
# THE IMPACT OF EUCALYPTUS PLANTATION EXPANSION ON FOOD SECURITY IN BAMBASI WOREDA, BENISHANGUL GUMUZ REGIONAL STATE, WESTERN ETHIOPIA

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## Table of content

ACRONYMS

A.D.A.- Agricultural Development Agency

B.W.P. A.O.-Bambasi Woreda Public Affairs Office

B.G.R.S. -Benishagul Gumuz Reginal State

I.A.R.-Institution of Agricultural Research.

N.G. Os - Non-Governmental Organization

S.P.S.S. -Statistical Package for Social Science

S.D. -Standard Deviation

B.W.P.A.O.W. -Bambasi Woreda Public Administration Office

# The impact of Eucalyptus plantation expansion on food security in Bambasi Woreda, Benishangule Gumuz Regional State, Western Ethiopia

**Getachew Admassu**

**ABSTRACT**

The study was conducted at Bambasi woreda Asossa zone Benishargul Gumuz Regional state(B.G.R.S) in the western part of Ethiopia. The objective of the study was to observe if the Eucalyptus plantation expansion affect the food security. The study through questionnaire, interview and field observation proved that as the farmers in the area planting Eucalyptus for its more income generation, being construction materials and for fire wood requirement. These benefit which are obtained from the Eucalyptus plantation devoted the farmers to expand the plant on their crop land in a very fast rate. The crop lands of the area are being converted to the Eucalyptus plantation. Crop fields are decreasing from year to year which is resulting in the reduction of food crops in the locality. The plant produce higher biomass within a short period of time by consuming much amount of water and nutrients from the soil. Other plant species and crop plants are being dominated by the shortage of water and nutrient. On the other hand, it's shading effect and alellopathic chemicals which is produced from different parts of the tree is controlling the growth of other plant species. If the plantation expansion of the plant continue in the presenting rate the community in the study area may suffer from food security. So all the stake holders in the area should take part in banning of the expansion of Eucalyptus on fertile crop lands.

## CHAPTER- ONE

### *1.2. INTRODUCTION*

### 1.2.1. Back Ground of the Study

Eucalyptus, a genus of more than five hundred species, has became the most planted genus of trees in the world (Demel, 2000).The major planting of Eucalyptus outside of its native environment of Australia. The genus was introduced to East Africa in the late of 19$^{th}$ century and by the early 1970s. Today Eucalyptus plantation covers at least 12 million ha throughout the tropical zone, 90% of which have been established since 1955 (Turn bull 1999).In Ethiopia Eucalyptus was introduced during the reign of Minelik II (1868-1907) to fulfill the construction and fire wood requirement of people in Addis Abeba at the back of deforested native trees around the town. Since then the plant was expanded to all corners of the country and the concerns began to be felt around this time about possible negative impact of this plantation on the environment. Its effect is the concern of the country and the massive expansion of the genus created the fear of future food security of the country. Despite of this expansion, food insecurity remain the same because of agricultural productivity has been seriously eroded by resource depletion that followed the introduction of early maturing tree specious ,such as nutrient replenishing, leguminous trees in to agricultural system in area where trees can combined with production of crops groups Garay et al,(2004). Eucalyptus is an efficient biomass producer, It produce more biomass than many other tree species. It consume more than other species because of its fast growth and high biomass. Additonally

Allelopathic effect of Eucalyptus is more prominent in area with low rain fall [less than 400mm. annually]. Allelopatic effect may have implication when other species are grown near Eucalyptus trees .This is important especially in agro-forestry system. The biodiversity of Eucalyptus plantation is limited. Review of countries situation reveals that , in general, there is no objection to planting of Eucalyptus from the social point of view. It is also accepted that its planting is economically viable, However, Eucalyptus planting has been blamed for social impacts when taken up on public land occupied by peasants and also when natural forests are cleared for raising plantations

to meet the needs of industries . This has also been the case when the Eucalyptus planting is taken up in community areas formerly used for meeting fodder needs, or when people depending on the area where not consulted. Eucalyptus planting has acted as a buffer against financial crisis for many poor farmers on land unsuited to sustainable agriculture Wang, et al. (1967).

### 1.2.2. Statement of the problem

Eucalyptus plantation expansion influence the food security of the community. This practice is ongoing, particularly in the researcher's district of rural area nearer to the town. Attention is not given to the activity. The farmers' farm land is small and limited in the study area. Grazing lands are converted to this plantation. Eco-friendly trees which add soil fertility are not planted in and around the crop fields of the farmers. The objective of this study is to identify whether the Eucalyptus plantation expansion is reducing the farm land and then affecting the food security of the community or not and to indicate the consequence following this expansion to the administration and the community as well as to minimize the conflict between the public administrations and the private sector**.**

### 1.3.3. General Objectives

The general objective or purpose of this study is to survey the Eucalyptus plantation expansion and to suggest on its impacts on food security in Bambasi Woreda(B.G.R.S).

### 1.3.4. Specific Objective

The specific objectives of the study are to:

- Identify the dominant Eucalyptus plantation expansion preference of farmers in the locality.

- Determine the extent to which Eucalyptus plantation expansion on crop production in the area adhered to.
- Compare the income generated from Eucalyptus plantation biomass with crops product of farmers in the study area.
- Identify whether the farmers have concept about the negative impact of Eucalyptus plantation on food security or not in the area.

### 1.3.5. Research questions

- Do farmers of the study area prefer Eucalyptus plantation expansion than crop production on their crop field?
- Why are farmers of the locality devoted to expand Eucalyptus plantation expansion than crop production?
- To what extent are farmers of locality expand eucalyptus plantation over different crop varieties on their farm land?
- May farmers of the research area have enough recognition about the negative impact of Eucalyptus plantation expansion on their food security?
- Do farmers of the area generate more income from the sale of Eucalyptus biomass than crop yields?

### 1.3.6. Significance of the study

This research is important to students and other researchers who want to conduct related researches or other related topics.

### 1.3.7. Delimitation of the Study

This research is limited to B.G.R.S., Assosa zone, Bambasi woreda. the emphasis of the study was on Villages where the Eucalyptus plantation expansion is increasing in fast rate

and where there is more conversion of crop fields, natural forest area and grazing land with Eucalyptus plantation.

### 1.3.8. Study Site

The study was delimited to six villages (kebeles) of Bambasi Woreda. This village were selected because of the fast Eucalyptus plantation expansion activity is highly observed in these villages (kebeles) as they consisting convenient transport way for merchants of Eucalyptus tree biomass to other selling area. The researcher decided to do his work in these villages (kebeles) because he could collect sufficient information during his study.

Bambassi Woreda is found in Assossa Zone, Benshangul Gumuz Regional State, at Western part of the country, in the main road of Addis Abeba to Asossa, and far away 645 K.M from Addis Ababa and 42 K.M From the Regional city Assossa. Bambasi is bordered by the Mao-Komo special woreda on the southwest, Asossa Woreda in the west, by Menge Woreda in the north, by Oda Godere Woreda in the northeast,by Oromia Region in the south. Bambassi Woreda has total area of land 221,016 Sq. Km, and in terms of Administrative Structure ,the Woreda has totally 38 kebeles 36 of them are rural and 2 of them are Urban.

