# Report Research

**FARMER PERCEPTION AND ADOPTION OF AGROFORESTRY TECHNOLOGIES IN EASTERN RWANDA**

Prepared by

UMUHOZA Emmanuel

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# EXECUTIVE SUMMARY

Agroforestry systems are multifunctional settings that can provide a wide range of economic, socio-cultural, and environmental benefits. Agroforestry systems improve soil fertility and increases agriculture productivity. Government of Rwanda implemented restoration activities in 2017 through LDCFII-EbA project (Raasakka, 2013) with the aim to restore landscapes and improve peoples' livelihoods in eastern Rwanda. However, less is known whether agroforestry technologies used relieved the pressure on natural woodlands from human encroachment or contributed to improve livelihoods of local people living in eastern Rwanda. This research was done in eastern Rwanda with the aims to i) identify agroforestry tree and shrub species planted in the study area, ii) evaluate agroforestry technologies adopted by local farmers in study area to, iii) Examine the contribution of agroforestry to the supply of tree products to the smallholder Farmers in the study area, and iv) identify the challenges affecting adoption of agroforestry technologies in the study area .The sample size was selected randomly. In addition to 235 sample households, nine key informants were purposefully selected. Formal survey methods were used to gather information and 244 households, including nine local leaders and technical experts. Direct observations were used to identify agroforestry technologies practiced in farmlands. The handheld GPS (Garmin GPSMAP 78) was used to locate and map the sampled households. The results show that hedge was identified as the most dominant agroforestry technology rather than others in the area.Interview participants reported that they benefited firewood, soil erosion control, fodder for livestock and green manure from these agroforestry technologies. The results also show that lack of enough and good quality seedlings, termite attack, drought and lack of technical skills are the main challenges to the adoption of agroforestry technologies in the study area. Intensifying extension services is important as a means to address these issues to improve environmental conservation as well as peoples' livelihood. In additional, the contribution of agroforestry technologies on soil fertility and microorganism activity is highly recommended. And as one of the best indicators for adoption of agroforestry practices in this intervention area

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# Chapter 1. Introduction

## 1.1. Background of the study

Smallholder farmers' marginal lands are vulnerable to the low yield crops as there are almost Smallholder farmer depending on subsistence farming (Rapsomanikis G., 2015). Rwandan smallholder farmers generally have degraded small farmlands and lack knowledge of improved technologies in their daily farming activities. A study conducted by Rwanda Agricultural Board (RAB) indicated that the soil loss is in the range of 35- 246 tons/ha/year (Olson & Berry, 2017). This result involved to reduce soil fertility and diversity (Harvey et al., 2015). The best way to maintain soil fertile and biodiversity is to promote ecosystem services that play a role in increasing biodiversity on the earth and provide services that help people adapt to both current and future environmental and socio-economic conditions (Daba and Dejene, 2018). In this way, ecosystem services improve human livelihoods.

Ecosystem-based Adaptation (EbA) is the use of food, water, non timber production, soil, oxygen and pollination as ecosystem services and biodiversity which help the local peoples to adapt to the climate change. Ecosystem-based Adaptation (EbA) is one of the ways to reduce land degradation, maintain ecosystem functions, and improve people's livelihoods (Reid & Madrid, 2018). One approach to EbA strategy is the introduction of agroforestry technologies to improve peoples' livelihoods and also contribute to the ecosystem health (Vignola et al., 2018). Agroforestry is a dynamic, and ecologically-based natural resource management system that integrates trees, crops, forages, and livestock on the same land (Owooh, 2013). In this land-use system, trees and shrubs are grown together with crops and/or animals in the same land for ecological and economic benefits (Cairns and Garrity, 1999). Agroforestry systems are multifunctional systems that can provide a wide range of economic, socio-cultural, and environmental benefits, including fodder, fruits, charcoal, stakes for climbing beans, timber, clean water, improved soil fertility and controlling soil erosion and creation of microclimate (Kiyani et al., 2017).

## 1.2. Problem statement

Rwanda experienced extreme deforestation from 1960 up to 2007 due to human population growth (Ndayambaje, 2013). Especially the forest of Gishwati initially estimated to 280 km$^2$ was reduced to only 7 km$^2$, resulting in a loss of 80 % of its initial natural forest cover (Mukashema, 2007), as a result of overexploitation of the forest resources for fuel wood and charcoal, land for agriculture and settlement. Consequently, these activities caused rain irregularities and affected crop productivity (Okia , 2012). Indeed, food insecurity has been reported and expressed through extended droughts compared to the past years, and sometimes unexpected hungry which negatively to the local people livelihood (USAID, 2011).

The eastern Rwanda is characterized by irregular rainfall which negatively affect the life cycle of trees and forestry cover. Consequently, soil erosion problems occur in the area and the latter has been especially observed in the Mpanga sector (Johnson, 2018). In addition, high human population density which was reported to be 129 people/km$^{-2}$ (NSIR, 2012).They needed large quantities of tree production was recorded in the eastern Rwanda as one of the causes of deforestation (DDP, 2013). Kirehe district, one of the districts in the eastern Rwanda, is, like other areas in Rwanda, affected by intensive human activities.

This district contains Mpanga Lake whose water quantity has been reduced over time due to siltation and sediment accumulation from the hillsides as a result of lack of plant cover on hillsides since wetland/lake buffer zones are not protected against soil erosion. Changes in this area were accelerated by overcutting of trees mainly for firewood, charcoal, timber and land transformation (conversion of land to agriculture) (Bizuru et al., 2011).

In 2017, Government of Rwanda introduced restoration activities through afforestation and reforestation in the area through a project entitled "building the resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an ecosystem-based adaptation approach (LDCFII-Eba) (Raasakka, 2013). Agroforestry was one of the main activities involved landscape restoration and improvement of peoples' livelihoods in Kirehe district. Agroforestry tree/shrub species were planted on hillsides and a bamboo planting was established in a buffer zone around Mpanga Lake. However, it is not known whether agroforestry technologies used contributed to the reduction of human pressure on natural woodlands or contributed to the improvement of livelihoods of local communities living in eastern Rwanda. This research aimed to assess Farmer's Perception and Adoption of Agroforestry Technologies in Eastern Rwanda.

## 1.2. Objectives

### 1.2.1. Main objective

The overall objective of this research was to assess Farmer's Perception and Adoption of Agroforestry Technologies in eastern Rwanda.

### 1.2.2. Specific objectives

1. To identify agroforestry tree/shrubs species planted in the study area.

2. To evaluate agroforestry technologies adoption by local farmers in the study area

3. To examine the contribution of agroforestry to the supply of tree products to the smallholder in the study area

4. To identify the challenges affecting adoption of agroforestry technologies in the study area

### 1.3. Research questions

1. Which are agroforestry tree/shrubs species grow on-farms in the study area?

2. What are agroforestry technologies adoptions by local farmers in the study area?

3. What are tree products contributed by agroforestry to the smallholder Farmers in the study area?

4. What are the challenges affecting agroforestry technologies in the study area?

# Chapter2. Literature review

## 2.1. Role of agroforestry in improving rural people livelihoods

A large number of populations in developing countries are dependent on subsistence farming (Rapsomanikis, 2015). In Rwanda, reducing soil fertility caused by soil erosion is one of the major challenges that negatively affect agricultural productivity (Verchot et al., 2007).

