Assessment of Farmers' Attitude and Experience on Indigenous Agroforestry Practices in Ethiopia: The Case of Dibate District, in the Benishangul Gumuz Regional State

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Abstract

The study was conducted to document and analyse existing practices, farmers' experience and knowledge, opportunities and constraints of agroforestry by taking 105 farmers for formal interview, group discussion, field observation and informal interviews. Home gardens, shifting cultivation, alley cropping, windbreak and live fencing are among the main identified agroforestry practices including respective farmers experience and knowledge. The local farmers have remarkable knowledge on tree species preference based on its compatibility and adverse effects on the proximate crops, and its multipurpose use. The tree/shrub species preferred in agricultural lands are Acacia abyssinica, Erithyrina abyssinica, Erithyrina brucei, Piliostigma thonningii, Strychnos spinosa, Stereosperum kunthianum whereas Dichrostachys cinerea, Terminalia laxifolia, Combretum molle, Grewia ferruginea, Dombeya torrida, Strychnos spinosa, Piliostigma thonningii, bamboos, Vernonia amygdladina, Cordia africana, Ficus vastae and Ficus sur are the species preferred for animal feed. Farmers have positive attitude to practice agroforestry. However, water shortage, free grazing, infrastructures and drought are mentioned as the major constraints to practice it by 96.8, 91.4, 85.2 and 79.9 percent of the respondents respectively. Farmers' experience and knowledge about the use of multipurpose trees especially in improving agricultural lands was found to be considerably high. Every development strategies of agroforestry and related land use systems should integrate farmers' experience and knowledge.

Keywords: Farmer Participation, Agroforestry, Indegenous knlowledge, Ethiopia

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Introduction

For thousands of years, human beings, forest, and trees cohabited quite peacefully. However, in the recent centuries and decades, humankind has become a conquering predator, and the balances between human being, and trees and forest have been broken and lost, mainly due to over exploitation (1). This has led to loss of social, economic and environmental benefits of forest and woody vegetation. Adoption of sustainable agriculture is often proposed as a solution to these problems. Sustainable agriculture is concerned with agricultural practices that are economically viable, meet human needs for food, are environmentally friendly, and improve quality of life. As evidences across the world indicate, traditional agroforestry combination of trees, crops and animals is one of the major means of healing such problems.

An agroforestry practice usually denotes a specific land management operation of an agroforestry nature on a farm or other management unit, and usually consists of arrangement of agroforestry components (1). Commonly, these practices include the arrangement of components in space and time vise-a vise the major function of the tree component. Agroforestry is a dynamic, ecologically based natural resources management system that, through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (2).

Several agroforestry systems have been recorded from different parts of the world. For example, I) park land agroforestry practice is found in a large part of the agricultural landscape under subsistence farming conditions in the tropics (as in Africa), which is characterized by dispersed trees (1). Kessler (3) reported that approximately 20 different tree species are common in these parklands; II) hedgerows and living fences are planted and managed as part of a crop or livestock operation to enhance crop production, protect crops and livestock, and/or control soil erosion; III) Alley cropping is also a practice of growing food crops between parallel hedgerows of (usually leguminous) shrubs and trees. The hedges are pruned periodically during the growing season to provide biomass and to prevent shading of the growing crops; IV) Homegardens are practiced near to dwelling places and are intensively managed by family labor (1).

Different management systems are manipulated by the farmers to achieve the desired objective within the agroforestry systems. In most cases, local knowledge plays important

role in management of crops, trees, livestock and soil in their production systems of the rural communities rather than the scientific knowledge (4). The integration of trees, agricultural crops, and/or animals into an agroforestry system has the potential to enhance soil fertility, reduce erosion, improve water quality, enhance biodiversity, increase aesthetics, and sequester carbon (5-7).

Several characteristics could be identified as desirable attributes for trees in agroforestry systems. But often it is not possible to choose trees with all these characteristics, either because other plants are already established, or because production or protection goals favor the choice of other species. Whenever a tree species with all the desired characteristics is not available (which is most likely to be the case), tree crowns and roots can be manipulated through management operations, mainly by pruning and thinning. For instance, management systems such as coppicing, pollarding, pruning, and thinning are identified as the major management practices in Southern Gondar, Ethiopia (8). Tree root pruning is a potential tool for managing belowground competition when trees and crops are grown together in agroforestry systems (9). The biophysical interaction between trees and crops strongly influences tree management practices and their structural and spatial assemblage (10).

The important contribution of local knowledge can make to scientific knowledge has been increasingly recognized as useful in providing a deeper insight into the interdisciplinary and site-specific characteristics of land use and natural resource management and the understanding of the interaction between agroecological systems and humans (11). Local knowledge can provide valuable information that can feed back synergistically to channel the direction of conventional science to meet the needs of local people (12). In many circumstances, interventions that build on local practice to improve land management practices will be more readily accepted by farmers than new technology.

Studies have recommended agroforestry as a potential alternative for land use practices in relation to the other land uses for Ethiopia (13; 14). Agroforestry offers a potential solution to the problem of declining rural agricultural production in the tropics (15). This need to undertake different research works to better understanding on various agroforestry systems that exist and be able to incorporate them into the activities of development planning.

However, different constraints such as theft, water shortage, transportation, population pressure, termites, etc. hinder the development of agroforestry practices in Ethiopia (8; 16). Identifying the constraints and opportunities for the agroforestry practices are important issue to enhance agroforestry development. Constraints and opportunities are different in different areas for the agroforestry practices. In the Brazilian Amazon socio-economic and political constraints such as markets, agro-industrial development, community organization at the local level, credit, and the regulatory and fiscal, land tenure, environmental and technical constraints such as technical knowledge and extension activities were constraints for agroforestry promotion (17).

In Dibate district of Metekel zone, agroforestry practices and related experiences have not been documented. Hence, existing practices and its local experience and knowledge should be recorded and documented to be right to use in development and future studies. Therefore, it is imperative to know about the existing agroforestry practices and how the farmers are managing it. This study is therefore, intended to bridge some of these knowledge gaps in Dibate district, Metekel zone of Benishangul Gumuz region, Ethiopia by documenting the agroforestry practices, experience and knowledge of the local communities related to it.

Objectives of the study

* To document and analyze existing agroforestry practices and its evolution.
* To assess and describe farmers' knowledge, experience and attitude on agroforestry practices
* To identify opportunities and constraints of the existing agroforestry practices in order to improve future management system.

