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Plantation Forests in Amhara Region: Challenges and Best Measures for Future Improvements

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Abstract The total area of plantation forests in Ethiopia is estimated at 972,000 ha. Species wise, eucalyptus dominates the current plantation forests, covering more than 90%. The total area of plantation forests in Amhara region is estimated at 684,000 ha, of which Industrial Plantations are 44, 600 ha and Non-industrial Small-scale Private Plantations are 639,400 ha. The application of appropriate silvicultural practice during and after planting of different plantation species is not well developed in Ethiopia. Therefore, the objective of this paper was to identify effective plantation practices in the Amhara National Regional State that can be scaled out in other similar agro ecological areas of the country. The study was conducted between September 2013 and October 2015 in ANRS in Fagta Lekoma District of Awi zone and Lay Gayent District of South Gonder Zone. Multistage sampling technique was used to select sample households. The best example of smallholder plantation practices are *Acacia decurrens* based smallholder plantations in Fagita Lekoma District and *E. globulus* and *E. camaldulensis* based plantation in Lay Gayent District and Mecha District, respectively. Adaptability, growth rate, compatibility to the other land uses and suitability to the objective of tree planting were considered in selecting the tree species for planting. Silvicultural management of the plantation especially those of spacing, planting techniques and tending operations were considered in identifying the best plantation practices. In regard to ecological impacts of plantation 135 respondents (75.4%) agreed that plantation of *E. camaldulensis* have adverse effect on the soil, crop productivity of the adjacent farm land and water resources. Among recognized silvicultural management gaps, narrow spacing has been evaluated as the major constraint by regional experts and farmers. Economic issues like lack of adequate value addition, lack of assortment and product diversification has been identified as significantly important challenges. Proper implementation of best plantation management practices in Ethiopian plantation programs will significantly improve the forest cover of the country and increase the contribution of the forestry sector to the local and national economies.

Keywords: *Ex-ante evaluation, communal plantation, Silviculture, small holder plantation*

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1. Introduction

Plantation forests are cultivated forest ecosystems established by planting and/or seeding, which aids in the process of afforestation and reforestation for the purposes of wood biomass production, soil and water conservation and/or wind protection [1]. Plantations comprise either introduced species (all planted stands) or intensively managed stands of indigenous species, which meet the following criteria: one or two species of uniform age that are regularly spaced and are characterized by relatively short rotations when compared with natural forests [1]. The majority of planted forests comprise native species, with only 18–19% of the total area comprising introduced species [2]. The vast majority of the world's plantation forests are monocultures, with just a small number of widely used tree genera such as *Eucalyptus*, *Pinus* and *Tectona* spp. [3,4].

Ethiopia has engaged in plantation development for over 100 years [5]. Tree plantations are comprised of three sub-types: commercial/industrial plantation, wood-lots, and peri- urban plantation (mainly for fuelwood). The plantation forests in Ethiopia are comprised mainly of exotic tree species. With the decline and subsequent banning of industrial wood production from natural forests combined with growing demand for

wood products, the importance of plantation forests is increasing [6].

The total area of plantation forests in Ethiopia is estimated at 972,000 ha. Afforestation/reforestation practices are meant primarily to increase the supply of wood products in the country. These practices comprise mainly three forms: industrial plantation, peri-urban energy forestry and small-scale plantations. The former two are mainly government-driven, while the third is undertaken principally by farming households [5]. Often termed non-industrial plantations, smallholder woodlots are the main suppliers of poles for electricity and scaffolding and contribute a significant share of the biomass fuel consumed nationally [5]. Species wise, eucalyptus dominates the current plantation forests, covering more than 90%. *Cupressus* contributes 3.3% and other species cover a small fraction of the standing stock [6].

The Amhara National Regional State (ANRS), with a total area of approximately 170,052 km^2, is situated in the north western and north central part of Ethiopia. The forest resource of the Region is estimated to be around 6% of the total area of the region, which includes high forest (0.48% of the total area); woodlands (4.2%); bamboo and plantation forests (1.23%) [7]. The overall forest resources of the region have shown slight increase in area coverage for the last 15 years. The major plus comes from Eucalyptus plantation and rehabilitation efforts in Eastern and recently in Western highlands of Amhara [7]. The total area of plantation forests in Amhara region is estimated at 684,000 ha, of which Industrial Plantations are 44,600 ha and Non-industrial Small-scale Private Plantations are 639,400 ha [5]. Therefore, Amhara region has the largest woodlots in the country [6].

Contrary to the growing interest for expansion of plantation forests in Ethiopia in general and Amhara region in particular, the application of appropriate silvicultural practice during and after planting of different plantation species is not well developed. In order to improve the growth performance, stand quality and the yield of the plantation forests, it is essential to identify effective practices for scaling up at a wider scale. Therefore, the objective of this paper was to identify effective plantation practices in Amhara National Regional State that can be scaled out in other similar agro ecological areas of the country so as to enhance the role of plantation forest in "Ethiopia's Climate Resilient Green Economy (CRGE)" strategy.