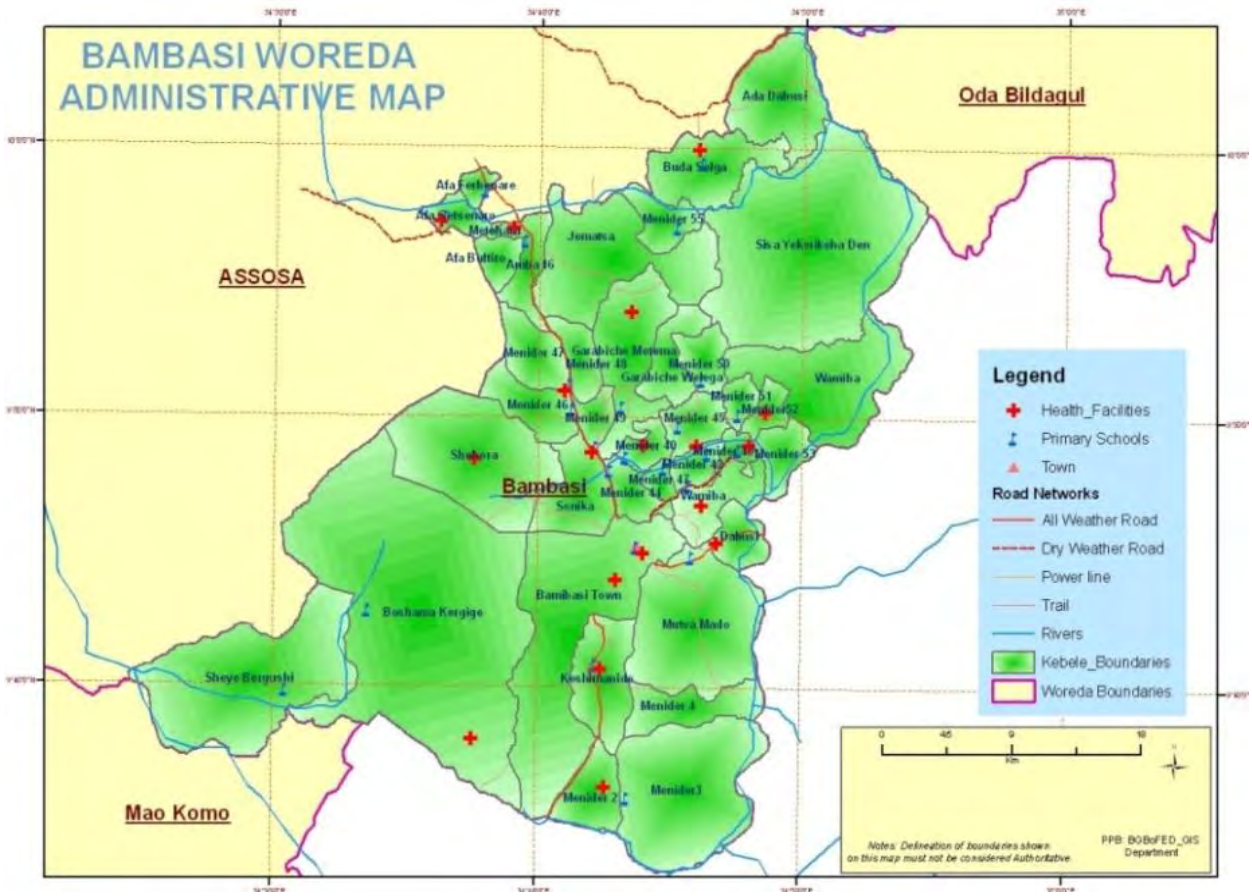


*Figure 1 Location map of the study area in Bambasi Woreda*

# CHAPTER - TWO

## *2.1. REVIEW OF RELATED LITERATURE*

### *2.1.1. INFLUENCE OF EUCALYPTUS ON PLANTS OF ETHIOPIA*

The genus is highly popular with farmers as cash crop but on the other hand the Eucalyptus are blamed for a great evil, notably on nutrient cycling and soil properties (FAO 1988). There is main argument against the Eucalyptus plantation expansion which includes; it drains water resources, it suppresses biodiversity (under growth), it enhances soil erosion, it introduces allelopathic effect and large scale planting cause crop land reduction . In Ethiopia socio-economic evaluation of Eucalyptus have been carried out mainly on *Eucalyptus globules* and *Eucalyptus camaldulensis***.** They showed that planting the genus made a substantial contribution to the income of the house hold, even more than agricultural crop did (Tesfaye 2000, Amare2002) Asaye (2000) reported that, on average, at least 26% of total family income come from such plantation. At a moment Ethiopia has the largest area of Eucalyptus plantation in East Africa and one of the 10 pioneer countries that introduced the Eucalyptus. Its cultivation has gradually expanded throughout Ethiopia encouraged by academic, research and development institution including Alemaya college of Agriculture, Institute of Agricultural research(I.A.R.) and chilalo Agricultural Development. In many developing countries, the area of private planting(N.G.Os) is much greater than that planted by government. Eucalyptus globules has been a common species introduced during past agro forestry efforts. The biomass energy demand of the country by 2004 , 6 percent of the total land utilizable land area would to be put under Eucalyptus plantation entailing major shift in land use. Kidanu, et.al.(2005). Increasing plantation would create competition between agricultural food crop and Eucalyptus trees for land area, major resources such as water, nutrients and light.

Ecological implication of exotic trees like those that Eucalyptus species which have been used for industrial purpose as well as for agro-forestry are often questioned since their ecology has not been appropriately studied.

Lane et. al,(2004) found in china described that he expansion of Eucalyptus plantation on lands previously used for crops and occupied by indigenous trees and grass lowers water tables and reduces water availability for other plant species. El-amin et.al, (2001), in Sudan reported that eucalyptus caused crop yield reduction due to nutrient depletion and production of toxic exudates

In comparison with agricultural crops and other tree crops species small-holders in Ethiopia produce Eucalyptus. The seed can be obtained locall, fertilizers and chemicals are rarely required. (Gessesse and Teklu, 2011).

Wood shortage for firewood and construction in the highlands of Ethiopia was as old as 19$^{th}$ century. Intrigued by wood products scarcity and tree-less landscape surrounding the newly, established capital Addis Ababa, Minilik II was forced to introduce a rather fast growing species of Eucalyptus in 1895. Since then, the species has expanded into all corners of the country. It also pioneered in the plantation development of the country. Currently, it is common to observe at least few Eucalyptus trees at the homesteads of most farmers and urban communities in Ethiopia. It has supplemented woods from natural forests that do not provide the desired quantity and quality of woods.

### 2.1.2. Potential competitive Mechanisms of Eucalyptus

Competition can occur between organisms when one depletes the supply of an essential resource to the determinant of another, the competition mechanism of Eucalyptus trees mainly involves nutrient and water that can be enhanced by climatic factors .Eucalyptus plantation have a negative environmental impact .There is no difference between crops species in resisting the negative effect, i.e., all crops such as finger millet, maize, teff, bean and other vegetables are affected because of the shading effect, water and nutrient competition, thinning of seedlings and forcing poor grain fillings. Tilashwork, (2009). In addition to competing life supporting resources Eucalyptus can cause the wastage of some natural resources.

