees in this region contributed to the increase of household income. The specific objectives to achieve are: (i) to identify the forest products collected; (ii) to determine the contribution of forest products to the household income; (iii) to identify the challenges faced by reforestation process; (iv) to evaluate the contribution of reforestation to the increase of both crop and livestock productivity.

2. Material and methods
Study area description

Kiramuruzi sector is located in Gatsibo District in Eastern Province of Rwanda. It is bordered at the East by Kayonza District, to the North by Kiziguro and Murambi sector of Gatsibo District, to the South and West by Muhazi Lake. The Kiramuruzi sector is composed of four cells which are Nyabisindi, Akabuga, Gakenke and Gakoni. Kiramuruzi sector has 27,843 inhabitats of whom 51% are females and 49% males. The young aged below 25 years are 63 %. The economy of Kiramuruzi sector is based on agriculture, livestock and commerce. Agriculture and animal keeping are the principal bases of economy. The main crops grown in Kiramuruzi sector are banana, rice, sorghum, beans, maize, groundnuts, soya beans and tree growing.The most important trees are *Grevillea robusta* (38.8%), *Eucalyptus sp.* (26.2%), Avocado (12.5%) and *Acacia sp.* (7.6%). A household has an average of 40 to 50 trees of *Eucalyptus sp.* and *Grevillea robusta*. Kiramuruzi sector is located in semi-arid zone with temperatures typically ranging from 20.3 -21.7^{o}c with maxima reaching 26-29°c. This

sector experiences a climatic rhythm of 2 main seasons: dry season and rain season. However, during these seasons, the rains are not regular and this situation can especial contribute to a considerable reduction of the production in the region. The rainfall can be highly irregular, with annual average of 800-900mm. The highest monthly rainfall is observed, generally during November-December and March-May, while the period from June to October is largely dry. In general, the relief of Kiramuruzi and Umutara region is that of the areas of low plateau. The mean altitude in Kiramuruzi is around 1350 m.a.s.l.

Methods

As Kiramuruzi sector has four cells, the purposive method was used to select them because through the reforestation activities, many trees have been planted. The concerned cells are Akabuga, Gakenke, Gakoni and Nyabisindu. After, a cluster and purposive sampling methods at all selected cells, a proportionate allocation sampling method was used to know the sample size to interview in each cell. Data were collected by using a structured survey questionnaire containing open and closed-ended questions. The formal and informal interviews were conducted with 67 households 'heads randomly selected at the sector level. Pretesting method was used with 20 randomly selected respondents. The data were analyzed by using the Statistical Package for Social Sciences (SPSS) version 16 where Friedman test one way ANOVA and Paired sample T-test were applied.

3.Results and discussion
3.1Household characteristics
Age

The flowing Figure 1 indicates the age distribution of farmers sampled in four cells (Akabuga, Gakenke, Gakoni, and Nyabisindu) of Kiramuruzi sector.
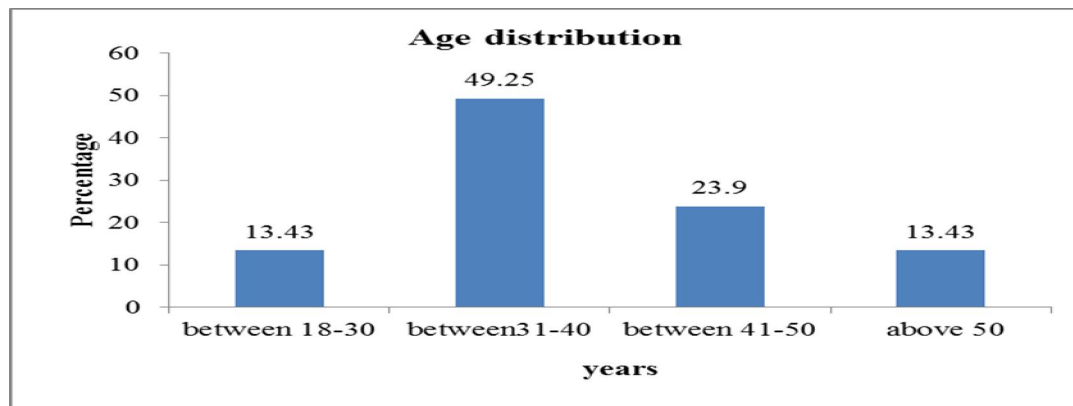

