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# The Impact of Farm Tree Degradation on Rural Livelihood in Manna District of Jima Zone, Ethiopia

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**Abstract**
This research was conducted in Mana district of Jimma zone to assess the impact of farm tree degradation on rural livelihood. For socio-economic data collection 60 households were selected randomly. Focus group discussions and direct field observation were made to verify and supplement the results from questionnaires. Thirty (30) soil samples were taken from the canopy of randomly selected four different trees species (Gravellia robusta, Sesbania Sesban, Coffee arabica, and Avocado), and the land where farm tree degraded land with six replication. Soil texture, pH, Electrical conductivity (EC), soil OM, soil OC, and Total nitrogen were analyzed. The qualitative data was narrated, while quantitative data was analyzed by using descriptive statistics. One-way ANOVA was computed for the soil data by using SAS version 9.2, and least significant difference (LSD) at $P<0.05$. This study has shown that the high level of illiteracy in the study area might be contributed to the low rate of adoption of farm tree management practices since the educational level affects house hold decision. Thus, as a response of farm trees degradation, the decline of crop productivity and loss of tree products including household energy source were becoming prominent constraints that affected the livelihood in the district. Farm trees which could have been used to maintain soil quality and enhance crop productivity; and support local livelihood with different tree products are degraded. Consequently, some soil physico-chemical properties deteriorated under the lands where farm trees degraded. Hence, to make the livelihood more sustainable, it is necessary to integrate varies tree species and its management practices in the farmlands. Besides, there is an urgent need to look for alternative forest products harvesting strategy to reduce the pressure on farm trees.
**Keywords:** Agroforestry, Crop production, Farm tree, Rural livelihoods, Soil property

## 1. Introduction

### 1.1. Back ground

Farm trees are those tree species in which the farmers deliberately integrated/ or managed from the natural remnants in their farm land for various product or service they gain from them. The role of trees on farmland providing both services and products, replenishing organic matter and nutrient levels in the soil, helping control erosion and conserving water; and yielding food, fuel wood, timber, fodder and medicines, which are much needed for home use and for income generation (TOFNET, 2004).

Farm trees are enhancing a means of rural livelihood options through provision of food, medicines and all their other products needed for everyday survival of households. This is particularly important in developing countries where most households do not have other sources of income or social support. Many indigenous tree species in the farmlands have the potential to produce marketable food, fodder, and non-food products (Kwesi, 1993). Farm trees have also a good potential for promoting and facilitating development of tree-based enterprises through small-scale industries. Processing of high-value agro forestry products can provide employment opportunities to a section of the population in farming activities. High-value tree products from agro forestry practices and trees grown on farm can generate cash income and consequently play significant role in poverty alleviation.

In addition to the productive function, farmland trees also provides service functions which include environmental resilience, such as soil fertility replenishment, soil conservation, climate change mitigation, improved water supply and biodiversity conservation in the cultivated land scape, and this can improve sustainable livelihoods (Nair, 1993).

Impoverishment of standing woody material mainly be caused by human activities such as over-grazing, over-exploitation (for firewood in particular), repeated fires, or due to attacks by insects, diseases, plant parasites or other natural causes such as cyclones. According to ITTO (2002) forest degradation refers to the reduction of the capacity of a forest to produce goods and a service capacity includes the maintenance of ecosystem structure and function.

One of the effects of farm tree degradation is loss of soil organic matter (OM). Soil OM arises from the debris of green plants, animal residues and excreta that are deposited on the surface and mixed to a variable extent with the mineral component (Nair, 1993). It is considered as the storehouse of nutrients in the soil, and it improves soil structure to be able to store moisture. It has direct effect on the productivity of the land.

The farmland trees degradation affects human livelihood and ecological services they provide for the ecosystem function. The impact of this degradation is very high on human livelihood directly or indirectly. This is critical problem for the farmer households due to the reason that, the loss of nutrient-rich topsoil/ and or soil fertility due to the degradation of farmland trees can result in significant decreases in agricultural productivity (Tengberg, Stocking and Dechen, 1998).

