BEST PRACTICES ON DEVELOPMENT AND UTILIZATION OF ACACIA DECURRENS IN FAGTA LEKOMA DISTRICT, AWI ZONE, AMHARA REGION

Environment, Forest and Climate Change Commission

By

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Forward

Tree biomass is one of the main energy sources widely used in Ethiopia in the form of fuel wood and charcoal. In addition to naturally existing forests/vegetation, establishment of plantation forest has been promoted for long to provide sustainable biomass energy sources. The existing forest policy and strategy and the revised forest proclamation of the 2018 ensures the sustainable development, conservation and utilization of forests fostering to maximize its economic, social and environmental contribution. Hence, the Environment, Forest and Climate Change Commission (EFCCC) is working on increasing the area coverage of plantation forests to enhance the supply of forest products, including for biomass energy supply. According to the recent estimation of forest resource mapping and regional reports, there is nearly one million hectare of plantation forest and the majority of these plantations are found in Amhara national regional state. These plantations are owned by small holder farmers as wood lots, community and state forests mainly administered by Amhara forest enterprise. Therefore, Amhara regional state has a huge potential for establishing commercial plantations for the supply of industrial and non-industrial forest products. *Eucalyptus* is the dominant plantation species in the region and largely established by small holders as wood lots and community providing forest products that are widely used locally and exported to Sudan’s market for construction material.

*Acacia decurrens* become the dominant tree species in Awi zone that covers vast area of land. Significant number of small holder farmers is now highly using it as the main source of income for supporting their livelihoods. In the highlands of Awi zone, there is higher rainfall amount (average rainfall is 1700mm/year) that resulted in to nutrient leaching problem and the associated soil acidity. Hence, *A. decurrens* has been widely used for improving the soil fertility on acidified soil by converting acidic crop land into productive cultivable land. *Acacia decurrens* plantation also contributes for restoration of degraded land. It is widely practiced partly as one of agroforestry system known as tangua system where inter-cropping is practiced until the canopy of the tree gets closed. Through the process of seedling production, site preparation, plantation establishment, harvesting, processing and marketing of *acacia decurrens*, large number of labor is involved in the system across the value chain. Hence, *acacia decurrens* is now become popular species for its economic uses that has great potential for combating desertification, land degradation and to enhance adaptation capacity in the region. It has great land reclamation potential for acidic soils especially where Nitisols dominate, in order to resolve the problem of fixing phosphate fertilizers by forming aluminum and iron phosphate. Through phosphate fixation the nutrient becomes unavailable to plants thereby reduce the production and productivity of cereals and pulses.

Therefore, through identification and documentation of best practices on establishment, management and utilization of *acacia decurrens*, it needs to further scale up in to other acid prone areas of Amahara and other regions. This is quite useful for increasing the production of forest per unit area and reclamation of degraded land for combating desertification.
ACKNOWLEDGEMENT

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1. Introduction

In the forest policy of Ethiopia, sustainable forest management is indicated as the main component of forest sector development towards the development, conservation and utilization of forest resources based on research findings. Documentation and scaling up of best forestry practices will contribute to achieve the objectives of this policy. In this regard, the agriculture sector has profound procedure and guideline for identification, registration, analysis and scaling up of best practices of sustainable land management. Since, the sector has well established institutional arrangement from federal to the village level it is possible to disseminate agriculture based research technologies through the extension system to end users to enhance production and productivity per unit area. Therefore, it is normal to adopt and use this guide line to identify, document and scale up best practices under sustainable forest management for increasing forest production and utilization. The identification and documentation of farmers’ best practices is one of the core activities of forest sector in the second growth and transformation plan aiming to scale up the practices.

Restoring degraded forests and landscapes is a national and international agenda and target from the perspective of EFCCC. These activities are crucial and boldly indicated to be achieved by 2030. The best practice in Amhara region have brought significant change by reclaiming acid soil through biological amelioration method for increasing agricultural productivity on abandoned lands. In Awi zone of Amahara regional state several efforts have been made in order to progressively build farmers knowledge that brought promising changes in boosting the production and productivity of forest per unit area. Under the national framework of the revised forest proclamation No. 1065/2018, Amhara regional state developed a regional Forest Directive and started implementing throughout the region that supports the sustainable development, management and utilization of forest resource in the region. In Awi zone many small holder farmers already engaged in the establishment of planation forest as wood lots. In addition, establishment of planation on communal and state owned land is practiced.

*Acacia decurrens* is one of the most popular species in Awi zone that has a great potential for reclamation of acidified soils and restoration of degraded land. According to the department of zonal agriculture, this species was introduced in the area through extension system. It is introduced in the 1970s by the ministry of agriculture, research centers and nongovernmental organization as a pilot planting along road side and few areas with fewer acceptances by farmers. According to information gathered through interview made during field work, little formal extension service has been delivered to the farmers to increase its production/development. Following the severe reduction of land productivity and land degradation in Awi zone, because of high rainfall, it resulted in to a complete leaching of soil nutrient making the soil unproductive. Hence farmers often suffered from the failure of crop production. Gulley erosion was also another problem due to the same reason, high rainfall. Awi
zone has highly acidified deep Nitosols dominated with ferric and aluminum oxides scientifically known fixation of phosphate fertilizers forming iron and aluminum phosphate. Hence, during the application of phosphate fertilizers crops does not utilize the nutrient fixed in the soil solid as it does not release nutrient to the soil solution and benefit crop production. Thus, farmers suffer from crop failures by getting less response from fertilization application.

In the late 1970s farmers were prone to extreme poverty and liable to opportunities of migration to adjacent zones because of extreme land degradation and abandoning the land from crop yield. The introduction of acacia decurrens was considered way out this problem and now they have reclaimed the acidification problem making the land suitable for cereal crop production and restoring their land from land degradation. This practice looks Tangua system or inter-cropping and the land value has greatly increased after two decades of hardwork where farmers brought the land into higher productivity using acacia decurrens. This practice also created more rural jobs across the value chain. Hence, this documentation was made by EFCCC in Awi Zone, Amhara region.