Figure 1: **Age of respondents**

The Figure 1shows that the half (49.25%) of surveyed farmers are mature people being in the middle-aged class of 31-40 age.
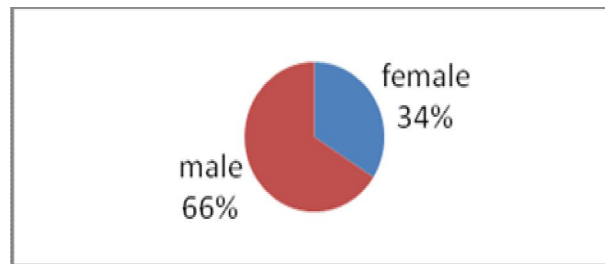
Sex distribution

Figure 2: Sex of respondents

The figure 2 shows that among 67 respondents surveyed, the number of males was greater (65%) than the number of female (34%) because the families are usually governed by males and have both control and access to forest resources and they are involved in household decision-making. Similarly, the National Institute of Statistics of Rwanda (2007-2008) stated that 69 % of households are headed by males while 31 % are headed by females.

Marital status
Table 1: Marital status of respondents

Marital status	Frequency	Percentage
Single	4	6
Married	25	77.6
Widowed	10	14.9
Separated	1	1.49
Total	67	100

Source: Primary data, 2011

The results illustrated in Table 1 show that 77.6 % of farmers interviewed are married, 14.9% are widowed, 6 % are single and 1.49 % is divorced.

Size of household

The Figure 3 identifies the size of household of respondent in the study area.
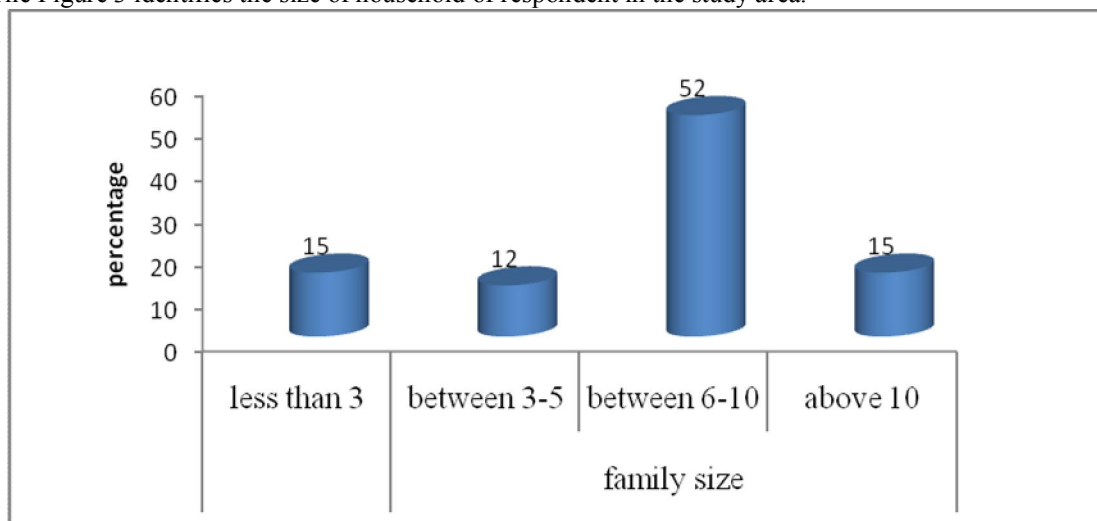

Figure 3: The size of household

The figure 3 shows that 52 % of households interviewed are composed of between 6-10 persons while 12 % composed of between 3-5 persons, the mean household size is 5 persons. According to the National Institute of Statistics of Rwanda (2007-2008), the mean household size was 4.6 persons in general and 4.5 persons in rural areas and 4.8 persons in urban areas. There is no significant difference (0.4) in mean household size between Kiramuruzi sector and the figure at the national level.

Education level of respondents
The figure 4 illustrates the education level of respondents.
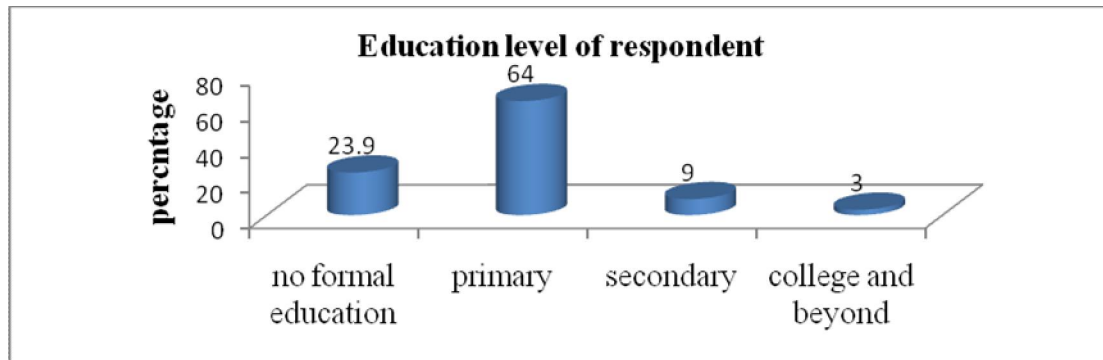

