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AGROFORESTRY PRACTICES AND FARMERS' PERCEPTION IN KOGA WATERSHED, UPPER BLUE NILE BASIN, ETHIOPIA

SUMMARY

Agroforestry has made tremendous strides in recent years, but many challenges remain in-terms of its application. The objective of this study was to describe the existing agroforestry practices in relation to species richness and ecological significance, to know farmer's perception, techniques of management of woody trees and to assess socio-economic potential and constraints of agroforestry in North-western Ethiopia. The study was carried out at farm-landscape, homestead levels, woodlot and grazing areas. At farm level, 20 plots of 100 m x 100 m each and at homestead level, 20 plots each having an area of 10 m x 10 m each were selected using simple random sampling technique. Result indicates that on-farm tree density ranged from 21-127 trees ha^{-1} and the existing fragmented landholding possession affects the intensification of agroforestry while around homesteads there is a mix of animals, woody trees, food crops and fruit trees which composes an incredible amount of biodiversity. Agroforestry technologies should be widely distributed and promoted through farmers' participation to provide more options for livelihood improvement.

Key words: agroforestry practices; diversity; on-farm; farmer, trees/shrubs, home garden.

INTRODUCTION

In the context of climate change, increasing population, deforestation, reduced landholdings and declining soil productivity, Ever Green Agriculture is emerging as an affordable and accessible science-based solution that will help smallholders protect and enrich soils, increase food production, adapt to climate change and reduce greenhouse gas emissions (Garrity *et al*., 2009). The challenge of spreading the knowledge and uptake of evergreen agriculture and other "climate smart" agriculture practices is being taken on as a priority by regional governance bodies in Africa (Garrity, and Verchot, 2008).

Deforestation causes loss of biodiversity and environmental degradation. Population pressure is the main cause for the depletion of forest resources which

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in turn poses many social and economic problems in Ethiopia (Teshome *et al*, 2009). One way of reducing deforestation problem is through agroforestry the integration of trees with crops on farmlands has a great potential for enhancing land productivity while providing essential services to people and the environment and shielding forests from further deforestation and land degradation problems common in the highlands of Ethiopia. Agroforestry can also provide food, fuelwood and fodder for the farm family on a sustained basis (Bishaw, 2003).

In the study area the natural resources including forest, soil water and biodiversity are highly degraded. To rehabilitate the degraded areas, governmental and non-governmental organizations have been implementing rehabilitation programmes such as soil and water conservation. However, the types of agroforestry practices applied, the tree species planted and farmer's perception on utilization of the practices have not been studied and documented. In addition, factors affecting the expansion of agroforestry practices are not well known and the extent of tree species inventory and diversity on farm lands and social and environmental reasons for maintaining these species has not been clearly studied and documented in the study area. Therefore, this paper aims to indicate the gaps which influences on the expansion of agroforestry and to point out potential role of agroforestry. The investigation is also crucial to provide base line information on tree/shrub species, diversity and type of agroforestry practices in the watershed.

MATERIALS AND METHODS

Study area

The study was carried out in Blue Nile Basin. It is located between 11^0 10′ - 11^0 25′ North and 37^0 2′- 37^0 17′ East in the Blue Nile Basin, within the North western highlands of Ethiopia (Figure 1). The total catchment of the study area is 27,850 ha. The study area receives an annual rain fall ranging from 1000 to 2000 mm and has a daily temperature ranging from 20 – 27^OC (Bureau of Agriculture (BOA) annual report, 2011.Unpublished data).

Data collection

Simple random sampling technique was used for selecting on farm study plots where agroforestry practices are used. Field observations were held along a transect walk accordingly, 20 plots each having an area of 100 m x 100 m and for homestead agroforestry practice, 20 plot each having areas of 10 m x10 m were selected to take inventory and tree height and diameter measurement. The number of plots was twenty due to the difference in farm land size and the tree is scattered over large areas, these large number of plots helps to collect representative and sufficient data. On-farm, homestead, and grazing areas of agroforestry were observed and types of tree species identified and characterized. Numbers of woody trees species per hectare were counted and identified. Tree/shrub identification and nomenclature was done using (Bekele, 2000 and

Edwards, *et al*., 2000). Height of each woody tree and diameter at breast height (dbh) above ≥10 cm were measured. Techniques of tree management practices were observed and recorded. Frequency of management practice time of cutting and level of cutting height were also recorded. The household survey was conducted using a structured questionnaire. A total of 120 household heads were systematically selected and studied. Similarly focus group discussion was carried out to collect socioeconomic data.