Due to the degradation of farmland trees, currently local communities of the study area have lost wide opportunities of the access to all these important products formerly gathered from their farm land. Consequently, most of the land in the district has been subjected to aggravated soil erosion and the reduction of productivity of the farmlands. However, at any stage, the farm tree degradation process can be halted or reversed by forest improvement or other management interventions. Hence, this study was conducted with the aim of assessing the impact of farmland tree degradation on the livelihood, and make bold recommendation to curve the problem of the rural people.

## 3. Material and Methods

The study was conducted at Mana district which is located in the Jimma Zone of Western Ethiopia. Its mean altitude is lies between 1800-2200m above sea level; it is located at 369 Km away from the capital city of Ethiopia, Addis Ababa. The climate of the area is classified in to *Wega* (12%), *Woinadega* (63%) and *kola* (25%) agro-climatic zones. Average rainfall is 1,467mm.

From various livelihoods and income sources for local communities in the district, coffee, honey, crops (agricultural activities), livestock production, timber and other non-timber forest products, and farm trees are dominant. The local community is heavily depends on farm tree products directly or indirectly for their livelihood.

### 3.1. Sampling and collection of Socio-economic data

Based on the importance of farm tree for livelihood, and current status of the farm tree, Mana district was selected purposively to represent the other districts in the Jimma zone, Ethiopia. The random sampling was used as an appropriate technique since it avoids bias of representing; hence 60 households were selected randomly for semi-structured questionnaire interview. The socio-economic data (mainly the product derived from farm tree, the extent of community dependency on the farm tree product, the effects of farm tree degradation on soil fertility, and the effects of farm tree degradation on agricultural yield) was collected.

Two focus group discussions, each containing 8 discussants were made with selected key informants. The key informants are individuals lived continuously in the area more than 15 years, knowledgeable about the district and willing to be interviewed. Besides, the key informants were selected as those understand the major impacts of farm tree degradation. Direct field observation was made to verify and supplement the quantitative results from the structured questionnaires.

### 3.2. Soil Sampling and data collection

To answer the impact of farm tree degradation on soil physic-chemical properties, randomly selected farmlands in the district were used to collect soil samples from the canopy of four different trees species (*Gravellia robusta, Sesbania Sesban, Coffee arabica,* and *Avocado*), and the land where farm trees have been degraded. For each tree canopy, three samples were taken in different directions of the canopy by digging the soil up to 30 cm depth, and mixed to get 1 Kg bulk sample. For each tree species and degraded farmland, 6 bulk samples have been collected to get a total of 30 sampls. The collected soil samples were air-dried, crushed by using mortar and then passed through a 2 mm square-mesh sieve.

The texture was determined by the Boycouos hydrometric method (Bouyoucos, 1962,Van Reeuwijk, 1992) after destroying OM using hydrogen peroxide ($H_2O_2$) and dispersing the soils with sodium hexametaphosphate $(NaPO3)_6$. The pH of the soil was determined in water suspension at 1:2.5 soils: liquid ratio potentiometrically using a glass-calomel combination electrode (Van Reeuwijk, 1992). Electrical conductivity (EC) was measured from a 1:5 soil to water ratio after a one hour equilibration time as described by (ASTM, 2009). The Walkley and Black (1934) wet digestion method was used to determine carbon content and, percent OM was obtained by multiplying percent soil OC by a factor of 1.724 following the assumptions that OM is composed of 58% carbon. Total N was analyzed using the Kjeldahl method by oxidizing the OM in (0.1N H2SO4).

### 3.3. Method of Data analysis

The qualitative data was generated from focus group discussion with key informants, physical observation and secondary sources was analyzed by narrative description. Descriptive statistics like percentage mean and frequency distribution was used to analyze quantitative data. The sample soil data were analyzed by using SAS version 9.2. One-way ANOVA was computed to see significant difference between each treatment for physico-chemical parameters. Means separation was done by using least significant difference (LSD) after the treatments were found significant at $P<0.05$.