Figure 4: Education level of respondents

According to the results shown in the figure 4, it is evident that the majority (64 %) of respondents attended primary level of education, and few of them had university education (3%) followed by secondary education (9%). According to the National Institute of Statistics of Rwanda (2007-2008), 40.8 % are not educated, 50.7 % finished primary school and 8.5 % finished post-primary school (secondary and university). According to these results, the great majority of interviewed farmers have got basic education skills and knowledge, so the reforestation process is facilitated.

Time of residence
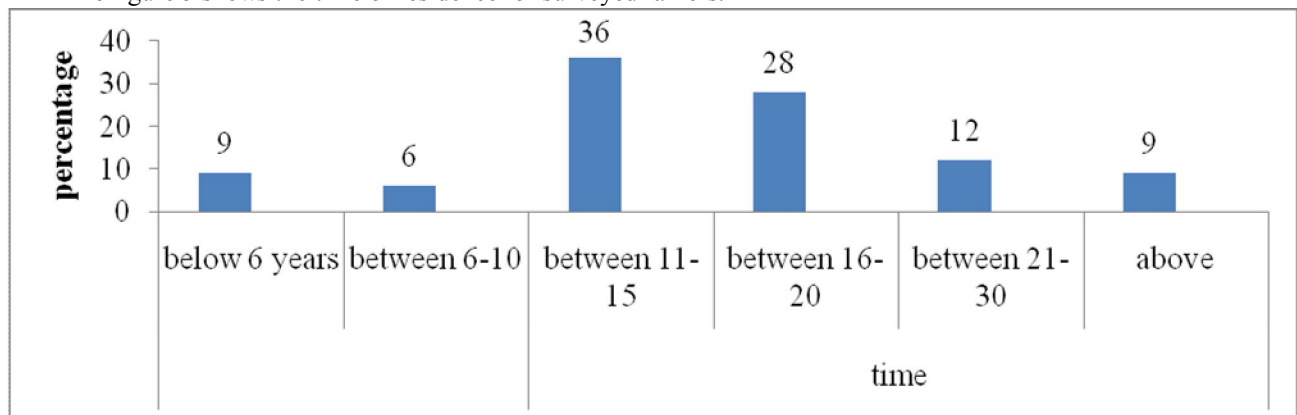The figure 5 shows the time of residence for surveyed famers.

Figure 5: Time of residence

The figure 5 indicates that the majority of Kiramuruzi sector farmers did not stay in the region before, 51% came to live there after the war and genocide of 1994.This explains why there was a massif deforestation in the region through human activities, e.g human resettlement. According to MINAGRI (1998), it is estimated that during the war, approximately 15,000 ha of forest plantation were completely destroyed and 35,000 ha damaged.
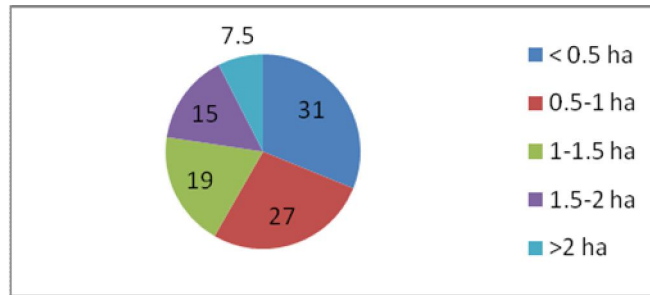
Land size
  Land size for household

Figure 6: Total farmland size

The figure 6 shows that the majority of respondents have a problem of shortage of land where 58% of respondents have less than 1hectare. Therefore, there is a big problem related to the shortage of land especially the lack of land for reforestation. The total farmland size for household will influence the land used for forest plantation. According to the results of MINITERE, (2007), the average landholdings capacity in Rwanda is very low, less than 25 % of farmers cultivate the land of more than 0.5 ha, 50 % cultivate less than 0.5 ha, and more than 25 % cultivating less than 0.2 ha.

