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# Financial Analysis of Smallholder Farmers Woodlot and Homestead Agroforestry Systems and its Implications for Household Income Improvement, the Case of Hawassa Zuria District, Southern Ethiopia

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## Abstract

Farmers determine their land use selections based on potential benefits of the farm products and costs related to the production processes. Undertaking the financial cash flows in the farming practice of woodlot and homestead agroforestry system can help the farmers to decide on their land use practices. Furthermore, farming practices can be integrated to the optimal combination of a better financial reward considering the available resources. The objective of this research was to evaluate the financial profitability of smallholder woodlot and homestead agroforestry systems. To undertake this research both primary and secondary data were used. Primary data were gathered through a questionnaire, key informant interview, focus group discussions and field tree measurements. Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) analysis were used as profit indicator. Maximization of profit from the two farming practices was analyzed using linear programming model. SPSS and excel solver were used to analyze the data and presented in graphs, tables, and descriptive texts. The average land size owned by the household was 0.8ha where Farming was the major means of living for about 98.5% of the farmers in the study area. The average land size allocated for smallholder woodlot was 0.125ha whereas 0.68ha was allocated for Homestead Agroforestry system (HAFs). In the study area, 42% of the households sustainably secured their fuelwood demand and sold extra fuelwood to the market. Only 18.5% of the household sold Eucalyptus poles to the market which have extra waiting time than firewood. The NPV calculation shows that both farming practices were profitable whereby HAFs was 1.33 times profitable than woodlot. The BCR for both farming practices was greater than unity at an interest rate of 10%. Investing on HAFs above 44% of interest rate was a loss for the households that extend up to 129.8% in the case of the woodlot. A decrease in 10% of the HAFs commodity (chat, coffee, enset, avocado, cordia, and gesho) had a reduction of 104,245 birr (4,430.41 US$) per hectare of production per year which was about 33.3% of the NPV. In the case of the woodlot, reduced price of Eucalyptus poles by 10% has a profit reduction of 23,781 birr (1,009 US$) per hectare of woodlot production which means 20.39% profit loss per year. To maximize the profit, land allocation of woodlots and HAFs can be allocated as a combination of 0.53 and 0.47 hectare, respectively.

**Keywords:** Woodlot; HAFs; Financial analysis; NPV; BCR; IRR; Linear programming

## Introduction

Resource scarcity, the absence of technical capacity and experience, as well as market and policy disincentives are the main limiting factors to plant trees or expand traditional tree-based systems for smallholder farmers [1]. In most parts of Ethiopia, Eucalyptus woodlots are widely grown mainly in farmers' land to generate cash from poles, fuelwood, and wood-based products through selling to urban and peri-urban markets thereby contributing to their livelihood [2]. Besides the financial benefits that farmers can draw from the woodlots established either on household's farmland or community woodlots, there will also be an improvement on land conditions of the farmers [3].

In Sidama zone of Southern Ethiopia, homestead agroforestry system (HAFs) of enset-coffee based practice is the main source of food and cash income for the farmers [4]. On the other hand, as supplies of wood and other products from natural forests decline, trees grown outside forests on homesteads and communal lands have become more important [2]. The household's high fuelwood consumption is the main driver next to generating household income to establish woodlot on the parcel of farmland [5].

The financial and economic profit of different agroforestry systems has been studied by different scholars. Nevertheless, the role of smallholder trees for livelihood improvement and household's income contribution in Ethiopia is not yet well documented. The study conducted by Duguma in central highlands of Ethiopia revealed woodlots rewarded the households with more financial cash as compared to boundary plantings and home gardens [6-9].

Nevertheless, agroforestry is site-specific to analyze where the profitability can be dependent on the location and site-specific characteristics [6]. In Southern Ethiopia, HAFs is being practiced for centuries supporting the livelihood of a large population in the region [10]. Hence, comparing the financial benefit of Eucalyptus woodlot and traditional HAFs with major cash crops such as coffee and khat can help to make decisions to select farm practices.

The general objective of this study was to evaluate the financial reward of smallholder woodlot and HAFs and the potential to contribute to household income improvements in Hawassa Zuria district. Specifically, the research intends to meet the following objectives.

1. Compare the financial benefit and degree of sensitivity of the two farming practices.
2. Identify optimum land size combination of woodlots and HAFs to maximize benefit.
3. To analyze the relationship between the adoptability of woodlot by different wealth class households.