Materials and Methods

Description of study area

Location

Dibate district is situated in Metekel zone, Benishangul-Gumuz regional state at 550 km from Addis Ababa capital city of Ethiopia and 1300 km from Assosa, regional capital (Figure 1). Dibate is located at latitude and longitude of $10^0$39'N, $36^0$13'E respectively with an elevation of 1438 meters above mean sea level. It is one of the 21 districts, in Benishangul-Gumuz Region of Ethiopia. It is part of the Metekel Zone, bordered by Mandura on the north, by the Dura River on the east which separates it from the Amhara Region, by the Abay River on the south which separates it from the Kamashi Zone which is the other zone of the region, and by Bullen district on the west.

Climate and Topography

The climatic condition of the area is characterized by mono-modal rainfall pattern with about average annual rainfall ranging from 800-1200 mm that rains from April/May to October/November (18). The temperature reaches a daily maximum of 20^0C to 25^0C during the rainy season and rises to 35^0C to 40oC during the dry season. The minimum temperature ranges from 12^0C to 20^0C, depending on season and altitude (19).

Map of Ethiopia

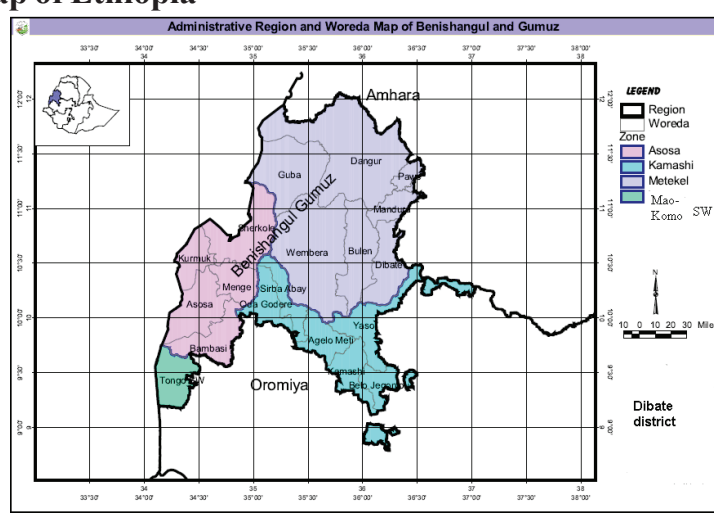


Figure 1: Location of Dibate district, Benishangul - Gumuz Regional State, Ethiopia

Demographics

Based on figures from the Central Statistical Agency's report of population and housing census (20) of Ethiopia, Dibate has an estimated total population of 66, 654. Out of this, 33,452 are men and 33,202 are women; 7,399 or 11.1% of the population are urban dwellers which are less than the Zone average of 13.7%. With an estimated area of 2,425.32 square kilometres, Dibate has a population density of 22.3 people per square kilometre, which is above the Zone average of 8.97 (20).

Economic activities

Rain fed, mixed and semi-subsistence farming system is the major economic activities of the area. Teff, sorghum, maize and millet are the dominantly grown cereal crops, groundnut and niger seed are the major cash crops cultivated in the area. The main income source of the area is selling the livestock (animals and animal products) and cultivated oil crops (niger seed and groundnut). In the area, there are trade activities by transacting animals, cereal and cash crops from the area where it is cheap to an area where it is with high value or keeping the crop or the animals until the price gets high.

Methods Employed

Preparatory phase

Before starting the main field work, discussions were held with the administrators of the district and local leaders to get permission to conduct the study in the area. Reconnaissance survey on the selected kebeles was conducted to get a firsthand understanding of farmers' practice, capture the greatest diversity or ecosystems, land use systems, socio-economic situation, and for planning of the survey.

Research site selection

Zone, district and kebele selection was purposively, based on dominantly existence of agroforestry practices (major criteria), and accessibility for transportation. Accordingly, out of the 29 kebeles found in the district two kebeles (Gallessa and Chancho) were selected. Finally, two villages from Gallessa (Gallessa and Jajabagissa-mandan) and three villages from Chancho (Gishigara, Geshie and Bishandida) were randomly selected for

the study. Due to high number of households per village only two villages were considered in Gallessa.

Sampling procedure

Key informant selection

Selection of key informants was necessary to discuss about the evolution of agroforestry. For each of the selected villages five key informants were selected by village tour. During village tour the farmers were randomly asked to list the name of five key informants (KIs). Of which the top frequently appeared five KIs were selected for group discussion at each village.

Focus group selection

Elders and youths group within each village were selected for focus group discussion. In this way two groups were formed in each village. The purpose of the group discussion was to get information how and where the local communities acquire knowledge in use and management of agroforestry practices.

Household selection

The household lists of each selected villages were collected from the offices of local administrators and development agents (DAs). Based on information from these offices, the following household (HH) figures were obtained, 1152 from Gallessa, 492 from Jajabagissa-mandan, 179 from Geshie, 156 from Gishigara and 167 from Bishandida. By simple random sampling technique with 5% sampling intensity 57, 24, 9, 7 and 8 totalling, 105 household respondents were respectively selected from each village. Perhaps, the sampled HH number is not representative of a zone or a region, but as financial limitation was a big problem, it is believed to be enough for analysis of the current information.

Data collection

Different approaches were used to generate the different information required for the study following the above selected techniques as shown below. Data of existing agroforestry practices, related management knowledge and experience were collected.

Primary data collection

Informal interview

Informal interviews with the selected key informants were carried out to get overview of the land use changes, evolution of agroforestry (AF) practices, local knowledge for managing AF systems, constraints and opportunities for development of agroforestry. Information collected at this level was used to develop and adjust questionnaires.

Household survey

Structured household interviews were conducted using the questionnaires. The interview was with the head of the household because it is believed that the head of the household would give much information on the household's affairs and activities of farm management.

Field observation

Visiting and observation through village to get an overview of existing AF practices, and management systems of the practices especially the tree components was conducted. Each farm land of the selected households has been observed well.

Group discussion

Group discussion among the selected groups in each village was carried out. In the group discussion, information on vegetation status of the area and problems for current land use practices, etc. were generated. During the discussions, care was taken from factors that will discourage active participation of individuals.

Data processing and analysis

First, the collected data were translated from the local language to English. Then the data were summarized, registered, cleaned, coded and analyzed with the help of statistical package for social science (SPSS version 16.0) and presented by tables, figures and percentages.

Results and Discussion

Socio-economic characteristics of the respondents

The age of the respondents was 31 and above. As it can be seen from Table 1 most of the respondents are 50-60 years age old. This implies that agroforestry practices are developed through experiences from what the farmers observe and understood throughout their life (trial and error) and environmental conditions. Except in Geshie, on average, most of the respondents in all villages could read and write and were in first and/or secondary cycles. This might have positive implication for positive relationship between the education status of respondents and agroforestry practices. This could especially true for Gishigara, Bishandida and Gallessa villages where majority of the respondents had first and secondary cycle educations (Table 1).