To achieve the objectives of the intervention measures, a study was carried out in the Amhara National Regional State where there is wide small-scale plantation development practice. The specific objectives the study included 1) to identify and select the best plantation practices, 2) to assess biophysical and socio-economic impacts of plantations, 3) to propose plantation forest improvement measures.

2. Materials and Methodology

The study was conducted between September 2013 and October 2015 by a working team consisting of five members (two researchers from federal research, one researcher from Amhara Region Agricultural Research Institute (ARARI), one expert from Regional Bureau of Agriculture (BoA), and one member from Bahir Dar University).

2.1. Description of the Study Areas

The study was carried out in Amhara National Regional State (ANRS), in Fageta Lekoma District of Awi zone and Lay Gayent District of South Gonder Zone (Figure 1).

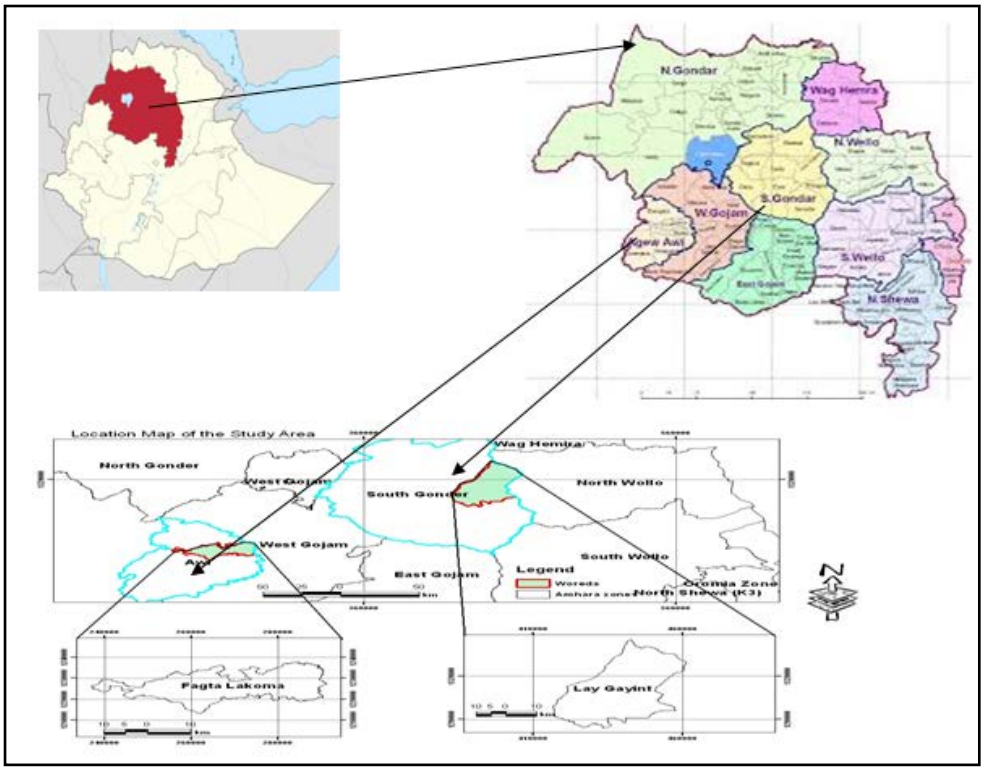

Figure 1. Location of the study areas (Amhara region, Lay Gayent and Fageta Lekoma Districts)

Fageta Lecoma district is one of the eighth districts and three town administrations of Awie zone. It is bordered by west Gojam zone in the east, Ganga and Dangla districts in the west, Dangla district in the north and Banja district in the south. Within the district, there are about 25 rural and 2 urban kebeles. The altitude of the district ranges from 1,800 to 2,950 meters above sea level.

Lay Gayent district is found in South Gondar zone. It is found 75 km away from zonal capital city Debre Tabor, and about 175 km from regional capital city Bahir Dar, along with the main road from Bahir Dar to Woldia. It is located south of Tach Gayent district, north of Ebnat distirct, East of Mekete district and west of Estiea and Farta districts. Altitude of Lay Gayent ranges from 1, 500 to 4, 231 meters above sea level.

2.2. Method of Data Collection

Multistage sampling technique was used to select sample households (Figure 2). Amhara region was purposively selected as study site by CIFOR in consultation with the concerned national government line ministries'. In the first stage, field visit have been undertaken by the research team to observe the plantation experiences in the region based on the recommendation of the experts in the stakeholders meeting.

In order to facilitate selection of the best plantation forest practices, the team categorized the existing plantations into three different ownership types, namely smallholder (boundary planting and woodlots established on piece of land owned by rural household, communal (planted on land owned by the community) and commercial plantation (trees planted by individuals or group of people licensed to plant trees or state plantation forests). These categorizations were made based on suggestion of the stakeholders.