2. Objective

The objective of the field survey was to identify, analyze and document the best practices and approaches of farmer’s progressive knowledge and adoption on this agroforestry system. It also aims to scale up the practice in to similar conditions in the region and throughout the country. Specifically, the objectives are;

- To collect data from identified key informants
- To conduct focus group discussion
- To discuss with relevant and concerned government officials at regional, zonal and district level

2. Forest Resource of Amhara Regional State

The region is located in the northwestern and central part of Ethiopia and borders with four national regional states: Oromia in the south, Afar in the east, Benishangul-Gumuz in the west and Tigray in the north. It also shares a common boundary with Sudan in the west. Approximately 83.8% of the population lives in rural areas. Agriculture, livestock, and forest production are the main economic activities of the region. Amhara is endowed with a range of diverse ecological zones and natural resources, including forest resources. However, due to pressure from free grazing/ livestock movement, expansion of agriculture, and unsustainable use of resources, forest resources have undergone severe degradation and depletion, which resulted in high rates of soil erosion, loss of soil fertility, and sedimentation of water bodies.
Hence, the regional government, community and non-governmental organizations are attempting their best efforts to conserve and manage the remnant forest, through sustainable development, management and utilization. In the region, forest resources are mainly owned by regional state including forest enterprise, private/smallholder farmers and the community.

**a. State Forests**

As indicated in CIFOR (2015), Amhara regional state has both priority state forests and regular state forests. Seventeen forest areas in the region have been identified nationally as priority forest areas that must be conserved for their biodiversity and ecological benefits. These are Wof Washa in N. Showa; Erkie in Oromo ethnic zone; Yegof and Denkoro Chaka in S.Wollo; Woinye in N. Wollo; Guna, Alemsaga and Tara Gedam in S. Gondar; Matebia, Angereb and Gundo Gordim in N.Gondar; Kinbaba and Sekela Mariam in W. Gojam; Yeraba and Abafelase in E. Gojam; and Kathasa and Elala Guangua in Awī Zone. There are approximately 124 regular state forests in various districts of the region. In addition to this, the region also has significant area of plantation forests established through state run projects. These include the Gondar fuel wood Plantation in N. Gondar, Dessie fuel wood plantation in S.Wollo, and Debre Birhan fuel wood plantation in N. Showa Administrative Zones. Regional and national parks (e.g. Alatish and Semen parks in N. Gondar) and Denkoro Chaka priority state forest in S. Wollo are known to host diverse wildlife. The region also has significant areas of dry forest and woodlands, which includes bamboo and a number of gum and resin producing species.

Gum and incense are found in the North Gondar Zone (particularly in Metema, Quara, West Armachiho, Tegefe, Tach Armachiho and Aderkay districts), Awi Zone (mainly in Jawi and Zigma districts), in East Gojam Zone (in Shebel Berenta, Baso Liben and Debre Elias districts), South Wollo Zone (in Wogide district), North Shewa Zone (in Merabete district), and West Gojam Zone (in Bure Zuria and Womerima districts). These resources are also found in other zones, although to a lesser extent. In Metema district alone, Boswellia papyrifera accounts, on average, for 51% of woody plant density (Eshete 2002), although variations occur from site to site as a function of local edaphic, climatic and anthropogenic factors. Ecologically, the species is important as it can grow in areas where other trees fail to grow. Bamboo is another species important for people in the region as it is becoming an important source of cash income to smallholders. According to recent mapping by INBAR and Tsinghua University (2018), Amhara region is the second in its bamboo resources in Ethiopia. There are two types of bamboo species in the region; highland bamboo (Yushania alpina) and lowland bamboo (Oxytanalthera abyssinica). Lowland bamboo is mainly found in North Gondar, Awi and West Gojam, and to a lesser extent in East Gojam Zones. Highland bamboo is mostly widespread in Awi, West Gojam and East Gojam Zones, but is also found in the South Gondar Zones. However, there is a lack of awareness among smallholders particularly in the lowland areas of bamboo's economic value, and in many cases, it is being burned and cleared for farming. Current levels of lowland bamboo
are expected to decrease significantly due to such actions, which are likely to be exacerbated by the resettlement of farmers from less productive and crowded highland areas to these areas and because of rapid expansion of commercial farming, in the lowlands.

b. Community and private Forest

According to a study conducted by CIFOR (2015) and source from MEFCC/NFSDP (2017), in Amhara region, there are significant private and communal forests owned by mainly stallholder farmers that makes the region the top in Ethiopia in terms of plantation forest, including woodlots. Community forests are developed and managed by kebeles on communal lands, to promote rehabilitation of degraded areas as well as to generate economic benefit out of it. Many forests, which in the past were developed and managed by government, have now been transferred to kebeles, to be managed and used as community forests. Community and privately owned forests are significant sources of forest resources. Still, forest development programs are required in the region to address shortages of wood for fuel, construction material and industrial input for various end use products, and to create sustainable sources of income for the rural poor and private sectors.

3. Forestry Sector Governance of Amhara Region

As indicated by CIFOR (2015), Amhara region has weak and fragmented forest governance, particularly related to the efforts to ensure sustainable forest management and in looking for industrial application, as it has immense potential in this sector. The weak governance has caused numerous and interrelated obstacles to sustainably manage, harvest, add value and provide different end use forest products to different market outlets. Governance constraints, such as lack of transparency, responsiveness, rule of law, accountability, and regional institutional coordination represent significant barriers to progress in the forest sector. Additional efforts are required to ensure the active involvement of local communities, non-state actors, and civil societies, in economic, social, and political matters in general and in managing forest resources of the region in particular. Having strong and well organized regional forestry institution with clear mandate will highly improve regional forest resource governance and will benefit the region and the country in economic, social and environmental aspects, including bringing significant difference in rural and urban job creation. It is also required to have a clear strategic direction on how to engage and coordinate efforts of private sectors in establishment of commercial plantation and forest enterprises for value addition.
4. Best Practice of Fagta Lekoma District in Awi zone

Awi zone has a total land area of 893,520 ha, where 285,232 ha is agricultural land, 217,139 ha is pasture land and 74,514 ha is belong to other lands. The forest cover is estimated as 36% which is 227,845 ha. Similarly, according to the source of district agriculture office, Fagta-Lekoma is one of the districts in Awi zone which has 76% forest cover within the total land area of 67,733.32 ha with a human population of 176,196 people. The basic livelihood is forestry and agriculture categorized under the mixed farming system of crop and livestock production. The forest land covers 49194 ha, out of which plantation forest is 45675 ha while natural forest is 3519 ha. The cropland area coverage is 9674 ha while 8865 ha of land is covered by pasture. The main types of crops grown are cereals and pulses including teff, wheat and barley, which are the dominant grains. The private small holders, communal and state forest are the main types of forest ownerships.

