

# Management of Traditional Agroforestry Practices in Gununo Watershed in Wolaita Zone, Ethiopia

Madalcho AB<sup>1\*</sup> and Tefera MT<sup>2</sup>

<sup>1</sup> Jigjiga University College of Dry Land Agriculture (Natural Resource Management Department), Jigjiga, Ethiopia

<sup>2</sup> Mekelle University College of Dry Land Agriculture and Natural Resources, Mekele, Ethiopia

## Abstract

This study was conducted in Gununo watershed at Wolayitta zone to document indigenous knowledge on agroforestry practices management, and assess the socioeconomic factors affecting tree planting in agroforestry practices. Participatory rural appraisal, and transect walk was used to get qualitative data, whereas, household survey with semi-structured questionnaire was used through systematic sampling method to collect quantitative data. Among different socioeconomic factors, only family size and past participation in agroforestry training were significantly and positively related to tree planting activities. The common management practices on woody species include fertilizer application, pruning, coppicing, prescribed burning, thinning, pollarding, protection from animal damage, mulch application, crop residue application, and watering. After giving due recognition to the indigenous agroforestry management knowledge in the study area. This study has suggested some improvements such as, introduction of new agroforestry practices, and replacement of some of the tree species in order to reduce detrimental interaction of the components. In addition, training is needed to fill the knowledge and skill gap on tree plantation, and management.

**Keywords:** Homegarden; Indigenous knowledge; Management; Parkland; Woodlot

## Introduction

In developing countries especially Africa, rapid population growth, decline in per capita food production and environmental degradation are the main problems. Consequently, the need for intensification of agricultural production coupled with population growth forces poor farmers to expand their cultivation to hilly and marginal areas. This aggravate the degradation of natural resource and unsustainability [1]. The forest resource of Ethiopia is under tremendous pressure due to continuous population growth, rudimentary farming techniques, land use competition, and land tenure [2-4]. In relation to this, agroforestry can help to reduce pressure on remnant natural forests from deforestation and enhances soil fertility [1,5]. The interventions of agroforestry has more to do with agricultural sustainability as it enhances higher yield, production stability, and others such as livelihood support, positive environmental impacts [1].

The concept of agroforestry puts woody perennials, including trees, shrubs, bamboos, etc. as pillars for the system/practice. Accordingly, agroforestry system can be classified mainly as agrisilvicultural, silvopastoral and agrosilvopastoral [6]. Within each system of agroforestry there are different agroforestry practices. Agroforestry system consists of one or more agroforestry practices that are practiced extensively in a given locality or area; usually there is biological, ecological and economic interactions among the components [6,7]. Whereas, an agroforestry practice indicates specific land management actions on a farm and other management units in spatial and temporal scheme [8].

The common traditional agroforestry practices in tropical region are scattered trees on crop fields, homestead tree planting and multi-story home garden [6,9,10] described agroforestry practice of Ethiopia as largely agrisilvicultural with spatial mixed arrangement, which is mainly practiced for soil fertility replenishing function for poor soil. Others [11-14] also described the traditional agroforestry practices in different part of the country as Coffee Shade based scattered trees on the farm land, home gardens, woodlots, farm boundary practices, and trees on grazing lands.

Including Wolayitta area where this study was conducted, agroforestry is a major component of Ethiopian farming systems [3,15] and recently taken as one of the development objectives in PASDEP of national development policy of the country [16,17]. It becoming one of the common features in watershed management especially in the highlands of Ethiopia. This is also true in Gununo watershed, that traditional agroforestry practices have been a main feature in the watershed and serving numerous protective and productive functions in both up streamers and lower catchments since, woody perennials have huge potential for this.

In the agroforestry system, woody perennials are either deliberately retained or planted on the farmland [7]. Different agroforestry systems require different periods of time to develop and manage. Therefore, depending on different benefits obtained from the system, farmers could employ different kinds of component management in the system.