### 2.1.3. Competition for Nutrients

Effect of Eucalyptus on soil were noted as it sucking up the soil nutrient exhaustion others un specified effects, the tree uses a lot of nutrient which is leading to soil exhaustion and reduction of crop yields.

This could be because of its fast growing rate than other most plants which perform poorly on site previously planted with Eucalyptus the growth rate of the plant leads to a high demand for nutrient. If the trees are harvested before attaining the age of the maximum growth, soil decline in nutrient and moisture content. Considerable nutrient capital change should be expected in Eucalyptus wood lots managed for pole production because of the frequent thinning or felling of the wood. The nutrient in the products are removed with in a comparatively short period of time because of Eucalyptus grow very fast and harvested with in short duration Sanginga, et al. (1992)

Nutrients are exported out from the plantation's soil system by removing trees from timber sales and fuel wood (zerfu, 2002) .From the soil nutrients, total nitrogen percentage in the plow zone from 0 to 20 cm depth at all distances were in the very high range .Near the Eucalyptus stand, this might be due to its allelopathic effect, which oppose the mineral up take by the plants and low mineralization. Tlashwork, (2009).

Michelsen et al.(1993) found that indigenous wood land in Ethiopia provided much higher nitrogen and phosphorus content in above ground herbaceous plants, indicating that nutrient cycling in sited dominated by exotic tree species is more constrained. Bioassay result indicated that the factor limiting growth in agricultural crops such as Eragrostis tef was likely the low availability of phosphorus, calcium and potassium in Eucalyptus soil.

### 2.1.4. Competition for Water

Another cause for degradation of biodiversity and environment in Eucalyptus plantation forest is that eucalyptus grow faster than other any tree species it thus needs a large amount of water for growing. This would lead to the drought in Eucalyptus plantation forest and the

environment degradation. The moisture at 5m from Eucalyptus tree was significantly lower than values at 1and 40m.In the other depths and times the moisture contents at 5m was generally lower. At the end of rainy season, the moisture content near the Eucalyptus stand in all depths were significantly less than the moisture contents farther away. It is interesting that at 15m distance from the tree, the moisture content from Eucalyptus stand was statistically similar with another plant species.

As study made Yunnan academy of forest showed that the water content for Eucalyptus forest soil was 20.4% for mingled forest soil was 20% for bare land was 18 4% Wang, (2012). The water consumption of Eucalyptus tree to synthesize 1kg of dry matter is 510 liters. The study of Davidso (1989), the competition for soil water between trees and crops is said to be predominant reason for stunted growth and decrease yield of agricultural crop in transition zone between Eucalyptus plantations in agricultural fields tree roots absorb vast quantities of water to replace loss due to transpiration and metabolic activities and water use efficiency per unit of bio mass vary among different species and highly dependent on plant development stage, stand density and environmental condition. The growing season begins with a moderately heavy series of rains which saturate all soils in the area. After these rains, soil moisture levels depend on duration, intensity, and spacing of precipitation, and evapo-transpiration. The interaction of these factors results in the aforementioned mosaic. The pattern of inhibition of herb growth was only partially correlated with the level of soil moisture. Gravimetric soil moisture determinations throughout the two growing seasons indicated soil in the bare zone to be consistently drier than that in the grassland. Since water holding capacity and wilting percentage differed little between soils in these areas, this was indirect evidence that plants, growing in the bare zone were inhibited substantially more by the effects of drought than were grassland plants. soil moisture content in the litter zone was usually similar to that in the grassland, suggesting only slight differential drought stress. This results from shade and the mulching effects of the litter itself. Nevertheless, the density and vigor of litter zone plants is significantly less than that of even bare zone plants. The soil moisture differences. Observed between litter zone and grassland failed to explain the absence of herbaceous vegetation in the litter. If drought stress were substantially influencing

the development of annual herbs, this effect should not be evident until differences in soil moisture content occurred.

Table 1 Plants Water Use Efficiency (source: Davdison, 1989).

| Plants | Water use per total biomass(liters/kg) | Water use per harvested bio mass(liters/kg) | Harvest index |
|---|---|---|---|
| Cotton, coffee, banana | 3.200 | 800 | 0.25 |
| Sun flower | 2.400 | 600 | 0.25 |
| Soybean | 1.430 | 500 | 0.35 |
| Potato | 1.000 | 600 | 0.60 |
| Eucalyptus | 785 | 510 | 0.65 |
| Finger millet | 592 | 225 | 0.40 |

### 2.1.5. Effect of Eucalyptus on Soil

In last decades the biodiversity and environments has been significantly degrading in Eucalyptus plantation forest. Land fertility has severely degraded; Chen, (1992) the stability and elasticity of forest soil worse. The soil structure and biological properties were injured. The traditional reclamation for eucalyptus forest lands led to vegetation reduction and thus the biological debris and above earth fertility reduction largely strong precipitation in rainy season sped up the loss of soil and water in eucalyptus plantation forest. The vicious cycle further induced the continuous reduction of soil fertility and productivity and further deterioration of forest environment and limited the growth and restoration of vegetation and biodiversity Wang, (2012).

As study made by Betre Alemu, (1998) effects of Eucalyptus on soil were noted as dry up the soil (48%), nutrient exhaustion (30%) and other unspecified effect (22%). (fig.1) shows as the tree uses a lot of nutrients leading to soil exhaustion and reduction.

In crop yield this could be because of its fast growing rate. Eucalyptus hybrid established the fact mean annual increment reaches a peak in the 6th and 7th year of growth.

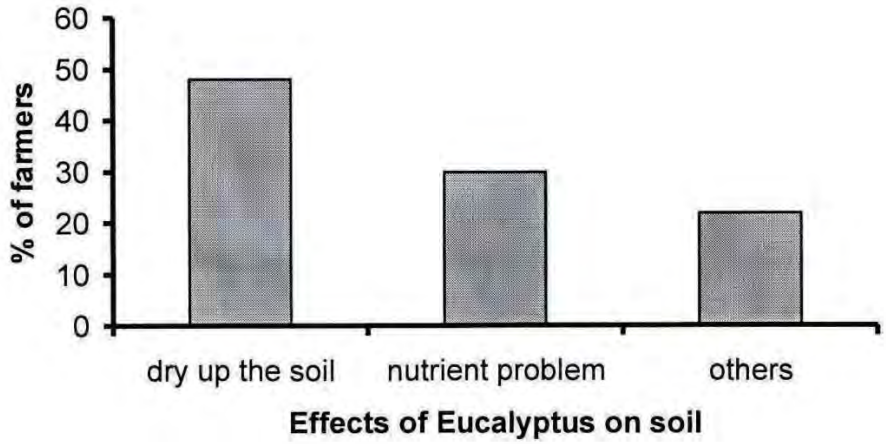


*Figure 2* ***Effects of Eucalyptus On Soils (source: Betre Alemu 1998)***

Hydrophobicity has been often associated with Eucalyptus tree. The dried Eucalyptus plant parts (leaves, barks and roots) are found to be slightly water repellent. The water repellent value of the Eucalyptus tree leaves is greater than the value of bark and root. The leaves of Eucalyptus cannot easily have decomposed to add soil fertility.