## Methodology

### Study area description

Hawassa Zuria district is found in Sidama Zone, Southern Nations Nationalities and Peoples Region (SNNPR). The district covers an area of 92,000 ha and has an estimated population of 105,000. The district is divided into 23 kebeles which are also known as Peasant Associations (PAs). The study is conducted in Chefasine kebele (figure 1) which is located at 6o55’58.6”N latitude and 38o29’48.8”E longitude. The study was conducted in Chefasine kebele (Figure 1) which is located at 6o55’58.6”N latitude and 38o29’48.8”E longitude [11].

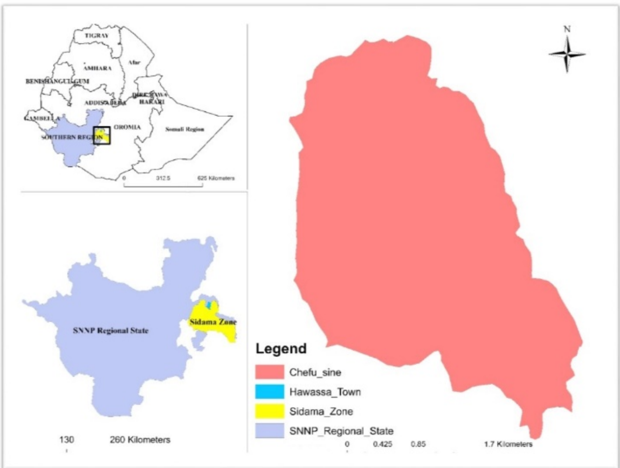


**Figure 1:** Map of the study area.

There are three villages and six sub-villages (two sub-villages under each village) in Chefasine kebele. These are Danisa, Alawo and Mato. To distribute the sample spatially, one sub-village from each were taken as a sample. To select the sub-villages, the same criterion used to select the study area was used. Hence, the sub-villages with woodlot and HAFs were selected. Among the sub-villages, Argeta, Butelo and Hankamo were finally selected to undertake this research.

### Sampling technique and sample size

Systematic sampling technique is used to distribute the samples through the sub-villages. The intensity of the sample size is distributed to the sub-villages based on the current farming practices of the households which help to acquire more information. Accordingly, 65 households have been considered for the household survey of the study.

The sample size decision of the household considers the budget and time limitation without compromising the quality of the research. For this study, 16% of the total households in the study area were sampled. The proportion is quite representative of the target groups were defined geographically and the theme of the research. This type of sampling procedure was suggested by *UNDESA-SD* (2006) which helps to reduce bias and problem of “too large” or “too small” sample size. Among the 65 sampled households, 56 households were practicing both farming systems. Considering the farming practices as a sample, data were collected from 56 woodlots and 65 HAFs farmlands. The sampled households were diverse in terms of available resources (land size, capital, labor), age and wealth status. The households in the study area are divers from education, wealth, age, education and many other aspects. The more diverse the sampled households, it will be more representative of the population which also reduces sampling error.

### Method of data collection

**Key informant interviews:** Key informant interview have been conducted in the kebele office. Semi-structured interview was used for active households in the study area and those who have general knowledge about the farming practice of the study area. The Households were selected based on snowball sampling technique adapted from Den Biggelaar [12]. Based on this, six key informants (two from each sub-village) were selected.

**Focus group discussion:** The focus group discussion has been held finally after key informant interview and the household survey was completed. The participants are selected using snowball sampling method adapted from Den Biggelaar [12]. The criterion to participate in the focus group discussion was good knowledge about agroforestry systems, woodlots and ability to speak in public. To undertake focus group discussion, 8 men and 5 women participated whereby; women and men were invited to discuss issues about their farming practice separately. The group of men and women were created due to the cultural fact that women are not “able to” and “not allowed” to speak in front of men in public.

**Household survey:** For the household survey, 65 households have been selected randomly based on the proportion of households from each sub-village. The structured and semi-structured questionnaire has been developed to interveiw the respondents. Data regarding the farming practice they follow and detailed production costs and the production per harvesting time were collected.

**Market assessment:** The prices of the marketable outputs of the two farming systems were gathered through triangulation assessment. The market prices of the commodity are provided by key informants, household survey and data obtained from the market were used. From the markets located in Tula and Hawassa, data regarding the prices for eucalypt pole, split wood and pieces of fuelwood bundle were gathered.