Table 1: Age, education status and HH size of the respondents, Dibate district, Benishangul Gumuz regional state, Ethiopia

Age (%)		Education (%)		Household size (%)	
<40	18.44	Cannot read and write	27.74	1-5	44.32
		Can read and write	18.32		
40-50	17.37	First cycle (1-4 grades)	27.01	6-10	44.21
50-60	48.73	Second cycle (5-8 grades)	25.55	11-15	8.47
>60	15.46	High school (9-12 grades)	1.39	Others	3.0

The large household sizes may have serious implications on the labor requirement and farm families land acquisition. As the younger members of the household grow older, the demand for farmland may increase and may lead to agitation to encroach on the forest reserve and marginal lands for farming activities. During the group discussion, it is suggested that arable land was scarce and their land had become poor to give yield. The situation is leading to increased interest of the local community in maximizing the productivity of the land they had. This may be one reason that led the local communities to practice agroforestry. This is supported by available evidences from tropics, enhancing productivity, stability and sustainability (1; 21).

Most of the farm families consist of two adults and their children (Figure 2). Elder child who could help his parents are in school during most of the year in all the villages except in Jajabagissa-Mandan. The larger family size had important contribution for the availability of family labor. To diversify the farming activities labor are detrimental factor. In addition to facilitating farm activities larger family size also reduced the need for casual labor for the family, and hence reduced monthly expenditure for laborers. Within the production year, harvesting season is the critical time for the farmers of the area. During this time the large family sizes wins the season easily, because they use family labour for transportation of their products to the market and storage. In another way in families with large sizes, the adults are engaged in selling of different tree products such as, firewood and construction materials by extracting from the natural forest that has its own contribution to the household incomes. This is the negative implication of the large family size on the forest/natural resources.

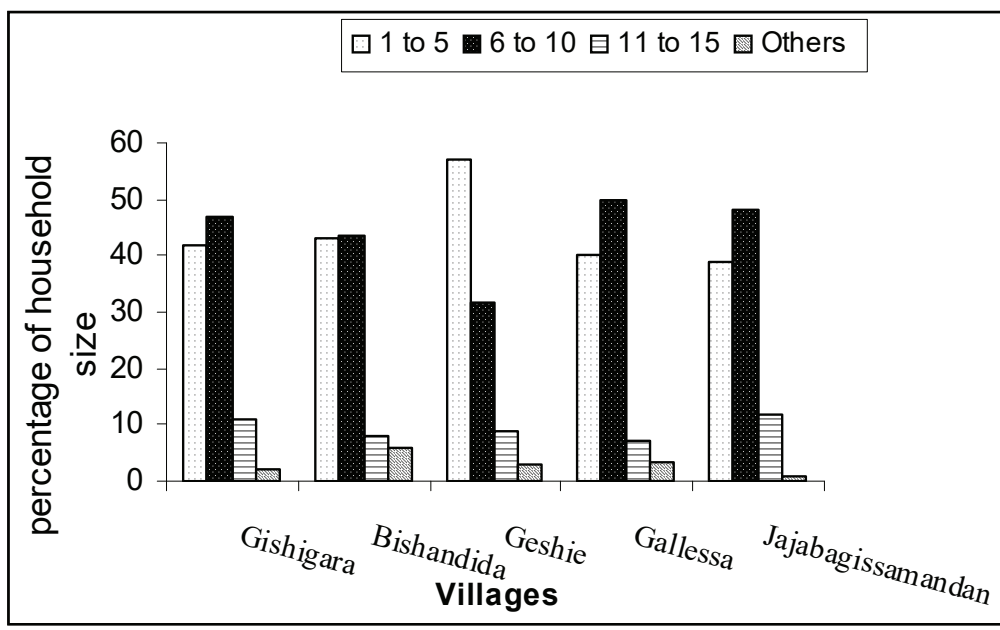


Figure 2: Household (HH) sizes of the respondents (Gallessa and Chancho kebele), Dibate district, Benishangul Gumuz regional state, Ethiopia

Evolution of vegetation cover changes over time

Key informants and HH respondents have identified and described the difference between the past and the present status of vegetation at various niches. It was mentioned that prior to the last two and three decades, the forest cover of the area was highly dense. But today because of rapid of population growth, the vegetation cover of the area has been highly depleted and almost most of the wild animals are disappearing. Increase in values and purposes of the trees raised as a case for the aggravation of the problem. So to reverse this situation it is important to understand for what purpose the trees are used. If what motivates the rural people to cut trees is do not known, it is impossible to convince them to plant trees instead (22).

Respondents indicated that informal migration to the area was listed as a reason for the rapid population growth. Migration has disturbed the traditional land holding and resource utilization system of the native people of the area. Increase in population number has been resulted in competition for arable agricultural land and construction materials, encroachment of forest areas, consequently exploitation and destruction of vegetation cover has been resulted. In addition to population growth lack of strong local land use policies and legislation that can insure effective utilization of natural vegetation and farmland trees, aggravates vegetation destruction in the area. Local norms and values are preferably used in land use policies; these have been easily broken by the new comers or migrants.

The local community put two sequences of time trends in the vegetation status of the area. That is prior and after the coming of the current government to power. Especially in the last three decades, there had been high destruction of vegetation with unprecedented increase of migration to the area. Information from the local community is indicating that, migration to the area has been a serious problem in the last three decades. After this time, the inhabitants of the area started to compete for virgin lands expanding their land holdings to the land of Gumuz ethnic group, which is an area with high forest covers and arable lands. Often this is raised as a major reason for the local conflict that was held between the Gumuz, Shinasha and the Oromo ethnic groups in 1994, which was resulted in high bloodshed.

Currently the local communities are retaining valuable tree species like Acacia abyssinica, Erithyrina abyssinica, Erithyrina brucei, Vernonia amygladina in their agricultural lands.

Domestication of some valuable tree species like Cordia africana, Breonadia salicina, Ficus vastae has also been started by the local people as lack of accessibility to wild forest resource is getting increased. Shrinkage of arable land and forest products is directing the current land use system in the area to be intensive to increase productivity of the land. Incorporating and selectively retaining valuable tree species in the agricultural lands are among the systems that the local farmers are using, but assistance of extension that can encourage the practices is negligible.