### 2.1.6. Allelopathic Effect of Eucalyptus on Soil Type

Many groves of Eucalyptus occur in sandy soil. Uninhibited herbs abound throughout such stands. In these cases, since there is no correlation with the presence or absence of litter, the soil type suggested itself as an important factor. Sheng, (1992) inhibition would occur primarily on heavy, unstructured soils by a series of comparative experiments. The level of toxicity that could be induced in soils representative of inhibitory (Milpitas loam) and non-inhibitory (Oakley sand) conditions were determined and compared with the actual inhibition in the field on these soils. the sand was not rendered inhibitory by the trepans, whereas the loam became significantly inhibitory, reducing the growth of bioassay plants to 74% of controls. The difference in induced toxicity in the two soils was judged to be very highly significant when all means were adjusted proportionately to the loam control and tested statistically. The capacity of sand and loam to retain phenolic toxins was determined by a filtering experiment. The major implication of Allelopathic effect in small holder farming system is the reduction in crop output when trees are planted adjacent to crops. Allelpathy is

the chemical from leaves or litter that inhibit the germination or growth of another plant species. (FAO, 1985)

### 2.1.7. Physiological Responses of Eucalyptus Leaf Leach ate on Seedling Physiology Rice, Sorghum and Black gram

Leaf leach ate of *Eucalyptus globules* was evaluated for allopathic effect on rice, sorghum black gram. the inhibition germination is dependent on the concentration of the extract; perhaps it may be due to the entry of water soluble allelochemical is well known. Garay (1995). The leaf, stem and roots extract or leachates from different Eucalyptus globules the germination and seedling growth of cereals[wheat, maize],millets, sorghum, pearl and. Legume etc. Therefore, Eucalyptus was not recommended as an intercrop in agro-forestry systems. mild water stress inhibited the growth and development of all the hybrids at different growth stages maize crop and also had effect on yield. Each farming cereal crops on a one-hectare plot on each side of Eucalyptus plot, we assume that 100% of crop yield will be lost within 10m of the trees, the four neighboring small holders will loose 11% of their gross crop production (Pamela. Jagger and John Pender. 2000)

Eucalyptus are prone to growth stresses and reduced with risk management strategies such as species site-matching, maintaining genetic diversity and reducing stress caused by drought, frost, pest and diseases. when compared with a range of crops Eucalyptus can achieved a high biomass production on a low nutrient up take, as little as one half to one tenth that of most agricultural and estate tree cropsakley sand and Milpitas loam were placed in a Buchner funnel and loaded twice with 100 ml of aqueous litter extract. Similar samples of each soil treated with distilled water served as controls.

All soils were air-dried, divided into two 50g samples and placed into 500ml storage dishes. A portion of the original extract was, retained for a sponge bioassay to assess its initial toxicity. The portions of the extract that were filtered through soil also were bioassay by the sponge technique. The soil aliquots were irrigated with distilled water and each planted with 12 seeds of bromusrigid us. All these bioassays were conducted simultaneously. Root radicle

growth in treated sand was reduced to 78%o of control, compared to 42% in the loam. By proportional adjustment of both controls to 36.5 mm, the difference between the tests was judged to be statistically significant. Loam clearly retained a higher proportion of toxicity from infiltrating solutions than did the sand. The application of toxins in this experiment is similar to that occurring under natural conditions. The retention capacity for phenolic compounds of the loam is important in the development of inhibition in the field.

The production, release, and stability of toxins from *Eucalyptus camaldulensis* are subject to seasonal variation. Production of litter is minimal during the wet winter and spring, but gradually increases as the summer drought intensifies so that by the time of the first winter rains, there is abundant un leached litter on the soil surface. The rain therefore washes large quantities of leachate into the soil. Terpene production, release, and adsorption parallel this pattern. On an annual basis, the building of soil toxicity appears to be balanced by the activity of soil microorganisms. Apparently these organisms ameliorate the effects of allelopathy by denaturing, over a period of time, the compounds produced. A series of investigations, Close, et al. (2003), indicated that phenolic toxins were effective in soil, but that they were less effective in soil taken from litter zones than in identical soil from the grassland. This suggested that the biota of the litter zone was better adapted to utilization of these com-pounds than was that of the grassland. If degradation of toxins occurred rapidly in the field, the importance of allelopathy would be minimized

### 2.1.8. Effects of Eucalyptus on Maize Crop

Eucalyptus root density is realest at 5m from the tree and the macronutrient is most depleted at this point. Moisture content is also the lowest here, but not statistically significant difference. Yield and biomass of maize is also most reduced near the Eucalyptus stand Tilashwork (2009)

At the maize maturity stage, moisture content was reduced even farther away 5m because of Eucalyptus border effect. Selamyhun and Strunider, (2004) reported that irrespective of crop species, less water remained in the soil in tree - crop system than in the sole cropping. Since the growing medium is nit sol, both species can extend their roots deeper to take out water

during the drier period. the nearest crop plants were wilted unlike the farther stands since Eucalyptus competes for moisture even deeper in the soil. Yu et al. (2006) reported that the occurrence of most densely, maize plant rooted layers at or below 30cm soil depth was very conductive to maintain plant water under dry soil condition. In other words, The roots of Eucalyptus tree are usually well developed in the dry areas and enable them to use the water stored deep in the soil during the dry season. This oppose the maize plant to use the local water during the dry period by sending the roots deeply. Eucalyptus suctions excessive water from the soil and water stores. Thus, Eucalyptus trees unlike the other tree spp. compete with maize plants for soil moisture, and the plant available water is insufficient for the crop performance to get good yield.

In maize plant any kind of stress decreased a number of grain per plant. number of pollen could be decreased with increasing drought stress; Hall et al,(1981). Drought stress before one week to silking and two weeks after silking decreased the grain yield. To reduce grains filling duration of all the hybrids, however drought stress had little effect on the physiological maturity of maize crop. In maize plant flowering ,silking ,pollination and grain formation are the sensitive stage of vegetative and reproductive growth. Water competition of Eucalyptus tree on maize plant during critical growth period reduce the grain yield up to 2t /hal. (1990) reported Leaf leach ate of Eucalyptus globules was evaluated for allopathic effect on rice, sorghum black gram. the inhibition germination is dependent on the concentration of the extract; perhaps it may be due to the entry of water soluble allelochemical is well.

### 2.1.9. Effects of Eucalyptus on other Plant Species

While primary metabolism has been related to biomass development and reproduction exhibit very slight difference among living organism, secondary metabolism possible to classify plants in different species through the chemical taxonomy, according to each particular profile

Eucalyptus trees produce allelochemicals, which were originally defined as secondary metabolite involved in plant to plant and plant to microorganisms interaction the chemicals

this pant provide protection towards competition by weed and other plants and to avoid detrimental action of herbivores, fungi, bacteria viruses. This condition helps the plant to control other plant species and animal to be dominant over the environment. China Eucalyptus research center (2009) allopathic effect of eucalyptus is prominent in area with low rain fall (less than 400ml annually).