Different aspects of evaluation grouped under five major criteria constitute the basic framework of the evaluation. Silvicultural management, socio-economic significance, environmental and ecological role, as well as policy and institutional criteria were used for selecting the best plantation practices. For each criterion indicators were identified and means of verification was clearly stated. Following this, the team together with the regional Bureau of Agriculture (BoA) had identified and prepared short lists of candidate plantation sites for evaluation and selecting the best plantation practices.

Accordingly 51 plantation sites distributed in ten Districts and in five administrative zones of the Amhara region were identified and short listed. The short list comprises of smallholders, communal and commercial plantations. Most of the selected districts are situated in the highland and midland areas of the region. From the observation made during the field visit, the information obtained from stakeholders meeting, group discussion with farms and the discussion made with key informants was understood that the smallholder tree growers predominantly plant *Eucalyptus globulus* and *Acacia decurrens* tree species in the highlands while *Eucalyptus camaldulensis* is comply planted at midland and even lowlands. Taking this into account, 12 plantation sites (seven smallholders, three communal and two commercial plantation sits) were evaluated to select the best plantation practices.

Ex-ante questionnaire preparation and evaluation: Detailed questionnaire have been prepared to evaluate the major constraints in plantation forests. Hence, major gaps/constraints and corresponding measures have been identified and evaluated.

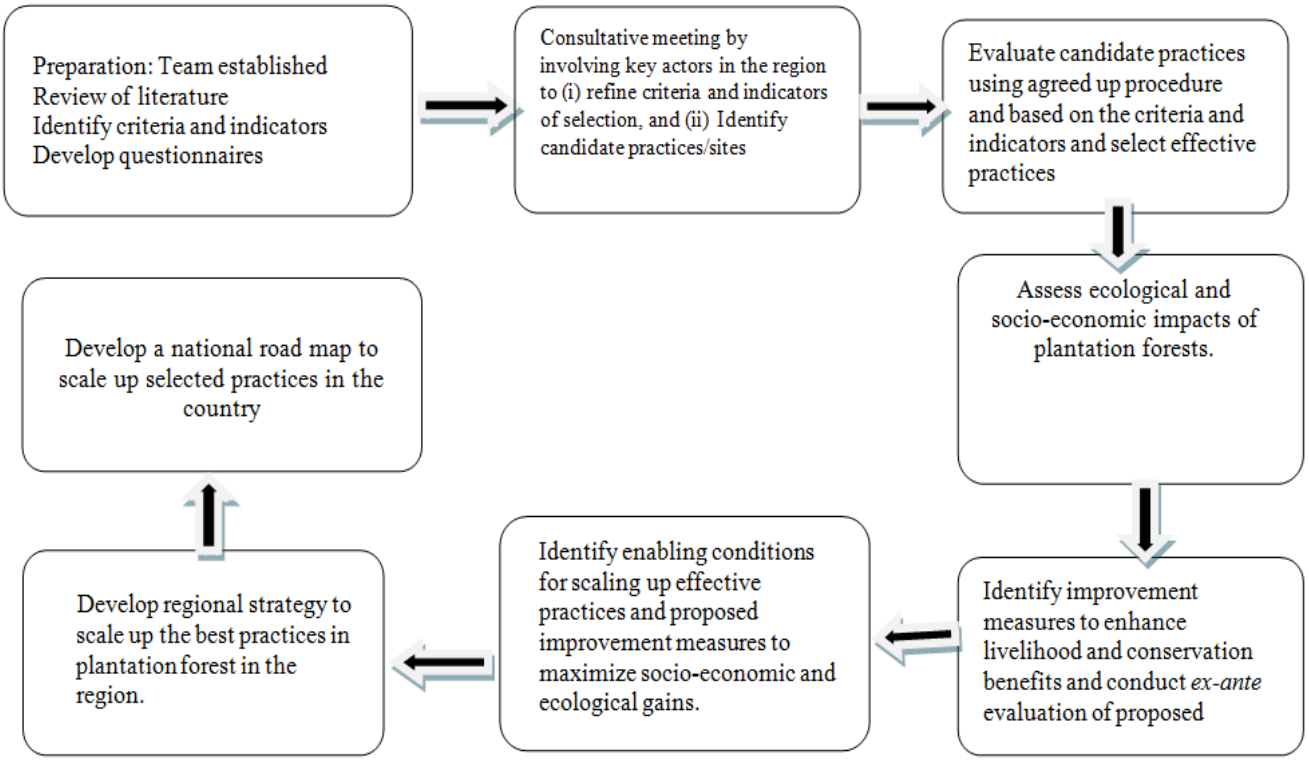

Figure 2. Schematic diagram of the processes involved in developing the national road map for scaling up effective forest management practices [8]

24 stakeholders representing different government and non-government organizations have attended the workshop, which was prepared to communicate the criteria and indicators prepared to evaluate and select the best plantation practices from each of the three plantation categories. Similarly, the list of candidate sites were presented to the stakeholders meeting held in the region so as to get feedback from the stake holders. Collection of secondary data, key informants and field evaluation were conducted.