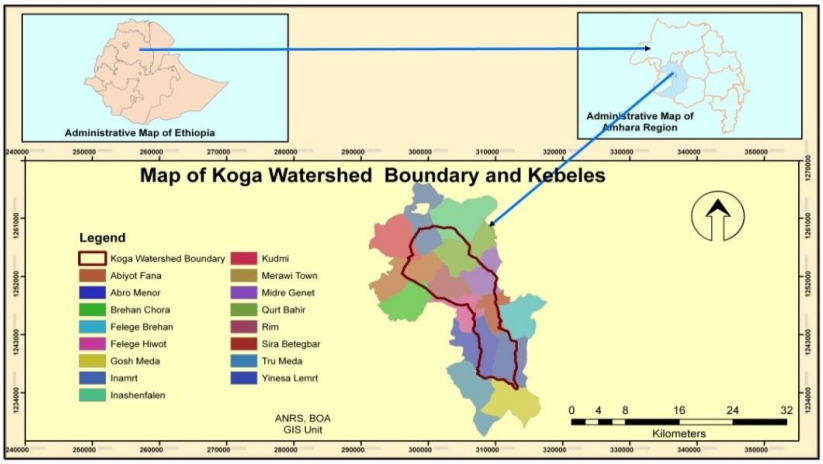

Figure 1. Map of the study area

Data analysis

Structural arrangement for type of agroforestry practices; whether dispersed trees on the farmlands homegardens, taungya, or woodlots were described. Data for tree height and diameter were arranged in classes. The total number of tree species in a community is referred to as species richness. Richness of each agroforestry practice types is calculated as the number of species observed in each plot. In addition to this, importance value index (IVI) was calculated to demonstrate the importance of individual tree species on farm land and to compare the ecological significance of the species. It was calculated with three components (Kent and Coker 1992) as follows:

$$IVI = RF + RD + RDO$$

where:

$$Relative\ frequency\ (RF) = \frac{Frequency\ of\ species}{Sum\ of\ frequency\ of\ all\ species} x100\%$$

$$Relative\ density\ (RD) = \frac{Number\ of\ individuals\ of\ species}{Total\ number\ of\ individual\ of\ all\ species} x100\%$$

$$Relative\ dominance(RDO) = \frac{Dominance\ of\ species}{Total\ dominance\ of\ all\ species} x100\%$$

The collected socio-economic qualitative and quantitative data were analysed in SPSS Version 19. Information obtained from informal interviews with different people was more of qualitative in nature and was used as supportive information.

RESULTS AND DISCUSSION

Scattered trees on-farm lands

The practices of traditional agroforestry system practiced in the study area are summarized in table 1, 2 and 3. Within farm lands scattered trees are found and cover large areas. The major trees found on-farm lands and which were deliberately left by the farmers were *Croton macrostachys*, *Acacia abyssinica* and *Cordia africana.* The major crop types grown in the area include cereals such as finger millet (*Eleusine coracana* (L.) Gaertn.), barley (*Hordeum vulgare* L.), bread wheat (*Triticum aestivum* L.), teff (*Eragrostis tef* (Zucc.) Trotter), maize (*Zea mays* L.), pulses (such as faba bean (*Vicia faba* L.), field pea (*Pisum sativum* L.), lentil (*Lens esculenta* Moench.), chick pea (*Cicer arietinum* L.) and oil seeds.

Farmers explained that some crops like barley, maize and wheat do well when grown with *Croton macrostachys*, *Acacia abyssinica* and *Cordia africana*. These crops are shade tolerant and show vigorous performance while finger millet and pulse crops like fababean and field pea under the tree canopy tends to decrease its performance. Studies show that, the incorporation of shade trees (‘maintain tree stratum’ or other shade tree-based variables) is frequently shown to positively affect and nutritional status through improved light regulation and nutrient cycling (Beer *et al*., 1998; Schroth *et al*., 2001).

