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The Eucalyptus Dilemma: The Pursuit for Socio-economic Benefit versus Environmental Impacts of Eucalyptus in Ethiopia

Mekonnen Daba
Oromia Agriculture Research Institutes, Bako Agricultural Research Center, Bako, Oromia, Ethipia

Abstract
Eucalyptus is one of the most planted types of trees in the world, has been grown in Africa and elsewhere for over a century. The Ethiopia population is growing rapidly. The natural forest coverage and native forest tree species are decreasing in an alarming rate. There are many dilemmas among users, growers, environmentalists, researchers and policy makers on the ecological, socio-economic benefit and environmental impacts *Eucalyptus*. Ethiopia Farmers commonly plant eucalypts tree on their farmlands. Currently, growing eucalypt trees is becoming a great concern due to its socio-economic benefit and environmental impacts.In Ethiopia, where there are huge gaps between demand and supply of wood as a result of increasing deforestation, the use of fast growing plantation species such as eucalypts is unavoidable as they are preferred to other species, because of their peculiar features; these include they require minimum care, fast growth and good quality of wood and fibres, easy reproduction through seeds, coppice after harvested, grow in wide ecological zones and poor environments; resistant to environmental diseases and stress and generates substantial income to rural and urban households.On the other hand, Some of *Eucalyptus* impacts on the environment are: adverse effects of their leaf litter on soil humus, removal of too much water from farmlands, stream banks, catchments areas and underground water, heavy consumption of soil nutrients (deplete soil nutrients), failure to provide food supplies or adequate habitat for wildlife, inability to prevent soil erosion and inhibition of growth of other plants. Numerous study reports appeared that the benefits of *Eucalyptus* trees are far more than its negative impacts.Consequently, instead of complain whether to avoid plantation of *Eucalyptus* trees; emphasis should be given by the environmentalists, researchers and policy makers to support users and growers of *Eucalyptus* in selecting the appropriate place of plantation and species selection for the adequate uses and management on *Eucalyptus* planting, so that the environmental impacts are minimized and the socio- economic benefits of *Eucalyptus* were optimized. Therefore, this review paper briefly summarizes the socio-economic benefit and environmental Impacts of *Eucalyptus* trees.
Keywords: Eucalyptus Dilemma; Socio-economic benefit; Environmental Impacts; Ecological effects

Introduction

Eucalyptus is the species most widely introduced overseas and is a long and ever green tree from Myrtaceae family (Rassaeifar *et al*., 2013). *Eucalyptus*, a genus of more than 500 species, has become the most planted genus of tree in the world (Teketay, 2000). The major *Eucalyptus* growing countries are: China (170 million ha); India (2.5 million ha); and Brazil (3.7 million ha) (Davidson, 1995; Stape *et al*., 2001; Stape, 2002; Liu and Li, 2010; ICFRE, 2010). In Africa, South Africa has the largest area under *Eucalyptus* plantations of about half a million hectares (Teketay, 2003). In Ethiopia the genus was introduced during the reign of Emperor Menilek II (1868-1907) in 1894/95 (Von Breitenbach, 1961). The purpose was to supply fuel wood and construction timber to the new and growing capital city, Addis Ababa. Species of the genus *Eucalyptus* (common name *Eucalyptus*) are widely planted all across Ethiopia including on large areas of land previously allocated to food production (Liang *et al*., 2016). In recent decades *Eucalyptus* has also increasingly been planted on lands around and within "church forests," sacred groves of old-aged *Afromontane* trees surrounding Ethiopian Orthodox Tewahido churches. These revered holy sites have long been recognized for their cultural values and also for their ecosystem services including their potential to support species conservation and restoration, as church forests are some of the only remaining sanctuaries for many of Ethiopia's indigenous and endemic plant and animal populations (Liang *et al*., 2016). Currently, it is estimated that, over 500000ha of the land is covered by *Eucalyptus* plantation in Ethiopia (Abebe and Tadesse, 2014).