### Data analysis

Both quantitative and qualitative data obtained were analyzed quantitatively and qualitatively. The first objective of this study was to identify the potential of smallholder woodlot plantation to meet household’s domestic wood need and contributions to income. To achieve this, the quantitative data obtained from the household interview, key informant interview and the market survey were analyzed using descriptive statistics (mean and percentage). The second objective of this research was to compare the financial benefit and degree of sensitivity of the two farming practices. To meet this objective, the financial profit indicators were analyzed. Section 3.5.1 below describes the steps followed to calculate the financial profit indicators. LP model was used to achieve the objective related to the optimum land allocation for the two farming practices to maximize profit. The LP model used to analyze the household data was described under section 3.5.2. To achieve the objective aimed at analyzing the relationship between the two farming practices and wealth class, correlation analysis was employed. The fifth objective of this research was to identify most common tree species and their market value. Data obtained from field observation and tree measurement were analyzed using descriptive statistics (percentage). Statistical Package for Social Sciences (SPSS) and excel were used for the data analysis. The obtained results were presented in tables, graphs, and analytical text.

**Financial and sensitivity analysis:** Gittinger states that feasibility of investments and decisions should be based on financial indicators. These indicators are Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). The NPV determines the net returns of the production system by discounting the streams of benefits and costs back to the establishment year using appropriate discount rate over the lifetime. The farming practice with higher NPV is taken as a better option than with lower NPV (ibid). It is calculated using the following formula 1 below.

$$\mathrm{NPV} = \sum_{t=0}^{n} \frac{(Bt - Ct)}{(1+r)^{t}} > 0$$

Where; NPV= Net Present Value, Bt= Benefit flows at time t, Ct= Cost of production at time t, r= discount rate and t= time.

The BCR is used to compare the discounted benefits to discounted costs. The farming practice with higher BCR is taken as a better option and it is computed using the formula 2 below

$$\mathrm{BCR} = \frac{\sum_{t=0}^{n} \frac{\mathrm{Bt}}{(1+r)^{t}}}{\sum_{t=0}^{n} \frac{\mathrm{Ct}}{(1+r)^{t}}} > 1$$

$$\mathrm{IRR} = \sum_{t=0}^{n} \frac{(Bt - Ct)}{(1+r)^{t}} = 0$$

The expected profitability of an investment is the rate of return which provides enough income to cover the inputs' opportunity cost. An agroforestry practice is considered financially attractive if the IRR is higher than the opportunity cost [13].

The values in the calculation are used based on the current input and output set constant throughout for 15 years of cash flow analysis. Based on a recommendation by Ministry of Finance and Economic Development of Government of Ethiopia, an interest rate of 10% was used for the evaluation the two farming practices. The financial discount rate reflects the opportunity cost of capital, defined as the forgone expected return by bypassing other potential investment activities for a given capital [13].

If the households have no means to access wood and wood products from natural forest, either they must establish their own woodlot, or they are obliged to buy. The cost households incur to buy wood especially for energy must be considered during the cost-benefit analysis of HAFs. Smallholder farmers are risk averse and their livelihoods are based, agricultural and forest products are surrounded by verities of risks and uncertainties such as tenure insecurity, recurrent drought, and diseases [14]. It is difficult to predict the future input and output prices, yields and discount rates due to lack of data or information. Hence, a sensitivity analysis was carried out to show the effect of the change in these key variables on the NPV. In the process of the adoption of new farming practices; farmers are not only concerned about costs and benefits but also associated risks. Moreover, the farm households may attach high value to present income and discount the future income at a higher rate. To do the sensitivity analysis of the farming systems on smallholder farms, two assumptions were considered. These assumptions are:

1. If discount rate increases by 10%, 20%, and 30% keeping other key variables constant and
2. If the price of the product increase or decrease by 10% keeping another variables constant.

The price of the commodity produced on the farm has a vital role in deciding the profit of the farming practice whereby, the interest rate also contributes its own effect on the benefit.