## 4. Result and Discussion

### 4.1. Socio-demographic characteristics

**Age and Gender of the respondents**

The age class of the respondents in the study area were fall under young to older age, while young (23.3%), medium 48.3%, and old 28.3% (Table 1). More than 76% of the population is in the age of above 35 years. This indicate that, the respondents could have enough understanding about what is happening on their farmlands in relation to farm tree degradation and their impact on livelihood of the local community.

From the sample households, 90% were male-headed household and 10% were female-headed household (Table 1). This reveals that, male are very important in decision making on farming system management than female. The data from focus group discussion with key informants indicated that female work in the home while male is actively participating on the work of agricultural production due to the cultural influence of the study district. Hence, the information collected could have high level of accuracy.

Table 1: Age and gender of the respondents

| Age class | | | Gender | | |
|---|---|---|---|---|---|
| **Age** | **Frequency** | **Percentage** | **Sex** | **Frequency** | **Percentage** |
| 20-35 | 14 | 23.3% | Male | 54 | 90% |
| 35-60 | 29 | 48.3% | Female | 6 | 10% |
| >60 | 17 | 28.3% | Total | 60 | 100% |
| Total | 60 | 100% | | | |

**Educational status of the respondents**

Regarding the educational status of the district, illiterate holds the highest percentage (41.7 %), and read and write (30 %) followed by elementary (28.3 %) as shown in (Table 2). The high level of illiteracy in the study area implies that there would be low chance of technology adoption regarding the farm tree management. Educational level of the society affect house hold decision, in turn which determine the welfare of the society such as income, and their attitude towards using farm tree. Education may also enable the households to have broad vision of the surrounding environment including farm tree resources.

**Table 2: Educational Status of household**

| Level | Frequency | Percentage |
|---|---|---|
| Illiterate | 25 | 41.7% |
| Read and Write | 18 | 30.0% |
| Elementary | 17 | 28.3% |
| Total | 60 | 100% |

### 4.2. Livelihood strategy and Source of energy

Since agriculture is the main means of livelihood in the area, crop production, livestock production, farm tree production and honey production are known source of income (Table 3). A crop makes about 66.7% of the whole economic activities or source of income in the area. The major types of crops grown in the area are teff, maize, and sorghum. Next to crop production, about 15% of the households are dependent on farm trees as a means of livelihood. Most farmers are not entirely depending on farm tree products as a means of livelihood. This may be due to the reason that the farm trees are becoming degraded in the district from time to time; and this in turn leads the society to be depending mainly on crop production. In fact, this approach can make the soil fertility declaim from time to time due to continuous plough of the lands.

However the level of dependency of local people on farm tree as a mince of livelihood is lower compared to the crop production, the contribution of farm trees to livestock production, sell of timber and other tree products is very important source of income in Mana district. Farm tree products also have an important role in food security as "buffer" foods, helping to meet dietary needs during periodic food shortages Even if farm products only constitute a small part of overall food consumption and income generation, their absence at a critical time can greatly increase the risk of food shortages (Scott, 2004).

Table 3: Livelihood strategy and Source of energy

| **Source of income** | **Frequency** | **Percent %** | **Fuel source** | **Frequency** | **Percent %** |
|---|---|---|---|---|---|
| Farm tree | 9 | 15.0 | Farm tree | 45 | 75.0 |
| Crop production | 40 | 66.7 | Cow dung | 7 | 11.6 |
| Livestock production | 5 | 8.3 | Crop residue | 4 | 6.7 |
| Business/trading | 2 | 3.3 | Electricity | 4 | 6.7 |
| Honey production | 4 | 6.7 | Total | 60 | 100.0 |
| Total | 60 | 100.0 | | | |

Biomass, particularly farm trees are largely used as a main source of energy (both for cooking and lighting) (75.0%) for rural households in Manna district of Jima zone since, the rural households are not affordable to use electricity or other fuel sources (Table 3). Consequently vast numbers of trees are cut each year, playing a significant role to the rate of deforestation in the district as per focus group discussion and field observation. As it is well known that the energy sector in rural parts of Ethiopia is remains heavily dependent on wood for fuel, deforestation and land degradation are the most serious problems (Bekele, 2001). This phenomenon also influences food security through its negative impact on soil property change. Some households in Mana district have already lost the access to fuel wood from the agroorstry trees, they utilize caw dung and crop residues for fuel (11.6%) which could have been significantly contribute to maintenance soil quality, and better crop productivity.