Nowadays in Ethiopia, the *Eucalyptus* continue to be planted and used by many farmers in various ways: mainly grown in small woodlots for building materials and fuel wood and charcoal making, locally- they are also found in shelterbelts, shady groves in and around the villages, churches and other dwellings; they also constitute a major source of honey and their leaves are traditionally used as a medicine to fight flu and fever (*E. globulus*) just to mention few products and services of the *Eucalyptus* to be considered as a major multipurpose tree in Ethiopia (Louppe and Denis, 2010). Several studies have been conducted on plantation forest in Ethiopia in relation with social, economic and environmental concerns (Luttge *et al*., 2002; Minda, 2004; Abiyu *et al*., 2011; Dessie and Erkossa, 2011).

In Ethiopia, *Eucalyptus* species are commonly integrated into the various farming systems and their planting has resulted in high economic profitability compared with agricultural use of land for crop production

(Mulugeta, 2010). Farmers' raised interest in eucalypt farm forestry has now caused for conversion of croplands into eucalypt woodlots (Dereje *et al*., 2012). However, the uncontrolled expansion of eucalypts on productive farmlands has raised great concern, particularly as eucalypts are claimed to have detrimental effects on soil productivity (El-khawas and Shehata, 2005; Forrester *et al*., 2006; Jiregna, 2006). Numerous studies conducted in the Ethiopia have shown reduction in crop growth and yield when agricultural crops are grown close to eucalypts (Kidanu *et al*., 2004, 2005; Jagger and Pender, 2003; Chanie et al.,2013 Jiregna G, 2003). Eucalypts have been reported to cause crop loss by outcompeting crops for water and soil nutrients (Michelsen *et al*., 1993; Jiregna Gindaba, 2003), through shading (Chanie *et al*., 2013) and producing allelochemicals (Lisanework and Michelsen, 1993; Ahmed *et al*., 2008). *Eucalyptus* seedlings are vulnerable to severe water stress unlike the seedlings of indigenous deciduous tree species in Ethiopia (Gindaba *et al*., 2004). This shows that *Eucalyptus* trees need more water and compete with neighboring plants for the available water in the soil.

Despite its greater importance and the potential for *Eucalyptus* to improve rural livelihoods and national development initiatives, *E.globulus* is undermined by several scientists and communities related to the belief that "there are significant negative environmental externalities associated with *Eucalyptus* trees" (Zhang and Fu, 2009; Rassaeifar *et al*., 2013). Most criticisms are based on a range of technical, ecological and socio-economic arguments (FAO, 1988). According to Chin Ong. (2006), fears that *Eucalyptus* will deplete water supply, affect wildlife habitats and soil fertility in undesirable ways, and cause soil erosion seem to be valid in arid and semi-arid lands. And one may add that effects of climate change along with an increased scarcity of water resources, locally, do not militate in favor of the *Eucalyptus*. The same author indicates that fears that it will affect wet zone biodiversity adversely appear unfounded.

The major factors driving farmers to plant *Eucalyptus* are: increasing demand for wood products in the market, the unavailability of wood on farm, high rate of biomass production, ease to cultivate and wider adaptability, non-palatability to livestock (Mekonnen *et al*. 2007). Other recent evidence from the literature suggests that *Eucalyptus* may not always have negative effects on topsoil retention and soil nutrient availability. If planted properly, for example, *Eucalyptus* can act as shelterbelts for crops (Zegeye, 2010; Jagger and Pender, 2003).

Even though there has been concern among users, growers, stakeholders, scientists and farmers that, *Eucalyptus* trees are affecting ecosystem negatively and positively. The environmental impacts and ecological services of *Eucalyptus* trees have been studied only to limited extents in Ethiopia and Africa. Therefore, the main objective of this review paper is to highlight the socio-economic benefit and environmental Impacts of *Eucalyptus*

Eucalyptus **products and services**

Eucalyptus is an excellent tree for producing quality short fibre, vegetable coal and non-forest products (FAO, 2002). In Ethiopia and Rwanda smallholder farmers grow *Eucalyptus* mainly for fuel wood, poles, furniture making, and construction wood and farm implements. *Eucalyptus* trees are suitable for two key functions in Ethiopia, both urban and rural households: namely the household fuel wood needs and for construction of economic housing and fencing (Amare, 2002). According to Nduwamungu *et al*. (2007), in Rwanda smallholder farmers produce charcoal and lumber which are not widely known in Ethiopia.