Based on the information obtained from the field visit, plantation experiences in Lay Gayent District and Fageta Lecoma District were selected as representative study areas. These study sites were selected based on their best smallholders' plantation experience and plantation species' difference. *E. globulus* and *A. decurrens* plantation experience is widely found in Lay Gayent and Fageta Lecoma Districts, respectively.

Data collection for assessing the impact of the plantation practices: The team has developed questionnaire for collecting information on the economic and environmental impacts of plantations in and around the selected best plantation practice areas. The team conducted impact assessment on *E. camaldulensis* in Mecha District, West Gojam Zone.

Sample households selection: Three Kebeles/localities namely, Enamrt, Kurt Bahir Mekeni were purposively selected based on their accessibility and the expansion of plantation practices in the localities. Among the different villages in the kebele, four villages /*Goates* were selected at random. Based on the proportion of female households in the kebele, about 10% of the total samples were female headed households. About 25% of the selected sample households were non planters/non-tree-growers.

2.3. Data Analysis

After sets of data have been collected, the data were encoded and quantitative and descriptive analyses were used to analyze the impacts of plantation on the study areas.

3. Results and Discussion

3.1. Effective practices on smallholder plantations

The best example of smallholder plantation practices are *Acacia decurrens* based smallholder plantations in Fagita Lekoma District, Awi Zone, and *E. globulus* and *E. camaldulensis* based plantation in Lay Gayent District of South Gonder Zone and Mecha District of West Gojam Zone, respectively. Adaptability, growth rate, compatibility to the other land uses and suitability to the objective of tree planting and acceptance of the product in the market were considered in selecting the tree species for planting. Silvicultural management of the plantation especially those of spacing, planting techniques and tending operations were considered in identifying the best plantation practices. The smallholder tree growers are well aware of the advantage of adequate silvicultural management with respect to enhancing productivity of plantations compared to unmanaged ones.

The commonly used spacing between rows and between trees of the selected best practice is 1mx1m (for current market of fuel wood and poles). People adopted a technique where they plant trees together with cereal crops including wheat (*Triticum aestivum*), Teff (*Eragrostis tef*), maize (*Zea mays*) and even green pepper (*Piper Nigrum* L) in the first growing season then after harvesting the cereals allowing the tree to grow. Planted trees showed good survival rate. According to farmers, plantation of the tree species will be ready for harvesting in five or six years after planting. In *A. decurrens* plantations farmers uproot the tree at the time of harvesting so that the farmer could grow on it cereal crop of preference for one or two years before replanting it with *A. decurrens.*

The major purpose of *A. decurrens* plantation is to generate income by selling the stand to charcoal producers and wholesalers. The farmers are well aware of the multiple socioeconomic advantages of *A. decurrens* compared to *E. globulus,* the other potential tree species commonly planted in the region. The economic benefit from growing tree is better compared to cultivating crops like Teff and Wheat. Farmers were encouraged to plant this tree species (*A. decurrens)* due to its fast growth, its use as fuel and construction wood, charcoal, animal fodder, soil fertility maintenance and availability of market for the products. Smallholder tree planting has provided occasional employment opportunity for job-less youth and women.

The most preferred criterion that all best practice owners have in mind is product marketability, and value addition practice is the criterion that owners of these best practices did not consider much. Some smallholder plantation owners are adding value up to the level of cutting trees and debarking. But, most of other value addition practices including charcoal making, transportation, exporting, etc. are done by other value chain actors (Figure 3).

3.2. Best Practices in Communal Forest Plantations

In general, the coverage of communal plantations in ANRS is limited. Most of the existing communal plantations were established during the previous "Derg" regime with diverse objectives like fuel wood production, soil and water conservation and the stands were neither managed nor utilized on time. It is difficult to find new communal plantations. During the establishment of the communal plantations the local community has not been actively participating in planning and implementation processes and as a result in some cases the trees are over matured and in other cases harvested several times and remained without coppice management and protection in place. Therefore, it is very difficult to identify best practices from communal plantation sites. However, an effort was made to assess and evaluate eleven communal plantation sites. Among these three newly planted and communally managed sites were evaluated for their management status.