Agroforestry is land use system where tree/shrubs grown together with crops or pasture on the same piece of land in order to improve socio-economic and environmental benefits (Regmi, 2003).Agroforestry strengthens farmers' capacities to control land degradation by building resilient agricultural techniques and by increasing the diversity of income sources (Rioux, 2012). Agroforestry also offers many benefits to communities by improving catchment water quality and landscape biodiversity (Masibo et al., 2018). It improves soil fertility, soil moisture content, cation exchange capacity (CEC) and soil structures through the retainment of sediments and nutrients; it also contributes to reducing the potential of salinity and acidity in soils, creating a good microclimate, reducing soil erosion and supporting biodiversity through provision of suitable habitat for animal species (Kiyani et al., 2017).

In addition, agroforestry plays a crucial role as it meets the needs of a growing population as it sustains crop and livestock production and provides tree products that can improve rural peoples' livelihoods (Regmi, 2003). Furthermore, agroforestry improves and maintains the surroundings of forests as it acts as an alternative source of fodder for livestock, used in medicine and firewood for the local community (Regmi, 2003). Agroforestry is appreciated to reduce soil erosion and improve soil quality that leads to improved agricultural productivity (Tiwari et al., 2017).

## 2.2. Farmers' perception of agroforestry technologies and ecosystem services

Humans have always depended on nature by exploiting environmental assets that include soil, water, forests and air (FAO, 2008). These assets gained global attention under the umbrella of ecosystem services; these can be defined as a set of diverse ecological functions essential for human welfare that can provide benefits to humans so that there is an urgency in the environmental conservation (Sileshi et al., 2007). A study conducted in Nepal concluded that farmers were aware of economic and environmental importance of agroforestry technologies like trees dispersed in cropland, home gardens, boundary planting and hedges and also had positive attitudes towards such technologies as they agree that agroforestry technologies were at the fore front in increasing soil fertility, farm incomes, creating microclimate and aesthetics (Regmi, 2003).

A review on the farmers' approaches towards farm tree management technologies indicates that farmers perceive trees in terms of how they contribute to their livelihoods ; they fail to link agroforestry to ecosystem services as well as the well-being (Regmi, 2003). The relationship between agroforestry and ecosystem services is that agroforestry systems benefit provide ecosystem services such as crop pollination by insects, and in turn, ecosystem services are impacted by the agroforestry systems (Tahulela, 2016).

### 2.3. Facilities influencing farmers to adopt agroforestry technologies

It is important firstly to understand the underlying facilities that can influence farmers' adoption of agroforestry technologies to facilitate smallholder farmers' adoption of these improved farming technologies (Obeng, 2016). facilities that include participation in farmers' clubs and cooperatives, availability of labor forces and the degree of innovation by individual farmers have been highlighted to be key facilities influencing the adoption of agroforestry technologies by farmers (Kabwe et al., 2009). Socio-economic facilities such as income level, education level, household size as well as gender influence the adoption of agroforestry in a positive way. Household provide income from timber production and reduce the time spend for needed firewood. It has been revealed that gender also can influence agroforestry technologies where men are found to be interested in trees for commercial purposes while women are more focused on the tree products for subsistence use such as firewood, soil fertility improvement, fodder and fruits (Kiptot & Franzel, 2011).

### 2.4. Challenges in perceptions of agroforestry technologies

The importance of trees has always conflicted with the need for infrastructure activities that are always given priority (FAO, 2000). The needs to provide building and roads overwrite the need food through agriculture and to conserve forests (Sharma, 1992). Being a great contributor to the farm income which leads to multiple benefits for the farmers' livelihoods, agroforestry is facing significant challenges that are grouped into three categories: prevailing land tenure systems, common agricultural technologies of slash and burn as well as farmers' limited awareness and knowledge on alternative technologies which hinder tree planting and agroforestry (Rioux, 2012).

A study conducted in Nepal indicated that, despite the importance of agroforestry systems, local farmers lacked the necessary skills and technologies to grow, harvest, process and market agroforestry products, and this discourages some of them to keep on practicing those agroforestry technologies (Kiyani et al., 2017). The main challenges to the adoption of agroforestry technologies are also inadequate capital source as well as small lands on which the system needs to be carried out (Masibo et al., 2018). Poor handling of tree seedlings is also another kind of discouragement for famers to practice agroforestry, preferring sticking back to old traditional farming ways (Saliu et al., 2018). Agroforestry technologies are key to the improvement of rural community livelihoods as well as its crucial benefits such as of providing timber, fruits and charcoal in terms of income from agroforestry and alleviation of adverse environmental effects related to climate change effects.

## Chapter3. Materials and Methods

### 3.1. Description of the study area

The present study was conducted in the Mushongi cell, which is located in Mpanga sector, Kirehe District, Eastern Province of Rwanda (Figure 1). It is located between 02°05'09''S and 030°50'44''E (https://earthexplorer.usgs.gov/). The annual average temperature ranges between 20°C and 21°C and the rainfall ranges between 700 mm to 950 mm (USAID, 2019). The soils of the region are mostly loamy sandy (Kirehe DDP, 2018). The climate is characterized by four seasons, including a long dry season (June to Mid-September), a short rain season (Mid-September to end of December), a short dry season (January to mid-February) and then a long rain season (March to May) (MINIRENA, 2007). Mushongi cell covers a total area of 1250 $km^2$ and is subdivided into six villages, with 867 households. The main economic activity in this area is agriculture practiced by around 91% (NSIR, 2012). Almost of farmers have owner land which are cultivated those dominant crops include banana, beans, maize, sorghum and different types of vegetables.