Some of the known products and services of Eucalyptus are shown in (Table 1). *Eucalyptus* can be used for plywood, telephone transmission poles, fuel wood power and pulp, timber, medicine, building and fencing posts, rails, tannin, perfumery and environmental conservation; honey production (FAO, 1979; Davidson, 1989; Pohjonen and Pukkala, 1990; Jagger and Pender 2000; Teketay, 2000; Amare 2002; Zerfu, 2002; Hailu *et al*., 2003; Oballa, 2005; Mekonnen *et al.,* 2007, Nduwamungu *et al*., 2007; FAO, 2009; Gebrekidan *et al*., 2012; Jaleta *et al*., 2016).

Table 1: some of the known products and services of *Eucalyptus*

***Eucalyptus* products and services**	**Descriptions**
Products	
Plywood	There are few plywood plants using *Eucalyptus* in Ethiopia
Transmission poles	Almost all power and telephone lines especially in Ethiopia use *Eucalyptus* transmission poles
Lumber	It is only in Rwanda where lumber is produced commercially. However, household level pitsaw is practiced in Ethiopia
Fuel wood	The most important benefit of *Eucalyptus* in all East African countries is household energy
Perfumery	Few commercial distillers exist in Ethiopia where essential oil is produced from the leaves of *E. globulus* and *E. citriodora*
Rails	*Eucalyptus* was important in the Kenyan and Ugandan rail way construction
Building and fencing posts	Almost all wooden houses and wooden fences are built from *Eucalyptus* in Ethiopia
Scaffolding	The construction boom in East Africa including skyscrapers, bridges, dams and roads use *Eucalyptus* scaffolding
Pulp	There is no commercial pulp production from *Eucalyptus* in East Africa
Tannin	This is not a well-known product in east African countries
Medicine	*Eucalyptus* is used as a medicine at household and community scale in Ethiopia *E. globulus* leaves are used to treat common cold and flus
Honey production	*Eucalyptus* flowers pollen are important bee forage in east Africa (Ethiopia and Rwanda)
Ecosystem services	
Environmental conservation	*Eucalyptus* trees are planted for gully stabilizations, soil conservation and road embankments strengthening
Nurse tree	Experiences in Ethiopia showed that some indigenous trees such as *Juniperus procera*, *Podocarpus falcatus* can regenerate well under *Eucalyptus* stands
Socioeconomic services	
Livelihood	Contribute positively to income/food security. Growing of *Eucalyptus* is considered a growers green bank account
Economic	*Eucalyptus* is a high value cash crop. In Ethiopia about 25% of farmers income is from *Eucalyptus*
Social significance	Owning *Eucalyptus* stand is considered a sign of affluence/wealth
Access to credit	In Rwanda eucalypts stands are recognized as collateral to borrow money from banks
Land tenure	Farmers plant eucalypts to ensure land tenure security in case of dispute or if the landowner cannot cultivate the land for some reason

Sources: FAO, 1979; Davidson, 1989; Pohjonen and Pukkala 1990; Jagger and Pender 2000; Teketay, 2000; Amare 2002; Zerfu, 2002; Hailu *et al*., 2003; Oballa, 2005; Mekonnen *et al.,* 2007, Nduwamungu *et al*., 2007; FAO, 2009; Gebrekidan *et al*., 2012; Jaleta *et al*., 2016.