Allelopathic effect may have implications when other species are grown near the tree. These conditions were especially seen in agro forestry system .Eucalyptus trees have a negative effect on other plants. This is evidenced by the fact that very little vegetation is able to establish in eucalyptus woodlots, Michelsen et.al (1996). Effect covers 33% on agricultural field and 67% on natural forest plants area as represented in figure be low

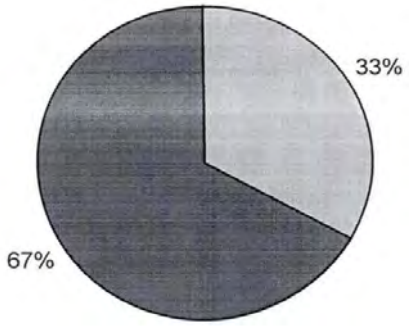


*Figure 3 Effect of Eucalyptus on other vegetation (source Michelsen et al (1998)*

### 2.1.10.Effects of Eucalyptus on Coffee Plant

Eucalyptus species were usually considered as having understory vegetation than the other types of forest stands due to its competition and hydrophobic effect. There have been easily manageable, fast maturing and widely adaptable, leguminous tree species, which improve the productivity of the adjacent plantation. The good performance of understory plants under this coffee shade trees due to absence of competition for resources with the over story plants as well as the advantage from the shade like nitrogen fixation. Hanil et al. (2008) stated that the undergrowth plant might show different patterns than the shade tree specious because of different responses to light level, nutrient availability and temperature. Shaded crops such as coffee shallower roots than the other fruit trees, then perform well Lehman, (2003). This not true for Eucalyptus since local farmers tried and failed growing coffee under its shade. In addition the different strata with in coffee garden shade facilitate infiltration, reduce erosion increases water table and improve soil physical and chemical properties throughout the under such as Acacia albida,

### 2.1.11. Effect of Eucalyptus Tree on Status of Light Intensity

Eucalyptus tree causes serious light intensity reduction up to 5 and 10m distance at 9:00 am and 12:00 am in the in the west direction, up to 10m at 12:30 pm in the north and up to 15m at 3:00pm east direction. At 4 :00 pm, Eucalyptus trees shade effect extended to 20m in the east direction. Tilashwork (2009).

# CHAPTER –THREE

## *3.1. Research Design and Methodology*

### 3.1.1. Research Design

The study was tried to describe the alternate planting area for Eucalyptus trees rather than planting the tree on crop fields, if it is selected plant kind based on its fast growing. Thus purposive survey approach was used as it enables the researcher to describe the existing planting activity preference of the community in the study area. In this study the researcher was mainly used a quantitative method design (while analyzing the data gathered through questionnaire because it is the main instrument to answer all research question) and that of qualitative design to some extent while analyzing the information gained through observation and interview because they were used as supplementary instrument for confirmation. The coverage of Eucalyptus tree plants and different food crops on farmer's crop fields was described in percent**.**

### 3.1.2. Population of the Study and Sampling Technique

Although the localities in which the research was conducted includes the villages in which the Eucalyptus plantation expansion mostly practicing, for this reason the researcher selected purposive research method because the reliable information could be collected as the respondents are those who are participating in Eucalyptus plantation expansion in in the stuy areas. Among the total population (2909) of house hold farmers, 150 sample farmers were represented. Then (10 %) of sample farmers from each villages(kebeles) 25 individuals were selected by random sampling method. The reason why the researcher used this sampling technique was to give an equal chance for the population.

### 3.1.3. Data Gathering Instruments

Mainly questionnaires, field observation and interview was employed as instrument to collect data. Different materials and Internet service were used as a reference to gather information

for the study. To confirm the information gathering through questionnaires about the Eucalyptus plantation expansion on crop land and its impact on crop production, some photographs was taken during field observation as supplementary information from planted farmers farm land.

### 3.1.4. Data Collection Procedure

Before the questionnaire was distributed, the researcher explained the purpose of the study to the participants. How to complete the questionnaire was presented orally to have meaningful data about the problem. They were also informed that the items were completed individually. The instructions was given by the researcher. In this way all the participants were get the purpose of the study and were became voluntary to complete the questionnaire without any hesitation.

Before the questionnaire is dispatched to individual, participants were given ordinal numbers according to the row of their seat. The purpose of coding the questionnaire before distributing to know each participant who fill the questionnaire and relate the impact of Eucalyptus plantation expansion on food security. In this case, no one knows which code relates to which participant except the researcher so that confidentially and ethical considerations was maintained. At the same time the participants were provided with the questionnaire to complete it with their practice in mentioned plant and their crop producing conditions.

The impact of Eucalyptus plantation expansion on food security was assessed through interviews, questionnaire and field observation with key information. One hundred -fifty interested, active farmers and six Agricultural Development Agencies (A.D.A.) were interviewed in six representatives villages (01,02,41,44, womba and mutsa ) which are dominated by Eucalyptus plantation expansion .

The primary purpose of this information collection concerning the history and back ground of Eucalyptus and to provide direction concerning the fundamental issue and questions to be answered about the influence of this plantation expansion on food security. The answers

from respondents were expressed in the percentage for comparison. since the interviewed farmers were very familiar with their environment, accurate indigenous knowledge concerning Eucalyptus trees with their environment and farm land was definitely collected. additionally some photographic evidences were collected that shows as the farmers planting Eucalyptus seedlings on their fertile crop fields by intercropping system for the first year with crops plants those consisting shorter and simple vegetative parts.

### 3.1.5. Data Processing and Analysis

The collected data on the impacts of eucalyptus plantation expansion on food security was analyzed by different statistical techniques. The analysis was included quantitative and qualitative approach in analyzing and interpreting the data. In this case, descriptive statistics (Excel and SPSS program) was used to see the mean, S.D. and percentage differences among the respondents. Moreover, the analysis was included qualitative approach while analyzing the information gained through observation and interview.

## CHAPTER FOUR

### *4.1. Data interpretation, Result and Discussion*

This chapter has two parts; the first part deals with the character sits of the respondents and the second part present the analysis and interpretation of the main data. The data gathered through interview was supposed to complement quantitative data.

Questioner was distributed to 150 respondents and all copies were returned back. In addition, 6 Agricultural Development Agencies (ADA) were interviewed successfully.

### 3.2. **Characteristics of the respondents**

Table 2 Statistical summary of Ages and gender of the respondents (n=150)

| Age and sex | Frequency | Percent | mean | S .D |
|---|---|---|---|---|
| m 25-35 | 22 | 14.7 | | |
| m 36-75 | 99 | 66.0 | | |
| F 25-35 | 9 | 6.0 | | |
| F 36-65 | 20 | 13.3 | | |
| Total | 150 | 100.0 | 37.5 | 19.99 |

As can be observed from Table 2, from the total sample farmers (150), 129 (80.7%) were males and 21(19.3%) with X=37.5and S.D=19.99 were female house hold heads. The respondents' key information were nearly all males ranged in age from 25 to 75 years old with an education level that varies from non-formal educational to grade 12 and above. Females were less familiar with the agricultural activities and there was little exchange of information with males. Most commonly planted tree species in Bambassi worada was Eucalyptus which began during emperor Hailesilase and rapidly expanding still today (2008 E.C).