Farm boundary plantation

Sixty percent of the respondents plant trees and shrubs along the boundary of their farms to protect their crops and as a source of different wood products. *Ficus ovate, Sesbania sesban, Vernonia amygdalina, Solanum gigantium and Eucalyptus camaldulensis* are familiar trees planted on farm boundaries. Trees are planted in a single or multiple rows consisting of a mixture of different species. The trees are regularly pollarded and farmers used the branches for fuel and fencing. *Ficus ovate* pruned materials/branches are used as mulch and fodder. In addition to these the live fences offer shade for animals. Some farmers (35%) of the respondents perceive that trees provide a micro-climate which minimizes soil moisture loss as well as improving pasture growth. But most farmers (65%) of the respondents said that trees at the border of the farm compete with crops and pasture for light and also act as a refuge for birds, and other pests. Gebeyehu (2010) in North Western Ethiopia also found high number of tree/shrub species in boundary plantations.

Table 1. Major Agroforestry practices in the study area

Agroforestry practices	Trees/shrubs	Crops	Arrangement	Ecological significance	
				Production role	Protection role
Scattered trees on farm land	*Croton macrostachys* *Acacia abyssinca* *Cordia africana*	Teff (*Eragrostis tef* (Zucc.) Barley (*Hordeum vulgare* L.) Maize (*Zea mays* L.) Wheat (*Triticum aestivum* L.)	-Trees are scattered, no pattern -Food crops broadcast except Maize in row	-Trees (for fuel, fence construction, farm equipment, feed and lumber) -Crop grain and straw (for food and feed)	-Shade (For crops, animals) -Wind break, -Shelterbelt, -Moisture conservation -Soil improvement
Farm boundary	*Ficus ovate* *E.camaldulensis* *Vernonia amygdalina* *Solanum gigantium* *Sesbania sesban*	Maize (*Zea mays* L.) Shallot (*Allium cepa var.a*) Pepper (*Capsicum frutescens*) Onion (*Allium cepa* L.) Teff(*Eragrostis tef* (Zucc.) Potato (*Solanum tuberosum* L.)	Trees on edge of plots/ fields	-Fuel, fence construction, farm equipment, fodder and lumber) -Food and feed	-Shade (For crops, animals) -Wind break, -Shelterbelt,
Taungya system	-*Eucalyptus camaldulensis*	Maize (*Zea mays* L.) pepper (*Capsicum frutescens*)	Trees planted in rows and maize or pepper in between rows	*Crop for food *Tree (Fuelwood Construction material)	-Shade (For crops, animals) -Wind break, -Shelterbelt,
Live fence	*Ficus ovate* *Sesbania sesban* *Vernonia amygdalina* *Solanum gigantium* *Melia azedarach*	Maize (*Zea mays* L.) Shallot (*Allium cepa var.a*) Pepper(*Capsicum frutescens*) Onion (*Allium cepa* L.)	Trees planted in single/double row - Crops planted in row	-For fuel, fence construction, farm equipment, fodder and lumber) -Grain and straw	-Live fence -Shade -Wind break, -Shelterbelt, -Moisture conservation -Soil improvement

Table 2: Home garden agroforestry practices

Trees/shrubs	Crops	Arrangements	Production role	protection role
Rhamnus prinoides	Teff (*Eragrostis tef* (Zucc.)	-Trees are	-Trees (for fuel, fence	-Shade (For crops, animals)
Acacia abyssinca	Barley (*Hordeum vulgare* L.)	intercropped with	construction, farm equipment,	-Wind break,
Cordia africana	Wheat (*Triticum aestivum* L.)	crops	fodder and lumber)	-Shelterbelt,
Croton macrostachys	Maize (*Zea mays* L.)	-Food crops broad	-Crop grain and straw (for food	-Moisture conservation
Albizia schimperiana	Coffee (Coffea abs.)	cast	and feed)	-Soil improvement
Sesbania sesban	Vegetables	-Maize in row	-Fruit trees for food	
Coffea arabica		-Coffee plantation no		
Mangifera indica,		pattern		

Table 3: Trees and animals on grazing lands

Silvopasture	*Trees*	Animals	Pasture	Arrangement	Production	Protection
Scattered trees on pasture land	*Acacia abyssinica* *Cordia africana* *Sesbania sesban* *Vernonia mygdalina* *Ficus vasta*	Cattle Sheep Goat Donkey Mule Birds	- *Cymbogon commutatus* *-Andropogon dumereri* *-Cynodon nlemfuensis* *-Andropogon gayanus* *-Trifolium rueppellianum* *-Cyperus rotundus*	-Mixed sparse -Trees scattered irregularly or arranged according to some systematic pattern. -Cattle graze fresh grass under *trees*	-Trees (for fuel, fence construction, farm equipment, fodder and lumber) -Crop grain and straw (for food and feed) -Cattles dung	-Shade (For crops, animals) -Wind break, -Shelterbelt, -Moisture conservation -Soil improvement

Taungya

Taungya farming involves the growing of annual or biennial agricultural crops along with the forest species during the early years of establishment of the forest plantation (Agera *et. al.*, 2010). The planting of *Eucalyptus camaldulensis* with maize and green pepper at the early establishment of the eucalyptus is commonly practiced. Farmers care for the trees and at the same time grows crops for a year; then the woodlots take over the plots.