*Acacia decurrens, eucalyptus globulus and pinus patula* are used for economical uses in the form of fuel wood, charcoal and construction material. In 2003, when Amhara region Bureau of Agriculture classified the region according to its potential for diversification and specialization, this district was classified to specialize on forest development, dairy farm and honey production. Hence, this district is known for its widely spread acacia decurrens plantation with higher adoption by farmers. According to source from zonal agriculture department, since its introduction, wide scale plantation of acacia decurrens were started in 2006/2007. Once it starts in this way, farmers widely adopted and spread the practice unexpectedly beyond their expectation. The increase in forest area coverage of the district mainly comes from the widely practiced acacia decurrens plantation in the form of woodlot that gradually become large scale plantation as most farmers practiced it adjacent to each other. There are 27 village/ kebles which are now engaged in acacia decurrens plantation and production. According to district office of agriculture, about 60% of the district is covered by acacia decurrens plantation forest. Hence, this district is known for its acacia decurrens plantation establishment in the region, which is the focus of this documentation. Development and utilization of acacia decurrens is considered as the best practice in the district as it was widely practiced and benefited the community.

5. Driving factors for adopting and planting *acacia decurrens*

There is two prominent driving or push factors for the adoption and extensive plantation of acacia decurrens in Awi zone. Based on the information gathered during the interview with the farmers and experts, there were severe problem of soil nutrient leaching due to presence of high rainfall amount in the area. The average annual rainfall amount of Awi zone is 1750mm per annum while it is 2000mm per anum for Fagita Lekoma district. The other push factor to adopt
this tree is the presence of soil erosion or land degradation due to higher erosive capacity of the rainfall accompanied with poor land management practice at the time. Hence, these two factors, leaching and land degradation, contributed to the less productivity of the area and reduced annual crop yield. This low soil productivity was then become the root cause of poverty and even initiated migration of rural families to other lowland areas. Head of Awi zone agriculture office, Ato Ajebe Seneshaw, explained the same way that it was a serious concern for the Zonal administration that worried them their community were vulnerable to migration due to less productivity. The experiences of farmers shows how land degradation has affected their livelihood and even to cause migration before the introduction and development/application of *acacia decurrens* both for improving cropland productivity and generating reasonable income from its wood products by the framers. Farmers were vulnerable to extreme poverty.

It was at that time this species were introduced to the area and farmers gradually adopted to plant first at steep and communal lands and gradually started to plant on their farm land as woodlot but with intercropping system. According to district office of agriculture, one farmer, Ato Aynalem Teshale, who have had the exposure to see this tree in other part of the country, Oromia region, come back to the area to demonstrate how to produce charcoal in his village that gradually widely spread in the area. The same farmer brought another farmer from Oromia region who know how to produce charcoal and demonstrated for the first time. Framers have been employing this best practices and approaches of agroforestry system intercropping *acacia decurrens* mainly with cereal crops for charcoal production that has now good value chain process in the zone. We have seen that the leaders/politicians, experts and farmers have great assertion on the development, processing and utilization of *A. decurrens* that have changed the livelihoods of farmers and hastens the rural job creation at large. This also contributed to increased forestry sector contribution to regional growth domestic production that contributes to national economy.

### 6. Methods of Data collection and Analyses

There are a number new technologies and approaches of sustainable land management practices which are identified, documented and scaled up for forest and soil conservation purposes in Ethiopia. There is continuous process of replacement of the old best practices by the new one which are useful for sustainable management of land and forest resources. The groups of best practices are identified by a set of criteria’s and coordinated process using procedures from sustainable land management guideline by regional-, zonal- and district-level experts and development agents who have the ability, expertise and willingness to carefully watch what is ‘happening’ on the ground. The following three procedures helped them in this task.
1. Observe carefully any sustainable forest management practices which looks new, and discuss with the users how and why they developed it.

2. Compare these sustainable forest management practices against the list of earlier documented practices. There exist many documented and undocumented best practices (technologies and approaches) which have not been systematically screened against well-defined criteria such as those listed below. This situation has necessitated the establishment of clear screening and documentation criteria which allow the responsible bodies to identify worthy best practices.

3. The screening process of sustainable forest management’s best practices includes the criteria of acceptance, effectiveness, efficiency, relevance, sustainability and scalability to be applied as measurements. Then, weighted values are given to each criterion based on its importance in determining the performance or value of a given practice.

While acceptance and effectiveness are considered to be the most important criteria in determining the performance of a given practice, each has been given a weighted value of 22% or 0.22. The remaining four criteria (efficiency, relevance, sustainability and scalability) are considered to have similar importance in measuring the value of a given practice, and are given a weighted value of 14% or 0.14 for each. A sustainable forest/land management practice is labeled as best practice if it earns a minimum weighted average of 1.72 from the screening process. The process of screening requires that the experienced farmers of a given watershed present and discuss their thoughts and opinions in semi-structured interviews. Each criterion is given a score point of 1 to 3 based on the percentage of respondents who support it. For instance, if the percentage of respondents agreeing that a given sustainable forest management practices efficient is 75% or more, then the score gained is 3. However, if 50-74% of the interviewees consider the best practice to be efficient, the point given is 2; if the percentage is 25-49%, the point given is 1, and if it is less than 25%, zero points are given for the best practice. For this field study we used nine small holder farmers to focus group discussion and eight key informant interviews to collect the information on the production and utilization of acacia decurrens.