### 4.3. Farmers perception on Soil fertility change after farm tree degradation

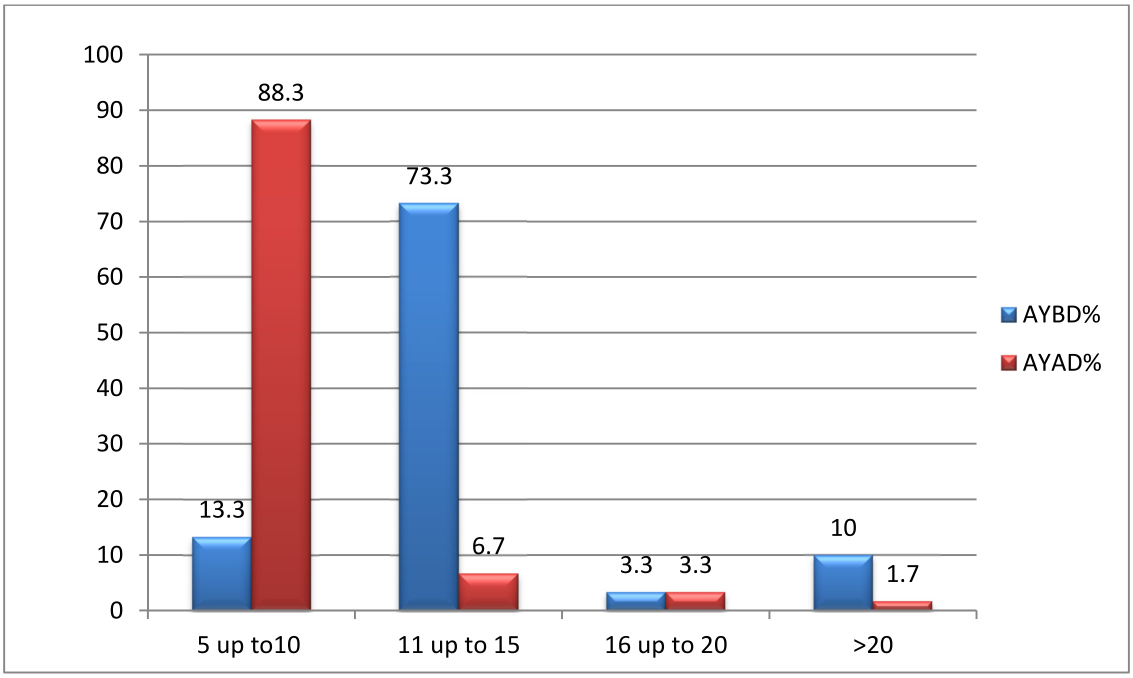
The farmers' perception on soil fertility before and after farm tree degradation is associated with the loss of crop productivity. Hence, they perceive that the farm tree degradation has brought changes in the status of soil fertility (Table 4).

Table 4: Farmers' perception on soil fertility change before and after farm tree degradation

| | Soil fertility before degradation | | Soil fertility after degradation | |
|---|---|---|---|---|
| | Frequency | Percent (%) | Frequency | Percent (%) |
| High | 34 | 56.7 | 2 | 3.3 |
| Medium | 25 | 41.7 | 13 | 21.7 |
| Low | 1 | 1.7 | 45 | 75.0 |
| Total | 60 | 100.0 | 60 | 100.0 |

Of the households, 56.7% perceived that the soil fertility was high before farm trees were degraded. About 75% of households in the district were perceived that the soil fertility is declined after farm trees were degraded (Table 4). The farm land without tree is not much fertile compared to the farmlands with trees may be due to soil erosion. This shows that farm tree degradation impacts soil fertility, which has adverse impacts on agricultural production and the biological process of microorganism in the soil. Farm tree degradation also causes higher rates of soil erosion and siltation of waterways, loss of species and genetic diversity (Kaimowitz, Byron and Sunderlin, 1998). This is directly or indirectly creates poverty to the local livelihood due to the constraints imposed on crop productivity.