Table 3 **Statistical summary of Educational background of the respondents (n=150)**

| Educational Status | Frequency | Percent | mean | S .D. |
|---|---|---|---|---|
| F>12 | 2 | 1.3 | | |
| F-Illiterate | 15 | 10.0 | | |
| m-1-4 | 28 | 18.7 | | |
| F-1-4 | 6 | 4.0 | | |
| M-5-8 | 39 | 26.0 | | |
| F-5-8 | 4 | 2.7 | | |
| M-9-12 | 14 | 9.3 | | |
| F -9-12 | 3 | 2.0 | | |
| M >12 | 9 | 6.0 | | |
| Total | 150 | 100.0 | 17 | 13.7 |

X = Mean

S.D. = Standard Deviation

Respondents asked whether the community in the locality satisfy their demand for their fire wood. ( X=17 and S.D.= 13.7) respectively. 97.3% of the respondents' reports show that as the community depending up on tree branches for their firewood, one cause for the Eucalyptus plantation expansion by farmers in the study area was to fulfill their fire wood consumption because there is no any other choice for energy source to cook food in study area.

Table 4 **Statistical data of tree plantation for fire wood in percent (%)(n=150)**

| Source of fire Wood | | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Valid | By tree planting | 146 | 97.3 | 75 | 33.4 |
| | Others | 4 | 2.7 | | |
| | Total | 150 | 100.0 | | |

With regard to item 2 of table 6-, the respondents rated whether the community in the locality were planting Eucalyptus tree rather than other tree species with (X=75 and S.D.=33.94) respectively. 98% of the respondents answered that Eucalyptus tree is the most planted tree in the study area rather than other tree species. The plantation of other plant species was very low about (2.7%) which includes fruit plants. This is because of the profitability of the Eucalyptus; its multiple use and its generation quick return than other tree species, it is also easily cultivated and gives high biomass for firewood, construction, and income generation, it regenerate after coppicing. In line with FAO (1988), Tesfaye(2000),Amare(2002),Gesse and Teklu (2011) .This merit of the plant devoted farmers of the locality to expand the plantation of Eucalyptus on their fertile crop land in fat rate since its introduction to their area. In line with Kidanu et al.(2005), FAO (1979),FAO (1985),FAO (2005).

**Table 5** Statistical data the type of tree planted in the area (%) (n=150)

| Planted tree species | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| eucalyptus | 147 | 98.0 | 75 | 33.94 |
| mango tree | 3 | 2.0 | | |
| Total | 150 | 100.0 | | |

In item 3,the respondents asked to indicate the time when the Eucalyptus plantation expansion was started in the location with (X=75and S.D.= 59..06) respectively. Few respondents (3.3%) answered as the plantation was started during emperor Hailesilasie, In lined with Demel (2000), Turn bull (1999) but from the result (52%) more Eucalyptus plantation expansion seen at presenting time. Since then the expansion was taking place in a fast condition on fertile crop land. This indicates as Eucalyptus plantation expansion is increasing from year to year in Bambasi Woreda(B.G.R.S.) still today.

Table 5 **Statistical data representing the time when Eucalyptus plantation started in the area (n=150)**

| Started time of Plantation | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| during mengistu | 66 | 44.0 | 75 | 59.06 |
| during menilik II | 1 | .7 | | |
| during emperior Haile Silasse | 5 | 3.3 | | |
| 2008 | 78 | 52.0 | | |
| Total | 150 | 100.0 | | |

In item 4, the respondents asked whether the Eucalyptus plantation expansion is very slowly slowly, fast or very fast .In line with Sangninga, et al(1992), Jouquet et al (2007) Lane et al

(2004) In this case, the farmers of the samples about (92.7%) with (X =75) and S.D.=69.77) respond as Eucalyptus plantation expansion occurring in very fast rate in the study areas respectively. From this information one can conclude that the Eucalyptus plantation expansion rate is rapidly increasing on cropland in the area.

Table 6 S**hows the rate at which Eucalyptus plantation takes place in percent.(n=150)**

| Plantation Rate | Frequenc y | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| Slowly | 3 | 2.0 | 75 | 69.77 |
| Fast | 8 | 5.3 | | |
| very fast | 139 | 92.7 | | |
| Total | 150 | 100.0 | | |

In item 5, the respondents asked whether they have their own land in the study area or not, and they all (100%) with(X=1.00 and S.D. =.000) respond as they have their own farm land on which they whether to cultivate or planting trees in the locality

**Table 8. S hows whether farmers having farm land or not in the area.(n=150)**

| Land possession | Frequency | Percent |
|---|---|---|
| Yes | 150 | 100.0 |

In item 6, the sample groups asked how many hectares they have, and then they respond relatively in between 0.5-2 hectares (68%) mostly. Some have between 2.5-4 hectares (32%) with (X= 75 and S.D. = 45.94) respectively. This indicates as most farmers in the area consists small land area which is not sufficient for both crop production and plantation of trees in the locality.

Table 7 **Shows the (%) of land owned by farmers (n=150)**

| Width of farmers land | Frequency | Percent | Mean | S.D |
|---|---|---|---|---|
| 0.5-1 hectare | 60 | 40.0 | | |
| 1.5-2 hectare | 42 | 28.0 | | |
| 2.5-3 hectare | 26 | 17.3 | 75 | 45.94 |
| 3.5-4 hectare | 22 | 14.7 | | |
| Total | 150 | 100.0 | | |

7 In item 7, the respondents asked whether the farmers in the study area used their land for crop production or for planting trees, with (X=46 and S.D.=43.86), (22.7%)of them used all their land for plantation of Eucalyptus trees and 77.3% of them were answered as they used for both cultivation of crops and for Eucalyptus trees plantation. (some part for Eucalyptus plantation and other part for crop production ). This information leads to conclude that farmers need to lead both crop cultivation and planting trees side by side but their idea seems that crops are produced for the consumption of the families where as the tree plantation is for income generation

Table 8 **Shows the (%) of land used by farmers (n=150)**

| Usage of land | In ha | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| for tree plantation | 124.05 | 45.15 | | |
| For crop production | 151.95 | 54.85 | | |
| Total | 276 | 100 | 46 | 43.86 |

In item 8, the respondents asked how much land they planted in Eucalyptus and then, their response were 0.5-1 hectare 82%;1.5-2 hectare14% ; greater than 2.5hectare 4% with X=75and S.D=72.17.This show as the farmers in the study area planted Eucalyptus tree relatively at least half hectare and mostly one hectare of their land .Based on this information, there was no respondent without the Eucalyptus plantation on his land; From the respondents total land (276 ha); (124.05 ha) which is about 45.15 % was converted to Eucalyptus plantation. This conversion of crop land to this tree plantation can result in the

reduction of food crops in the study area. In lined with Dvidso .J (1989), Ei-amin.et al (2001), Pamela ,Jagger and John Pender (2000), YU et al (2006), Hall et al (1981), Selam yihun and Struder (2004) The remained of their land about 151.95 ha (54%) was the land for crop production. So plantation of the Eucalyptus tree is the burning issue of the community in the research area and this practice cause shortage of food crops.