Training for respondents
  The figure 7 indicates the information about training status for respondents
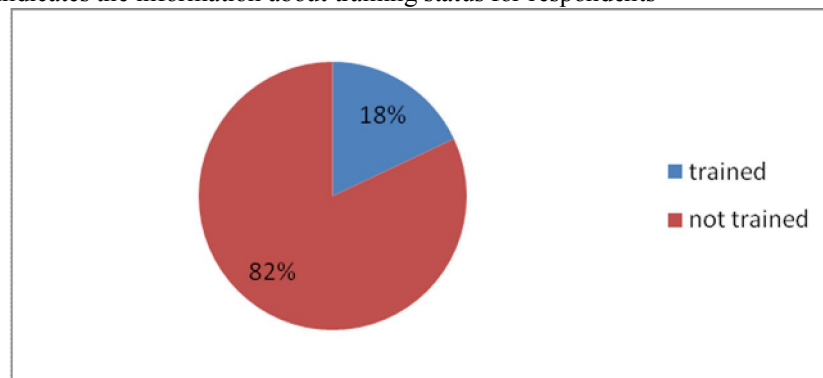

Figure 7: Training status for respondents

The figure 7 shows that 11. 82 % of interviewed farmers are not trained while18 % are trained. It implies that a huge number of interviewed farmers are not trained. The trained farmers are supported by Rural Sector Support Project (RSSP), WOLD VISION and ADRA and the trainings are given in different domains: use of fertilizers, follow-up of agricultural techniques, agroforestry and forestry management and modern livestock.
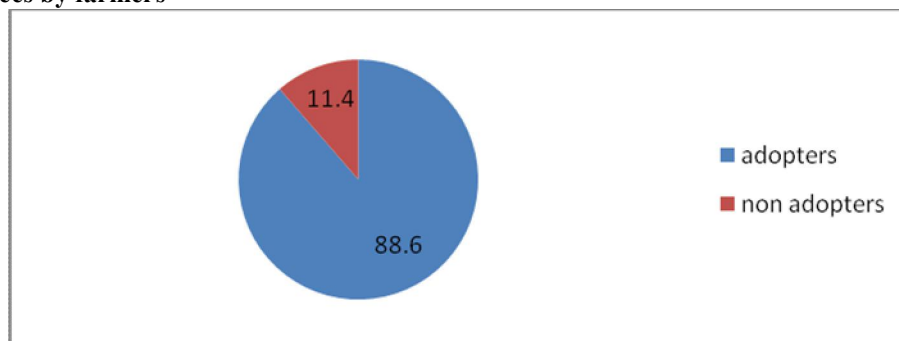
Adoption of trees by farmers

Figure 8: Adoption level of trees in farmland

The figure 8 shows that 88.6% of interviewed farmers have adopted trees while 11.4 did not plant any tree.

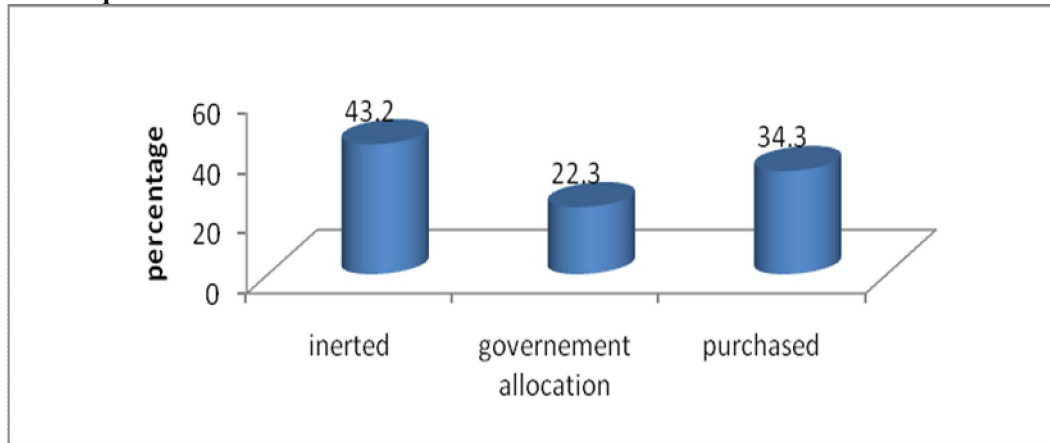**Mode of land acquisition**

Figure 9: Mode of land acquisition

The figure 9 shows that 43.2 % of interviewed farmers inherited their lands, 34.3 % purchased and 22.3 % by government allocation. This shows that even if the interviewed farmers obtained their land by heritage, they use other methods (purchasing and renting) in order to increase their farmland. According to the results of MINITERE, (2007), the average landholdings in Rwanda are very small. This influences farmers to purchase and rent the land for increasing the size in order to diversify their activities including afforestation and reforestation.