At present 90% of the respondents farmers has planted *Eucalyptus camaldulensis* for the reason that it is the only resource used for construction of houses and making farm implements as well for sale.

Trees on pasture land

Cordia africana, Acacia abyssinica, Ficus ovate and Sesbania sesban play an interactive role in animal production by providing shade and fodder. The fodder trees are left to grow sufficient wood so that they serve as live fence around grazing units and farmyards; the trees are lopped periodically for fodder and sometimes fruits and pods of standing trees/shrubs are consumed. The major livestock are cattle, goat, sheep, donkey and mule. *Ficus ovate* propagation is by cutting the branches. The most important parts of fodder species were found to be leaves and new shoots. *Ficus ovate, Cordia africana* and *Sesbania sesban* helps as supplementary feed during dry months.

Homegarden agroforestry

Homegarden agroforestry has been a long tradition in the study area. These gardens are planted and maintained by members of the household and their products are intended primarily for household consumption. Homegarden trees/shrubs foliage biomass enhances soil fertility and improves crop yield. The higher soil fertility from animal manure also contributes to the higher performance of trees and shrub as well as annual crops around homesteads (Felix *et al*., 2012). Different parts of trees were used for livestock feed. The flowers of the trees and crops are also used for bee farming. The idea is supported by (Kanshie, 2002) who reported that homegardens tree and shrubs, apart from optimizing the yields of diverse crop/tree species, regularly replenish soil fertility and productivity through continuous supply of organic matter and through protection from erosion and leaching.

Horticultural trees such as *Coffea arabica, Rhamnus prinoides*, *Mangifera indica, Citrus aurantifolia, Citrus sinensis, and Psidium guajava* fruit trees are common components of these agroforestry. Women prefer homegarden agroforestry trees (*Rhamnus prinoides and Coffea Arabica)* to manage and control closely while men focus wood lot plantation anywhere. The intimate mix of diversified agricultural crops and multipurpose trees help to improve biodiversity and plays a significant role in income generation (Fekadu, 2009).

Tree management practices

Tree management in this study refers to all activities/operations in handling the tree to harmonize their existence with crops and animals. Coppicing, pollarding, pruning, and lopping are among the most important tree management practices in the area. Farmers are aware of the importance of the different tree management activities for optimizing tree crop interaction and to derive benefit such as fuelwood, fodder, and soil fertility improvement from tree management activities. Farmers harvest forage leaves from *Sesbania sesban* twice a year and get 40kg of forage leaves from four shrubs in one harvest. Similarly the majority of farmers were practicing coppicing and thinning for *Eucalyptus camaldulensis* planted in their woodlot. The result of this study agrees with Zeleke (2006) who indicated that the farmers in Northwestern Ethiopia have similar tree management technique. Similarly, Reed (2007) reported that, farmer's management and interaction of trees with other components of the agricultural system is the basis for development of agroforestry interventions.

Tree/shrub species inventory, spacing and diversity

Species composition and tree density

Most on-farm trees are planted and maintained at different spacing's and mostly from 10 to 15 meter apart. Similar to what was reported by (HDRA, 2001). On-farm tree stand density ranged 21-127stems ha^{-1}, homegarden tree stand average density is 1450 stems ha^{-1} while woodlot trees stand average density is 5000 stems ha^{-1}.

Species richness

Farmers in the study villages retain trees according to the available spaces compatibility with agricultural crops and household objectives. *Croton macrostachyus* was the most frequent (100%) followed by *Eucalyptus camaldulensis* (90%). were the most frequent tree/shrub species *in* the study area (90%) (Figure 2). Similar results were reported by Gebeyehu, 2010 in Northwestern Ethiopia.