7. Establishment and management of Accacia Decurrens

*Acacia decurrens* is a fast-growing tree that reaches up to 6-12m or more high. It grows on sandstone soils with medium nutrients and good drainage. Seedlings should spend 7–8 months in the nursery before planting out. It regenerates through coppicing and also by seeds germinating naturally after exposure to light fire.
*Acacia decurrens* is more adapted to temperate coastal to cool inland but not dry or hot areas. It grows well in high rainfall areas with 600–1,400 mm (24–55 in) per year, otherwise tolerant to a wide range of conditions. *Acacia decurrens* is generally found on roadsides, along creek lines and in waste areas. It also grows in disturbed sites nearby bush lands and open woodlands.

In Awi zone, acacia *decurrens* stand is mainly established through seedling production, in nursery, and planting. Farmers do collect seed, sow on nursery site, germinate and grow seedlings and then plant on appropriate sites. Almost all seedlings are produced using polythen bag. Landless youth groups also produce seedlings and sell to farmers who have land to establish their woodlot/stand. According to their current practice, seedling production will take place 4 months in the nursery before planting. Also, it was observed that direct sowing on intended plantation site and natural regeneration on previously established and harvested stand was also seen possible with additional management practices. Though, *decurrens* stand was initially started to be established on steep and communal lands, gradually farmers adopted it and started to plant on their own crop land aiming to enhance productivity of crop yield. Now, it is widely established on flat to steep agricultural landscape covering significant area. As it is mostly planted by individual farmers on farm land, it doesn’t require much effort on site preparation except pitting. Because, they are usually planting with cereal crop on ploughed and loosen soil immediately after sowing crop seed/grain. Crop species used for inter-cropping are mostly teff, wheat, barley, potato, and sorghum. Lupine is sometimes used to intercrop during the second year depending on canopy cover of established stand. In most case, in the second and third year (depending on canopy cover to allow under growth) the stand provides fodder grass.

Seedlings are planted mostly at closer spacing, on average about 60cm spacing between seedlings. According to field observation and information from zonal forestry expert, the survival rate of planted seedling is almost 100%, i.e. on average 96%. The main reason is good quality of seedling, land preparation, site fencing/full protection and existence of sufficient moisture/rainfall in the area. Once planted on farmlands, the required management practice is minimal since it is usually grown on cropland. Weeding is normally done together with crop and there is no hoeing. The important measure they take is fencing to protect seedlings from free grazing, as free grazing is the major bottleneck for the success of Ethiopia’s Afforestation/Reforestation program, in general. Harvesting is usually done after 3 and half to 4 and half years.
8. **Utilization of *Acacia decurrens***

The use of *Acacia decurrens* includes for chemical products, environmental management and wood products. According to literature, more specifically, it is used for firewood, charcoal, poles, posts, forage (pods), bee forage, shade, ornamental, nitrogen fixation, soil conservation, windbreak, tannin (bark) and live fence. An edible gum oozing from the tree’s trunk can be used as a lesser-quality substitute for gum arabic, for example in the production of fruit jelly. The bark contains about 37-40% tannin. The flowers are used to produce yellow dye, and the seed pods are used to produce green dye. An organic chemical compound called kaempferol gives the flowers of *Acacia decurrens* their color. It has been grown for firewood, or as a fast-growing windbreak or shelter tree. Although the tannin from the bark is of good quality, special processes are needed to remove undesirable coloring substances. According to EEFRI’s wood utilization research result, there is a possibility of using its wood to produce industrial end use wood products, like for flooring, ceiling and particle board. In Fagita Lekoma district, its wood is mainly used for charcoal production. This plant may become a weed, spreading rapidly by seed in good conditions. In Ethiopian conditions, it has great potential for poles and firewood. Best grown in woodlots and can be used to stabilize soil.
Figure 2- The traditional charcoal Production at Fagita Lekoma District

Figure 3- Packing of charcoal for marketing
9. **Types of Best Practices**

There are many best practices used by the small holders across the process of stand establishment, management and utilization of acacia decurrens. This has to be supported by the research findings from the perspective of soil fertility management, tree spacing and planting density, wood quality and property for proper utilization of the forest resources. Though, there are many types of best practices and approaches that are being implemented in the development and utilization of acacia decurrens, only four community’s own endogenous knowledge, we thought, based best practices are used for the identification, analysis and documentation in the area. During the field work we have tried to identify and document the best practices with the support of the community as well as development agents which are now actively implemented at farmers’ field condition. The practice starts with the establishment of private nursery replacing the government owned nursery site with respect to using quality tree seed for producing standard seedlings. These four types of best practices are practiced by small holder farmers and to some extent on communal land on average from one to five hectares. The best practices are often exercised within the cycle of 3 and half to four and half years period based on classifying the land in quarter hectare bases. Literally, the traditional land allocation system is termed as “kada system” which means quarter hectare.

![Figure 4- Cyclic Land allocation system for planting Acacia decurrens](image-url)
a. **Intercropping of Acacia Decurrens with Cereals**

The intercropping of *acacia decurrens* with cereals basically starts in the first year of seedling plantation on the quarter hectare of land (one khada). So that, in the first year, the small holder farmers could get one seasonal harvest of food crops from the same plot. The indigenous knowledge and the scientific justification here is that the Nitisols which are basically acid soils can now get improved because of the nutrient cycling as a result of the deep rooted acacia decurrens plantation through two or three periodic cycling. This nutrient cycling enabled leaching problem to be ameliorated/restored from the subsurface to the top surface of the soil in which the acidity of soil is greatly improved. This is identified as best practice of planting trees with cereal crops having the advantage of food crop production under tree. It is described as agroforestry system which increased land productivity through soil nutrient improvement using deep rooted decurrens trees to uptake nutrient to sub surface/annual crop rooting zone. In the second season after they harvest the cereals the small holder farmers leave the land without crop or sometimes intercrop with lupine. At the end of second year, they will get good harvest of grass for animal feed that secure mixed farming of crops with dairy or cattle production before the next canopy closing. They also sometimes get lupine crop yield during the second year.