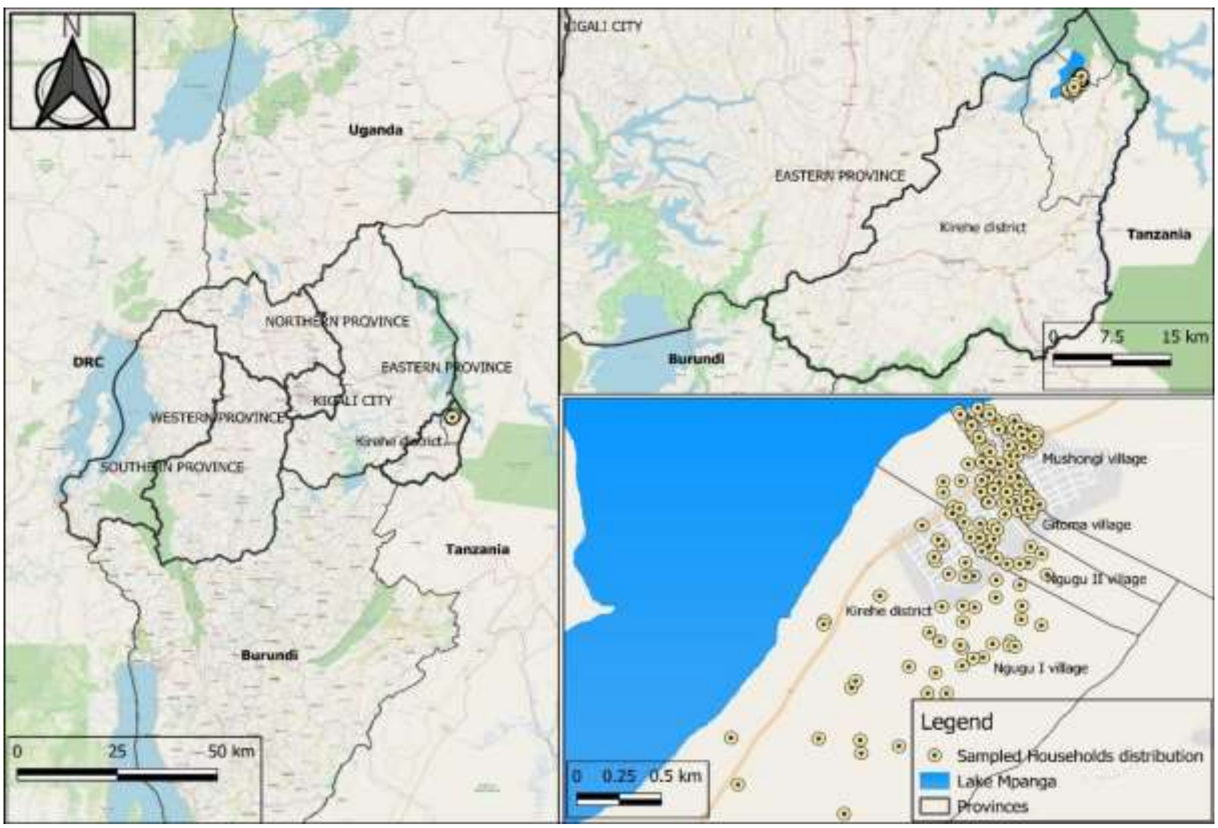

*Figure 1: Map showing the study site, Mushongi cell, Mpanga sector from Kirehe District, eastern Rwanda*

### 3.2. Sample design and sampling technique

The data were collected in Mushongi cell, particularly in its four villages namely Ngugu I, Ngugu II, Gitoma and Mushongi where the activities of the LDCFII-Eba Project are based around Mpanga Lake (Figure 1). Formal survey method was used during data collection according to ( de Graaff 1996). Participants in the survey were informed about the aim of the research project before giving their information about their Farmer's Perception and Adoption of Agroforestry Technologies in Eastern Rwanda.

A predesigned questionnaire was used during data collection in the peoples' households. The survey respondents of Mushongi cell were asked to respond to a set of questions on how they appreciate the use of agroforestry technologies in their daily life. The questions briefly included the age distribution of the farmers, marital status of farmer, education level, agroforestry technologies in their farmland, agroforestry species present in their farmland as well as benefits of applying agroforestry technologies and also contacts with extension staff as well as the challenges they face while practicing the agroforestry technologies.

The sample size for the survey was determined by using Yamane's formula (Israel, 2003):

$$n = N/[1 + N(\boldsymbol{\alpha})^{\mathbf{2}}]$$

Where **N**: is the total population of Mushongi Cell, **α**: confidence limits (level) when the confidence percentage is taken as 95% in this study, and **n**: is the size of the sample. The latter is detailed in table 1 for the different sample villages.

$n=N/ [1+ N (\alpha)^2]$.

$n= 570/ (1+570(0.05)$ ^$^2$))

n= 235.05

n ≈ 235.

The N applied in the formula above was obtained from the literature (NISR, 2012)

***Table 1: Number of households per village in the study area***

| **Sampled villages** | **Total population of each village** | **Number of sample household per village (n)** |
|---|---|---|
| Ngugu 1 | 135 | 135***235**/570 =56 |
| Ngugu 2 | 145 | 145*235/ 570=60 |
| Gitoma | 135 | 135*235/ 570=56 |
| Mushongi | 155 | 155*235/ 570=63 |
| **TOTAL** | **570** | **235** |

To collect data, the numbers of households sampled per village were selected randomly using a village inhabitants list provided by the local authorities. In addition to 235 sample households, nine key informants (mainly technical experts) were chosen from extension agents and local leaders. A list of these was obtained from the district agricultural office, REMA technician and cell executive secretary. In total, the number of respondents that were interviewed was 244. At each sample household, the survey was dispensed to the head of household or her/his representative when the latter was not available. During data collection, the handheld GPS (Garmin GPSMAP 78) was used to record the geographic coordinates of the visited households.

### 3.5. Data analysis.

Data were recorded, processed, and analyzed by using Microsoft Excel software. To answer research question of study, descriptive and analytical procedures were used to analyze common tree species, agroforestry technologies, agroforestry benefits and challenges affecting adoption of agroforestry technologies which included percentage, frequency distributions, means and standard deviation. Chi-square test were used to compare age and gender of respondents on adaption of agroforestry technologies in the study area. And after presented those data by using tables and graphs.

# Chapter4. Results and Discussion

## 4.1. Agroforestry tree species preferred by the local people in the study area

Results showed that *Calliandra calothyrus, Grevillea robusta and Senna spectabilis* were the most appreciated tree species than *Percea americana, Cedrela serrata,* and *Mangifera indica* by respondents in the study area (Figure 2). Our results concur with findings by Ndayambaje (2013) who confirmed that 47.8% of farmers in the area appreciated *Grevillea robusta* while 17.9% appreciated *Senna spectabilis*. Government of Rwanda through REMA focused on tree species because they are known to tolerate termite attack and dry conditions and are suitable for both hedges and dispersed agroforestry technologies (John et al., 2012).