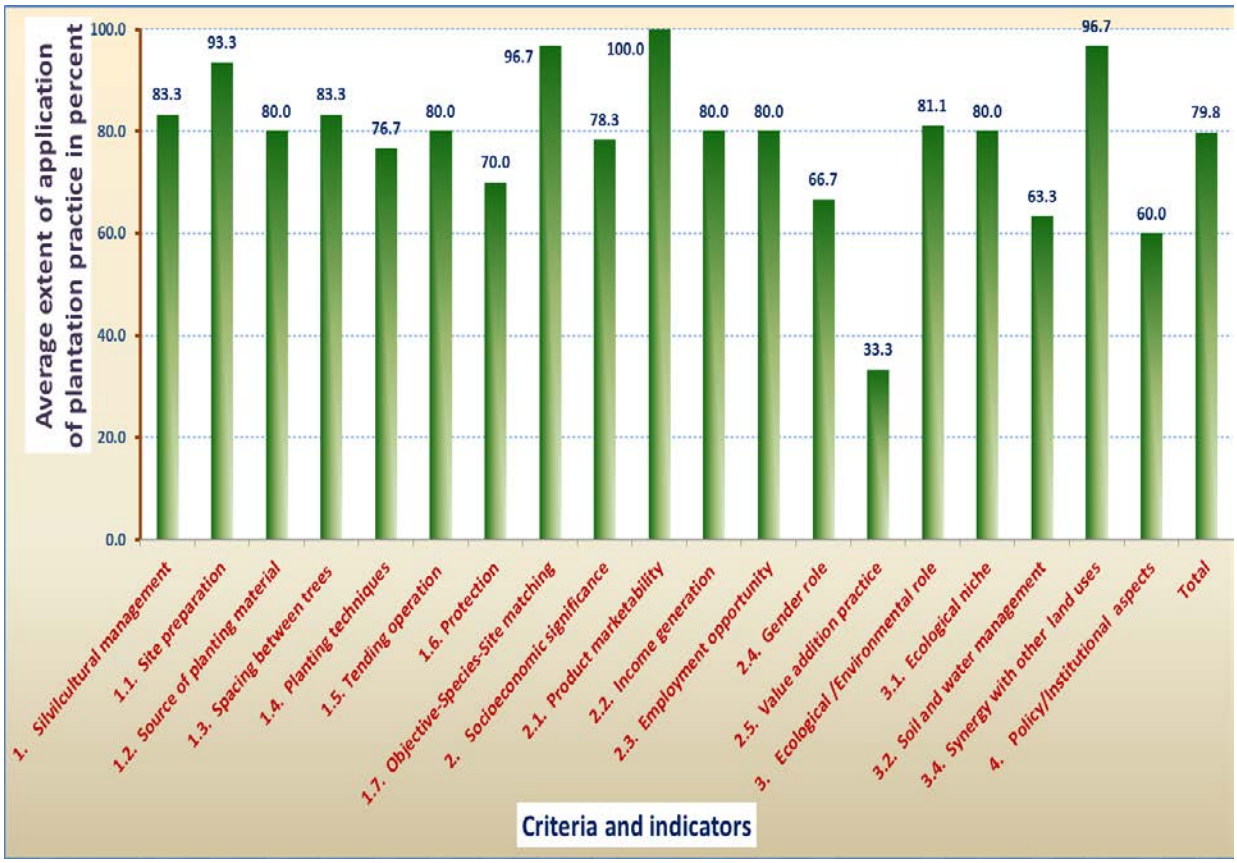

Figure 3. Average extent of application of plantation practices for each criterion in percent

The communal plantations located in Shabra "Gott", Abchikli Keble, South Achefer District of West Gojam zone was found to be under best management practices compared to others. With regard to silvicultural management, these plantations were better in site preparation, protection, species diversity, and soil and water harvesting structure. The preferred tree species planted are: *Grevillea robusta, Acacia saligna, Cordia africana, Jacaranda mimosifolia, Acacia abysinica, Croton macrostachys, Eucalyptus camaldulnesis* and *Sesbania sesban.*

3.3. Best Practices on Commercial Forest Plantations

Commercial forests in Amhara region comprised of forests administered by the Amhara Forest Enterprise (AFE) and plantations owned by individual investors and group of individuals licensed to invest on plantation forests. AFE owned about 25,000 ha of natural and plantation forests. Most of these forests the enterprise own were established during the previous regime for various purposes. Overall, it seems private investment on commercial plantation forests is not widely practiced in the region. It is very difficult to identify recently planted and well managed commercial plantations among the above mentioned plantation forests to be evaluated for selecting the best practices. However, an effort is made to visit ten of the commercial plantation forests and evaluated two of them for their good performance. One of these evaluated plantation forests belong to AFE and the other owned by group of individuals licensed to invest on plantation forests. The plantation forest owned by group of individuals licensed to invest on plantation forests have been selected as example of best practice. These plantations are found in Debre Tabor, Eyesus Kebele, Farta District, South Gondar Zone, and has been established in a cluster form (blocks) by group of individuals. The cluster is classified in four blocks and the owners of three of the blocks are dwellers of Debre Tabor town and the fourth block is owned by organized police men. The total area of the cluster is 10.5 ha and the tree species is *E. globulus*. Silvicultural aspects such as site preparation, protection, and species-site-objective matching are well done. Each of the plantation blocks have their own business plan and each group has its own tree nursery.