This is basically done on the first quarter hectare of land. After three or four years acacia decurrens stand can grow and harvested for charcoal making. The results of respondents on using this practice were analyzed in procedure as indicated in Table 1. Based on the proper procedure of the identification and analyses of the best practice the average weight of the intercropping of cereals with acacia decurrens is above 1.72 which is 3. It is above the minimum average values set for any best practice to be selected for further documentation and scaling up the practice to similar ecological areas.

**Table 1- Indicate the weighted average values of intercropping of acacia decurrens with cereals**

<table>
<thead>
<tr>
<th>No</th>
<th>Practice</th>
<th>Criteria</th>
<th>Weight</th>
<th>Response of Respondents%</th>
<th>values</th>
<th>Product Wt*score</th>
</tr>
</thead>
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<td>Intercropping of acacia decurrens with cereals</td>
<td>Acceptance</td>
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<td>88.26</td>
<td>3</td>
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<td></td>
<td></td>
<td>Effectiveness</td>
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<td>100</td>
<td>3</td>
<td>0.66</td>
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<tr>
<td></td>
<td></td>
<td>Efficiency</td>
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<td>100</td>
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<tr>
<td></td>
<td></td>
<td>Relevance</td>
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<tr>
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<td>Sustainability</td>
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<td>100</td>
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<tr>
<td></td>
<td></td>
<td>Replicability</td>
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<td>100</td>
<td>3</td>
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<td>1.00</td>
<td></td>
<td>3</td>
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</tr>
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</table>
b. Residue Management of Acacia Decurrens

Residue management of *acacia decurrens* is another best practice identified and analyzed. This is a practice of deliberately leaving/using all leaves, twigs, debris, broken branches and roots for incorporation with soil to improve the organic matter content of the soil. As the rotation period for harvesting the stand is short, 3 and half to 4 and half years, the entire residue will easily decompose and mixed with soil, including the uprooting’s that will easily be undertaken using normal oxen ploughing. Moreover through its deep rooting system decurrens tree root enables to recycle all subsurface leached macro nutrients to the top surface by which the soil fertility is substantially improved.

After harvesting the stand with clear cut, the small holder farmers often do practice leaving all residues on the surface just on the same plot of land. This practice drastically improves the soil physical, chemical and biological properties that obviously improve the soil fertility condition for the next cropping season. The analyses procedures for results of respondents on using this practice are indicated in Table 2. Based on the proper procedure of the identification and analyses of best practice, tree residue management practice has average weight of above 1.72, which is 3 above the minimum average values. Hence, this is also selected for further documentation and scaling up the practice to similar ecological areas table 2 and figure-5.

<table>
<thead>
<tr>
<th>No</th>
<th>Practice</th>
<th>Criteria</th>
<th>Weight</th>
<th>Response of respondents</th>
<th>values</th>
<th>Product Wt * scores</th>
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<tbody>
<tr>
<td></td>
<td>Tree residue management</td>
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<td>100</td>
<td>3</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effectiveness</td>
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<td>100</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>Efficiency</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sustainability</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replicability</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 2- Indicate the weighted average values of tree residue management
c. **On farm Rotation/Cycle Management of *acacia decurrens***

As explained above, the rotation period for harvesting acacia decurrens for charcoal production is often falls between 3 and half to 4 and half years, for stands owned by individual smallholders. Harvesting and charcoal production usually takes place during dry season. Immediately, after harvesting the stand and collecting charcoal product from the plot, they will start land preparation for the summer season crop production. Then, ploughing, sowing cereal crop and planting acacia decurrens seedling will take place simultaneously during the same season. They do not sow crop alone for some years, though the soil fertility gained as a result of the first rotation period could support to produce cereal crop for 2-3 years without intercropping with decurrens. According to farmer’s response, following harvesting of decurrens, it is possible to get good yield for 2-3 years without intercropping with decurrens as soil fertility is improved. But, they do plant seedlings just during the same year after sowing cereal crop. They do this because of border effect among neighboring farmers. As most farmers establish their own
decurrens stand on their plot of land, the adjacent farmer is by default forced to plant seedling immediately after harvesting the stand without fallowing for some years.

Hence, the cycle or rotation of establishing decurrens stand via intercropping continuous and managed like this every 3 and half or 4 and half years. The rotation follows the same cycle in each plot of land/ quarter of hectare.

As indicated in the earlier practices, repetition of the practice in the same land has continues improvement of the soil physical properties like the soil structure, good water holding capacity and increase of soil organic matter accumulation. Similarly there is continuous nutrient cycling from the lower soil profile to subsurface and surface soil. This will enhance availability of macronutrient and enhanced the soil biological activity/soil microorganism that fix soil nitrogen, It also help to anchor the soil and prevent from erosion due to its high rooting density. Hence it is considered also as the best way for restoring degraded land and combating desertification.

This practice also allows farmers to stay on their respective land due to continuous productivity and reduced vulnerability to migrate. This practice has greatly increased the land value in which farmers now looks for high monitory price for charcoal making. So, this cycle management has all those benefits. The responses of respondents towards using this practice were analyzed as indicated in Table 3. According to the identification and analyses of the best practice, the average weight of the on-farm rotation/cycle management practice of acacia decurrens is scored above 1.72, which is 3 and it is above the minimum average values set for any best practice to be selected for further documentation and scaling up the practice to similar ecological areas Tables3.

Table 3- Indicate the weighted average values recycling of production of acacia decurrens

<table>
<thead>
<tr>
<th>No</th>
<th>Practice</th>
<th>Criteria</th>
<th>Weight</th>
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<th>Product Wt*scores</th>
</tr>
</thead>
<tbody>
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<td>Rotation/cycle management of acacia decurrens</td>
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<td>88.26</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effectiveness</td>
<td>0.22</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficiency</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sustainability</td>
<td>0.14</td>
<td>100</td>
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<td></td>
<td></td>
<td>Replicability</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
</tr>
</tbody>
</table>
d. Plot Allocation and land management

The other best practice is the wise plot allocation or land use/cover management for establishing acacia decurrens stand. Farmers do not allocate the whole of their land to plant acacia decurrens at one time or season, even if they have more land size. Rather, they divide their land in to plot size of quarter hectare called one Kada. For example a farmer who has 1 ha of land often divides his/her land in to four plots. Then, they decide planting/intercropping decurrens on one of the plot in the first year, the 2nd plot will be planted during the 2nd year, the 3rd plot will be planted during the 3rd year and the last plot will be planted during the 4th year. Each year, planting of the plot/Kada/ is done via intercropping tree seedling with cereal crops with the determined spacing between. In this way, farmers do get crop yield each year from the respective plot turn by turn. Starting from the first rotation period of acacia decurrens harvest, they also annually collect and produce charcoal from harvested stands. They also harvest grass biomass during the second year of stand establishment.