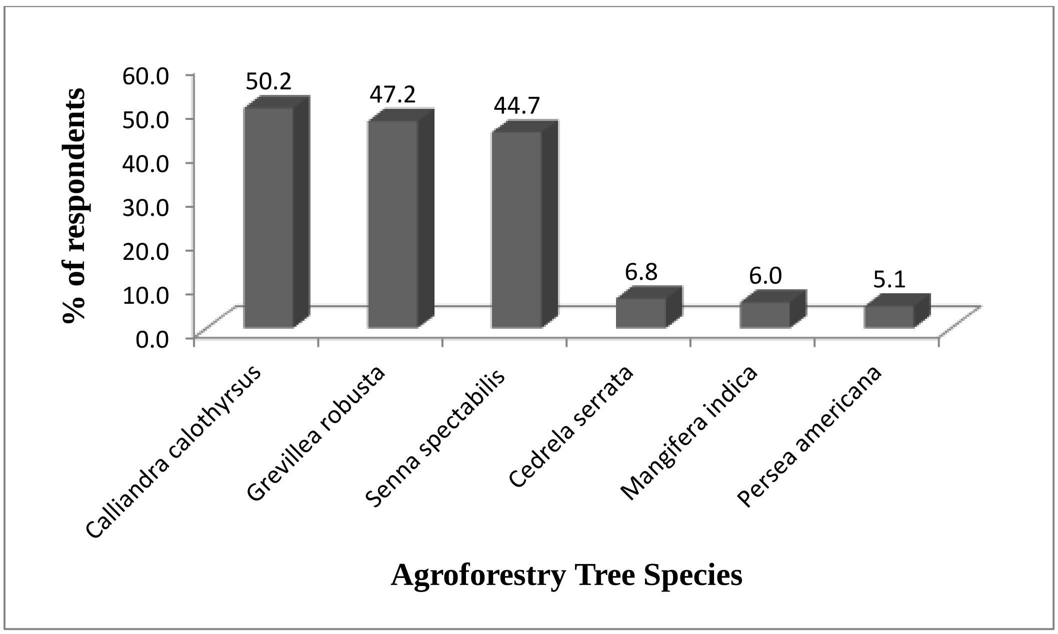


*Figure 2*: *Agroforestry species cultivated by the farmers in Mushongi cell, Mpanga sector, Kirehe district, and eastern Rwanda.*

To get a wider knowledge of on-farm trees in the study area, an identification of tree species other than those planted by government of Rwanda which are grown by the farmers themselves was done. In total, 20 species were identified seven of which were native and 13 exotics (Table 2). Farmers were asked to which use these species were put to and the responses provided are shown along with species names. Sometimes strange answers were given but the responsibility should solely be attributed to the respondents. Examples include using *Euphorbia candylobrum* for green manure, or *Senna siamea* or *Melia azedarach* for timber production. The results agree with findings highlighted by (Nduwamungu, 2019) that there are other main agroforestry tree species adopted in the Eastern Province of Rwanda, including native species such as *Ficus thonningii,* *Vernonia amygdalina, Euphorbia candylobrum, Ricinus communis, Acacia spp.* and *Markhamia lutea* and exotic species such as *Senna siamea* and *Eucalyptus spp*.

**Table 2: On-farm tree species in Mushongi Cell that were not planted by REMA**

| Names of Species (Scientific name) | Category | Benefits from those species |
|---|---|---|
| *Ficus thonningii* | Native | Fodder, timber production, green manure |
| *Vernonia amygdalina* | Native | Medicine plant, green manure |
| *Erythrina abyssinica* | Native | Medicine plant, green manure timber production |
| *Citrus sp* | Exotic | Fruits, medicine, green manure |
| *Psidium guajava* | Exotic | Fruits, green manure |
| *Carica papaya* | Exotic | Fruits, improving soil fertility |
| *Eucalyptus tereticornis* | Exotic | Timber production, stakes, charcoal, firewood |
| *Albizia spp* | Exotic | Timber production, stakes, charcoal, firewood |
| *Jacaranda mimosaefolia* | Exotic | Green manure, firewood, stakes erosion control |
| *Casuarina equisetifolia* | Exotic | Green manure, firewood, stakes erosion control |
| *Markhamia lutea* | Native | Timber production, stakes, charcoal, firewood, erosion control, carbon sequestration |

| | | |
|---|---|---|
| *Acacia melanoxylon* | Exotic | Timber production, stakes, charcoal, firewood, erosion control, carbon sequestration |
| *Cedrela serrata* | Exotic | Timber production, stakes, charcoal, firewood, erosion control, carbon sequestration |
| *Senna siamea* | Exotic | Timber production, stakes, charcoal, firewood, erosion control, carbon sequestration |
| *Mimosa scabrella* | Exotic | Medicine plant , green manure and timber production |
| *Acacia mangium* | Exotic | Timber production stakes, charcoal firewood, erosion control and carbon sequestration |
| *Melia azedarach* | Exotic | Timber production, stakes, charcoal, firewood, erosion control and carbon sequestration |
| *Combretum ssp.* | Native | Fodder, timber production, green manure, improving soil fertility |
| *Euphorbia candylobrum* | Native | Green manure, firewood, stakes and erosion control |
| *Vachellia sieberiana var woadii* | Native | Green manure, firewood, stakes erosion control, and fresh air supply |

### 4.3. Agroforestry technologies practiced by local peoples in the study area

The results regarding that local people are more adopted for practicing agroforestry technologies across study area. Generally, hedge planting was practiced at the highest level compared to other technologies followed by dispersed trees/shrubs and then homegardens. The last was the woodlots and boundary planting (Figure 4). Agroforestry technologies practiced in the area differed significantly between households ($p = 0.001$). Hedge planting and dispersed trees were the most commonly practiced while boundary planting, woodlots and home gardens were the least. The results further indicate that farmers practiced more than one form of agroforestry technology. Our results agreed with findings reported by (Current et al. 1995) observed in small -scale farming areas. Tree planting on hedge row decreased soil erosion rate, wind speed and trees or shrubs on hedges when pollarded can meet immediate family needs such as charcoal, stakes for climbing beans, firewood, and the common source of timber tree species was *Grevillea robusta* in the area.

The farmers of study area especially women were revealed that the hedging technique is the most helpful in the intervention area. This technique is used to control soil erosion and produce fodder for livestock and for improving soil fertility while the men followed dispersed trees for providing more timber production. In generally, Farmers also said that the hedging technique prevents the Mpanga Lake from siltation. This is in line with (ICRAF, 1992) which states that hedges as trees and shrubs planted in thick bushes around farms help in soil erosion control, protection of cultivated fields against destruction and fuel wood production.