The common managements in tropical agroforestry system are pruning, prescribed burning, thinning, pollarding, grass mulch application, crop residue application, watering, and coppicing [6,18,19]. Pollarding is a cutting of crown of a tree for the purpose of harvesting wood, reduce shade, or protection from browse animals [18]. Prescribed burning is a practice of deliberate burning of plant materials on the surface of ground, while thinning is an intermediate cutting of stunted stands to adjust the stand density and produce better yield [6,18]. Thinning is very common practice for woodlot agroforestry practices

**\*Corresponding author:** Madalcho AB, Jigjiga University College of Dry Land Agriculture (Natural Resource Management Department), Jigjiga, Ethiopia, Tel: 251913687159; E-mail: [bajigoakillu05@gmail.com](mailto:bajigoakillu05@gmail.com)

**Received** November 17, 2014; **Accepted** December 30, 2015; **Published** January 01, 2016

**Citation:** Madalcho AB, Tefera MT (2016) Management of Traditional Agroforestry Practices in Gununo Watershed in Wolaita Zone, Ethiopia. Forest Res 5: 163. doi:10.4172/2168-9776.1000163

**Copyright:** © 2016 Madalcho AB, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

[18]. Mulching is a practice used for covering the soil surface to protect it from the direct impact of rainfall [18]. In addition, coppicing is a cutting practice of certain tree species that are close to ground level for the purpose of producing new shoots from the stump while pruning is a practice of cutting tree branches or roots [6,18].

Factors affecting different management decision such as tree planting are mainly related to farming system [20], household characteristics, rules and regulations imposed by state and community in local or national level and different biophysical circumstances, and tree characteristics [20,21]. The management decision in agroforestry is related to different on farm and off farm factors; including issues related with land security and external support services such as credit, input suppliers, and extension [21].

In the management of agroforestry the indigenous knowledge of local people is important, and in order to scale up the different agroforestry practices an appreciation of indigenous knowledge is needed [7]. Indigenous knowledge includes different sets of complex practices. The discovery of knowledge in managing resource is made by local people. Then, the knowledge exhibited and experienced will be transferred to generations with some modifications [22]. Therefore, understanding the historical development of indigenous systems is decisive in the design of ecologically desirable agroforestry production systems [23]. In general indigenous knowledge of local people are not simply producers, they are also engaged in pursuit of knowledge. Most development interventions in the past failed due to lack of giving adequate attention to indigenous knowledge [24].

The objective of this study was to document indigenous knowledge on agroforestry practices management, and assess the socioeconomic factors affecting tree planting in agroforestry practices.

## Methodology

### Study area description

Wolayitta zone is in southern nations, nationalities and peoples (SNNP) region of Ethiopia with a total land area of 4537.5 square kilometers is located between 6°4' N to 7°1' N latitudes and 37°4' E to 38°2' E longitudes. It is located 22 km from Sodo town and about 330 km from Addis Ababa. The watershed has an area of about 544 hectare with three rural Kebeles namely: *Demba Zamine* (middle elevation), *Doge Hanchucho* (lower elevation) and *Chew kare* (upper elevation).

Soil of the watershed is Eutric Nitosol according to FAO/UN classification system [25]. Soil erosion in watershed is severe due to conversion of natural forests to other land uses. The study area has high population pressure i.e., around 450 person per km<sup>2</sup> [26] and an average land holding is about 0.25 ha per household and drive farmers to cultivate slope lands [27]. Agroforestry is one of the major land uses at the area. Different species (tree crops and woody species) such as *Enset ventricosum*, *Musa accuminata*, *Moringa oleifera* and *Brassica oleracea* serve as primary food source while *Croton macrostachyus* and different *Acacia* species are the dominant trees in the degraded natural forest of Wolayitta [26]. From the agroforestry practices in the watershed, homegarden, parkland and woodlot agroforestry practices are the dominant ones. The management of these agroforestry practices are traditional based on indigenous knowledge obtained from their life long practices.

### Sampling and data collection methods

During this study time, different qualitative and quantitative data was collected with sequential procedure (began with qualitative and followed by quantitative data collection). The qualitative data

assessed the history of the study area regarding the practices of agroforestry, different characteristics of trees, and field observation on the management of agroforestry system as discussed below. These data were collected from primary data source through participatory rural appraisal (PRA) with tools such as observation, transect walk, and group discussion. House hold survey was conducted to collect quantitative data. In addition, secondary data from official documents and available literatures were employed to support different qualitative and quantitative data collected.

### Group discussion

The group discussion involved local chairman of the Gununo watershed, official manager of the Gununo woreda, youth representative, woman representative of the area, three natural resource management development agents (DAs), four elders in the area, and three model farmers, a total of fifteen people. The natural resource management DAs, elders and model farmers were involved from the three Kebeles within the watershed i.e., *Demba Zamine*, *Doge Hanchucho* and *Chew kare/Gununo*. The discussion took a week and respondents were allowed free to reflect their view concerning issues related to agroforestry system management practices in the area.