3.4. Impacts of Plantation Forests

A total of 180 respondents were included for evaluating impacts of *Eucalyptus camaldulensis* plantations**.** The socio-economic characteristics of these respondents indicated that 91.7%, 88.3% and 90% of the respondent from Enamert, Kurt Bahir and Mekeni kebeles, respectively are married, 62.4% are illiterate and 38% can read and write, 123 (68.3%) of the respondent have their own land and 99% of the land owners are involved in tree planting practices. The average land size of those who involved in tree planting is 1.25 ha (5 *timad*) and it is 0.6 ha (2.5 *timad*) for those households who do not plant trees. The results also showed that 40 respondents (80%) of those who do not have land were also involved in plantation practices. Establishment of wood-lot is the most preferred form of planting.

Both, tree planters and non-planters generate income from different forest related activities. The data illustrated that those people involved in tree planting get more forest related incomes. The respondents pointed out that the income generated from plantations and related activities are utilized to meet different needs of the household (Table 1). Over 45% of the respondents indicated that income from forest related activities is used for home consumption (70%), to purchase agricultural inputs (60%), house construction and cover costs related with school fee and medication (47%).

Table 1. Response on the utilization of income generated from different forest related activities

Purpose of income	Planters	Non planters	Total
Home consumption	120 (88.9%)	4 (9.1%)	124 (69.3%)
Agricultural inputs purchase	98 (85.2%)	2 (4.7%)	100 (63.3%)
Livestock purchase	61 (53.5%)	1 (2.3%)	62 (39.5%)
Land renting	55 (48.2%)	0	55 (35.0%)
Fees (school, health, etc)	74 (67.3%)	4 (9.1%)	78 (50.6%)
House construction	70 (63.6%)	3 (7.0%)	73 (47.7%)
Saving in banks	52 (47.3%)	1 (2.3%)	53 (34.6%)
Petty trading	47 (42.7%)	1 (2.3%)	48 (31.4%)
Business (Ex - Grinding mill)	56 (50.9%)	1 (2.3%)	57 (37.3%)
Tax	55 (49.1%)	0	55 (35.7%)
Others	41 (42.3%)	7 (28.0%)	(39.3%)

The tree non-planters indicated that the reasons were small size (or lack) of land, harsh environmental conditions to grow trees, shortage of labour and insecure tree/land tenure. The feeling of insecurity on tree/land tenure emanates from the state ownership of the land [19].

The sale of eucalypts poles and products has the potential to raise farm incomes, reduce poverty, win food security and diversify smallholder-farming systems [9]. For example, ex-ante benefit–cost analysis based on community and village level survey data from Tigray illustrated that planting Eucalypts yields high rate of returns, well above 20% in most circumstances. The effect of variable harvest rates, and the potential costs of decreased crop production when Eucalypts trees are planted on or near farmlands are considered relative to our base case scenario [9]. Different reports indicated that planting eucalypts trees has resulted in high economic profitability compared with agricultural use of land for crop production [10].

Improvements in silvicultural practices: One of the focus areas of the impact assessment is to look into how the involvement in tree planting helped to bring about improvement in different aspects of tree planting. 135 of the respondents pointed out that through time the practice has been changed as they gain experience, for example, seedling production has transformed from bare root to producing potted seedling, started to use wider spacing and it also has resulted to come up with some innovative planting practices like planting trees with different agricultural crops, introducing value additions like producing charcoal (Table 2).

Ecological impacts of plantation: The ecological impact was the other area captured in the data collection. 135 respondents agreed that plantation of *E. camaldulensis* have adverse effect on the soil, crop productivity of the adjacent farm land and water resources. During the discussion, it was learnt that uprooting and converting eucalyptus land to agricultural land in the Chemoga area gave better crop yield.

Institutional and extension aspects: The rules, regulations and directives which were formulated by the respective Bureaus were not implemented at grass root level due to lack of enforcement by the respective bodies. To decide the distance between two neighboring land holders for eucalyptus plantations, the community bylaws were not formulated.

The farmers also pointed out that expansion of plantations helped to rehabilitate degraded lands, some plantations helped some wild lives like birds including Midakua (*Sylvicapra grimmia*), kebero (*Canis aureus*), Jigra (*Numida meleagris*), kok (*Predix predix*) started to appear in some plantations. Farmers indicated as well that regeneration of tree species like Kitkita (*Dodonaea viscose)*, Zigba *(Podocarpus falcatus)*, Woira *(Olea africana)*, Thid *(Juniperus procera)* have started emerging under the Eucalyptus plantations.

From the group discussion it was understood that farmers are well aware about the social, economic and ecological advantage of tree plantings and this has been reflected by selecting tree species which they think are more valuable tree species and that suit best to the intended objectives. According to group discussion made with farmers, the expansion of eucalyptus plantation in their locality is encouraged by the ever growing local, regional and international markets demand for eucalyptus products. Farmers are also well aware of the advantages of using wider spacing and they are aware of the advantages of proper site preparation and planting potted seedlings to obtain healthy and vigorous tree growth. Farmers also pointed out that Eucalyptus has adverse shading and competition effects on adjacent farm lands. Hence, they plant eucalyptus 3-5 meters far from the farm lands to avoid crop yield reduction.