The whole cycle of development, production and utilization of acacia decurrens starts from the first year of planting with cereals in the first quarter hectare of land while the adjacent quarter hectares are used only for crop or already occupied by the previous tree plantation; in the second year the other quarter land is again planted decurrens seedlings with cereals while the first quarter land is grown with grass or sometimes intercropped with legume crop called lupine depending on the canopy cover of the decurrens sapling/tree. However the third and fourth quarter hectares are left free without any intercropping. During the 3rd year, the third quarter plot/land will be planted acacia with cereal crop while the first plot only grows decurrens and the second plot grows either decurrens with lupine or only decurrens, depending on canopy cover. Then, the cycle continues like this until harvesting after either 3 and half or 4 and half years growth. So it is very cyclic process that increases the land value with maximum efficiency of land management system. Traditionally many papers are published on the tanguay methods of land cyclic management and intercropping as the main form of agroforestry system with increased production and productivity per unit area.

Each plot/Kada will provide cereal crop yield during the 1st year of intercropping, lupine and/or grass product during the 2nd year, no product harvest during the 3rd and/or 4th year and offer charcoal, fuel wood and residue product during the 3 and half or 4 and half year. This process and product harvest will occur in each plot and allows the farmer to get all the product type (crop, grass, charcoal and residue) every year. When one plot provide crop yield, the other will provide grass for livestock production and the rest provide charcoal for market.

According to the discussion with farmer group, they have basic reasons to follow this plot allocation and management system. These are;

- It allows them to get sustainable cereal crop yield, charcoal product and grass biomass each year for their consumption and market
• It will enable them to regulate market price by avoiding over production of charcoal product at a time and market price failure following over supply; and
• Uses the system as safety insurance. Because they feel safe as they have continuous annual revenue from each plot.

Based on the procedure of identification and analyses of the best practice, the average weight of the plot allocation and land management practice is above 1.72 which is 3. It is above the minimum average values set for any best practice to be selected for further documentation and scaling up the practice to similar ecological areas. Table 4 & 5 illustrate the example of plot allocation and result of the analysis for the response of respondents.

Table 4- Plot allocation and land management practice for acacia decurrens intercropping

<table>
<thead>
<tr>
<th>Plot A</th>
<th>One Kada = quarter ha (Plot A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter hectare (1st year)</td>
<td>Acacia decurrens with Cereal</td>
</tr>
<tr>
<td>Quarter hectare (2nd year)</td>
<td>Acacia decurrens with Lupine &amp;/or grass</td>
</tr>
<tr>
<td>Quarter hectare (3rd year)</td>
<td>Only Acacia decurrens because of canopy closure (Harvest at 3 &amp; half year)</td>
</tr>
<tr>
<td>Quarter hectare (4th year)</td>
<td>Only Acacia decurrens because of canopy closure (harvest at 4 &amp; half year)</td>
</tr>
</tbody>
</table>

Table 5- Indicate the weighted average values plot cycling and land management

<table>
<thead>
<tr>
<th>No</th>
<th>Practice</th>
<th>Criteria</th>
<th>Weight</th>
<th>Response of respondents</th>
<th>values</th>
<th>Product Wt*sc</th>
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<tbody>
<tr>
<td></td>
<td>plot cycling and land management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptance</td>
<td>0.22</td>
<td>94</td>
<td>3</td>
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<tr>
<td></td>
<td>Effectiveness</td>
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<td>Efficiency</td>
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<td>Relevance</td>
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<td></td>
<td>Replicability</td>
<td>0.14</td>
<td>100</td>
<td>3</td>
<td>0.42</td>
<td></td>
</tr>
</tbody>
</table>
10. Rural Job Creation

Different categories of rural job is created in the development, management, harvesting, processing, transporting, marketing and utilization of acacia decurrens for the small holder farmers’, youths, traders, whole sellers, vehicle owners and retailers. Categories of job created in this best practice includes; Seed collection and marketing, quality seedling production and selling, labor for seedling planting, harvesting and processing of acacia decurrens (felling, de-branching, cutting in to pieces, piling and charcoal production), loading-unloading, transporting and whole seller and retailing of charcoal products. In this process, the practice created large number of rural job that are relatively distributed throughout the year. The rural job creation includes both for land owners and landless rural people. Landless youth groups have got an opportunity to be hired by land owners for harvesting products and charcoal production. According to information from district office of agriculture, charcoal products are transported and sold to different market destinations in the region and beyond the region in towns and cities. This includes Tigray region, Addis Ababa and even to Asmara, Eretria, markets Figure-6 & 7.

The charcoal making process in traditional way where a single small holder farmer produces from the 0.25ha/one khada 16-17 heaps of charcoal burning sites are produced with a total selling price of 40000-50000 birr from each quarter hectare. Normally the wood drying charcoal drying process is done takes two weeks in dry period while it dies in four weeks during summer time. Finally the charcoal burning process takes four days. Each burning site/heaps can produce from 56-60 bushels so from on khada/0.25 ha 16-17 heaps/burning site are produced. During the marketing process 1 bushel of charcoal costs 80 birr. The wood harvesting process is done using saw. The a problem of environmental pollution while charcoal burning affecting the health of the population.
Figure 6- Job opportunity and Charcoal products ready for marketing
Figure 7- Charcoal products ready to be transported to different market outlet.