**Land optimization analysis:** LP model is used to achieve the third objective which is identifying the optimal land allocation for the two farming practices to maximize profit. The proportion of land allocation for the two farming practices to maximize the profit of the household is analyzed by using LP model. It is designed to optimize an objective function subject to a set of constraints whereby, both the objective function and the constraints are set in a linear equation [15,16]. LP is a flexible tool which aims to maximize more than one objective function at a time dealing with several constraints [16]. For this study, the objective function is to maximize profit under physical and financial restrictions. The objective function of the model is to maximize the profit through constraints of labor, cost, land, and minimum required land for HAFs for subsistence food production. The net benefits of the farming practices are considered as the profit of the farming practices. The linear model for land optimization for the two practices is explained below.

Maximize total profit=Profit per hectare of WL (LWL) + Profit per hectare of HAFs (LHAFs)

Subject to:

LWL+LHAFs≤ Total sampled land size

LWL ≤ Total sampled land size suitable for WL

LHAFs ≤ Total sampled land size suitable for HAFs

ACWLMha-1 (LWL) + CHAFsM ha-1 (LHAFs) ≤ Total financial budget of sampled households

RLWL + RLHAFs ≤ Total available household labor

MRLHAFs≥ Sum of the minimum required land of sampled households to practice HAFs

LWL, LHAFs ≥ 0

Where; LWL= land allocated for a woodlot, LHAFs= land allocated for HAFs, ACWLM ha-1 = average cost of woodlot management per hectare, ACHAFsMha-1 = average cost of HAFs management per hectare, MRLHAF = minimum required land to practice HAFs, and RLWL and RLHAFs = required labor to practice woodlot and HAFs.

Gee and Edwards (1968) used LP model to maximize net farm return and applied only the feasible cash costs. Cost of land was not included in total cost calculation because most of the farmers owned their own land. This study followed the same principle of land and labor costs. Chibnik (2011) also mentioned that considering unpaid family labor in cost calculation depends on many factors. Estimating the cost of family labor is calculated by valuing the cost to hire labor instead of using family labor. If the opportunity cost of family labor is low, the net farm family income could be increased by using family labor more intensively in farming operations [14]. According to El-Osta and Aheam [18]; economic statement of USDA accounts labor cost in three ways:

1. Paid expenses for hired labor and management are included in variable cash cost.
2. Unpaid physical work hours are imputed an opportunity cost equivalent to hired labor wage rate exclusive of management.
3. The value of unpaid management is not direct cost so that it is included in the returns.

## Results and Discussion

### Financial and sensitivity analysis

The financial profit indicators; NPV, BCR and IRR were analyzed to show the best alternative farming practice for the area. The NPV, BCR, and IRR of the two farming practices were calculated using the method explained under section 3.5.1 and presented in Error! Reference source not found. below. The result shows that both farming practices are a good investment for the households rewarding with a positive NPV. The calculated NPV for woodlot and HAFs is 116,581.41 and 155,833.40 birr respectively. The NPV reveals that HAFs has higher profit gain of 1.33 times that of the woodlot. BCR of HAFs practice is 2.04 while woodlot assembles BCR of 1.43 per one hectare of production. IRR is 44% for HAFs and 129.8% for woodlot.

This shows that both farming practices have BCR of greater than unity at 10% interest rate. Investing in HAFs above 44% of interest rate is a loss for the household while it extends up to 129.8% to invest on the woodlot. The decision of the households upon selecting beneficiary farming practice upon their farmland mainly depends on the benefit reward and the essentiality of the products for the household needs. The detailed NPV and BCR calculation considering the sensitivity of the farming practices towards different interest rate is computed and presented in Table 1.

| Interest rate | Evaluation criteria | Woodlot (birr) | HAFs (birr) |
|---|---|---|---|
| 10% | NPV | 1,16,581.41 | 1,55,833.40 |
| | BCR | 1.43 | 2.04 |
| 20% | NPV | 60,355.43 | 25,866.00 |
| | BCR | 17.83 | 1.02 |
| 30% | NPV | 35,636.62 | 14,698.81 |
| | BCR | 10.03 | 0.71 |
| 40% | NPV | 22,830.33 | 9,158.80 |
| | BCR | 6.22 | 0.5 |

**Table 1:** Financial and sensitivity analysis towards interest rate.

Though the profit of farming practices decreases with increasing interest rate, both woodlot and HAFs are not sensitive to the interest rate of the investment. Comparably, HAFs is more sensitive than woodlot. This is due to the annual cost incurred for HAFs is higher than woodlot despite periodical profit reward of the woodlot. In long-term investment, woodlot is more profitable than HAFs. Change in price of the commodity has a pronounced profitability difference in woodlot and HAFs. 10% reduction on the price of the main product of HAFs (khat, coffee, enset, avocado, cordia, and gesho) has a reduction of 104,245 birr per hectare of production which is 33.3% of the NPV. In the case of the woodlot, reduced price of Eucalyptus by 10% has a profit reduction of 23,781 birr per hectare of woodlot production which means 20.39% profit loss.