Socio-economic Benefit of *Eucalyptus*

Eucalyptus has numerous required socio-economic benefits including employment, security and financial benefit. *Eucalyptus* plantation forestry has played and continues to play significant role in improving the livelihoods of rural communities, poverty reduction and reducing the pressure from remnant native forests in the highlands of Ethiopia (Tadele *et al*., 2014). According to the study by (Mekonnen *et al*., 2007), the income from *Eucalyptus* contributes up to 72% of total household annual cash income for poor household in central highland of Ethiopia. The income generated from *Eucalyptus* sale can be used to buy food and other household expenses. Similarly, the fuel wood that is used for household consumption was not converted to price, but it has significant impact on poverty reduction and women empowerment. In most rural areas of Ethiopia women took their major time in collecting fuel wood far places from their villages. Similarly, Kebebew and Ayele, (2010), argued that assigning 12% of the land to *Eucalyptus* can increase the income from the land up to 90% and reversely substituting the *Eucalyptus* covered land by important crops such as *teff* and barley may reduce the income from the land up to 125%. In general, practicing *Eucalyptus* planting as one land use besides other crops in the available field could improve the household income and contribute to poverty reduction straggle in Ethiopia. Growing *Eucalyptus* has significant economic benefit to the land user (Wirtu and Gong, 2000; Liu and li, 2010). The cash obtained from

Eucalyptus sale assist smallholder farmers to bridge the food shortage gab at household level. As a result, growing *Eucalyptus* at a farm level in a form of woodlot has become very common practice among smallholder farmers in rural parts of Ethiopia (Jagger and Pender. 2003). According to Hailu *et al*., (2003), Eucalypts are highly preferred and appreciated by local people than other indigenous or exotic species, which rarely present in the landscape, because *Eucalyptus* perform a high biomass production and a rapid growth, they produce valuable construction poles and fuel-wood in a reasonable short period of time for the local market, thus providing cash income for local village communities. Because of the fuel wood shortage in some regions litter (leaves, twigs, bark etc.) is ranked by women and children and locally used for fuel or marketed. According to Teketay, (2000), *Eucalyptus* plantations on steep slopes can provide effective erosion control if careful techniques such as contour planting are used. This method has been successful in Nigeria where a humid climate favored rapid site coverage and production of large volumes of wood from *E. hemiphloia* and *E. occidentalis* have been recommended for control of erosion in these conditions.

The imbalance between supply and demand becomes extremely wide and in subsistence households the demand is fulfilled through over-exploitation of woody vegetation and any kind of herbaceous materials in the vicinity of the villages and households by using dung and crop residues as a substitute for fuel-wood (Hailu *et al*., 2003). In most areas of the country all parts of the *Eucalyptus* trees (stem, bark, branches, leaves, and roots) are harvested for daily livelihood activities (Figure 1).