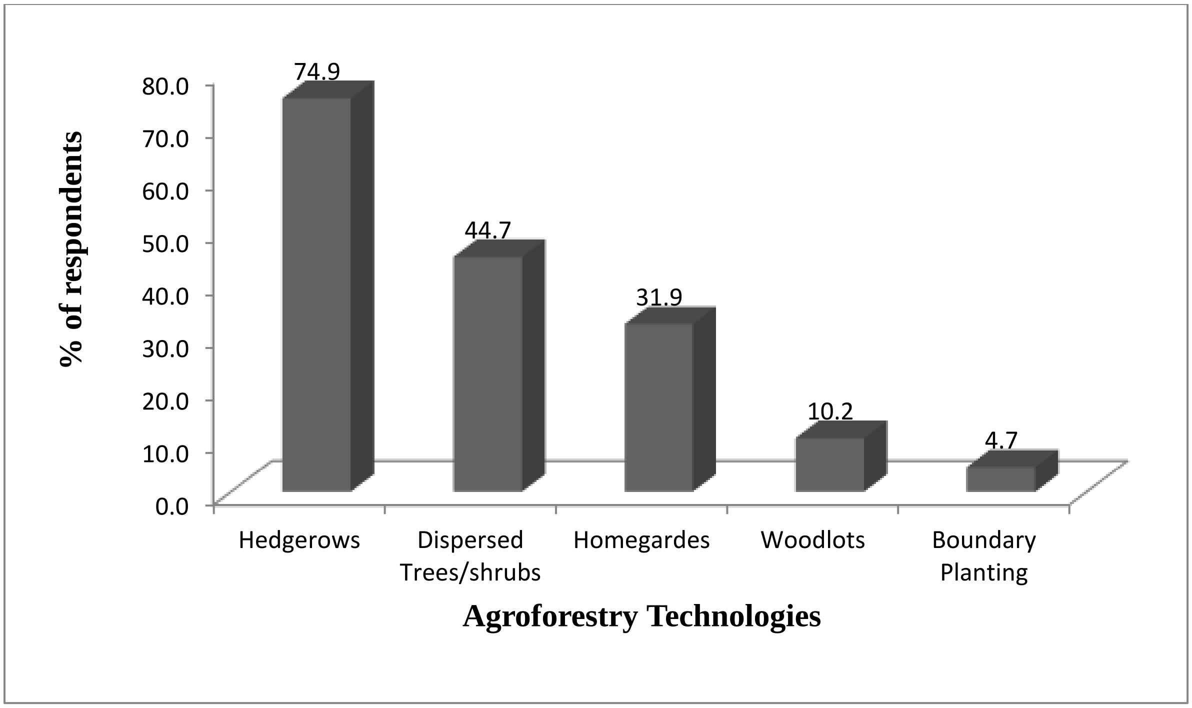


*Figure 4: Agroforestry technologies appreciated by local people in Mushongi cell, Mpanga sector, in Kirehe district in eastern Rwanda*

Hedges are shrubs/trees planted along lines in farmlands and the main tree species planted in these were *Calliandra calothyrsus*, and *Senna spectabilis* (Figure 5). According to (Warner, 1993), the farmers in the Murang'a district of Kenya planted trees and shrubs on hedge rows for soil erosion control and the production of fodder, fruit and firewood. Hedge row technology also helps them in push-pull technics as the method against crop pests and disease (Warner, 1993). In addition, this technology was also involved in increasing biodiversity and modifying microclimate in the same way as the home garden and woodlot technologies. Home gardens more directly supply daily family needs such as fruits, firewood and legumes rather than others because this Agroforestry technology is around the house of farmers (Wafuke, 2012).

*Figure 5: Survey on Calliandra calothyrsus under the hedgerow planting in Mushongi cell, Mpanga sector, Kirehe district in eastern Rwanda*

According to Motis (2007), dispersed trees is when trees are planted alone or in very small numbers on cropland or pasture. This technique is also very important in Mushongi cell because, the crop varieties that are tolerant to shade are grown well under the shade of those trees. *Grevillea robusta* species is the dominant in this technique (Figure 6).

*Figure 6: Dispersed trees technique in which single trees are intercropped with tomato in Mushongi cell, Mpanga sector, and Kirehe district in eastern Rwanda*

### 4.4. Farmers' adoption of agroforestry technologies in study area

The analysis of respondents' age classes showed significant differences ($\chi 2=72.2$ DF=2 and p = 0.029) in terms of practicing agroforestry technologies. The results showed that, the majority of the people who practiced the agroforestry technologies are in the range of 36-55 years, followed by those who are between 18-35 years and the last class is composed of elders (>55 years) (Table 3). This implies that agroforestry potential in Mushongi cell is high and its sustainability may be assured since it is practiced by the dynamic and young age groups. This further promises the sustainability of agroforestry technologies in the area.

Direct benefits include fodder and wood products such as firewood, timber, stakes for climbing beans, etc. (Vignola R et al., 2018). while indirect ones include environmental services such as soil erosion control, soil fertility improvement and climate change mitigation resulting from high amounts of C sequestration and their long-term storage in tree biomass (Kiyani et al, 2017). This observation is in agreement with that reported in the Nzoia division of Lugari district (Kenya) where the majority of farmers who adopted agroforestry technologies were aged below 50 years (Wafuke, 2012). This together with the continued government policies supporting and promoting agroforestry (MINILAF, 2018) indicate that the benefits of agroforestry technologies in the study area may be improved in the present and future generations.

Gender implication in agroforestry technologies analysis showed that women proportion was significantly higher than that of men ($\chi 2=161.41859$ DF=1 and p =0.008) (Table 2). Women are known to easily adopt more agroforestry technologies than men because they harvest a variety of tree products than men who look mainly for direct monetary benefits (Kiptot & Franzel, 2011). Initially, local people resisted planting trees according to the local leaders but now after sensitization by extension agents, farmers' willingness to promote agroforestry has gained pace. The results below show the contribution of leaders/extension staff to the farmers' application of agroforestry technologies (Table 3). This is supported by the farmers' response that they received quick responses from extension staff whenever they need their help and that extension officers often visited and provided advice to attain the success of the agroforestry technologies. They revealed that the agronomists from REMA and the Mpanga sector worked with them at least 4 times (days) in a week guiding them on how to care for the plants. According to (Orisakwe 2011), the highest adoption of agroforestry technologies depends on the frequency of extension agent contact with the farmers. Education level of farmer was followed by 7.8% with none education, 71.3% had primary level, 19.3% of secondary level and last one 1.6% university. This variable was shown that no significant for Local people's perception of the use of Agroforestry technologies in the study area (p>0.05 at p= 0.067). Our findings agreed with (Wafuke. 2012), education as socio-economic factor influencing adoption of agroforestry technologies. He was found no significant in adoption of agroforestry Technologies in the Nzoia division of Lugari District (Kenya) (p > 0.05 at p=0.961)

*Table 3**:** Farmers' adoption on agroforestry practice as affected by age, gender, education level and Extension Agents in Mushongi cell, eastern Rwanda*

| | Row labels | Respondents | %of the respondents |
|---|---|---|---|
| Age classes | **>18 -35** | 72 | 29.5 |
| | **>36 -55** | 132 | 54.1 |
| | **>56** | 40 | 16.4 |
| Gender | **F** | 135 | 55.3 |
| | **M** | 109 | 44.7 |
| Education level | **None** | 19 | 7.8 |
| | **Primary** | 174 | 71.3 |
| | **Secondary** | 47 | 19.3 |
| | **University** | 4 | 1.6 |
| Extension Agents | **Quite often** | 159.0 | 67.7 |
| | **Rarely** | 42.0 | 17.9 |

### 4.5. Reported benefits of agroforestry technologies

Agroforestry technologies that favor leaf biomass production are the most favored in the study area. This is because 74.9% of leaf biomass is used as fodder for livestock. And also, it's followed their use 51.1% as green manure and it is followed by 54.5% of firewood production; the least benefit practiced agroforestry technology is for 41.3% of erosion control which responded by the farmers in all visited villages of study area(Figure 7 & 8). The farmers reported that the Agroforestry trees species are very important for improving local people's livelihood in the study area. This is also supported by (Franz et al.,2014) in Turkey. He stated that sustainable soil organic matter management in organic farming can most easily be achieved by mixed farms with fodder legumes and animal manure in line building resilience of soil.