### Optimal land allocation

The third objective of this study was to identify optimum land size combination of woodlots and HAFs to maximize farm benefit. Since both farming practices have their own strength and weakness, integrating the two farming practices was considered as the best option. As it was explained under the financial and sensitivity analysis of the two farming practices, the benefit reward of HAFs is quite good. As compared to the woodlot, it is the most sensitive practice to interest rate and market price. Additionally, the households need to incur higher cost and labor for HAFs than woodlot. Distributing the available resources of the household; land, capital and labor for the right proportion of the two farming practices can increase the benefit.

Upton [16] suggested that in such scenario, finding an optimal plan using LP is possible if three conditions are met. (i) limited choice of several activities (woodlots and HAFs in this case), (ii) certain fixed constraints affecting choice (available land, budget and MRL) and (iii) linear relationship. The mathematical procedure to find optimal land allocation for the two-faring practice with a linear relationship was presented under the analysis section. The objective function was aimed at the maximum profit attainable from the two farming practices by considering constraint factors. Constraints considered in this model were: labor, production cost, land size and MRL for subsistence production.

**Labor budget:** Taking the labor budget as one of the constraint factors does not make it the limiting factor but consider the excess labor for the selected farming practices. Following Upton [16], distributing the available land for both practices to use the potential labor of the household was considered. For example, if the household has enough labor to be engaged in labor intensive farming practice which rewards with reasonable benefit, the available labor resource should be utilized. While comparing the two farming practices, HAFs is more labor intensive as compared to the woodlot.

The potentially available labor per household was aggregated based on the farm labor hour provided for the household head, children and women by taking the average for casual days and peak seasons separately. For the detailed household labor budget and average working hours on the farm for each anonymous sampled household. The labor hour is specified for man and children in the households thereby, the woman labor hour is calculated as half of the labor hour for the man in the household. This method was used following Kahan [14], explained as accurate farm labor data are frequently difficult to obtain but farm labor as person-hours per period used in farming can be estimated. Homogenous labor can be aggregated by adding together hours in the same period. The labor budget of the farmers was calculated based on the household labor data. During the months demanding peak labor (September, March and June), the household is supposed to work 9 hours per day. Other than these months, farmers spend 6 hours per day on average. Excluding off-days for market and church, farmers work for 20 days a month on average. The available labor hour per household is estimated based on the number of households engaged on the farm and their respective average working hours per day.

**Financial budget:** the cost that household can incur for the two farming systems were considered as the financial budget of the household. The cash cost incurred the production cost of HAFs are used for fertilizer, pesticide, seedling, land preparation, management activities paid for peak season and land tax. On the other hand, the cost of woodlot is during early establishment which is used to buy or prepare seedlings, land preparation and transplanting and annual land tax. The cash production cost of the two farming practices was aggregated to estimate available budget.

**MRL:** It is recommended by economists to study minimum land the household need to sustain their subsistence before any market-oriented production. Farmers are not able to produce marketable products unless they fulfill their subsistence [17]. Similarly, in the study area, farmers merely depend on their HAFs for subsistence food production. Though it needs a detailed study to set MRL for subsistence per household, the MRL for substance production of an average household size in the area is used for the calculation. Subsistence farmers normally produce food for the family than aiming to maximize profit. On average, 0.24 ha of land should be kept for household's food production.

**Land:** There are two possible ways to distribute the farm land for the two farming practices. The first one is to consider the village as a big firm and distribute the available land size of sampled households for the two farming practices. The other option is to calculate the optimal land allocation of one hectare of land for the two farming practices. Considering the above-mentioned constraints, the land allocation for the two-farming system was optimized.