3.2 Forests products characterization

Tree growing forms during reforestation process

Figure 10: Forms of trees grown

The figure 10 shows that forestry and agroforestry practices which are mainly found in the study area are trees scattered on farm, trees on boundaries, trees scattered on pasture, forests and woodlots represented by 33 %, 28 %, 21 %, 19 % and14 % respectively.

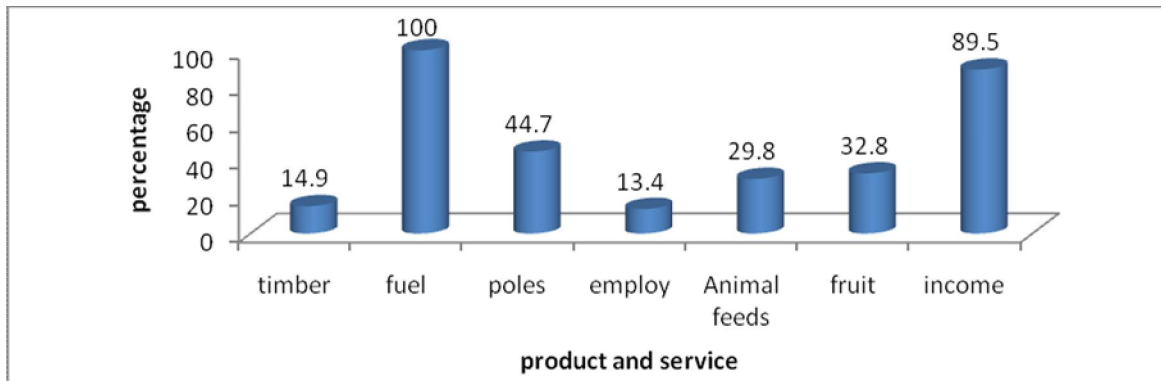**Awareness of forest products and services in Kiramuruzi sector**

Figure 11: Products and services provided by trees planted

The figure 11 shows that, as affirmed by interviewed, 100% of the forest products and services provided through reforestation and afforestation are firewood and charcoal, 44.7% are construction materials, 89.56% are income,32.8% are fruits, 14.9% are timber,29.8% are animal feeds and lastly 14.8% are employment. The totality of the forest products found in Kiramuruzi sector are timber, charcoal, building poles, firewood, beans stakes, fodder, medicines, fruits and honey. These products are produced from different tree species. Forest ecosystems provide goods and services such wood for fuel and construction, water catchments protection, water purification, tourism, non timber forest products such as medicinal plants, honey and material for handicrafts.

3.3 The contribution of forest products to the increase of household income
Economic activities
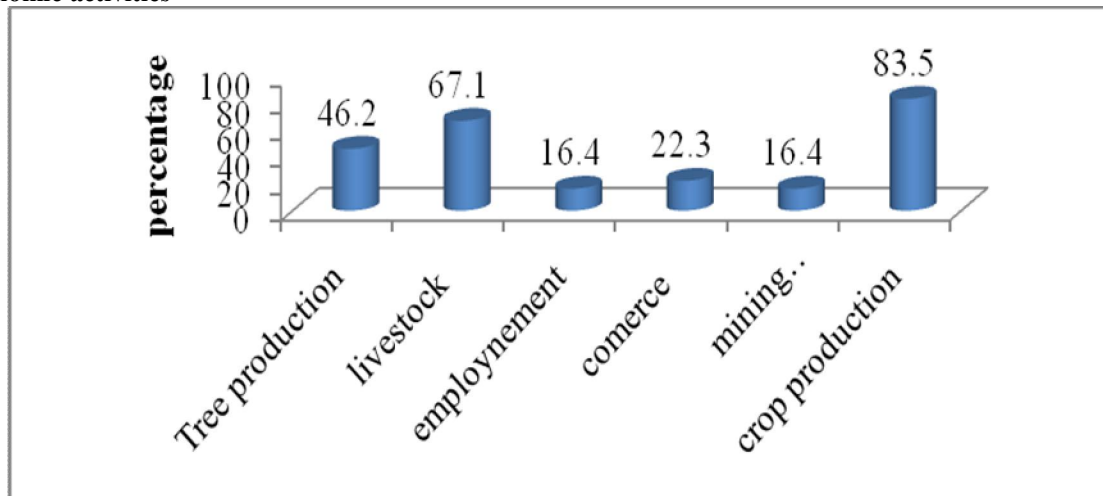
Figure 12: Main occupation of respondents

This figure 12 shows that 83.5 % of interviewed farmers do farming as the main occupation, 67.1 % are involved in livestock, 16.4 % in mining activities, 22.3 % in small businesses, 16.4% in regular employments while 46.2% do tree production. This shows that larger number of farmers of Kiramuruzi sector is involved in agriculture.