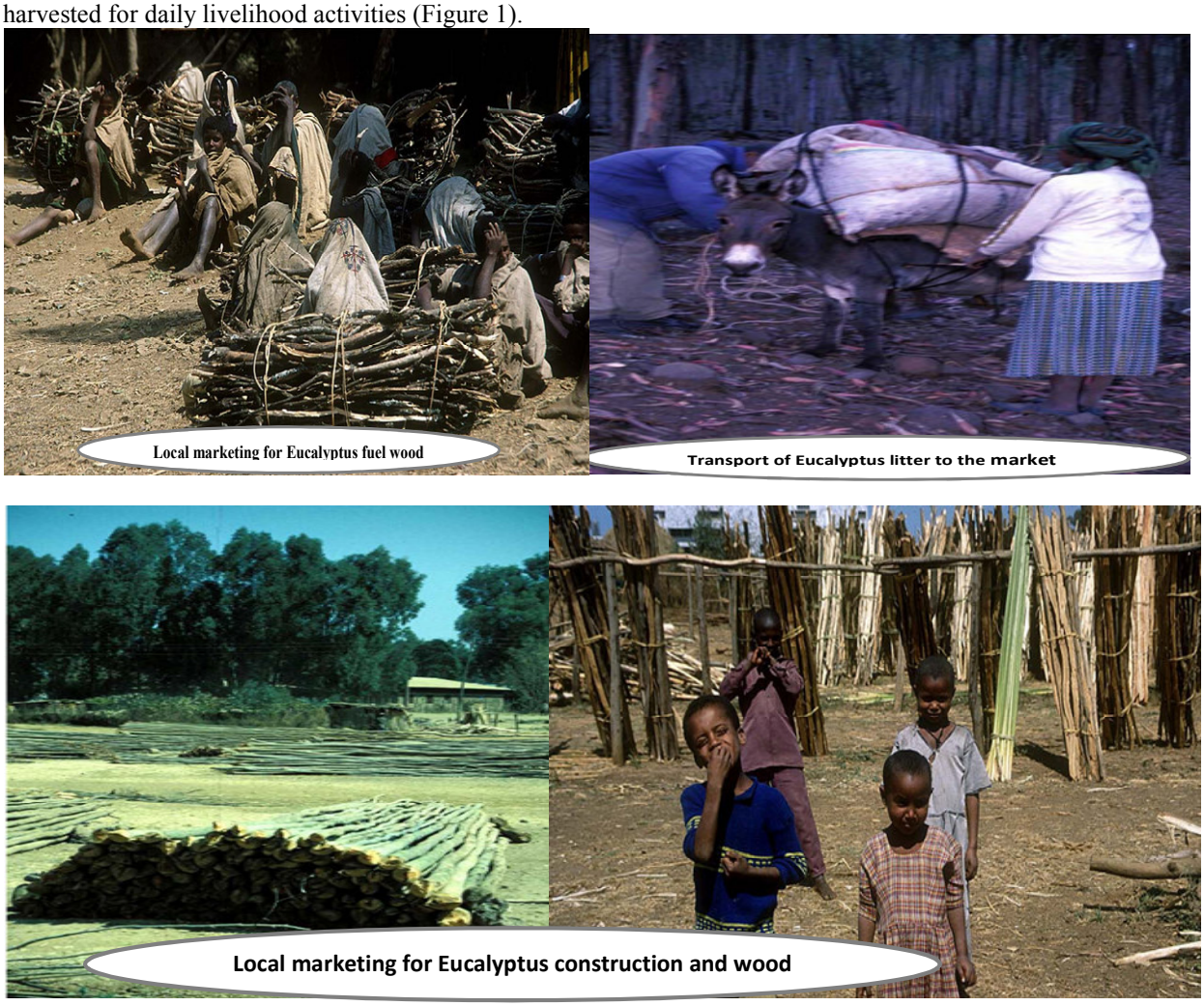

Figure 1: Some of socio-economic benefit of *Eucalyptus* (Hailu *et al*., 2003)

Environmental and industrial benefits of *Eucalyptus*

Eucalyptus plantation is not a natural forest nor is it an agricultural crop; it is a forest crop which through its functions acts in a similar way to a forest (ENCE, 2009). The environmental and Industrial benefits of *Eucalyptus* were showed in (Table 2). *Eucalyptus* has great industrial advantages which make it a tree of extraordinary value as a renewable raw material. As reported by (Du *et al*., 2015), *Eucalyptus* is a fast-growing forest tree with high potential biomass carbon sequestration. Since *Eucalyptus* has high potential to sequester carbon and therefore can mitigate climate change like *Moringa oleifera* and Bamboos as stated by (Daba,

2016).The author appeared that, *Moringa oleifera* and Bamboo were fast growing and well adapted to adverse climate conditions and therefore high potential to sequester carbon and mitigating to climate change.

Table 2: Environmental and Industrial benefits of *Eucalyptus*

Environmental benefits	Industrial benefits
• Due to its higher growth capacity and the density of its wood, *Eucalyptus* is very efficient at capturing CO 2, fixing carbon and generating oxy-gen • The mass effect means that forest plantations act as the planet's reserve oxygen tanks • Its speedy growth and its renewal every 10 or 15 years mean that it fixes a greater amount of carbon • *Eucalyptus* promotes biodiversity and eucalypt tus plantations create new natural spaces • A *Eucalyptus* plantation is not a natural forest but because of its functions it acts in a similar way to a forest • *Eucalyptus* recovers degraded soils which are unused or unusable • *Eucalyptus* protects natural woodland • *Eucalyptus* and its forest management reduce the risk of forest fires.	• *Eucalyptus* plantations create employment and wealth in the rural medium. The land on which wood is grown is owned by families. • *Eucalyptus* stands out because of its many industrial applications, which are profitable and sustainable. • Its forest production and the wood yield make white *Eucalyptus* the most appropriate tree for producing pulp and renewable energy. • *Eucalyptus* implies quality at a lower cost in manufacturing printing, writing and tissue paper. • *Eucalyptus* is also used for other many industrial and social uses, from manufacturing honey to essential oils, to hunting and livestock on its plantations, and leisure. • The energy potential offered by *Eucalyptus* bio-mass is an opportunity for economic and social development.