During the group discussion, it was also learnt that farmers are able to carefully quantify the economic advantages of planting trees before they change the crop lands to eucalyptus plantations. As indicated in the discussion when the farmlands become unproductive and fertilizer prices are becoming expensive they immediately switch to planting trees aiming at gaining more benefits.

From the field evaluation *E. globulus* is found to be the most preferred tree species in South Gonder, East Gojjam and North Shoa Zones, while *E. camaldulensis* is the most preferred tree species in some districts of west Gojam Zone. *A. decurrens* is exceeding Eucalyptus plantations in Awi zone. *A. decurrens* is fast growing, has more advantages and used for charcoal production, construction, soil fertility maintenance, and fodder production for livestock.

From experts' point of view, degraded landscapes, sloppy lands, and farm lands are found to be the common planting sites of smallholder plantations. Pruning and thinning were found to be the major plantation management practices experienced by farmers.

Table 2. Summary of plantation impact assessment

Impact variables	Number of samples/respondents			Mean			Std. Deviation		
	Plantation Practice			Plantation Practice			Plantation Practice		
	yes	no	Total	yes	no	Total	yes	no	Total
Knowledge and skill (Forest management and utilization)	135	44	179	1.92	2.17	1.98	0.52	1.05	0.693
Socio-economic aspect	135	45	180	1.87	2.16	1.95	0.43	0.69	
Biophysical (Biological and Ecological aspects)	135	45	180	1.55	1.66	1.58	0.42	0.60	
Institutional and extension aspects	127	41	168	2.05	2.16	2.07	0.71	0.84	
Average				1.85	2.04	1.90	0.52	0.80	0.69

NB: (1) Strongly agree, (2) Agree, (3) Neutral, (4) Disagree, (5) strongly disagree.

3.5. Major Plantation Constraints and Proposed Improvement Measures

According to the regional experts' evaluation results, for smallholder plantation programs, the major challenge to be improved is related to silvicultural management issues, while for communal and commercial plantation programs challenges related to institutional issues are the major ones to be considered for improvement. Environmental challenges are evaluated as least challenges in all plantation programs.

Among recognized silvicultural management gaps, narrow spacing has been evaluated as the major constraint by regional experts and farmers. Economic issues like lack of adequate value addition, lack of assortment and product diversification has been identified as significantly important challenges (Table 3).

programs challenges related to institutional issues are the major ones to be considered for improvement (Table 4).

With regard to Environmental issues, competition with cultivated land and shading effects, minimum distance from neighboring crop fields have been evaluated as important challenges to be considered. In connection to Institutional issues, formulation and implementation of proper forestry strategies and regulations and improve organizational setup of the forestry sector are the highly recognized challenges.

Studies conducted in different parts of Ethiopia have shown reduction in crop growth and yield when crops are grown close to eucalypts [9,11,12,13]. Reports indicated that eucalypts caused crop loss by out competing crops for water and soil nutrients [11,13,14], through shading [13] and producing allelo chemicals [15,16].

Table 3. Weight given for different criteria of impact in percentage by regional experts and research team

Gap/Measure- Criteria weight	Research Team (%)	Experts (Mean in %)	Std. Deviation (%)	t-Value
Silviculture	30	35.67	12.23	1.79*
Economic	45	26.67	14.35	-4.95***
Environmental	15	12.00	5.28	-2.20**
Institutional	10	25.67	12.94	4.69***

Remark: *, ** and *** significant at 1%, 5% and 10% significance levels respectively.

Table 4. Weight given for different criteria of impact in percentage by experts

	Impact criteria	N	Min	Max	Mean	Std. Dev
Smallholder	Silviculture	15	15	60	35.67	12.228
	Economic	15	10	60	26.67	14.351
	Environmental	15	5	20	12.00	5.278
	Institutional	15	10	50	25.67	12.938
Communal	Silviculture	15	9	50	27.60	13.174
	Economic	15	20	50	27.00	8.409
	Environmental	15	5	25	13.00	5.916
	Institutional	15	10	50	32.40	13.600
Commercial	Silviculture	15	10	40	25.67	8.209
	Economic	15	10	50	26.00	13.522
	Environmental	15	10	45	21.00	10.724
	Institutional	15	10	45	27.33	12.373
Average	Silviculture	15	18.00	43.33	29.6440	8.80985
	Economic	15	16.67	43.33	26.5547	8.43806
	Environmental	15	8.33	23.33	15.3333	4.88746
	Institutional	15	15.00	46.67	28.4673	10.55748