The use of income gained from forest products

The following figure13 shows different uses of income earned from forest products

Figure 13: Use of income earned from forest products

The figure 13 shows that the income generated by forest products is used in different ways: 80.6% use the income from forest (both afforestation and reforestation) products in health care improvement; 34.3 % i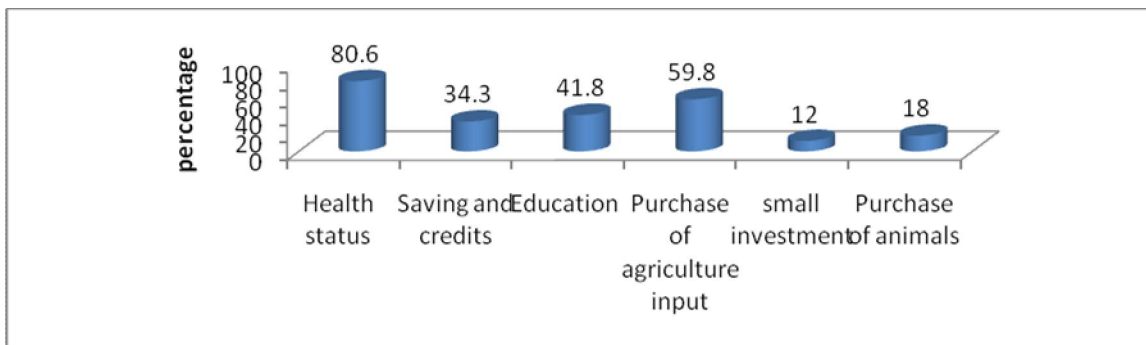n saving and credit, 59.8% purchase agriculture inputs; 41.8 % in paying school fees; 12 % in small investments and 18% purchase animals. According to FAO(2000) the contribution of forest products is particularly important to rural communities in terms of food and nutritional requirements, medicines, fodder for livestock, gums, fiber, construction materials and related domestic requirements; Sustainable harvesting of forest products is seen as an effective management approach that allows local people to meet and sustain their livelihoods while contributing to forest conservation; hence, in promoting the sustainable use of forest products, it is better to improve the conservation of forest resources as these play a crucial role in the local communities' lives by providing basic needs.

3.4 Extent of dependency on forest products

In order to verify if households of Kiramuruzi sector depend on fuelwood more than other forest products, the hypothesis was tested by using the Friedman Test.

Table 2: The level of dependency on forest products and services from reforestation

Products and services	Mean Rank	Statistical test
Timber	3.50	N
		67
Fuelwood	1.01	Chi-Square
		327.505
Medicinal products	7.00	Degree of freedom 7
Construction poles	5.79	Asymp.
Employment	4.38	Sig .000
Animal feeds	3.96	
Income earned	4.04	
Fruits	6.33	

This analysis has been done through the use of a 5-point   scale ranging from 1-very high through 5-very low and according to this scale the lower the mean the higher the importance attached by farmers to a given forest product. A non-parametric test (Friedman's Test) is used to rank importance of different forest products. The households view forest resources mainly as a source of fuel wood (both firewood and charcoal) and income. But in general, forest products and services are needed by farmers because the p-value (0.000) < α (0.05).

3.5 Challenges faced by reforestation process
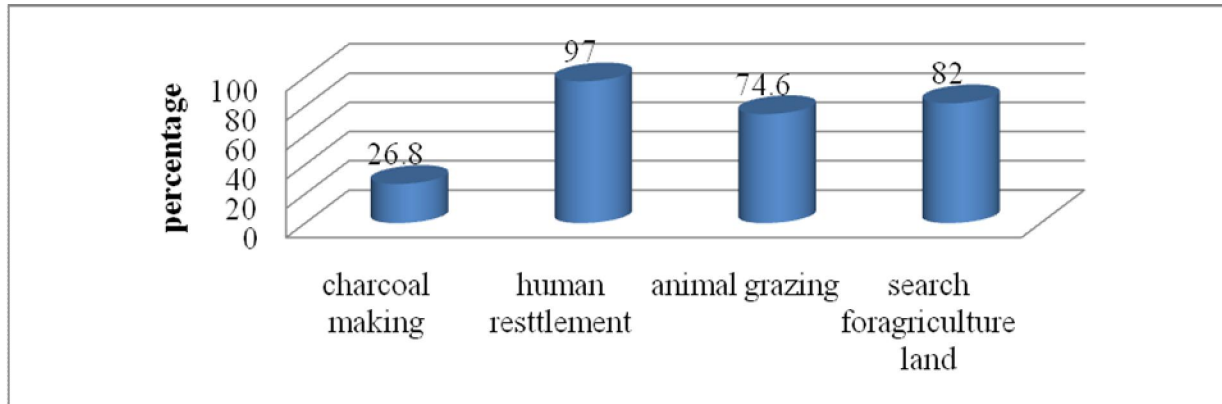**Causes of deforestation**

Figure 14: Causes of deforestation in kiramuruzi sector

The figure 14 shows that human resettlement comes at the first position with 97% followed by search of agriculture land with 82%, animal grazing with 74.6% and lastly charcoal making with 26.8%. These results are in agreement with (MINITERE, 2007) stating that Rwanda's environment has been further destroyed by people looking for agriculture land and for settlement.