Table 9 **Shows the percentage of respondents on land occupied by Eucalyptus tree(n=150)**

| Land in hectare | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| 0.5-1 | 123 | 82.0 | 75 | 72.17 |
| 1.5-2 | 21 | 14.0 | | |
| 2.5-3 | 5 | 3.3 | | |
| 3.5-4 | 1 | .7 | | |
| Total | 150 | 100.0 | | |

As indicated in item 9, respondents were asked whether they have the recognition about the effect of Eucalyptus on their crop production, the most respondents about 98% with (X=75 and S.D. =73) were answered as Eucalyptus plantation expansion has negative impact on crop production, this indicate as they have indigenous knowledge about the impact of Eucalyptus plantation expansion on food crops. Even if most of the respondents seems to have recognition about the negative impact of Eucalyptus on production of food crops,

farmers in the locality were attracted to the tree plantation following only a time being benefit; for this case they initiated to expand eucalyptus plantation on their farm land rather than cultivating crop plants because of the highest cost of the eucalyptus tree biomass have. Additionally, once planted eucalyptus can regenerated after coppicing again and again for years but crop cultivation requires much energy, time, cost for cultivation year to year.

Table 10 **Show whether farmers have concept about the tree impacts on crop production(n =150)**

| Farmers recognition | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| Yes | 148 | 98.7 | 75 | 73 |
| No | 2 | 1.3 | | |
| Total | 150 | 100.0 | | |

Table 11 Statistical summary of respondents on income generated from Eucalyptus trees per year.(n =150)

| **Cost in birr** | **Frequency** | **Percent** | **Mean** | **Standard Deviation** |
|---|---|---|---|---|
| **1000-5000** | **90** | **60.0** | **75** | 61.11 |
| **5100-5500** | **25** | **16.7** | | |
| **5600-10,000** | **10** | **6.7** | | |
| **10,000-10,500** | **3** | **2.0** | | |
| **>11,000** | **22** | **14.7** | | |
| **TOTAL** | **150** | **100.0** | | |

In item 10, the sample groups were asked how much money they generate from Eucalyptus biomass per year, then they respond as they gain about (60%) income relatively from their plantation with X=75 and S.D=61.11 In line with Assaye, A (2002), Tesfaye T.(2009) This implies that most farmers in the area generate more income from selling of Eucalyptus biomass than crop yields which is planted on similar size of land plot per year. This selling cost initiated the farmers to give attention to fast plantation expansion of Eucalyptus trees.

The income generated from maize yield per year as respondents asked was (34.7%) with the (X=75 and S.D.55.34) that indicate farmers interested to convert their farm land to Eucalyptus plantation because of the income generated from eucalyptus biomass is much greater than the cost of maize in Bambasi Woreda (B.G.R.S.).

Table 12 Statistical data representing the cost of maize in (%) per year(n=150)

| Cost in birr | Frequency | Percent | Mean | Standard deviation |
|---|---|---|---|---|
| 3000-600 | 52 | 34.7 | 75 | 55.34 |
| 601-900 | 17 | 11.3 | | |
| 901-1200 | 10 | 6.7 | | |
| 1201-1500 | 13 | 8.7 | | |
| 1501-1800 | 58 | 38.7 | | |
| Total | 150 | 100.0 | | |

The annual income from sorghum to the local farmers was relatively (32%), with the(X =75and S.D.=57.16). This indicate that the annual income from sorghum of the local community in the study area is very less, but from the equal size of land on which they produce Eucalyptus, is more than ten times greater than income gained from sorghum yield cost according to the information given from the respondents.

Table 13 Statistical data representing the cost of sorghum in (%)in the year(n=150)

| Cost in birr | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| 350-650 | 9 | 6.0 | 75 | 57.16 |
| 651-900 | 48 | 32.0 | | |
| 901-1200 | 33 | 22.0 | | |
| 1201-1500 | 16 | 10.7 | | |
| 1501-1800 | 36 | 24.0 | | |
| >1801 | 8 | 5.3 | | |
| Total | 150 | 100.0 | | |

To compare the income generated from teff yield with the income generated from Eucalyptus biomass that produced on similar size of land, respondents answered as the income from teff was relatively (45.3%) with( X=75 and S.D.=60.01). They also explained as environmental conditions is not suitable for cultivation of teff, then the community choice the Eucalyptus tree plantation that results more income per year than teff .

Table 14 **Statistical data representing the cost of teff in (%) in the year (n=150)**

| Cost in birr | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| 400-800 | 68 | 45.3 | 75 | 60.01 |
| 801-1200 | 30 | 20.0 | | |
| 1201-1600 | 30 | 20.0 | | |
| 1601-2000 | 1 | .7 | | |
| 2001-6000 birr | 18 | 12.0 | | |
| >6002 birr | 3 | 2.0 | | |
| Total | 150 | 100.0 | | |

One of the most commonly produced crop in Bambasi woreda is millet .The yield produced and the income generated per year was asked, the respondent answered,that (30.7%) with the X=75and S.D.=56.43).This indicate the much less income from millet per year was gained because of this the local farmers thinks to expand Eucalyptus trees on their land instead of cultivating millet.

Table 15 **Statistical data representing the cost of millet in(%)in the year (n=150)**

| Cost in birr | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| 350-650 | 28 | 18.7 | 75 | 56.43 |
| 651-900 | 46 | 30.7 | | |
| 901-1200 | 20 | 13.3 | | |
| 1201-1500 | 24 | 16.0 | | |
| 1501-1800 | 4 | 2.7 | | |
| >1801 | 28 | 18.7 | | |
| Total | 150 | 100.0 | 100.0 | |

To identify whether the annual income generated from soya bean product was preferable or not than eucalyptus biomass income, the researcher asked the respondents how much money they gain from the yield of soya bean per year, then they respond,(38%)relatively with the( X=75.and S.D.=53.94)This indicate the income generated from soya bean is not satisfactory just like the income generated from Eucalyptus biomass which was planted on the equal size of land cultivated with soya bean .

Table 16 Statistical data representing the cost of soya bean in (%) in the year (n=150)

| Cost in birr | Frequency | Percent | Mean | Standard Deviation |
|---|---|---|---|---|
| 300-600 | 25 | 16.7 | 3.61 | 53.94 |
| 901-900 | 14 | 9.3 | | |
| 1201-1500 | 18 | 12.0 | | |
| 1501-1800 | 30 | 20.0 | | |
| >1801 | 63 | 42.0 | | |
| Total | 150 | 100.0 | | |

Additionally, the information collected from A.D.A. in the six villages (kebeles) mate the data gathered through other data collection tools. They replied as "the farmers are converting their farm lands to Eucalyptus plantation because of the selling cost of Eucalyptus tree biomass in the area is much greater than the selling cost of crop yields, even if, the awareness is given to them about the negative impact of the Eucalyptus on the environment. Field observation was made by the researcher to see if the Eucalyptus plantation expansion is still the ongoing practice or not in each village. The real evidence for the practice was seen on farmers crop field. Many Eucalyptus seedlings plantation were observed as intercropped with simple vegetative crop varieties such as *Eragrostis tef* (Teff), *Lnum usitatissiumum* (Telba) and *capsicum frutescens* (Berbere) has been done. The following photographic representation realize the plant expansion practice in the area.