The actual data collected from 65 sampled households were presented in Table 2. The available land size of the area is not fully utilized by the farmers. The sampled households cultivated 52.42 ha of land for the two farming practices whereas the total land size owned by the sampled households is 57.65 ha. From the cultivated land, 44.25ha of land is under HAFs practice while woodlot is practiced on 8.16 ha of land. Table 2 below elaborates the actual profit of the whole farmland.

| Farming practices | | | |
|---|---|---|---|
| | **Woodlot** | **HAFs** | **Constraint level** |
| Profit (birr) | 2,58,030.00 | 20,26,092.00 | |
| Constraints | | | |
| Land (ha) | 8.16 | 44.25 | 57.65 |
| Budget (birr) | 12,660.00 | 1,39,153.60 | 1,51,813.60 |
| Labor (hr/yr) | 2,767.20 | 1,12,946.00 | 1,35,309.00 |

**Table 2:** The current farming practice of whole village farm.

To maximize the profit obtained from the two-farming system as a village, actual data from sampled households were used. As presented in Table 2, the land and the household labor were non-binding constraints whereas the budget (cost) was the binding constraint. To fully utilize the available land using the available resource which is the household labor, the LP model provided an optimal land allocation for the two farming practices. The result showed that, allocation of 39.5ha of land for HAFs and 18.5ha of land from the total available land size maximizes the profit by 4.01%. The profit maximized using linear programing in Table 3 shows an additional profit which will be gained by reallocating the available resources following the method used by Upton [16]. The total attainable profit is 2,377,533.77 birr from the total sampled farmlands. The additional unit of cost and labor on the current practice was presented in Table 3.

| **Profit (birr)** | **Farming practices** | | **Constraint level** |
|---|---|---|---|
| | Woodlot | HAFs | |
| | 2,58,030.00 | 20,26,092.00 | |
| Constraints | | | |
| Land (ha) | 18.5 | 39.15 | 57.65 |
| Budget (birr) | 1551.47 | 3144.71 | 1,51,813.60 |
| Labor (hr/yr) | 339.12 | 2552.45 | 1,35,309.00 |

**Table 3:** Optimized land allocation to maximize the benefit of whole village farm.

The potential of household labor still can be allocated to the optimum but, cost (household budget) is the binding constraint. To use the non-binding constraint which is labor, credit system can be introduced to relax the financial budget. Adding a unit of cost to the farming practice changes the situation by utilizing the available resource to the maximum. Credit system can be introduced to maximize the benefit by allocating the potential labor as suggested by Upton (1996). The profit can be maximized through allocating 325 birr (13.81 US$) per household. This extra budget allocation per household can increase the profit by 3,232.10 birr (137.6 US$). From the additional labor hours, farmers can increase the benefit up to 5.42 birr (0.24 US$).

The study area is homogeneous in ecological, social and economic aspects. This makes the collected data from sampled households to be more or less similar to non-sampled households of the area. Except for the characteristics of households is different, data collected from the 65 sampled households were representative. It is possible to estimate the production cost and output of a given land size under each farming practices since most of the production factors used by farmers are similar in the study area.

There is also another possibility of estimating a hectare of land for both farming practices considering each household individually. The inputs and farm outputs are more related to household characteristics such as the ability to incur cost and labor distribution in addition to their farm size. Taking this reality into account, the optimal land allocation of one hectare of land for the two farming practices was calculated. The input output data for each sampled household were all converted to one hectare and the average was taken for the calculation. The result showed that allocation of 1ha farm land in to proportion of 0.53 for HAFs and 0.47ha for woodlot can optimize the benefit of the available resources.

In addition to the financial reward of farming systems, their economic performance has to be studied whereby costs to the environment and other societal impacts can be considered. Externalities to khat production also need future research while performing economic analysis. Though there is enough labor potential in the area, the experimental field survey is needed to estimate the exact family labor hour needed for each farming systems. The LP in this model is computed by linear equation assuming outputs are linearly related to inputs. Though Upton [16] stated that Farm planning for individual households using LP is difficult, future research can be done at household level by household clustering. Farmers' categorization to different classes based on resources such as labor, land and capital can provide better farmland plan which can be generalized to other similar areas.