Source: ENCE, 2009

Environmental Impacts of *Eucalyptus*

Eucalyptus causes a number of environmental hazards like depletion of groundwater, dominance over other species by allopathic effects, loss of soil fertility and negative impacts on local food security issues (Joshi and Palanisami, 2011). Planting of *Eucalyptus* trees adjacent crop has effects on depletion of the water table and hydrological cycle. According to the report by FAO, (2009), among the criticisms against eucalypts plantations is that they promote a change in the local climate. This is because of their very high evapotranspiration rate, which drains water from the soil leading to a lower water table. This high evapotranspiration rate is claimed to adversely affect local rainfall levels, resulting in possible desertification of the area. The hydrological impacts of *Eucalyptus* are often displayed in terms of its runoff regulation, water uptake, canopy interception, and soil moisture depletion. According to (Jagger and Pender, 2000), there are both negative and positive arguments in literature about *Eucalyptus* (Table 3).

Table 3: Ecological effects of *Eucalyptus*

Effect	Positive	Negative
Biomass production	Planting fast growing *Eucalyptus* may be one of the best short-term options for the provision of critically required biomass	Land scarcity may be a constraint to wide-scale tree planting, however wasteland and degraded land in good supply
Effects on soils, nutrient depletion and topsoil retention	On degraded hillsides and wastelands the net soil nutrient contribution of *Eucalyptus* through leaf litter is likely to be positive	*Eucalyptus* trees deplete soil nutrients needed by agricultural crops, however the spatial magnitude of depletion is not known
	Good potential for topsoil retention on degraded hillside	The ability of *Eucalyptus* to provide organic matter is questionable
Allelopathic effects	Rainfall may decrease or negate the allelopathic effects of trees on crop	Allelochemicals negatively influence agricultural production and are a more significant factor in dry regions
Hydrological impacts	In regions with erratic and severe rainfall the ability to take up large quantities of water may reduce runoff, flooding and water logging	*Eucalyptus* may complete water away from agricultural crops decreasing agricultural output as far as 10 meters away from where trees are planted
	On previously barren slopes, tree cover may reduce erosion and gully formation caused by rainfall	Wide scale hydrological impacts are uncertain
Resistance to pests, pathogens and random disturbances	Some species of *Eucalyptus* have avoided attack from some commonly observed insect pests and are unpalatable to livestock	Pests and pathogens may migrate to unaffected regions causing medium-term losses
	Some species are drought, flood and fire resistant	Non-palatability of leaves to livestock is problematic for farmers who require livestock fodder.

Source: Jagger and Pender, 2000

Impacts of *Eucalyptus* on Agricultural Crop Production

There is no adequate scientific evidence regarding reclamation of farmlands planted with *Eucalyptus* for agricultural crop production. Many research conducted so far mainly focused on reduction in crop growth and yield when eucalypt trees are grown on or close to farmlands (Jagger and Pender, 2003; Chanie *et al*., 2013). There has been also fear of crop loss owing to the perceived long-term site deterioration allegedly caused by *Eucalyptus* (Jiregna, 2006). *Eucalyptus* caused crop yield reduction due to nutrient depletion and production of toxic exudates (allelochemicals) (EI-Amin *et al*. 2001). Experimentally, it was proven that the poor performances of the adjacent plants, particularly maize and undergrowth plants were due to light, water and nutrients (total nitrogen, available phosphorus and exchangeable calcium) competition and soil water repellency (Chanie *et al*., 2013). In areas where there are crops nearby, this can make *Eucalyptus* a problematic competitor. For instance, (Chanie *et al*., 2013) found that *Eucalyptus* decreased both soil nutrients and crop (maize) yield up to 20 m away from the *Eucalyptus* trees in the Lake Tana plain of Ethiopia, and additionally, soil hydrophobicity (water repellency) became a problem.