The number of famers practicing agroforestry responded that the benefits of *Percea americana*, *Cedrela serrata*, and *Mangifera indica* tree species are still little. This may not be an indication that agroforestry tree species are unimportant in the area but rather a consequence of the fact that agroforestry tree species in the area are too young to provide firewood and timber to the growers. Countrywide, wood fuel contribution to global domestic energy supply was as high as 97% (NISR, 2008). According to Braja (2012), firewood was the most preferred benefit from agroforestry technologies in Kenya.

*Figure 7: Fodder benefit from agroforestry technologies in Mushongi cell, Mpanga sector, Kirehe district in eastern Rwanda*

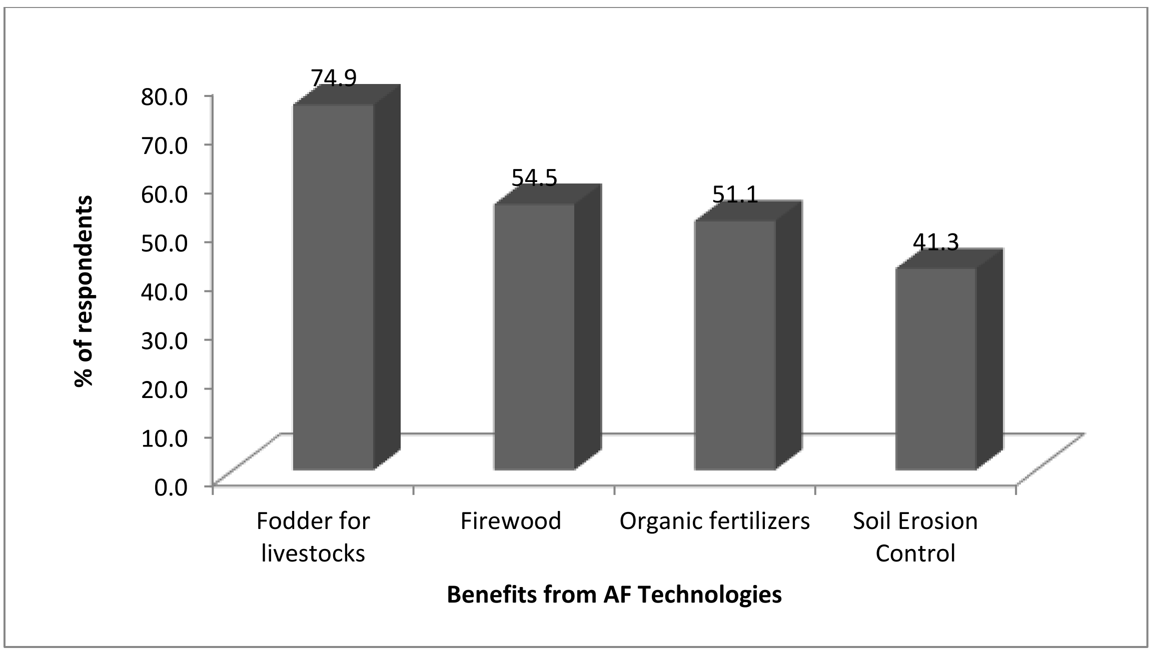


*Figure 8: Benefits of influencing local people perception on the use of agroforestry technologies in Mushongi cell, Mpanga sector, Kirehe district in eastern Rwanda*

#### 4.5.1. Monetary benefits from agroforestry technologies

Farmers reported insignificant income gains from agroforestry across the Mushongi cell (Figure 9). Only preliminary products such as fodder, green manure and firewood collected from on-farm trees were collected from the young trees. About 45% of the study population earned an income of less >15,000 Frw per year, while only 2.5% earned above 92,000 Frw per year (Figure 9). This income level from agroforestry is low but it is not unexpected since most of the trees were still too young to harvest. However, farmers are optimistic that the trees will earn them high income when they grow since wood products sell at high prices. Studies conducted by Kinyanjui (2007) noted that the local farmers in Kenya highly adopted agroforestry technologies because the letter improves their livelihoods through the sales of tree products such as firewood, timber and also the indirect services for environmental protection.

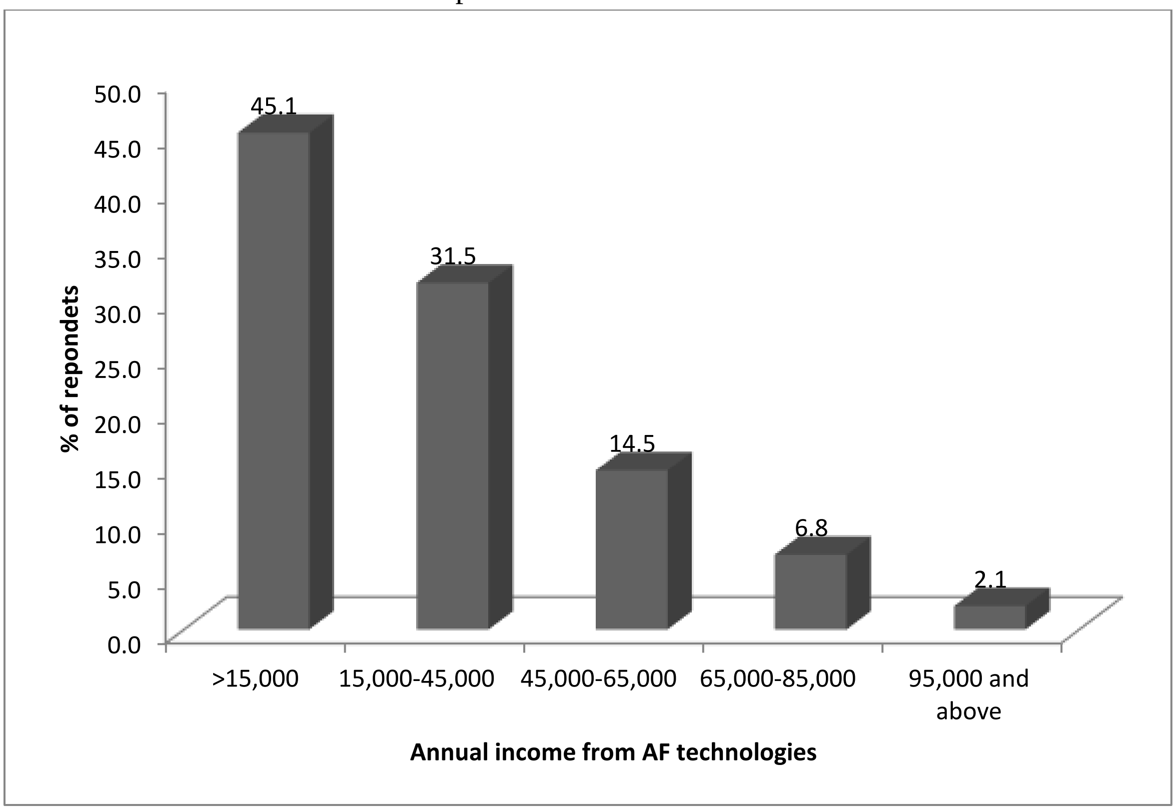


*Figure 9: Monetary benefits from agroforestry Trees in Mushongi cell, Mpanga sector, Kirehe district in eastern Rwanda*