### The relationship between farming practices and wealth classes

The Collins English dictionary defines adoptability as the quality or the extent of being adoptable. Adoptability can also be understood as eligibility to be adopted. What makes the two-farming system eligible to be adopted by the households was the major concern of this objective. Households choose the farming practice based on different criterion. Among these, the household's land size, an available resource like capital and labor are the decisive factors. The adoptability of HAFs was not related to wealth class of the farmers since it is a default farming practice for subsistence food producing households. On the other hand, the adoptability of woodlot was related to the household wealth class. This is because of the wealth category is directly related to the land size ownership. Those who have enough land size to produce food for their family allocate part of the land for woodlot. Thus, the adoptability of the two farming practices by different wealth category was assessed and presented below. The interview result from the sampled households revealed that 86.15% while 13.84% doesn't own woodlot. Error! Reference source not found. Below shows a pie chart representation of woodlot practice by sampled households (Figure 2).

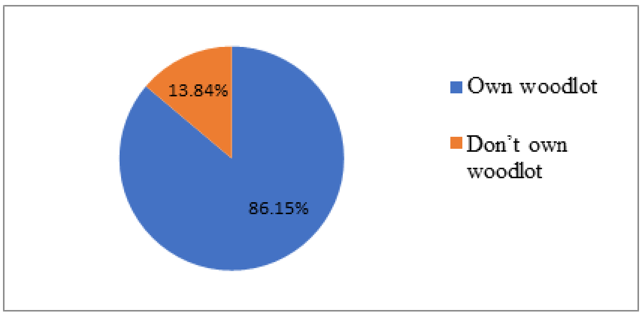


**Figure 2:** Smallholder woodlot practice of sampled.

## Conclusion and Outlook

The woodlot established by smallholder farmers contributes well to the fuelwood and other wood product demand of the household. Comparing the two farming practices, HAFs practice per unit area is more financially rewarding than woodlot in a short term. Integrating the two farming practices can maximize the financial profit and this is possible with the available land size of the households. Allocation of proportional land for both woodlot and HAFs is more financially rewarding.

Eucalyptus woodlot in the area is the most promising tree species for the area which can fulfill the wood demand in short period of time and needs less management cost. Above all, the number of trees doubled and tripled during each rotation which makes the species preferred by the local people. Local people in the study area were already familiar with the land segregation which ensures the farmers to benefit from the positive outcome of Eucalyptus and decrease the negative impact on the other land use.

The financial valuation is more dependent on the output, production of eucalypt stand in the case of the woodlot. This has to be improved by providing the farmers quality seedlings and training on the silvicultural practices. Thinning, rotation age and harvest mechanism have more effect on the final profit which is currently clear-cut harvest at the age of random rotation from three to twelve years.

It will be more interesting to investigate the value of woodlot planted for the different purpose. Future researches can be undertaken the financial benefit of woodlot plantation for fuelwood which will be practiced within three years of the rotation period. On the other hand, comparison of the optimal ration time for a better financial benefit of smallholder woodlot used for pole and fuelwood needs further study. Additional to financial reward of farming systems, their economic performance has to be studied whereby, costs to the environment and other opportunity costs of farming practices considered.

Generally, head of the household spends from 6 to 9 hours on their homestead farm especially khat and enset though the working hours can vary from date to date which can be interrupted by social activities, church, market, and meetings. During peak labor time (Khat harvest season), children have to work on the farm and sometimes they hire labor. Experimental field survey is needed to estimate the exact family labor hour needed in case of HAFs.

The financial valuation is more dependent on the output production of Eucalyptus stands in the case of the woodlot. This has to be improved by providing quality seedlings and training on the silvicultural practices. Thinning, rotation age and harvest mechanism have more effect on the final profit which is currently clear-cut harvest at the age of random rotation from three to twelve years. It will be more interesting to investigate the value of woodlot planted for the different purpose at different rotation period. Future researches can be undertaken in the area of financial benefits of woodlot plantation for fuelwood which will be practiced within three years of the rotation period. On the other hand, comparison of the optimal ration time for a better financial benefit of smallholder woodlot used for pole and fuelwood needs further study.

Through grouping farmers depending upon their practice on their farmlands, it will be more successful to establish community woodlot. The willingness and commitment to participate in community woodlot establishment, species selection, tree planting and management activities will be influenced by extension workers and other involved bodies. The communal land in the study area which makes up a size of 19.5 ha can be taken as a great potential for this community woodlot. The government and NGOs have to facilitate establishing community woodlot for the poor smallholder farmers in the area. In Northern Ethiopia, Tigray region, community woodlots are more operational and beneficiary than smallholder woodlots [5].

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