Impacts of *Eucalyptus* on Water Resource

There is limited evidence regarding the impacts of *Eucalyptus* on water. Water scarcity is an increasingly severe problem across the developing world, with many countries in East Africa already experiencing severe water scarcity (Jagger and Pender, 2000). Certain trees that are integrated into agricultural systems can increase the efficiency of water use, while plantations of fast-growing trees like *Eucalyptus* trees can exacerbate the problem of water shortages. It is claimed that *Eucalyptus* trees absorb more water from the soil than any other tree species. The results of research on the water use and water balance effects of trees in Kenya shows that, *Eucalyptus* consumes more water, especially during its early growing stages compared to pinus species (Dye and Bosch, 2000).

Eucalyptus is a well-known forest species of high water uptake ranging from 50 Lt/d/plant to even 90 Lt/d/plant, depending upon the adequacy of supply (Joshi and Palanisami, 2011). But, it is also reported that, in stress situation, its roots can grow even up to 20-30 feet and extract more water. The leaf area of the *Eucalyptus* plants is also another important factor affecting the rate of water consumption. The study by Hatton *et al*. (1998) concluded that there was a strong linear relationship between tree leaf area and mean daily water use for a wide range of Eucalyptus species grown under similar climatic conditions. *Eucalyptus* trees also take up a great amount of water from the soil and as a result can affect water availability, competing with crops and other vegetation for water and depleting the water table (Zegeye, 2010; Dessie and Erkossa, 2011; Palmberg, 2002; Jagger and Pender, 2003). Their high water requirements and deep root systems can give them a relative advantage over other plants in terms of water usage, which can be particularly damaging if *Eucalyptus* trees are planted in arid regions (Palmberg, 2002; Jagger and Pender, 2003).

Ethiopian farmers across the country blaming *Eucalyptus* plantations. This is due to its impact on the water availability and crop production. This was observed during field visit and other research work across the region like Oromiya (East Wollega and West Shewa), Amhara (Bahirdar) and Tigray (Gergera and Abreha Weatsbha). For example, farmers in the East Wollega (Diga) and West Shewa (Tulu kosoru) believe that Eucalyptus plantations around agricultural land and water sources significantly affect the flow rate of springs and reduced crop production. Some have witnessed that springs have disappeared due to *Eucalyptus* plantation. Consequently, the community banned any further plantation around water sources such as ponds and springs. However, in some instances, they are planting around degraded land and roadsides areas for their livelihood benefit. This was observed during the households' survey to East Wollega and West Shewa in Oromia, where farmers plant *Eucalyptus* around agricultural land, river and roadsides areas for their livelihood benefit (Figure 2). The community in this area explain that once *Eucalyptus* planted in any environments, its grow very fast as they get access to water throughout the years. Farmers claim that the profits that can be gained from the sale of the annually harvested *Eucalyptus* can outweigh what could have been obtained from the same plot, if they were to plant other crops.

Figure 2: Planted *Eucalyptus* around agricultural land (Diga and Tulu kosoru area)
Source: Photo by Author, 2015

Impacts of *Eucalyptus* on Soil

The criticisms of the *Eucalyptus* are justified but, argue that only some species, mainly the deep rooted types, drain water resources, and that poor forestry practices, like high planting densities and short crop rotations, are primarily responsible for depletion of the soil's nutrients, increased soil erosion, and suppression of the undergrowth (Dessie and Erkossa. 2011). The impacts of *Eucalyptus* species on soil health remain hotly debated among scientists and development practitioners (Palmberg, 2002; Jagger and Pender, 2003; Yitaferu *et al*., 2013). Fast growing and short rotation tree plantations such as *Eucalyptus* also use escalated amounts of nutrients from the soil in comparison to slow-growing species (Heilman and Norby, 1997; Dessie and Erkossa, 2011). Monoculture forest activities such as *Eucalyptus* plantations may further affect soil chemical characteristics if the organic litter is continuously raked, prohibiting nutrient recycling (Zewdie, 2008).