### 4.6. The challenges for practicing agroforestry technologies by farmers

Farmers reported the constraints they faced in tree planting technologies: termite attack with 63.3% and drought with 60.9% were recorded as the most affecting factors of agroforestry tree plantation in the area and they followed by insufficient seedlings with 36.6% and lack of technical skill with 33.2% while 19.1% the lack of quality seedlings at Mushongi cell were less recorded (Figure 10). This observation is not surprising because afforestation programmes in arid and semiarid areas are usually constrained by little and irregular soil moisture and termite attack (Parihar, 1981). Lack of high-quality seedlings was also reported as a constraint to the adoption of agroforestry technologies. Apart from the lack of enough and suitable seedlings for tree planting purposes, even few supplied ones may be available untimely which exacerbates the issue of seedling survival. Farmers showed interest in planting Eucalyptus species (eucalyptus tereticornis which they reported to be resistant to termite attack. While resistance to termites may be true with some Eucalyptus spp., the latter may not be a preference since they demand much water, a resource already scarce in the area. The lack of enough seedlings, poor field survival and low species diversity were also reported as a strong factor retarding agroforestry practice in all villages of Mushongi cell by local leaders including the technical staff.

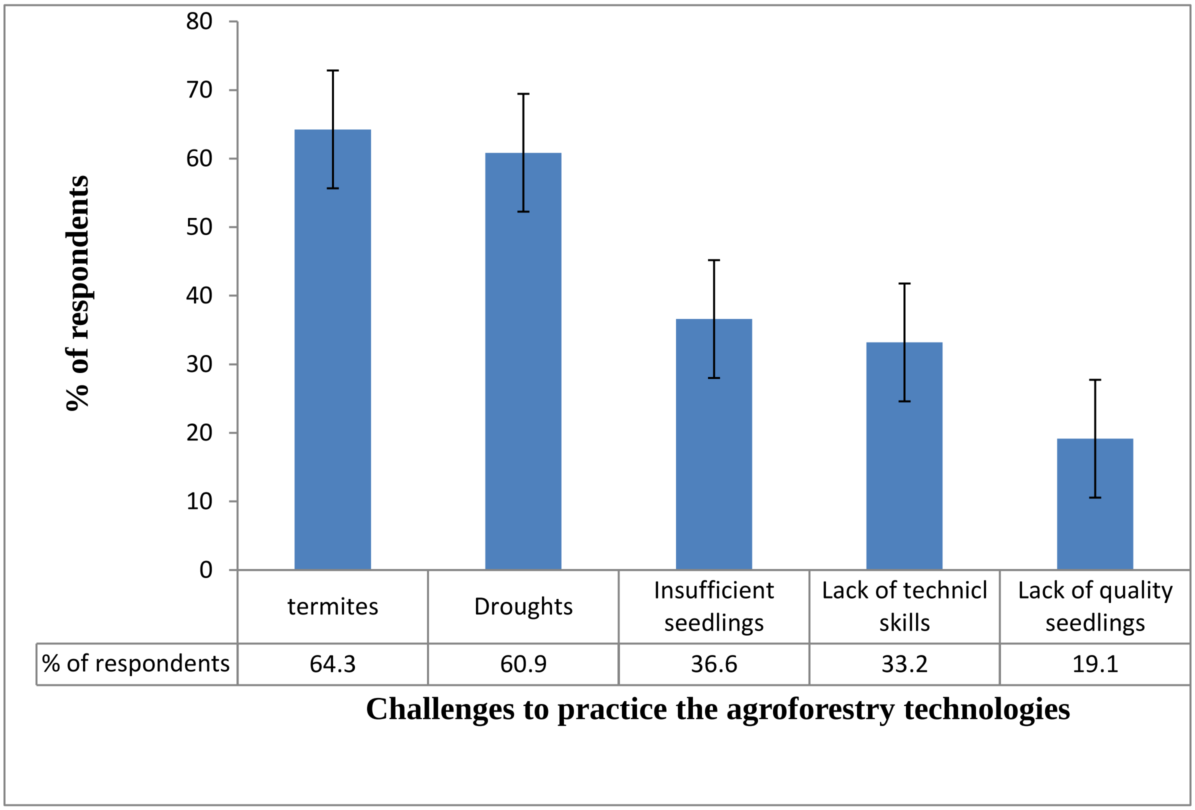


Figure 10: Challenges for farmers while practicing agroforestry technologies in Mushongi cell, Mpanga sector, Kirehe district in eastern Rwanda

# Chapter 5. Conclusion and Recommendations

## 5.1. Conclusion

Most farmers reported *Calliandra calothyrus* and *Senna spectabilis* was prefer for Hedge rows rather than woodlots and home gardens and *Grevillea robusta* was prefered tree dispersed and boundary planting on-farm were the most appreciated by farmers. Among trees planted by REMA, *Calliandra calothyrus*, *Grevillea robusta* and *Senna spectabilis* were the most dominant. According to the responses from observation and farmers 'survey, agroforestry technologies are practiced by the majority of surveyed farmers in Mushongi cell. This observation is also strongly supported by the local authorities and the benefits obtaining. However, both local people and their leaders reported that the challenges they faced in practicing agroforestry included insufficient and/or lack of quality seedlings that can resist drought and termites, and lack of enough technical skills. Irrespective serious constraints of drought and termite attack affecting tree planting programmes in the area, a variety of benefits farmers obtained from agroforestry were recorded in Mushongi cell. These include fodder for livestock, green manure, firewood, fruits, timber and etc. Tree planting should be strongly supported not only for direct benefits they provide to the farming communities but also for their contribution to environmental protection, especially the soil erosion control (including siltation of Lake Mpanga), soil fertility improvements, etc.

## 5.2. Recommendations

Basing on the findings of this research, it is recommended that:

1. Farmers are assisted to get enough seedlings to diversify tree species that are drought tolerant and resistant to termite attack and also respect the time planting to ensure tree adaptation to local conditions.
2. Encourage farmers especially who have pasturelands to restore their farmland by planting trees in the grazing grounds and more importantly, to encourage using native tree species which improve soil moisture content and more adapted to the local environment and may be more environmentally friendly through of incentives.
3. Next research can be focus the contribution of agroforestry technologies on the soil conservation in this intervention area

   With the above recommendations and considering the fragility of the field conditions of the study area, it is imperative to ensure a strong extension service to support on-farm tree planting in this intervention area.