About 93.3% of the respondents perceived the change in crop yield due to soil fertility loss after farm tree degradation. Within the last 10 years the amount of crop produced per hectare is declined by 45% in average. As the respondents (73.3%) indicated that crop yield was estimated to be 11-15 Quintals/ha/year before farm tree degradation. However, 88.3% of the respondents indicated that it is now declined to 5-10 Quintals/ha/year after farm tree degradation (Figure 1).




*Where AYBD refers to average yield before degradation and AYAD refers to average yield after degradation of farmland trees*

**Figure 1: Percent of the responses on total crop production in quintals /hectare/year**

### 4.4. Soil physio-chemical properties

**Soil texture**

In the soil samples collected from adjacent land uses that have similar parent material, the highest average sand content (56.67%) was observed under the degraded land, and the lowest (37.33%) was recorded from the canopy of *Sasbania Sesban*. The average clay fraction recorded under the canopy of *Sasbania Sesban, Gravellia robusta, Coffee arabica*, and *Avocado/Percia africana* was 31-37%. Consequently, clay loam textural class was observed under these trees canopy. Whereas under degraded farm land (land without tree) 23.67% and 19.67% clay and silt respectively was observed. In degraded land the content of silt% and clay% was lower, and possess sandy clay loam textural class (Table 5). This may attributed to the soil erosion occurred in the absence of farm tree which has removed the fine soil particles. Soil texture determines a number of physical and chemical properties of soils. As the group discussion with key informants recognized that, the soil stricture degradation has resulted in the crop productivity loss in the farmlands without farm tree in the district.

Table 5: Interaction effects of land use and particle size (sand, silt and clay)

| Soil sample from | %sand | %clay | %silt | Textural Classes |
|---|---|---|---|---|
| Degraded land | 56.67 | 23.67 | 19.67 | Sandy Clay loam |
| *Sasbania Sesban* | 37.33 | 31 | 31.67 | Clay loam |
| *Gravellia robusta* | 43.33 | 31 | 25.67 | Clay loam |
| *Coffee Arabica* | 39.33 | 31 | 29.67 | Clay loam |
| *Avocado/Percia Africana* | 38.67 | 37 | 24.33 | Clay loam |
| P<0.05 | 0.001 | 0.0025 | 0.0923 | |

**Soil PH**

Degradation of farm tree has resulted in statistically significant reduction of soil PH in the study area. The highest (6.79) and the lowest (5.42) soil PH values were recorded under the *Sasbania Sesban* and degraded land respectively (Table 6). The lowest level of PH recorded under the degraded land may be due to depletion of basic cation due to accelerated erosion. It may also be due to its highest microbial oxidation that produces organic acid, which provide H ion to the soil solution and lower soil PH.

**Table 6: Effects of farm tree degradation on some of the soil chemical properties**

| LU | PH | ECds/m | OC% | OM% | TN% |
|---|---|---|---|---|---|
| Degraded land | 5.42[d] | 0.09[b] | 1.7[e] | 2.84[e] | 0.14[e] |
| *Sasbania Sesban* | 6.79[a] | 0.13[b] | 2.6[d] | 4.49[d] | 0.22[d] |
| *Gravellia robusta* | 6.53[ab] | 0.24[a] | 3.1[b] | 5.35[b] | 0.27[b] |
| *Coffee Arabica* | 6.37[ab] | 0.17[ab] | 2.9[c] | 4.99[c] | 0.25[c] |
| *Avocado/Percia Africana* | 6.25a[c] | 0.14[b] | 3.33[a] | 5.68[a] | 0.28[a] |
| P<0.05 | 0.0001 | 0.06 | 0.0001 | 0.0001 | 0.0001 |

Soil reaction (usually expressed as pH value) is the degree of soil acidity or alkalinity, which is caused by particular chemical, mineralogical and/or biological environment. Soil reaction affects nutrient availability and toxicity, microbial activity, and root growth. This is mostly due to the fact that pH changes the form of many of the nutrients and many of the forms are relatively insoluble.