11. Scalability and Acceptance of the Best Practices of Acacia Decurrens

Based on the field observation and interview made with different institutions, the scalability and replicability of the best practices on the development and utilization of *acacia decurrens* has a great and potential role within the region and beyond in areas with similar ecological zone and problems. It is also possible to scale it up in areas with similar conditions and its acceptance rely on its potential of solving the problems and offering good benefit for the community with good awareness, which have seen it successful in this regard. The role of different institution is also important for its scalability and acceptance. For example, there are different institutions which are working on the research component on the fertility aspect. For instance the Amhara agriculture research institute, Bahir Dar Environment and Forest Research Center, and Injibara University need to strengthen the efforts and support the scalability and acceptance by providing evidence in its various aspects including identifying tradeoffs, if there exist. As areas all over the country with similar condition demands such kind of intervention for similar problems, there is good opportunity to scale up the practice.

This practice is also possible to be implemented by locally available resource, technology and capacity once introduced, with few external input like polythen bag/tube for seedling production. But, it is important to exert coordinated effort by different relevant institutions to improve existing management and production practices as well as market related issues. Identifying and addressing unforeseen issues and tradeoffs is also key aspects that demand further research evidence while considering scaling up. Role of extension and research institutions are important to support the practice in more scientific approach. The existence of forestry related projects and programs are also important entry point for its scalability. Showing up evidence based impacts of this practice will enhance its acceptance by other community members.
12. Challenges and General observation in the process of the practice

Though the practice is well accepted and widely implemented by farmers and community groups, there are several issues or challenges that we observed in the process of the development, harvesting, production and marketing of products. These issues demands appropriate and timely measures to be taken to sustain the positive role of the practice for social, environmental and economic aspects. We observed the following general concerns and issues for future action.

- Charcoal production is widely practiced throughout the district just on the same plot of land where they harvested using traditional heap processing method. No farmer is currently using charcoal producing kiln technology. Hence, there is no scientific charcoal producing procedure and no optimum limit in production per day and per site. As observed and the information from some people, every early morning we feel the smell of smoke. We have heard also that, before some years back GIZ attempted to introduce Kiln technology, but farmers' stopped after few practice due to irregular carbonization process and also due to limit of production per day with the technology. According to the information there is limit of charcoal production per day per Kebele in using kiln. So, the human and animal health related cases and environmental/air pollution aspect needs to be researched and come up with recommendations.

- The forestry sector institution is fragmented from region down to district level. Plantation stand establishment and management is handled in the agriculture sector while utilization and regulatory activities are mandated to the environment, forest and wildlife conservation and management authority that have only one forestry expert at zonal and district level. In addition, the number of forestry experts with in the district office of agriculture is too limited to properly and timely deliver the required service to customers as number of customers/farmers, traders/ of this practice is increasing from time to time. For example large number of farmers comes to district office of agriculture to get felling permit and charcoal merchants/dealers to pay royalty fee and get transport permit of products every day. Hence farmers are expected to wait for half day, some time for a day and even for two day only to get felling permit. Dealers also face the same problem. On the other hand the district collects huge amount of revenue only from royalty fee. For example, in this fiscal year, only within nine month they have collected about 27 million ETB royalty fee from charcoal marketing. There is also lack of/poor coordination between the institutions. This affects the governance of forest resource and utilization and also the service delivery to clients.
The region has recently increased the royalty fee from 10% to 13% ideally aiming to increase the benefit share of the districts and community who developed the forest. Ideally it is the buyer who will pay this royalty fee. However, following the new rate of regional forest royalty fee middlemen put the entire load on farmers who own the stand/charcoal to pay it, which is not legal. Hence, we observed during the interview farmers are complaining that the price for their harvest is reduced following the new regional directive of royalty fee. Even, experts told us no percent share of the revenue is left for the district and all goes to the region.

Decurrens grower farmers do not have cooperative/association to influence market and increase their bargaining power. Market price for their harvest is mainly influenced and guided by the middlemen/brokers. They also complain that the price for some industrial inputs used for the processing and packaging of products are increased.

Currently, all harvest of acacia decurrens is used only for charcoal production. There is no alternative uses and market for its wood product other than charcoal production. It is not used yet for industrial application like tannin, ceiling, roofing, etc.

Scientific studies on various roles and benefits of decurrens were limited. The extension and product processing is not supported with research. For example the role of decurrens bio-char for agriculture productivity and soil property improvement is not studied in the area as charcoal production is fully done on the agricultural field that allow the full distribution of charcoal powder in the field. Spacing during stand establishment is simply determined with farmer’s knowledge, though Amhara agriculture research institute is currently conducting research about effects of various spacing.
Tree maturity stage/age of harvesting for maximum production is not well studied and still determined by farmer's knowledge.

- Provided the land use land cover dynamics under this practice, it is difficult to clearly classify the land use type of the practice either as forest or crop land. It is also not easy to map and quantify the forest cover of the district under such dynamic development and harvesting stand. This demands a special mapping technique and decision to detect changes over time though the general trend indicates increasing trend for acacia decurrens area coverage. Hence, it needs to build capacity of district and zonal experts in charge of LULC mapping. Because resource mapping and assessment, and availability of mapping information is directly related to attracting private sector involvement in the business across the value chain of the practice.

### 13. Conclusion and Recommendations

The contribution of forestry sector in Amahara regional state is progressing in promising way. The small holder and state owned forests contributed a lot for the region and at national level. Small holder wood lots and communal and state/enterprise owned plantation forest contributes significantly to both the region and national GDP growth. The region has immense potential for the forestry sector transformation, forest industry and regional economic and livelihood improvement. However the forest governance of the region is disintegrated and handled by two different institutions (bureau of agriculture and Environment, Forest and Wildlife Conservation and development Authority) that weaken the role of the sector to play to its full potential. If the region has well organized and strong forest governance system and integrated institution, its contribution would become more than its current contribution.

Farmers in Awi zone, Fagita Lekoma district, have fully accepted and practiced the development and utilization of acacia decurrens to solve their productivity and land degradation related problems. Currently, acacia decurrens is widely accepted by farmers and spread almost throughout the district of Fagita Lekoma. Farmers seem to have proved that currently acacia decurrens plantation is a solution for their problem. They are progressively improving their practice and production as well as their land management. Their land value has been increased as a result of this practice. Charcoal production is solely practiced following traditional carbonization processes. Though the current market value for their product is profitable, it needs to consider reducing role of brokers to secure their benefit and sustainability of the practice. Scaling up of the practice in to other similar areas is worthy.
Hence the following recommendations are forwarded to address key issues in sustaining the practice and ensuring social, environmental and economic benefits are equally important.