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## 7. Appendices

**Appendix1: Questionnaire for farmers**

(These questions are used for research only and not for any other purpose. Your cooperation in answering questions is highly appreciated). / Ikiganiro tuza kugirana kizifashishwa mu bushakashatsi gusa. Tubashimiye ku bwitange bwanyu. Murakoze.

**Location/ Agace aherereyemo:**

District/Akarere…………….Sector/Umurenge:.Cell/Akagari...
Village/Umudugudu..........................Date/Italiki...
Latitude: ……………………..Longitude:……………………….

**Interviewees' information/Imyirondoroy'ubazwa**

Gender/Igitsina: (1) Male/Gabo (2) Female/Gore
Age/Imyaka......................................
**Marital status/ Irangamimerere:**
(1) Married/ Yarashatse, (2) Single/Ingaragu, (3) Widow/widower/Umupfakazi,
(4) Divorced/ separated/ Yatandukanye n'uwobashakanye.
**Education level/ Amashuriyize:**
Education level/Icyicirocy'amashuriwize – (1) None/Ntayo (2) Primary level/Amashuri abanza, (3) Secondary level/Amashuri yisumbuye, (4) College/University level/ Kaminuza

1) Has this been useful in your tree-planting activities? /Haba hari icyo amashuri ufite agufasha mu guhinga ibiti bivangwa n'imyaka? (1) Yes (2) No

If yes, how? / Niba ari yego,gute?
.........................................................................................
If no, why? /Niba ari oya, gute? ...........................................................................…………
.........................................................................................................................................

**Occupation/Akaziakora**

(1) Employed/Afite akazi (2) Farmer/Umuhinzi (3) Civil Servant/Teacher/Umwarimu (4) Business man/woman/ Umucuruzi (5)
Other, Specify/ Ibindi (6).

2. Agroforestry trees/shrubs present on the people's farmland / Ubwoko bw'ibiti biri mu murima

| | | | |
|---|---|---|---|
| *Grevillea robusta* | Most Common/Ibyiganje | Common/Ibirimo biringaniye | Not Common/ |
| *Senna spectabilis* | | | |

| | | | |
|---|---|---|---|
| *Calliandra calothyrus* | | | |
| *Persea americana* | | | |
| *Mangifera indica* | | | |
| Others tree species | | | |

1) Inventory of agroforestry trees status distributed during REMA project (LCDF) in Mushongi ecosystem.

| Species names | Status (growing well, dry, damaged) | Benefits of Tree species | Latitude | Longitude |
|---|---|---|---|---|
| Native species | | | | |
| Exotics species | | | | |
| | | | | |
| | | | | |
| | | | | |

2) Are agroforestry technologies beneficial to you?/ Ese mubona bibafitiye inyungu mu gutera ibiti bivangwa n'imyaka? If yes, what are they?

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3) Different agro forestry technologies practiced by the farmer observe and list/Uburyo umuhinzi akoresha avanga ibiti n'imyaka

| Agroforestry technologies | Most Common/<br><br>Ibyiganje | Common/<br><br>Ibirimo biringaniye | less Common/<br><br>Ibikeya |
|---|---|---|---|
| hedge planting, | | | |

| | | | |
|---|---|---|---|
| trees dispersed | | | |
| home gardens | | | |
| woodlots | | | |
| boundary planting | | | |

b. what are the environmental benefit you get from applying agroforestry technologies? / Ni izihe nyungu zishingiye ku kwita ku bidukikije mubona ziturutse mu guttera ibitibivangwa n'imyaka?

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4) What is your total annual income from the farm produce? /Ese umusaruro mukura mu buhinzi bwanyu ku mwaka uhwanye n'amafaranga angahe? (1) <10,000 (2) > 100,000 (3) More than one million/Arenga miliyoni imwe (1M)

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…………………………………………………………………………………………………
………………………………………………………………………………………

5) How much income do you earn annually from selling trees and tree products? /Mwaba mwunguka amafaranga angahe ku mwaka aturutse mu musaruro wo kugurisha ibiti muvanga n'imyaka?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

10) How much do you get visited by extension staffs that make follow up on agroforestry planted trees in your farmland? /Mukunda gusurwa n'inzobere zibafasha kwita no kubungabunga ibiti bivangwa n'imyaka mu mirima yanyu?

(1) not at all/Nta narimwe, (2) Rarely/Gake, (3) Yearly/Buri mwaka, (4) Once in a month/Rimwe mu kwezi, (5) Often/Kenshi

**Other land use activities/Ibindi bikorerwakubutaka**

11) What are the different land use activities you practice on your farm? /Ibindi bikorwa ukorera ku butaka bwawe n'ibihe?

- Crop production/Guhinga imyaka itandukanye gusa
- Livestock keeping/Ubworozibw'amatungo
- Others specify/Ibindi (bivuge).........................................................................

3. Yes/Yego (2) No/Oya

12) What do you see as major constraints to tree planting in Agroforestry production systems? / Ni izihembogamizi mubona mu buhinzibwo kuvanga ibiti n'imyaka? .................................

5.2**: Questionnaire to extension staff/ Ibibazo ku nzobere mu buhinzi bwo kuvanga ibiti n'imyaka**

1) Are you aware that this location is experiencing high wood demand? /Mwaba muzi ko aka gace gakenera inkwi/ibiti cyane?

.......................................................................................................................

.......................................................................................................................

2) You are a Forest/Agricultural extension officer,

How does your extension work influence Agroforestry technologies in this Area? /Nk'inzobere mu buhinzi bwo kuvanga ibiti n'imyaka, ni gute ibikorwa byawe bifasha abakora ububuhinzi bwo kuvanga ibiti n' imyaka muri aka gace?

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3) What resistance do you encounter when trying to promote Agroforestry extension? / Ni izihe mbogamizimuhura na zo mu kazi kanyu ka buri munsi kajyanye n'ubuhunzi bwo kuvanga ibitin'imyaka?

.......................................................................................................................

4) How often do you meet farmers in groups or as individuals? /Ni kangahemwegeraamatsinday'abahinzicyangwaabahinzikugiticyabo?

………………………………………………………………………………………………

………………………………………………………………………………………….............

5.3: **Community Leaders/Ibibazokubayobozi**

1) How are you as a leader encouraging people in your area to plant trees? /Nk'umuyobozi, ni ubuhe buryo ukoresha mu gushishikariza abaturage kwitabira ububuhinzi bwo kuvanga ibiti n'imyaka?

.......................................................................................................................

2) What do you think the government should do to encourage Agro forestry production in your area? /Ni ibiki wasaba leta byatuma ubuhunzi bwo kuvanga ibiti n'imyaka butera imbere mu gace uyobora?