Soil quality and composition is a significant indicator of ecosystem health, and thus the impacts of smallholder *Eucalyptus* planting on agricultural land can have great implications for larger development issues such as food security (Wiebe, 2003 and Lal, 2007). The potential negative impacts of *Eucalyptus* plantations on soil quality and other ecosystem services have been intensively studied. Studies conducted across many tropical and sub-tropical regions cite high demand for soil nutrients as an important drawback to *Eucalyptus* plantations (Bean and Russo, 1989; Harrington and Ewel, 1997; Kidanu *et al*., 2005). According to FAO, (2009), reports improper land use and soil management, which often leave the soil with less or no vegetation, are often cited as the major causes of soil quality deterioration. However, fast growing tree plantations may also lead to soil quality decline when they are poorly planned and not properly managed. The impact of tree plantations upon soil resources has been very much debated and there is no complete consolidated view, partly due to the fact that the impact is much dependent on variable site and forest conditions (Jagger and Pender, 2000). Numerous research reports were appeared on effects of *Eucalyptus* on soils in several countries over many years (Malik and Fries, 1985; Poore and Fries, 1985; Lugo *et al*., 1990; Lemenih *et al*., 2004; Lemma, 2006; Kindu *et al*., 2006a).

High rates of soil nutrient uptake in *Eucalyptus* spp. are due in part to the combined effect of fast growth and the inability to fix nitrogen (Zegeye, 2010); consequently in both the short and long-term *Eucalyptus* plantation establishment has been shown to have detrimental effects on soil quality and fertility (Yirdaw, 2001; Chanie *et al*., 2013). By degrading soils, *Eucalyptus* may render land less suitable for future growth of crops and natural forests alike (Palmberg, 2002).

In addition to soil fertility and nutrient content, *Eucalyptus* has been found to have impacts on topsoil retention and soil erosion (Poore and Fries, 1985; Sunder, 1993; Palmberg, 2002; Jagger and Pender, 2003; Dessie and Erkossa, 2011). Some studies have concluded that *Eucalyptus* can worsen soil erosion as an indirect result of frequent disturbance from repeated harvesting (Poore and Fries,1 985; Nyssen *et al*., 2004).

Conclusion

Eucalyptus has rapidly expanded and it became the most planted tree species across the world over the last century. Foresters, users, growers and wood industries support its expansion looking at its socio-economic benefits. Socio-economic studies have shown that these plantations have acted as a buffer against financial crisis for many poor farmers on land unsuited to sustainable agriculture. In contrasts, environmentalists and researchers fear this for the perceived negative environmental impact.

The research reports conducted in Ethiopia and elsewhere show that the *Eucalyptus* are among the most preferred trees, as they grow fast and can survive in marginal environments. In the face of growing economy and

increased demand for wood products, *Eucalyptus* remains to be the desired species that grows fast and produce wood to at least meet the demand of wood for fuel, construction and furniture materials. In contrast, its alleged negative environmental impacts and inability to meet both necessary productive and ecological services. Among the worries of eucalypts trees may not adequately benefit mankind as trees, as they may not always provide quality wood, soil conservation and watershed, wildlife habitat and even recreational or aesthetic values. The *Eucalyptus* products and its environmental impact are greatly influenced by plantation sites and management.

In General, impacts of *Eucalyptus* on the environmental and ecological services are: it drains water resources, enhances soil erosion, suppresses undergrowth, depletes the soil of its nutrients, and cannot provide habitat or food for native wildlife. On the other hand, *Eucalyptus* provides multiple environmental and socio-economic benefits: It is fast growing, requires minimal care, grows in wide ecological zones and poor environments, coppices after harvest, resists environmental stress and diseases, seeds are easy to collect, store and do not require pre-sowing.

Therefore, in order to avoid or minimize the *Eucalyptus* dilemmas; emphasis should be given by environmentalists, researchers and policy makers to support land users and growers in selecting the appropriate place of planting like degraded land; steep slopes; waterlogging area; roadside and selection *Eucalyptus* tree species and managing planted *Eucalyptus* trees; so that the environmental and ecological impacts are minimized and the socio- economic benefits of *Eucalyptus* were optimized.

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