3.3. On farm Trend of tree and shrub growing practices

At farm level an increasing trend of tree-growing at different agroforestry practices is shown in (Table 2). As the farmers mentioned, before 20 years there was decrease in tree availability in most of their farming practices. Currently, relative to the previous there is high cover of trees in parklands followed by grazing lands with the less coverage in the woodlot and riverside/riparian zone of agroforestry practices (Table 2). Zeleke (8) reported that the highest tree species decrease was in niches designated as parklands in his study area, which is contradictory with the current study. The low number of tree species found in the woodlots of the current study area disagreed with the finding of Alemayehu (23) who reported the preference of diverse tree/shrub species in woodlot. Declining of trees around the riversides (Table 2) may be a reason for the problem of water scarcity reported by the local farmers.

Vegetation degradation has forced the farmers to selectively retain and plant different valuable tree/shrub species in their land use systems; this can be considered as attitude change from looking trees/shrubs as obstacle in their farming activities.

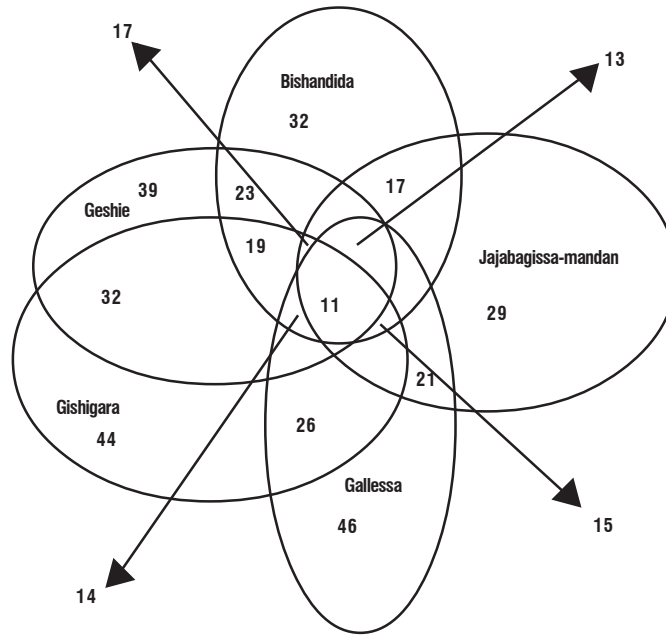
Table 2: Farmers' response on tree/shrub species increase at different niches during the last 20 years, Dibate district, Benishangul Gumuz regional state, Ethiopia

Tree/shrub species	**Percentage of respondents (n=105)**								
	HG	ST	FB	RSD	GYA	WL	LF	RDS	GL
Cordia africana	94	44	31	-	37	-	5	22	34
Croton macrostachus	17	100	82	77	84	-	69	29	96
Ficus spps.	41	71	62	-	42	-	21	-	64
Erithyrina abyssinica	-	-	73	-	-	-	92	80	55
Eucalyptus spp.	-	-	64	-	-	52	-	39	-
Mangifera indica	100	-	73	73	-	-	33	61	-
Stereospermum kunthianum	-	59	9	-	41	-	-	-	56
Combretum molle	-	88	-	-	52	-	-	-	63
Ziziphus mauritiana	-	74	-	-	-	-	-	-	39
Strychnos spinosa	-	91	67	-	47	-	-	-	100

HG=homegarden, ST=scattered trees, FB=farm boundary, RSD=riverside, GYA=gully areas, WL=woodlot, LF=live fence, RDS=roadside, GL=grazing land

Within the surveyed villages, difference in tree species was observed, and also there were common tree species grown by all villages. Farmers tried to explain adoption of important tree species, there is the tradition of experience sharing from each other. For instance, mango tree (Mangifera indica) was introduced to the area by a farmer before three decades ago; nowadays mango is a common tree in the homestead of individual farmers. Within homegardens, scattered trees in crop lands and farm boundaries of the study villages, 46 tree/shrub species in Gallessa and 29 species in Jajabagissa-Mandan were recorded (Figure 3). The figure shows number of tree/shrub species for each village and common species for the villages.

Figure 3: Number of Species Recorded in Home Gardens, Scattered Trees in Crop Lands and Farm Boundaries at the Five Surveyed Villages.



Note: on the Figure 3 above, the number with the village name is the total number of species in each village and the numbers within the circles are the common species for the villages.

There were many tree species commonly used by the all villages but there were some tree/shrub species impossible to get in certain villages (Figure 3). This may be from lack of knowledge how to use and manage these tree species within their farm lands. Within the locality there was variation in uses of the tree species. For example certain individuals are using Dichrostachys cinerea for farm implements, but others do not.

The local communities have accumulated traditional knowledge and experience on the uses of different tree and shrubs species with their management unless the species are new. For example they have no intensive knowledge on management of Eucalyptus species,

because it was introduced to the area in recent times. The farmers give high value based on the purpose or use of each tree species. A number of tree/shrub species used for similar purpose and a tree species have multi-purpose nature. For trees/shrubs that have similar purpose, there are criteria by which the farmers select a given tree/shrub species, such as nature of growing (fast or slow), market value, management system (difficult or easy), establishment system (difficult or easy), accessibility, etc. Breonadia salicina is a tree species highly preferred by the local communities for fuel wood, construction and bee hive hanging by 96.8%, 98.1% and 89.5% respectively and Cordia africana, Croton macrostachyus are the most multipurpose tree species respectively. Vernonia amygladina is the most preferred (by 76.4%) for soil fertility from the listed tree/shrub species.

Table 3: Number of HH Respondents Mentioned uses of Some Locally Available Tree/Shrub Species in Percent, Dibate District, Benishangul Gumuz Regional State, Ethiopa (n=105)

Tree/shrub species	Family name	Percent of respondents							
		FW	CW	FI	SD	BK	SF	FD	TP
Breonadia salicina	Rubiaceae	96.8	98.1	63.2	-	89.5	-	-	-
Eucalyptus species	Myrtaceae	28.3	50.4	-	-	-	-	-	-
Dichrostachys cinerea	Fabaceae	-	-	78.4	-	-	43.2	-	-
Croton macrostachyus	Euphorbiaceae	25.6	46.7	-	39.2	62.6	34.1	22.9	
Cordia africana	Boraginaceae	31.3	11.7	35.5	81.6	32.4	49.8	54.3	100
Vernonia amygladina	Asteraceae	92.5	-	-	44.8	-	76.4	82.3	-

FW=fuel wood, CW=construction wood, FI=farm implements, SD=shade, BK=bee keeping, SF=soil fertility, FD=fodder, TP=timber production

Types of agroforestry practices on the area

The types of agroforestry practices identified in Dibate include homegarden, shifting cultivation, tree row intercropping, windbreak and live fences.