- Environmental and social impact assessment need to be conducted to know if the current massive carbonization process have any negative impact on human and animal health and any biological resources including air, water and soil pollution.
- Human health related issues need to be researched, especially impact of smoke and dust particle on different social category /women, children, etc../
- Appropriate and safe charcoal production/carbonization system and technology that have better acceptance need to be introduced and piloted.
- Good to consider restructuring/redesigning the forestry institution for better service delivery and good forest governance. Fragmenting forestry institution will weaken and dilute the effort. Or consider strong institutional coordination for better delivery.
- Request the region to be flexible and context specific in designing required number of forestry experts. Hence, increasing the number of forestry experts in Fagita Lekoma and similar potential districts with better volume of forestry activities will enhance service delivery; reduce time consumed for farmers and traders in getting required legal services from forestry institution.
- Monitor and regulate the implication of recently improved royalty fee and take appropriate corrective action on who will pay royalty fee.
- Check if the district/community is receiving their percent share of royalty fee and take corrective measure if not.
- Consider establishing A. decurrens grower farmers’ cooperative/association for better benefit, market link, and rural transformation and benefit them from the power of cooperative.
- As volume of production is increasing, consider developing alternative end use products form acacia decurrens, other than charcoal production. The roles of research in diversifying decurrens based end use products are needed.
- Research must be conducted on various issues that support its sustainability and better benefit.
- GIS and Remote sensing training is needed for district and zonal level experts to map the resource.
- Organize a national workshop for stakeholder on this best practice for better action.
### 14. List of Institutions for the Information Gathering

<table>
<thead>
<tr>
<th>s./no</th>
<th>Name of the institution</th>
<th>address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amhara environment, wild life authority</td>
<td>Bahiirdar</td>
</tr>
<tr>
<td>2</td>
<td>The environment forest research institute</td>
<td>Bahiirdar</td>
</tr>
<tr>
<td>3</td>
<td>Amhara agriculture research center</td>
<td>Bahiirdar</td>
</tr>
<tr>
<td>4</td>
<td>Awie zone agriculture burero</td>
<td>Injibara</td>
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<td>Fagta lacome wereda agriculture office</td>
<td>Addis kidam</td>
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<tr>
<td>6</td>
<td>Community elders</td>
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<tr>
<td>7</td>
<td>Extension agents (DA)</td>
<td>Addis kidam</td>
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</table>

**Key Informant interview**  
(Technology and best practices on *Accacia decerens*)

Kebele__________________________  
Name of the respondent__________________________  
Position__________________________  
Sex__________________________  
Age__________________________

1. When did you started the practice?  
   __________________________________  
   __________________________________
2. Why did you state it/ what was the purpose?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

3. Who provided the information that initiated you to start?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

4. Did the practice help you to attain your aim of the practice?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

5. What support did you get?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

6. What benefits and products did you get from the practiced ?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

7. How did you practice the activity? Continuously, per certain period of time ?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

8. What did you get from the practice?/ how did you process it ?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

9. Future Improvement needed in the practice?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

10. Management options?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

11. Market condition of the products?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
12. What are the challenges associated with the practice; product processing (list them)?
<table>
<thead>
<tr>
<th>No</th>
<th>Criteria</th>
<th>Type of SFM Practice Technology (Accacia Decerens)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>
| 1. | **Acceptance**: To what extent is the SFM practice accepted by the Community/individuals where it is practiced?  
  ✔ the farmers to whom the technology has been introduced continue to use/apply it;  
  ✔ ከሆን እንጂ በተከደው በሆነ እየተጠቀመበት ይው? | Inter-cropping  
  1. ____________________________  
  2._____________________________  
  3._____________________________  
  4.____________________________  
  5.____________________________ | | |
| 2. | **Effectiveness**: To what extent does the SFM practice achieve its intended results in terms of forest rehabilitation and/or increased Productivity?  
  ✔ of the interviewed farmers respond that the practice is effective with regard to its immediate objective;  
  ➢ የከደው በታቀደው በማስልክ እስከመ ላገና? | 1. ____________________________  
  2._____________________________  
  3._____________________________  
  4.____________________________  
  5.____________________________ | | |
| 3. | **Efficiency**: To what extent farmers perceive investing in this technology is worthy? | | | |
| ✓ of the interviewed farmers perceived that investing in this technology is worthwhile |
| ✓ የከተለበት መጠቀም እንማ ከው ሙሉ ይክፈል? |

| 4. **Relevance:** To what extent is the SFM practice suitable for tackling Forest and land degradation and/or generating increased productivity? |
| ✓ of the interviewed farmers agree that the technology is relevant with regard to its immediate objective |
| ✓ የከተለበት ሙሉ ይወንወን መጨመር፤ ይመልቹ መጨመር ከስለ ይክፈል፣ ያርቃማነትን መጨመር ከስለ ይክፈል? |

| 5. **Sustainability:** To what extent is the SFM practice (or physical Infrastructure) with locally available resource? |
| ✓ of the interviewed farmers confirm that individuals or the community are applying the technology without external support; |
| ✓ የከተለበት ሙሉ ይወንወን ያቀኝ ያስፈልጉ መጨመር ከእስከ ከጠቅማል ይክፈል? (የገበሬው እቅመ ከሰራ ይስፈልጉ ይክፈል?) |
6. **Replication for scaling-up:** To what extent is the SFM practice, as it is currently carried out, replicated elsewhere under similar conditions?

- ✓ of the interviewed farmers confirm that the technology is replicated in adjacent areas;
- ✓ የተመሳሳይ በሌሎች ገጆጆች እንጂ ይችል ይችል።

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15. References

- CIFORE. (2015). Enhancing the role of forest sector in building climate resilient green economy. Center for international research center; Addis Ababa.