**Electrical Conductivity (EC)**

Electrical conductivity (EC) is a measure of salinity. Besides the high numerical difference in Electrical Conductivity (EC) of soils between the farmlands with tree and without tree, value observed under *Gravellia robusta* canopy (Table 6). The highest EC value under the *Gravellia robusta* might be due to its highest exchangeable basic cations content in the biomass is released immediately after the organic matter decomposition, whereas the lowest EC value under the degraded land may be associated with the loss of base forming cations such as Na, K, Ca and Mg by erosion, and leaching since, the soil texture was sandy clay loam (Table 5).

**Soil organic matter**

Soil organic matter content was highest under the farmland with avocado tree and lowest on the degraded land. The significantly decreasing order of organic matter value is: *Avocado* > *Gravellia robusta* > *Coffee Arabica* > *Sasbania Sesban* > Degraded land (Table 6). The decline in soil OM and TN contents in the degraded land might have been aggravated by the insufficient input of organic substrate from the farming system due to residue removal. This general truth was assured by different authors (Duff *et al*., 1995).

In general, as OM is the main supplier of soil N, S and P in low input farming systems, a continuous decline in the soil OM content of the soils is likely to affect the soil productivity and sustainability (Schroth & Sinclair, 2003).

**Organic carbon (OC)**

Although there are significant differences between the farmlands for the soil organic carbon content, the extremely lowest amount was observed under degraded land, and the highest was observed under avocado. In similar way to Soil organic matter, the significantly decreasing order of organic carbon value is: *Avocado* > *Gravellia robusta* > *Coffee Arabica* > *Sasbania Sesban* > Degraded land (Table 6). The loss of organic matter has influenced the value of organic carbon in degraded farmland.

**Total Nitrogen**

The average value of total nitrogen was significantly high under the canopy of Avocado compared to that of farmland without farm tree (Table 6). Similar to soil organic matter and organic carbon, the significantly decreasing order of Total nitrogen value is: *Avocado* > *Gravellia robusta* > *Coffee Arabica* > *Sasbania Sesban* > Degraded land (Table 6). The total N content of a soil is directly associated with its OC content (Mengel and Kirkby, 1987).

Nitrogen (N) is the fourth plant nutrient taken up by plants in greatest quantity next to carbon, oxygen and hydrogen, but it is one of the most deficient elements in the tropics for crop production (Sanchez, 1976; Mengeland Kirkby, 1987). However, the lowest nitrogen content was observed under the farmland without tree. Soil total nitrogen as part of very essential nutrients for crop, its insufficiency has contributed to the decline of crop productivity for the some of the households in the district (Figure 1). And it is pushing the poor farmers to apply inorganic fertilizer supplementation for their cropping.

## 5. Conclusion and Recommendation

### 5.1. Conclusion

From varies economic activities in the study area, crop production is the dominant source of income, and farm tree is the dominant source of household energy. Since the farmland trees provide multiple goods, and contribute to the farm productivity, it has significant impact on the livelihood of local farmer households in Mana district of Jima zone. Majority of the farmers in the district have well recognized the contribution of farmland trees, and the impact of farm tree degradation to the livelihood. However, lack of skill to maintain and manage farmland trees, lack of motivation to plant multipurpose trees on farmlands to restore degraded ones, are coupled with overexploitation of this resource in the district; and this has negative implication on soil quality of the farmlands.

The loss of crop productivity of the farmlands after degradation of farm trees is observed in the district. Farm tree degradation was affected the soil phyisico-chemical properties in the study area, and subsequent agricultural yield and household energy supply reduction were identified. Furthermore, the deterioration of land quality has imposed adverse impact on the overall local livelihood components. Hence, it aggravates food insecurity and makes the people and their environment more vulnerable to the changing climatic condition in Mana district.

## 5.2 Recommendations

Encouraging the community to plant multipurpose tree species on their farmlands to maintain the soil fertility is needed for sustainable livelihood through crop production. Besides, building the rural peoples skill to manage the trees on the farmland is needed. Finally, instead of relying on farm trees, it is advised to build up the capacity of farmers to establish woodlots with fast growing tree species as an alternative approaches to meet the demand of household energy and other tree products.

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