Table 4: Agroforestry Practices Identified on Farms of the HH, Dibate District, Benishangul Gumuz Regional State, Ethiopia

Villages	Respondents percent (n=105)				
	Home gardens	Shifting cultivation	Tree row AF practice	Windbreak	Live fence
Bishandida	98	100	39	63	54
Geshie	100	97	27	72	66
Gishigara	100	90	48	80	73
Gallessa	91	82	54	75	79
Jejabagissa-mandan	96	100	36	51	59

Homegardens

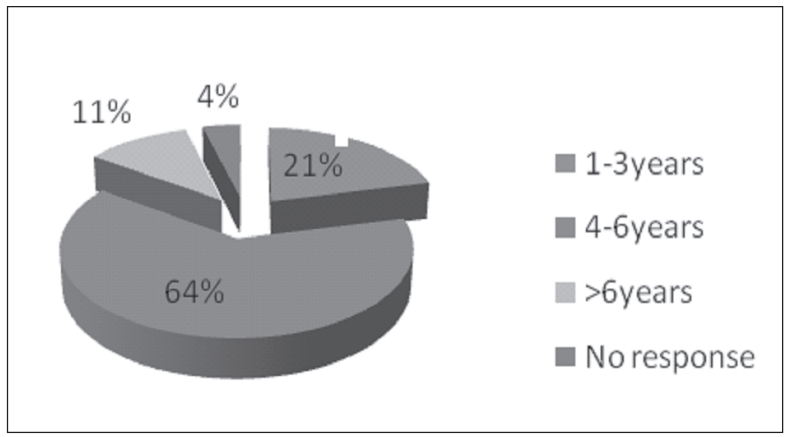
Over 91% of the respondents had homegarden type of agroforestry practice (Table 4). The limitation of forest products especially construction and fuel wood needs from the wild, and the need of additional food supply for income and consumption forced the communities to plant different exotic and indigenous tree species around their homes. Selectively leaving and planting of trees like Cordia africana and Ficus vastae near their home was a common practice in most of the local communities. Under the shade of these big trees fruit trees like Banana, Citrus species and Coffee were planted both for consumption and cash.

Shifting cultivation is the traditional cropping sequence, and the main and the old system of farming in the study area. In this farming system the productivity is determined by the potential of the soil, which is mostly maintained by the long fallow period. The fallowing depends upon the yield of the crop. When yields on a particular field drop below a certain level, the farmers allow fallow out of desperation.

Today most of the farmers in the study area cultivate the same piece of land for 4-6 years before shifting to another area (Figure 4); even this is not with good yield. The farmers indicated that about 20 years ago, there were the possibilities to cultivate a given land for

long years. In addition, they claimed that the yield obtained during the first year of cultivation after the fallow was different from the yield obtained in the first year of cultivation in recent fallow.

Figure 4: Number of HH (in %) Mentioning the Length of Cultivation Period for a given Land, Dibate District, Benishangul Gumuz Regional State, Ethiopa



Tree row agroforestry practices (Agri-horti method)

There was a practice of agroforestry in block plantation in the study area. The agroforestry practice involves planting of fruit trees mostly Mangifera indica in a wider rows in a single line with the spacing of (5x5 m) , and then crops such as sorghum, millet and maize grown between the rows. Until the branch of the fruit trees are fully expanded and close, and become shade for the growth of these agricultural crops the farmers cultivate within the open site minimum for 4 or 5 growing seasons.

Windbreaks and live fences

The communities of Chancho and Gallessa plant trees and shrubs in the border of their farm lands in order to protect their crops from strong winds, entrance of animals and human beings. When there was high vegetation cover on the area the problem of wind was not a serious problem, today there are a concern of suffering from strong winds. In summer season there is damage of crops and homes damage in the winter season. Planting trees around farmlands and homestead are becoming common practices (Table 5). The

respondents claimed that planting trees around the farmland is good for productivity of the system. The farmers also stated that windbreaks are important for their animals.

The other type of tree planting is for live fences. Currently the communities are changing dead wood fencing system to live fencing system, because of shortage of woody vegetation and its short durability. The two commonly practiced live fencing systems of the area are: live fence posts and live fence hedges, which are practiced using different tree/shrub species (Table 5).

Table 5: Tree and Shrub Species Identified by Local Communities as Preferred Species for Windbreak and Live Fences, Dibate District, Benishangul Gumuz Regional State, Ethiopa

Tree/shrub species	Windbreak	Live fences
Caesalpinia decapetala		✓
Erithyrina abyssinica	✓	✓
Vernonia amygdalina	✓	✓
Eucalyptus spp.	✓	
Agave sisalana		✓
Mangifera indica	✓	
Justicias schimperiana	✓	✓

Local knowledge in managing agroforestry practices

Trees and its management

Agroforestry is a system in which different tree/shrub species are used simultaneously or sequentially with the other components, such as animal and/or crops. Management of agroforestry practices is seen from the point of the management of the components, through decreasing the negative attribute of each component while increasing the positive attributes over each other. This study has emphasized on the knowledge of the local farmers in managing the interaction of the components within the practices.

Woody tree species, shrubs, herbs (agricultural crops or pasture plants), herbaceous vegetations and animals exist within the different agroforestry practices of the area. Fruit crops were the common components in most of the agroforestry practices. Some of the fruit species were mango, lemon, orange, banana, papaya, etc. Mango was dominantly grown in many of the practices followed by banana (Table 6). During the household survey fruit tree/shrub species were registered.

Table 6: Number of HH (in %) and Fruit Trees/Shrubs Commonly Cultivated, Dibate District, Benishangul Gumuz Regional State, Ethiopia

	Respondents with fruit trees (%)				
Fruit trees/ shrubs	Gishigara	Bishandida	Gallessa	Geshie	Jajabagissa-manda
Mango	87.3	74.5	78.1	63.4	100
Banana	59.6	42.4	25.8	51.7	34.3
Lemon	62.2	35.6	13.7	40.3	41.5
Papaya	25.2	26.1	68.7	19.6	37.7

While the local farmers are running to increase product and productivity, they have accumulated different management systems over time to control interaction of each component in the agroforestry practices. Therefore, there is considerable local knowledge on the effects of the different components of agroforestry practices over each other, which may be increase or decrease on the yield obtained.

Pruning and pollarding activities are the most frequently observed management activities done by the farmers to control negative effects of trees on their agricultural crops. Mostly tree species in the homegarden agroforestry practices were managed by pollarding. In the homegarden there were a number of tree species, so farmers were forced to pollard especially Cordia africana, Croton macrostachyus, Ficus vastae, Vernonia amygdalina during the summer season to reduce protection of sun light penetration for the understory components such as coffee and citrus species.

The local communities have recognized that the present day problems of low yields from agricultural production are directly the results of decline in soil fertility. Crop yield obtained

from the land is taken as the measurement for the soil fertility of the land. When the yield is decreased, locally the soil is said to be 'due'era' equivalent to mean the land is dead and cannot give yield. Local farmers identify the fertility status of the soil by odder, colour and type of vegetation grown on the soil.