Table 5. Summary of major gaps and the respective proposed improvement measures

Gaps/constraints	Proposed measures
1. Silvicultural issues	
Poor seed and seedling quality	Using selected seed sources and Improved seedling production technique
Lack of timely seed supply	Provide the required amount of seed on time
Inadequate site preparation	Timely and adequate site preparation
Narrow Spacing	Use wider and appropriate spacing suitable to the objective of the plantation
Poor planting technique	Using standard planting procedures (time of planting, pit size, removing poly bags during planting)
Poor post planting management	Carryout adequate weeding, cultivation and Protection of plantations
high dependence on single tree species	Introduce alternate and high value indigenous timber spp. and MPTS
In adequate coppice management	Adopt appropriate harvesting technique
2. Economic issues	
In adequate value addition	Improved small scale wood processing and Product diversification
Poor marketing system	Provision of market information and strengthen market linkages
Limited expansion of forest industries	Promote expansion of different forest product base industries
3. Environmental issues	
Discourage under growth	Use of wider spacing, use thinning, pruning etc
Competition and shading on crop land	Buffer planting and Introduce minimum distance from crop field
Adverse effect on natural resources	Leaving leaves and bark on site and Use wider spacing
Lack of knowledge on mixed plantation.	Use mixed plantation.
4. Institutional Issues	
Insufficient extension and land administration service	Install better extension service system and implement proper land use plan at local level and certify to legal land owner
Inadequate institutional and policy support	Set clear objectives and management plans for plantations, Development of bylaws and training and Enhance monitoring and evaluation system
Lack of skills and knowledge of experts at various level	Provision of consecutive capacity building

The patterns of water use by exotics are potentially detrimental to ecosystem productivity through impacts on ecosystem water budget; indigenous species have been widely neglected, even though they are generally well adapted to their natural environment [17]. Sustainable forestry requires knowledge of the performance of both indigenous and exotic species as influenced by climate, their effect on ecosystem processes and the regional implications particularly on dry season river discharge [18].

Major constraints of plantation forests have summarized and appropriate alternative measures have been proposed (Table 5) to properly scale up selected best plantation practices.

4. Conclusions and Recommendations

4.1. Conclusions

In Ethiopia, forests in general and plantation forests in particular play a crucial role in satisfying the needs of the society for forest products in particular and in the enhancement of the national economy in general. Plantation forests have the ability to provide affordable wood for industry and wood-based products for consumers. In addition, tree plantations are often the most rational way of producing some non-timber forest products, for rehabilitation of degraded areas and improvement of watersheds, and for meeting environmental quality objectives such as windbreaks, shelterbelts. Plantation forests have positive economic, social, and environmental impacts in the livelihoods of the local communities and national economy.

However, due to lack of proper management; institutional, legal, and market constraints, the performance of the forest resources is poor and they are unable to meet the wood demands of the society. Many failures of plantation forests are often due to knowledge gaps for example in matching species and provenances to sites and uses, improper plantation establishment techniques, silvicultural management and harvesting technologies, how to protect trees from damage caused by various damaging agents, and handling conflicts between plantation forestry and other demands on land and water resources. There is also a problem of species provenance-site matching. Due to these and other problems in nursery, planting and post planting activities, the performance of most established plantations are very poor and consequently there is a very wide gap between wood demand and supply. The current management and handling of plantation forests is below the desirable level and it requires change. Hence, the above mentioned proposed strategies and management measures need to be seriously considered if sustainable and viable forest plantation is desired in the Amhara and other Regions of Ethiopia.

The country as well as the region has been involved for many years in different forest development and management initiatives. The lessons learned from these initiatives as well as from watershed conservation activity, the millennium tree planting experience and mass mobilization experience

acquired to date can be used as spring board for planning effective scaling up of the selected effective intervention measures. This strategy is designed to contribute to the targets set in national strategies, REDD+ initiative as well as other international agreements and pledges the country is committed to implement.

Proper implementation of best plantation management practices in Ethiopian smallholder, communal and commercial plantation programs will significantly improve the forest cover of the country, increase the contribution of the forestry sector to the local and national economy, combat climate change and contribute to the achievement of government forestry development programs set in the CRGE strategy.

4.2. Recommendations

Based on the findings of the empirical assessments, the following recommendations have been found to be crucial to mitigate challenges and exploit opportunities for properly enhancing and promoting plantation forests in Ethiopia:

Silvicultural management interventions: Setting clear objectives and preparing forest management plans, using certified and quality tree seeds, wider and appropriate spacing suitable to the objectives of the plantation and applying standard and timely tending operations and forest protection measures.

Economic measures: Enhancing/establishing small, medium, and large scale wood processing industries and product diversification, improving and standardizing charcoal production procedures, establishing strong and viable market information systems and development and familiarization of grades and standards for forest products.

Legal and institutional considerations: Proper land use planning that clearly demarcates areas for forest development, Initiate and implement out growers' scheme and technology transfer to the community, development of participatory local bylaws compatible with regional regulations and policies and improve organizational setup of the forestry sector.

Silvicultural, economic, environmental, and institutional gaps and constraints that have been identified and the respective measures and solutions proposed during the ex-ante evaluation need to be properly taken care of during the upcoming regional and national formulation of forest strategy.

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