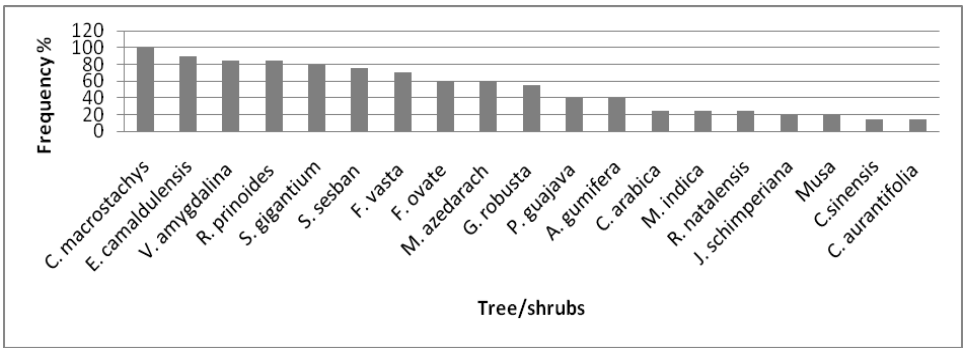

Figure 2. Frequency of agroforestry tree/shrub species in the sample plots

Importance value index (IVI)

Importance value index was calculated for those tree/shrub species with a (dbh) of ≥ 10 cm. On-farm tree inventory shows that the species with the highest IVI value were *Croton macrostachyus* (104 %), *Acacia abyssinica* (45 %), *Cordia africana* (36 %) and *Ficus vasta* (26 %) (Table 4). The high IVI value for *Croton macrostachyus* and *Acacia abyssinica* was because of their high relative density and relative frequency. On the other hand, the high IVI value of *Ficus vasta* was because of its high relative basal area though it had low relative density and relative frequency. According to (Zegeye *et al*, 2011) IVI value is an important parameter that reveals the ecological significance of species in a given ecosystem.Distribution of different (dbh) and height classes is indicated on figure 3 and 4.

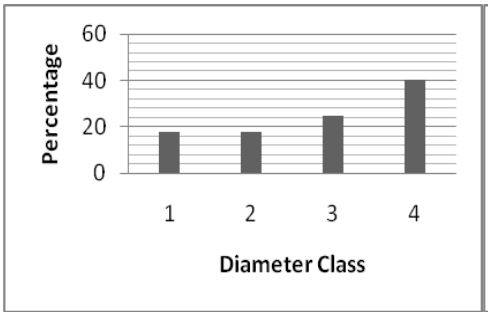

Fig. 3. All woody trees aver diameter (cm)
1=1-10cm 2=10-20cm, 3=20-30cm and 4=30-40cm

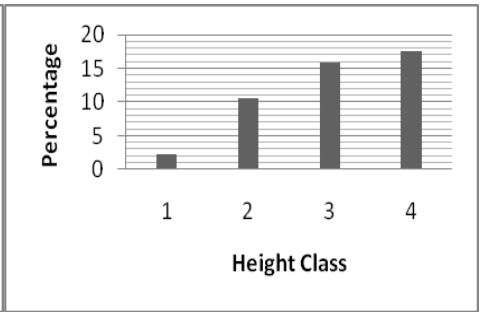

Fig. 4. All woody trees average height (m)
1=2-5m, 2=5-10m, 3=10-15m and 4=15-20m

Socio-economic circumstances

Farm size and wealth status of households were important factors that influencing species richness. The influence of farm size at the study site was variable. Tree species richness increase as farm size increases. The possible explanation is that more number of tree/shrub species requires sufficient land and farmers with more land size are favoured for diversified woody species. A farmer with shortage of land may not be committed to incorporate trees with field crops as some trees/shrubs require long time (3 to 4 years) to increase productivity of the farming system. Similarly Negash (2002) explained that the species characteristics are also important features because species that grow fast and need low input are highly preferred by farmer.

In the study area the variation among different wealth groups is explained by farm size. There was a significant positive correlation ($P<0.01$) between wealth category and total farm size. Similar trend was observed for species richness, number of families and age of household heads. But, household head sex correlation was not significant with species richness (Table 5). Wealth status of farmers is highly correlated with farm size. Tree species richness increase as farm size increases.