Furthermore, farmers are developing methods to cure, improve and maintain the soil fertility status. They are developing knowledge from what they observe in their daily activities and events through their life, and they have remarkable knowledge which tree species more positively interact with a given agricultural crops. Justicias schimperiana was planted in line on the degraded lands. Then after the land has been rehabilitated back to its potential to support the growth of another tree/shrub species, tree species like Croton macrostachyus are planted, and then crops like sorghum, maize and millets are started to be cultivated between the lines on the next seasons.

Tree/shrub species preferred by the local farmers that have positive effects to their agricultural lands are given in Figure 5. Accordingly, Acacia abyssinica, Erithyrina abyssinica and Erithyrina brucei are the most preferred tree species by the respondents for the improvement of their agricultural lands. The preferences to use in the agricultural lands are based on the tree or shrub properties, such as rate of litter decay, absence of suppression to the agricultural crops, capacity to grow on poor soils and absence of severe competitive effects with the agricultural crops. This is in line with the research conducted in Nigeria, which suggests for their best trees; farmers had a wide range of preferences. Often they gave more than one character (24). These ideas are also strengthened by result of experimental researches conducted to see effect of trees on soil fertility (15) found that tree species Cordia africana and Croton macrostachyus have contributed to the high nitrogen and soil organic matter content under their canopies compared to area without trees. Nitrogen content of the soil under both trees was 26% higher than the corresponding soil away from the trees canopies. The leave part of the trees was preferred by the farmers in the integration of different tree species in agricultural lands (Table 7).

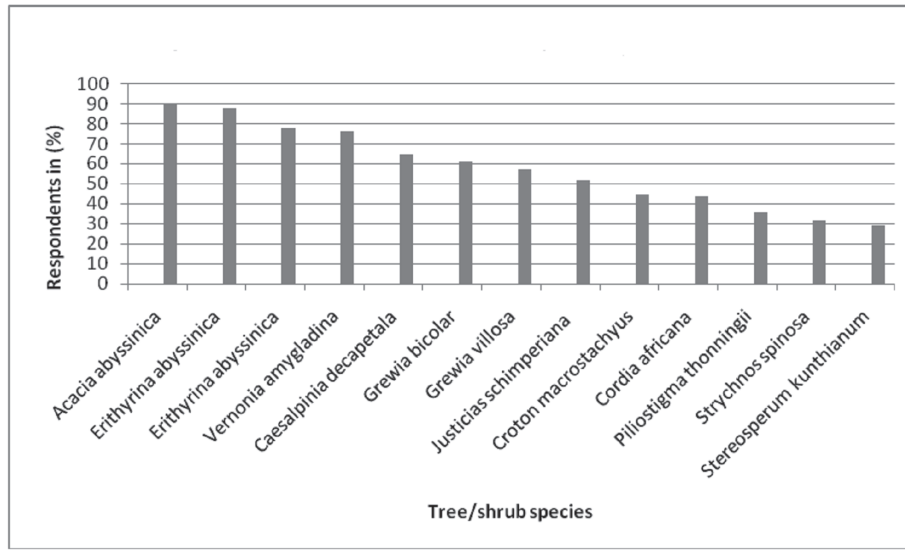
Tree species like Acacia abyssinica, Erithyrina abyssinica, Erithyrina brucei, Vernonia amygladina, etc are more preferred in the study area than Cordia africana and Croton macrostachyus for agricultural lands (Figure 5). Preference of the farmers is from the point of interaction of the trees to agricultural crops. Detailed biophysical study of these

tree species are required, why these trees are preferred by the users than those tree species preferred in the other areas.

Table 7: Tree/shrub Species Parts Identified by the Respondents as Suitable Species for Soil Fertility in Agricultural Lands (n=105)

tree/shrub species	Percent of respondents		
	Roots	Leaves	Stems
Acacia abyssinica	31.3	73.6	13.2
Erithyrina abyssinica	24.2	66.8	18.1
Erithyrina brucei	26.1	69.4	9.3
Vernonia amygladina	45.6	65.4	6.7
Caesalpinia decapetala	27.6	61.9	3.4
Grewia bicolar	19.4	59.7	11.2
Grewia villosa	16.7	63.5	10
Justicia schimperiana	39.5	43.8	-
Croton macrostachyus	12.4	67.3	3
Cordial africana	7.1	43.5	-
Piliostigma thonningii	13	31.8	9.2
Strychnos spiosa	2.4	40.3	
Stereosperum kunthianum	17.5	54.6	-

Figure 5: Trees/shrubs Preferred for Inclusion in Agricultural, Dibate District, Benishangul Gumuz Regional State, Ethiopia



Farmers have their own strategy to prefer or retain different tree/shrub species to their land uses (Table 8). An important implication of these finding is that without external assistance, farmers are capable of integrating substantial numbers of more compatible species into their land use systems and landscapes. Because the chance to get tree products from the wild is getting narrow, tree choice of farmers for construction purpose was high and for soil fertility purpose because of soil fertility decline (Table 8).

In the study area, there was no special nursery site to grow seedlings except only small nurseries near some individual homesteads. Many of the farmers collect wildings from their homegarden or from the natural forest, and give them protection. Then the wildings are planted to the desired open niches. This confirms the farmers have their own knowledge how to produce seedlings and grow trees. So knowledge limitation to grow trees may not be as a big constraint for the local farmers to practice agroforestry, which is in line with the findings obtained from the northern parts of Ethiopia by (25; 8).

Pollarding, lopping side branches, felling and coppicing are the major traditional management practices done by the local farmers to promote normal growth of the trees and to control its interaction with crops. The total lifetime contribution of a tree which is used in this way can be considerably greater than the volume it will produce if it is simply allowed to grow and is then cut down (26).

Table 8: Strategy of Farmers to Choose Trees and Shrubs in their Land uses, Dibate District, Benishamgul Gumuz Regional State, Ethiopia

Criteria	% of respondents
Palatability	69.7
Soil fertility	93.9
Construction wood	96.4
Shade	80.8
Unpalatable	41.5
Decomposability	89.4

Interaction of animals with trees in agroforestry practices

Communities of the study area rear animals like cattle, goat, sheep and poultry. But cattle are reared in high number except in Jajabagissa-Mandan village. The farmers claimed that currently the number of animals especially cattle is decreasing per household because of the shortage of grazing land and grazing materials. As most of the respondents indicated, shortage of feeding materials, especially during the dry season was the major challenge for animal production. The local farmers met the requirement of their domestic animals feed by depositing crop residues, harvesting grasses during the summer season when the grasses are available, taking the animals to another area where there is no heavy grazing; graze the cattle at night to increase length of grazing time, remnant of weeds in agricultural lands after harvest and tree fodder during this harsh condition.