Constraints associated with the reforestation in Kiramuruzi sector
The following figure 15 indicates the factors affecting negatively the adoption of reforestation and afforestation. The constraints are classified in three levels which are very severe, moderately and severe.
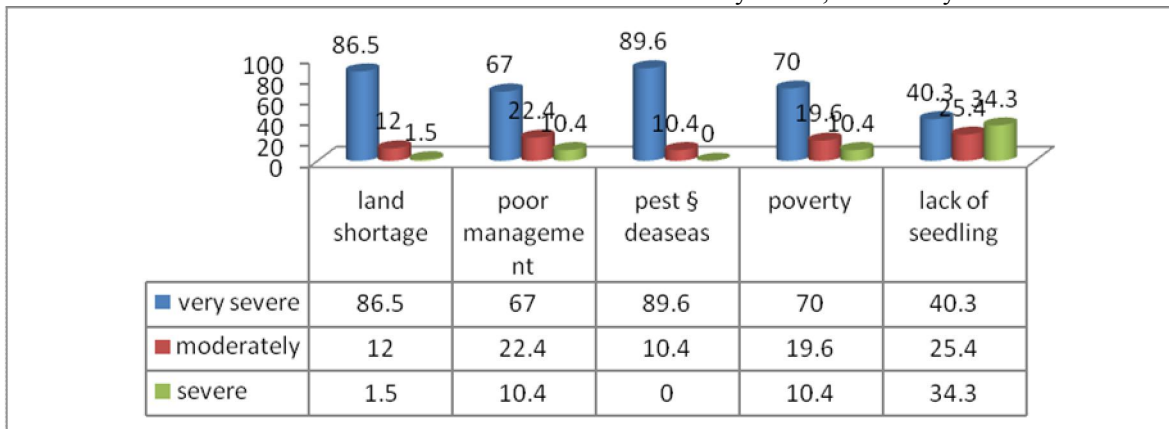

	land shortage	poor management	pest § deaseas	poverty	lack of seedling
very severe	86.5	67	89.6	70	40.3
moderately	12	22.4	10.4	19.6	25.4
severe	1.5	10.4	0	10.4	34.3

Figure 15: Level of constraints for reforestation/afforestation

The figure 15 shows that the levels of constraints in reforestation and afforestation are different due to the observation of farmers and their expected outcomes and needs. The low land holding and poverty pests and diseases are respectively highly observed (86.5 and 70%) because of land competition for crop production, animal grazing, settlement and forestry compared to the household size in the region. Also this figure 14 shows that the poor management of existing forest resources is observed with 67 %, the lack of seedlings with 40.3 % and the pest and diseases with 89.6 and this is due to ecological conditions that facilitate the presence of huge amount of termites in the region.

3.6 The contribution of reforestation on agricultural and livestock productivity
  Statistical test on annual profit from forms of tree grown before and after reforestation
In order to compare the annual profit from tree grown before and after reforestation, I have used paired samples test.

Table 3: Paired Samples Statistics for annual profit from tree grown before and after reforestation

	Mean	N	Std. Deviation	Std. Error Mean
Annual profit after reforestation	3.09E5	67	208077.783	25420.747
Annual profit before reforestation	3.8856E4	67	44619.06238	5451.08606

Table 4: Paired Samples Test for annual profit from tree grown before and after reforestation

Annual profit	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Standard Deviation	Standard Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before and after reforestation	2.69914E5	1.89383E5	23136.80344	2.23720E5	3.16108E5	11.666	66	.000

Source: Primary data, 2011

The Tables 3 and 4 show the difference between annual profit earned by farmers before and after reforestation. There is a positive impact of reforestation on household income because p value =0.00 is less than α and we state that there is a significant difference between annual profit earned by farmers before and after reforestation. The mean is 5,451 RWF before reforestation instead of 25,420.747 RWF after reforestation. These results are in agreement with FAO, (2000) where the study revealed that forest products contribute substantially to the national economy growth and international trade as they have the potential of being marketed and thus providing rural people with cash income without the need of clearing the forest; trade products contribute to the fulfillment of daily needs and provide employment as well as income, particularly for rural people and especially women.