Table 4: On-farm trees basal area, relative basal area, frequency, relative frequency abundance, relative abundance, dominance, relative dominance and Important Value Index (IVI) %

Species	Basal area (m^2/ha)	Relative basal area (%)	Frequency	Relative Frequency (%)	Abundance	Relative abundance (%)	Dominance	Relative dominance (%)	IVI %
Croton macrostachys	2.095	48.3	20	19.42	24.5	36.98	2.095	48.05	104.45
Acacia abyssinica	0.569	0.54	17	16.51	9.95	15.02	0.569	13.06	44.59
Cordia africana	0.520	13.1	14	13.59	6.9	10.41	0.520	11.94	35.94
Eucalyptus camaldulensis	0.023	0.21	7	6.79	3	4.53	0.023	0.55	11.87
Albizia schimperiana	0.092	0.156	8	7.77	1.5	2.26	0.092	2.12	12.15
Ficus ovate	0.148	11.9	5	4.85	2.25	3.39	0.148	3.41	11.65
Sesbabnia sesban	0.006	0.17	5	4.86	5.4	8.15	0.006	0.16	13.17
Vernonia amygdalina	0.007	3.42	8	7.77	3.8	5.74	0.007	0.17	13.68
Ficus vasta	0.883	2.13	5	4.86	0.5	0.76	0.883	20.26	25.88
Grevillea robusta	0.0032	0.074	3	2.91	1.15	1.74	0.003	0.07	4.72
Solanum gigantium	0.0091	20	11	10.67	7.3	11.02	0.009	0.21	21.9
Total	4.3599	100.00	103.00	100.00	66.25	100.00	4.3599	100.00	300

Table 5. Pearson correlation results of tree species richness index with the suggested factors

Factors	Species richness
Wealth status	0.84^{**}
Farm land size	0.80^{**}
Age of household head	0.47^{**}
Number of families	0.30^{**}
Sex of household head	-0.14^{ns}
Household head education level	0.14^{ns}

**,* =Correlation is significant at the P<0.01, P< 0.05 level respectively. ns= not significant

Farmers' perception on agroforestry trees

Opinions regarding the effects of trees/shrubs on crops vary as viewed by some farmers. Trees/shrubs were not considered important especially for cereals particularly for finger millet and pulses (faba bean) since they are assumed to decreases yields. Therefore, these crops are usually not intercropped with trees/shrubs in crop lands. The intercropping of trees/shrubs with crops such as barley, wheat, maize and coffee is important. Consequently, farmers' used to retain the naturally growing trees/shrubs on farmlands. 58.3% of respondents indicated that planting trees on farmland has no significant problem on the crops.

Majority of the sample respondents know the role of agroforestry in food security and soil fertility improvements and filling the gap of forest product demand. However, all farmers who are aware of the agroforestry practices and technologies did not practice agroforestry. Decision to plant agroforestry trees may be influenced by different bio-physical and socio-economic factors. A study by Mekoya *et al*, (2007) showed that fodder production is affected by bio-physical and socio-economic factors other than awareness and perception of values. Hasan and Alam (2006) also reported that, agroforestry has both biophysical and socio-economic roles wherever it is practiced. Farmers in the study area perceived each of the packages and the species used differently. Accordingly farmers in the study area appreciated the provision of multipurpose tree like *Sesbania sesban.* Perception of farmers about agroforestry technologies is associated with the presence of fruit trees and woodlots which are income generating sources. This could be justified by the income they earn from sale of agroforestry products (fruit and eucalyptus tree poles) which ranges from US$ 111 to 1,388 annually as explained by the key informants.

Socio-economic importance of agroforestry

Agroforestry practices in general have an important role in the watershed both for food and wood security and the conservation of the environment. For example, *Eucalyptus* spp and C*ordia africana* are used by farmers as a

"guaranty" which can provide cash income and used as risk aversion alternative during poor rainy seasons. Accordingly, farmers prefer *Eucaluptus Camaldulensis* for its multipurpose uses (poles, fuel and charcoal, construction, furniture making and farm implements) and its contribution to income generation. Farm gate price of *Eucalyptus* in the area is US$ 1.1 /log and if farmers transport by themselves and sell it at the nearby town market, the price goes up to USD 1.4/log.

Croton macrostachys is useful for its fuel, fence, soil improvement and shade while *Cordia africana* is preferable for its lumber, farm equipment, fodder and fruits. Consequently, they are widely found on farmlands, homesteads and farm boundary and it has no any harmful effect to crops. *Ficus ovate* is mostly found around homesteads and used as live fences and fodder. But there is some conflict between agriculture and woodlots. For instance, there is a controversy about e*ucalyptus* that completion for nutrient and moisture is high, leading to poor undergrowth and low crop yields.