In the dry season most of the grasses are dried out except near the rivers and few wet areas. At this time trees and shrubs become the important sources of feed. Mostly leaves, new shoots and pods/fruits of the plant parts are fed by the animals in this area. This is in

line with the result obtained by (27) in the southern and (8) in the northern parts of Ethiopia. In both the study sites, new shoots, pods and fruit parts of the trees/shrubs were used by animals. Mamo (27) has indicated that barks are used as feeding parts of trees in the Southern part, which is not observed in the current study site and by Abebaw in the northern part of Ethiopia.

The local farmers have long tradition in observing which tree species are preferred by their animals. They indicated that because of the shortage of feeds obtained from grasslands the numbers of tree and shrub species palatable by animals are increasing over time. There are important nutrients in the tree fodder which are not found in the other feed resources such as grasses (28). When the animals feed different tree and shrub species the farmers are continuously following its effect on the health of the animals. They have the knowledge which tree species may create discomfort to the animals when they use it.

Dichrostachys cinerea (pods and leaves), Terminalia laxifolia (leaves), Combretum molle (leaves), Grewia ferruginea (leaves), Dombeya torrida (leaves and shots), Strychnos spinosa (pods), Piliostigma thonningii (pods and leaves), bamboos (new shoots and leaves), Vernonia amygdladina, Cordia africana, Ficus vastae (pods), Ficus sur (pods) are among the tree/shrubs species noticed by the farmers preferred by their animals. During the dry season farmers collect branches from the natural forest, grassland and farmlands, chopped down the leaves of the tree and shrub species and feed their animals. This is a new tradition for the area introduced recently by the people of new comers from another area. There is competition for chopping by the farmers from the natural forest and from the free grazing system. This may be one reason for the fast destruction of vegetation covers on the area.

In addition, the local communities have knowledge about tree species used for medicinal and reproductive purposes for the animals including humans. Farmers used different tree/shrub species to cure when the animals are injured or diseased and to initiate sexually impotent bulls to facilitate reproduction. But this knowledge is only in the hands of a few. So the local farmer who has the knowledge gets economic benefit by selling these tree/shrub species for medicinal purpose.

The local communities do not only understand the advantageous of the animal interaction with the tree components, but also their negative interaction, which is mostly related with

establishment of the tree components in their farming system. The farmers claimed that planting the tree components in inappropriate place leads to reduction in overall yield production. For example, Vernonia amygladina is mostly preferred as live fence in most of the communities because of its positive attribute to the many crops. However, because it is highly palatable by cattle and goats, rather attracts animals rather than protecting the crops from animals. There is also tree species pointed out by the farmers that has negative effect on the product and health of the animals. As the farmers tried to explain Piliostigma thonningii is good palatable tree species by most of the animals in the area especially in the dry season. However, the farmers noticed that the feed reduces fatness and milk amount of the animals. Not only its effect but also they have understanding why that is so. They suggested that most of this tree leaves could not digested based on their observation when the animals were sloughed. Such a type of local farmers' knowledge is in line with the local knowledge in Kajiado district of Kenya where the Massai people developed considerable knowledge about the effects of fodder tree species on livestock health (29).

The most problematic issue related with animal rearing on the study area is free grazing system. In the dry season free grazing system is accepted as a customary and it is a usual practice on both the communal and private land. Today this grazing system is becoming a serious problem for the practice of agroforestry.

Interaction of crops with trees in agroforestry practices

Like animals, crops are also components of the agroforestry practices. The overall objective of agroforestry practice in all the system is to increase overall yield production of the system through managing the interaction of the components (Schroth, 1995). The interaction between the crop and tree component may be positive or negative. Farmers have their own view when they want to incorporate the tree components into the farmlands.

This study confirmed that farmers have great contribution for the evolution of agroforestry practices while they are struggling with their environmental condition for survival. Their local knowledge in management of the tree components at different niches is the reflection of this objective. Tree cultivation and management is a major feature of the way of life (26). In the study area farmers have the knowledge to decide which tree species fits with a given crop species or which can improve the productivity of the land (Figure 5). This

implies that the farmers have the knowledge about the role of trees in the agricultural production system, or the role of trees/shrubs to increase yields. The farmers' idea is strengthened by different experimental studies and observations conducted in many areas. In Hararghe highlands of Eastern Ethiopia, Poschen (31), Jiregna (15) found that crops under the canopy of Acacia albida were increased by 56% when compared with the crops away from the tree. Boffa (10) also reported crop yield was better around tree stumps than elsewhere in his field observation. In the Sahelian region of Senegal, it is reported that farmers have improved their yield when crops were planted with Acacia senegal, Acacia albida and Borasus aethiopum, when grown directly underneath or near trees (33).

Tree growing in the agroforestry practices

Rural people's access to trees has, especially in Africa, become more difficult with the global trends of deforestation and degradation of forests and woodlands (34). During olden times the respondents confirmed that edible fruits were excess in the wild for consumption especially for children, however, these are getting limited today. So there were no practices to plant trees except for fences and few fruit trees for consumption. However, in recent times when the communities lacked what they need from the natural forests, started to transport forest products (construction woods) from remote areas, and domestication of wild trees. The domestication of many species for food and other products has been carried out for thousands of years in almost every part of the world, often arising from extractive uses by indigenous people (35). Agricultural products were as the major sources for both household consumption and income generation. Decline in agricultural productivity was also enforcing the farmers to plant fruit trees to diversify their incomes and products.

. In the surveyed area, trees are started to be planted in the niches of homegarden, as scattered trees in agricultural lands, as farm boundaries and roadsides. Decrease in accessibility of forests and woodlands and expansion of agriculture increase tree planting traditions (36). This is appreciative condition for the future practice and development of agroforestry. It was uncommon to observe tree planting and naturally growing seedlings in most of the grazing lands. This may be from the problem of free grazing that resulted in hampering newly growing seedlings by the legs of the animals and browsing.

Farmers' attitude towards agroforestry practices

There were different opinions about the practices of agroforestry within the communities. Although agroforestry was a new word to most of the farmers the practices were well represented in different land use systems. Generally, appreciable number of the respondents, (73.8%) indicated the practices of agroforestry as ways to use the land intensively and productively. The majority (87%) of the farmers interviewed have an interest to practice if appropriate agroforestry practices that maximize land productivity and protect future land degradation could be introduced.