*Figure4 Widely planted Eucalyptus seedlings on farm land.*

*Figure 5 Eucalyptus seedlings intercropped with Linseed (telba).*

*Figure 6 Eucalyptus seedlings intercropped with Capsicum frutescens (berbere) plant.*

*Figure 7 Figure 8Eucalyptus seedling planted at the side of Eragrostis tef (Teff) field.*

*Figure 9 Newly planted Eucalyptus seedling on fertile soil*

# CHAPTER - FIVE

## *5.1. Conclusion*

In the study area, farmers prefer Eucalyptus plantation expansion on their fertile crop land than cultivating crops in a very fast rate because of rapid growth and higher biomass production of the tree in a short period of time f or the requirement of fire wood, construction material and especially for its highest income generation than crop yields. In another hand farmers in the area which is not so much sufficient for both tree plantation and crop production. Even if their land is small sized about 45.15 % of their land is covered with Eucalyptus plantation but only 54.95% is for crop production in the study site. If the plantation expansion continue in the presenting rate the remained could be covered in a short period of time. The future food security of the community as well as the next generation of the area could be affected because of its adverse effect and the competition for crop field. . Some dwellers give suggestion about the negative impact of the Eucalyptus plantation expansion on the environment;but most of them practicing the plant expansion still now. The farmers are only following the income generated from the selling of the biomass of this plant and its relative advantages. They never give attention to the ecosystem degradation which is resulting by Eucalyptus plantation and the redaction of food crops in this area year by year.

## *5.2. Recommendation*

Giving priority to crop production is better to have stable food security. Crops cultivating on productive land is advisable instead of expanding Eucalyptus tree plantation on fertile soil. Even unfertile land could be treated in scientific way to bring its productivity again rather than converting it to the Eucalyptus plantation expansion. Eco-friendly indigenous plants which increase soil fertility is to plant by mobilizing the community in continuous manner in and sounding the crop land which can give dual benefit. New Eucalyptus plantation is unnecessary to authorize in protected natural area or in another area of intact for the conservation of endangered habitat of species. Generally if forestry planning authorizes the

new plantation and to keep the advantage of Eucalyptus, priority could be given to land exchange (the steep slopes and gorges of the area). Furthermore, it is better to try to select the less resource seeking Eucalyptus spp. by experts through additional studies. Continuous awareness is needed to convince the community to stop the plantation expansion crop land. and effective controlling measures must be taken on illegal individuals who trying to expand the plant on farm land. Prizing crop producing farmers by Administrators is necessary to attract the attention of the illegal planate of Eucalyptus. Giving emphasis by extension service to support land users in selecting the right species for the right site is desirable. Finally there is a need of policy or regulation on Eucalyptus plantation practice.

## APPEDIX I

**Research Questions**

Questionnaires to Survey the environmental impact of Eucalyptus plantation

On Food Security In Bambasi woreda

Date ----------

Gender Male ☐ Female ☐

Village /Location ----------

Age ----------

Education ----------

Questions that will be asked to study the impact of Eucalyptus plantation expansion on food security in Bambasi woreda Assosa Zone Benishangul Gumuz Regional State (B.G.R.S.)

**1.** How does the local community satisfy demands for fire wood?

**A.** Animal manure ☐ **B.** by tree planting ☐ C. by fuel gas ☐ D. others ☐

**2.** Which tree species do most people plant in this locality?

A. Eucalyptus ☐ B. Acacia ☐ C. Mango tree ☐ others ☐

**3.** If your response is Eucalyptus, for what purpose do you plant the tree?

_____

_____

**4.** When do you think Eucalyptus tree planting was started in this locality ? during emperor

A. Mengstu ☐ C. during emperor Haileselasie ☐

B. during emperor Menelik ii ☐ D. during E.P.D.R ☐

**5.** How eucalyptus planting expanded in this area?

- Very slowly ☐ B. slowly ☐ C. fast ☐ D. very fast ☐

**6.** Do you have your own land

A. yes ☐ B. No ☐ C. if your response is yes, how many hectares? ☐

**7.** For what purpose(s) do you use your land?

A. For crop production ☐ B. for tree ☐ C. plantation ☐ D. for both ☐

**8.** How much land do you plant in Eucalyptus? ----------

**9.** Do you think that Eucalyptus trees have effect on your crop production?

A. Yes ☐ B. No ☐

**10.** If eucalyptus plantation expansion continues at presenting rate in your locality what do you think about the future food security of the community?

Please explain your feeling----------
--- ----------

**11.** What measures could be taken to maximize crop productivity and the advantage Eucalyptus in your locality? ----------
---- ----------

**12.** How much money you may generate each year from Eucalyptus? ----------
----------

**13.** How much cash you may generate each year from crop yields which is produced on the same size of land occupied by your Eucalyptus plantation? Fr0m maize----------
From sorghum-------From teff ---------- From millet ----------From soya bean---------

APPEDIX II

**Interview for Agricultural Development Agency (D.A.)**

Interview to survey the impact of Eucalyptus plantation expansion on food security in Bambasi woreda

Date ----------

Gender----------

Village [location] ---------- Age ---------- Education ----------

1. How do the local community fulfill their wood demand?----------
   ---
   ---
   Why do you think that the local community plant eucalyptus tree rather than indigenous trees?----------
   ---
2. Do you think that farmers have enough awareness about the effect of Eucalyptus tree on the environment as well as on food crops?----------
   ---
3. What force farmers to plant Eucalyptus tree on their farm land instead of cultivating crop plants? ----------
   ---
4. If the Eucalyptus plantation expansion continue at presenting rate in your locality what do you think about the future food security of the community? ----
   ---
5. What measures could be taken to maximize crop productivity and the advantage of Eucalyptus in your locality?----------
   ---
   ---

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*Table 17* ***Statistical data of respondents for items from one to ten (n=150)***

| | question one | question two | question three | question four | question five | question six | question seven | question eight | question nine | question ten |
|---|---|---|---|---|---|---|---|---|---|---|
| Valid | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | 2.03 | 1.04 | 2.63 | 3.91 | 1.00 | 2.07 | 2.77 | 1.23 | 1.01 | 1.95 |
| Median | 2.00 | 1.00 | 4.00 | 4.00 | 1.00 | 2.00 | 3.00 | 1.00 | 1.00 | 1.00 |
| Std. Deviation | .162 | .281 | 1.472 | .354 | .000 | 1.079 | .420 | .533 | .115 | 1.441 |
| Sum | 304 | 156 | 395 | 586 | 150 | 310 | 416 | 184 | 152 | 292 |

*Table 18* ***Statistical summary of respondents on income generated from crops per year (n=150)***

| | **Maize** | **Sorghum** | **Teff** | **Millet** | **Soya bean** |
|---|---|---|---|---|---|
| **Valid** | **150** | **150** | **150** | **150** | |
| **Missing** | **0** | **0** | **0** | **0** | **0** |
| **Mean** | **3.05** | **3.31** | **2.20** | **3.09** | **3.61** |
| **Median** | **3.00** | **3.00** | **2.00** | **3.00** | **4.00** |
| **Std.Deviation** | **1.775** | **1.423** | **1.433** | **1.735** | **1.510** |
| **Sum** | **458** | **496** | **330** | **464** | **542** |

Expansion of Eucalyptus on farm land

Eucalyptus expansion year by year