Statistical test on seasonal yield of beans and maize before and after reforestation
Table 5: Paired Sample test for crop production

Yield(t/ha)	Mean	N	Std. Deviation	Std. Error Mean
Seasonal yield for beans and maize before reforestation	0.7318	57	0.49352	0.06537
Seasonal yield for beans and maize after reforestation	2.9702	57	0.85711	0.11353

Table 6: Paired Sample test for crop production

Yield (t/ha)	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Yield of beans and maize before reforestation –yield for beans and maize after reforestation	-2.23842	.90604	.12001	-2.47883	-1.99802	-18.652	56	0.000

Source: Primary data, 2011

The table 5 and 6 show that the beans and maize production was increased after reforestation because the mean difference is positive and the P-value (0.000) < α (0.05). Thus we conclude that the reforestation has positive impact on crop production. Other crops available were sorghum, cassava, sweet potatoes, Irish potatoes, groundnuts, rice, tomatoes, cabbage, banana and peas and reforestation intervenes to the cutback of major constraints of agriculture production that was reported as availability of land (about 52%), drought (16%), lack of water (9%), lack of improved cattle (3%), and others.

Statistical test on annual income for cow and goat before and after reforestation
Table 7: Paired Sample test for the income from grazing

	Mean	N	Standard Deviation	Standard Error Mean
Income for goat and cows before and after reforestation	8.5674E4	46	55086.21701	8122.01959
	7.2500E5	46	1.01414E6	1.49527E5

Table 8: Paired Samples Test for the income from grazing

Annual income for goat and cows before reforestation - for goat and cows after reforestation	Paired Differences							Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	
	-6.39326E5	9.77046E5	1.44058E5	-9.29473E5	-3.49179E5	-4.438	45	.000

Source: Primary data, 2011

The table 7 and table 8 show that the animal breeding production generates high income to the farmers in region after reforestation than before. This is affirmed by the P-value (0.000) which is less than α (0.05) meaning that there is a significant difference between annual income generated by animal breeding production before and after reforestation. This shows the importance of both agroforestry and forestry species to the increase of animal productivity.

4. Conclusion

This study aimed at assessing the impact of reforestation to the increase of household income in Gatsibo district in Kiramuruzi sector.The results show that in Kiramuruzi sector through reforestation the different forest products and services are Timber, Charcoal, Building poles, Firewood, job creation, Medicines and climatic regulation. According to the mean annual net profit obtained from the different forest products and services, crop (maize and beans the main crops in region) production and animal productivity; the results are evidence for a greater positive difference in output before and after reforestation. According to the dependency of farmers on forest products, the farmers depend on forest resources as firewood, building, materials generating income, climatic regulation, job creation and medicinal plants. The income earned from forest products is positively and significantly influenced by different factors which are area under forest, diversification of forest products and education level. Concerning the constraints in reforestation, the availability of pest and diseases especially termites, lack of land for both reforestation and afforestation, poverty, poor management of existing forest resources are cited by the farmers. The income from forest products is very important because it is used by households such as health care insurance, building

house, saving and credit, buying animals, paying school fees and purchasing agriculture input. In short, forest products are very important source of income for rural farmers in Kiramuruzi sector and they contribute to their household' livelihood improvement.

Corresponding author
NAHAYO Alphonse
Higher Institute of Agriculture and Animal Husbandry (ISAE)- Busogo; Department of Forestry and Nature Conservation; P.O.Box 210 Musanze, Rwanda; Email: nahayo1@yahoo.fr

References
1. FAO (2000). Global forest resources assessment. Main report. Rome, Italy. FAO, pp140.
2. FAO. (2000). Forest Resources Assessment. FAO, Rome.pp24-27.
3. MINAGRI, 1998 : Stratégie et plan d'action pour la sécurité alimentaire. Ministère de l'agriculture, de l'élevage de l'environnement et du développent rural, Kigali.pp56.
4. MINIFOM, 2010: National Forestry Policy. Kigali, Rwanda.pp24.
5. MINITERE and CGIS-NUR2007: Final report on mapping of Rwandese forests.volume1.Kigali pp40-43.
6. ORTPN, 2004: Plan d'aménagement de gestion du Parc National des Volcans. Draft 2 Kigali. Pp 39-48.
7. ORTPN, 2005: Nyungwe National Park GENAL Management 2006-2010 Draft1 Kigali.pp28-33
8. UNEP, 2009: Rwanda State of Environment and Outlook Rwanda, Kigali. pp54-68.

8/29/2012