Farmers have traditional knowledge on the usage of trees in their daily lives as well as some environmental uses of trees such as protection of water resources and habitat for wild animals (Table 3). As the farmers indicated, previously when there was high vegetation cover on the area there were many species of birds that pray for the coming of rain using the vegetation as home. However, today because of the loss of different tree species, which are used as habitat and food, many of bird species have been disappeared. Locally it is believed that the disappearance of these bird species creates shortage of rainfall, which is an indication of the fact that the local communities have the knowledge that different tree and shrub species are sources of food and homes to wild animals.

The farmers know the easiness and quickness of inorganic fertilizer to increase soil fertility; however, there are affordability problems for majority of them. Among the respondents only 19% of them use inorganic fertilizer to some extent. Also the societies do not give equal value for agricultural crops produced by inorganic and organic fertilizers. Crops produced without inorganic fertilizers are preferred. They have understanding that agroforestry practices have the potential to diversify their incomes, increase soil fertility, provide favorable climate for their crops and animals (based on KIs interview and group discussion).

Constraints and opportunities for agroforestry development

The exact nature and significance of the different constraints and opportunities, as well as the relation between them vary depending on the specific geographical and social context (34). Understanding the exact nature of constraints and opportunities as well as rural people's needs and priorities is a precondition for developing locally adapted small-scale techniques and strategies that could be applied directly and meaningfully (37).

Factors hindering the practice of agroforestry

There were several factors identified and understood by the local communities that hinder the practices of agroforestry. Free grazing system (91.4%) and shortage of water (96.8%) were the major constraints for the practice of agroforestry addressed by the local farmers (Table 9). Free grazing is customary in the area in the dry season. During this period seedlings planted during the rainy season are destroyed by animals. Most of the existing water in the area is seasonal and the season of rain is decreasing from year to year, which is increasing the dry season that creates difficulty for the growth of seedlings. But as the study conducted in Wondo Genet most of the households (60%) reported that they did not have problems in growing trees (38). Teklay (25) showed that shortages of water and land are the major constraint in the northern part of Ethiopia, which is line with this study.

Table 9: Identified Constraints for the Practices of Agroforestry, Dibate District, Benishangul Gunuz Regional State, Ethiopia

Constraints	Percent of the Respondents
Water shortage	96.8
Free grazing	91.4
Drought	79.7
Thieves	42.1
Labor shortage	63.1
Seedling shortage	70.9
Transportation	85.2
Price	68.5
Disease	26.3

Opportunities for agroforestry development

There was an effort to organize the farmers in order to establish common nursery sites are the promoting activity just to reduce the shortages of seedling in recent years in the area. This could create high opportunities for the future development of agroforestry.

Remnant trees on farms: according to the group discussion held in each village, intentional retention of trees on the farm land is a recent practice for the area. It is hope for development of agroforestry practices, since the local farmers are becoming familiar with the importance and benefit of trees. Sinclair and Joshi 2001 (12) confirmed that farmers recognized soil and crop enhancing role of trees as most farmers preserve some trees to maintain the soil structure, enhance soil fertility and soil nutrient cycling and the exhibition of favorable interaction with crops. Therefore, for the development of agroforestry, it is simply educating and helping the farmers to utilize the full potential of the system as there are no traditions that forbid tree planting in the area.

Understanding of decline in soil fertility: farmers have complained that there is food self insufficiency, because unproductive of land. The important advantage that the farmers can get from the practice of agroforestry is increase in productivity through the maintenance of soil fertility. The knowledge that the farmers have about the soil condition of their farm land is another opportunities for the practice and development of agroforestry. The local farmers have understanding about decline in soil fertility resulting in reduction of food self-sufficiency. This is indicating that, if appropriate technologies are delivered the local communities can easily accept it, because they are in search of options to solve the problem of land productivity.

Fruit tree growing: The local farmers grow fruit trees for subsistence and income, within the vicinity of their communities and in the field. Mango (Mangifera indica), Banana (musa paradisiaca), Citrus aurantifolia and Citrus medica are the commonly cultivated fruits on the area even though their price is low in the market. This is a favorable condition if future attempts are made to combine food crops with timber species. Again because the practice is familiar within the communities, if conditions that can increase the demand of the products (e.g. value addition) are created the practice can be better developed.

Farm input costs: Most of the farmers are facing challenge to afford the high costs of farm inputs, such as fertilizer, pesticides, etc. High costs of farm input are an opportunity for the future development and practice of agroforestry. As it was possible to understand from the informal interview and group discussion most of the rural poor who use fertilizer and pesticides are under credit of these materials loaned from government. So if low-input system like agroforestry system is offered as options it can be a relief for the farmers. As

study conducted in Ghana indicated that the cost of agricultural infrastructure, pesticides, and fertilizers are assessed to be higher and beyond the reach of most farmers (Tenkorang 2003).

Increased understanding of the importance of trees: Locally, trees are used for different purposes, such as for firewood, shade, windbreaks, live fences, bordering, fodder, etc. This indicates that the woody perennials are highly demanded. In the study area dead trees are the main sources of domestic fuel for nearly all of the community. However, increase of pressure on the trees has caused shortage of some useful tree species for fuel wood. In all villages farmers have complained on the shortage of fuel wood since the responsible family members' for fetching fire wood, women and children walk long distances to acquire some.

Knowledge of the farmers about the importance of trees is another opportunity for the future development of agroforestry practices. The local communities have knowledge about the importance of different tree species. High demand led to shortage of some species (example Breonadia salicina, which is highly preferred for construction and fuel wood in the area). The local communities have complained about the shortage of trees for fuel wood and construction. This evidences that the local communities can easily accept if they get options for the problem. In the study area the local communities have knowledge about the importance of trees to maintain water sources like river and streams. This gives more hope for the adoption of even more trees for better water source management.

Conclusion and Recommendations

Result of this study confirms that there are traditionally practiced agroforestry systems, related management experience and knowledge in the current area. The retention of tree species, which are critically endangered in Ethiopia like Cordia africana, Breonadia salicina in the agroforestry practices have its own contribution for the conservation of the species. But, there are constraints needed to be addressed to encourage the development of the practices. Financial and time resources were the major limiting factors for this study; consequently, it is impossible to say the data collection was finalized without difficulties. Based on results of this study the following points are recommendable:

Learning from, building on, and working through the local knowledge is less. Hence, integration of farmers' knowledge in local development programs needs to be encouraged.

In the current study, tree/shrub inventory was not conducted. Physical enumeration of the different tree/shrub species and its diversity per each niche is necessary.

The current study is needed to be repeated based on wealth category, as it can affect the practices of agroforestry.

This study is a descriptive one, further confirmatory studies are suggested to quantify the relationships between different variables described in this study.

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