Opportunities for agroforestry expansion

Respondents indicated that there were opportunities for agroforestry expansion in the area. This includes the presence of market availability for wood products (38%), availability of extension agents at each site (28%), and effective seedling distribution (23%). Fekadu (2009) observed that market demand motivated farmers to plant trees on their farms.

Major constraints of agroforestry development in the study area

During focus group discussion, farmers identified and listed a number of problems currently limiting agroforestry development in the area. Ranking of these constraints was done with the farmers using the direct matrix ranking technique. Scarcity of arable land was ranked the first followed by open free grazing (Table 6).

Table 6. Major problems of Agroforestry identified in the study area

Major problems	Total Score	Rank
Scarcity of arable land	22	1st
Free grazing	11	2nd
Shortage of seedlings	6	3rd
Pest (Termite)	5	4th

During free grazing cattle, goat, sheep and equines damage young tree seedlings and new emerging shoots. Some farmers prefer to plant trees around their home to protect them from the livestock by family members. Limited supply of seedlings for indigenous trees species was the third factor constraining agroforestry expansion. Increased demand for tree seedlings arise from increasing demand for different purposes. Termite damage is also a major problem in the watershed for forest related developments. Termites live and feed on dead wood but sometimes attack living parts of mature trees and causing serious damage.

CONCLUSION

The preceding analysis showed that the main purpose of the study was to provide a practical framework for the synthesis and analysis of information about existing practices and the development of new and promising agroforestry technologies. Accordingly, homestead agroforestry practice is widely practiced. Farmers have their own traditional way of integrating tree-crop-livestock on their farm lands. Scattered trees on farm lands and pasture lands, boundary planation, homegarden, live fence and woodlot are commonly used.

There was variation among farmers in agroforestry practicing. This has occurred due to variation in farmers' perception, farming system, and land holding size. The inventory result of this study also revealed that there was variation in tree density of the packages practiced across the study sites due to difference in access of seedling and land size allotted for the agroforestry packages.

Social acceptability of agroforestry is closely linked to the economic feasibility of the system, the integration of tree planting into the traditional farming system and social acceptability relied to sustainability of the practice. Furthermore, the availability of extension service and the potential of direct benefit of wood products were contributed for acceptance of agroforestry practices.

Challenges in the area which hindered the expansion of agroforestry packages were less productivity, small farm size, scarcity of arable land, free grazing, and shortage of variety of tree seedlings which needs strong strategy and enforcement. However, there are good opportunities for expansion of agroforestry in the study area such as the market availability for wood products and availability of extension agents.

Participatory domestication of *Ficus ovate,* nitrogen fixing trees, fruit tree species, promoting sustainable agroforestry technologies such as community empowerment through awareness creation and education on need for agroforestry land use systems, generation of agroforestry technologies and demonstration them are still important in the study area.

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AGRO-ŠUMARSKE PRAKSE I PERCEPCIJE POLJOPRIVREDNIKA U PODSLIVU KOGA, SLIV GORNJEG NILA, ETIOPIJA

SAŽETAK

Agro šumarstvo je napravilo ogroman pomak u prethodnom periodu, ali i dalje postoje brojni izazovi u primjeni. Cilj ovog rada je da opiše postojeće agro-šumarske prakse sa posebnim osvrtom na bogatsvo vrsta i njihov ekološki značaj, percepciju poljoprivrednika, tehnike upravljanja šumama, kao i procjenu socio-ekonomskog potencijala i ograničenja poljoprivrede i šumarstva u sjeveroistočnoj Etiopiji. Istraživanje je obavljeno na nivou domaćinstva na gazdinstvima i to na površina pod šumama i pašnjacima. Na nivou gazdinstava odabrano je 20 parcela dimenzija 100 m x 100 m, 20 parcela od dimenzija 10 m x 10 m, koristeći tehniku nasumičnog odabira. Rezultati ukazuju da se gustina sadnje na farmi kretala od 21-127 stabala po hektaru, a postojeća usitnjenost posjeda utiče na intenzifikaciju agro-šumarstva. Agro-šumarske tehnologije treba da budu široko zastupljene i promovisane kroz učešće poljoprivrednika, radi poboljšanja uslova života u ruralnim sredinama.

Ključne riječi: agro-šumarske prakse, biodiverzitet, poljoprivredno gazdinstvo, poljoprivrednik, drveće, vrt.