### Household survey

To collect quantitative data on management practices of agroforestry and factors affecting number of trees planted in agroforestry, the following formula after Watson (2001) [28] was used, and the sample size of respondents were determined by using equation below (Equation 1):

$$n = \frac{\left( \frac{P[1-P]}{Z^2 + \frac{P[1-P]}{N}} \right)}{R} \quad (1)$$

Where n=sample size required, N=number of people in the population, P=estimated variance in population, as a decimal, A=Precision desired, expressed as a decimal, Z=Based on confidence level, R=Estimated response rate, as a decimal. Consequently, the estimated variance in population (P) of 15%, estimated Precision of 5%, Confidence level of 95% and Estimated Response rate of 95% was used to calculate the sample size.

Accordingly, by using systematic sampling, 50 HHs were sampled. After getting the lists of names from each of three Kebeles involved in the study, semi-structured questionnaires were distributed. The name of the first person was chosen randomly so that the next sampling unit (person) was selected at each 10<sup>th</sup> person. Then, with the help of DAs each sampled person was interviewed by semi-structured questionnaire.

### Data analysis

The qualitative data was narrated based on the existing conditions and knowledge on the literature, whereas, quantitative data collected from household questionnaire survey was also analyzed by a multiple regression and descriptive statistics with help of SPSS Inc., Chicago, USA (2007). The collected data was summarized using descriptive statistical tools like tables and figures.

## Results

### Factors affecting number of trees planted in agroforestry

**Characterization of woody species by local people:** In relation to agroforestry products and other environmental roles such as, soil and

water conservation (SWC), the local people have identified suitable trees. Consequently, trees such as *Eucalyptus globules*, Avocado, *Cordia africana*, Mango (*Mangifera indica*), *Gravillea robusta*, *Podocarpus falcatus*, *Cupresus luistanica* and *Ficus* species are considered to be preferred suitable trees in decreasing order. The characteristics of suitable trees are mainly either based on monetary value or SWC functions. Tree characteristics such as, having deep root/shallow, competition for light and nutrient, allelopathic effect, contribution for nutrient improvement and rate of decomposition (from litter) are the main selection criteria for categorizing woody species as suitable. Local people know the suitable tree/shrub species for the specific agroforestry practice in which they establish. In fact there is no “good or bad tree”, local people call unsuitable trees as bad, and suitable trees as good trees. Accordingly, *Eucalyptus* species are taken as both good and bad tree in different points of view. In point view of local people, it is good in generating income. Since it is fast growing and coppiced more frequently for firewood selling and construction purpose, when planted as woodlots. Whereas, it is hardly possible to integrate with other crops for soil fertility maintenance. Its interaction to other integrated other component is always negative, especially in the moisture constrained

area. Its leaf is not decomposed easily, and the soil fertility reduction and soil moisture completion is very high. Following *Eucalyptus*, *Cupressus lusitanica* and *Prunus africana* are considered as bad (unsuitable species) for integrating in agroforestry system/practices. In the area, Avocado (*Percia Americana*) and Mango (*Mangifera indica*) is chosen for both fertility maintenance and household income generation value, and its contribution continues all year round. Therefore, the criteria to select and plant trees in agroforestry practices are highly related to the local people’s indigenous knowledge to select those good (suitable) trees.

There are different biophysical (elevation level), and socioeconomic factors such as, sex, education, age, distance from market, family size, land holding, number of animals per house hold and past participation in agroforestry training have been assessed. From among those, only family size and past participation in agroforestry training were significantly and positively related to tree planting activities in the last five years (Table 1).

Family size per house hold in the area include children (age less than 15), productive age (15-64years) and elders (age greater than 64). In the family where large productive age class, the practice of tree plantation is very high compared to the family with small size and unproductive age class dominated.

The knowledge and culture of tree plantations are transferred from the family of their ancestors. The knowledge is not even similar to each households in the watershed, it vary based on the past habit family attitude towards the need of trees in the farming system. In addition to that, those who have got training on tree plantation in the agroforestry system in different sort of occasions have better understanding and positive outlook on tree plantation. The have planted and retained more trees on their farmlands.

**Management practices in agroforestry:** There were different kinds of management observed in agroforestry practice of Gununo

Factors affecting tree planting	P- value
Elevation level	0.572
Sex	0.991
Education	0.192
Age	0.318
Distance from market	0.442
Family size	0.005
Land holding	0.158
Number of animals per house hold	0.581
Past participation in agroforestry training	0.040

Table 1: Factors affecting number of tree planted in agroforestry in Gununo Watershed, Wolaita.

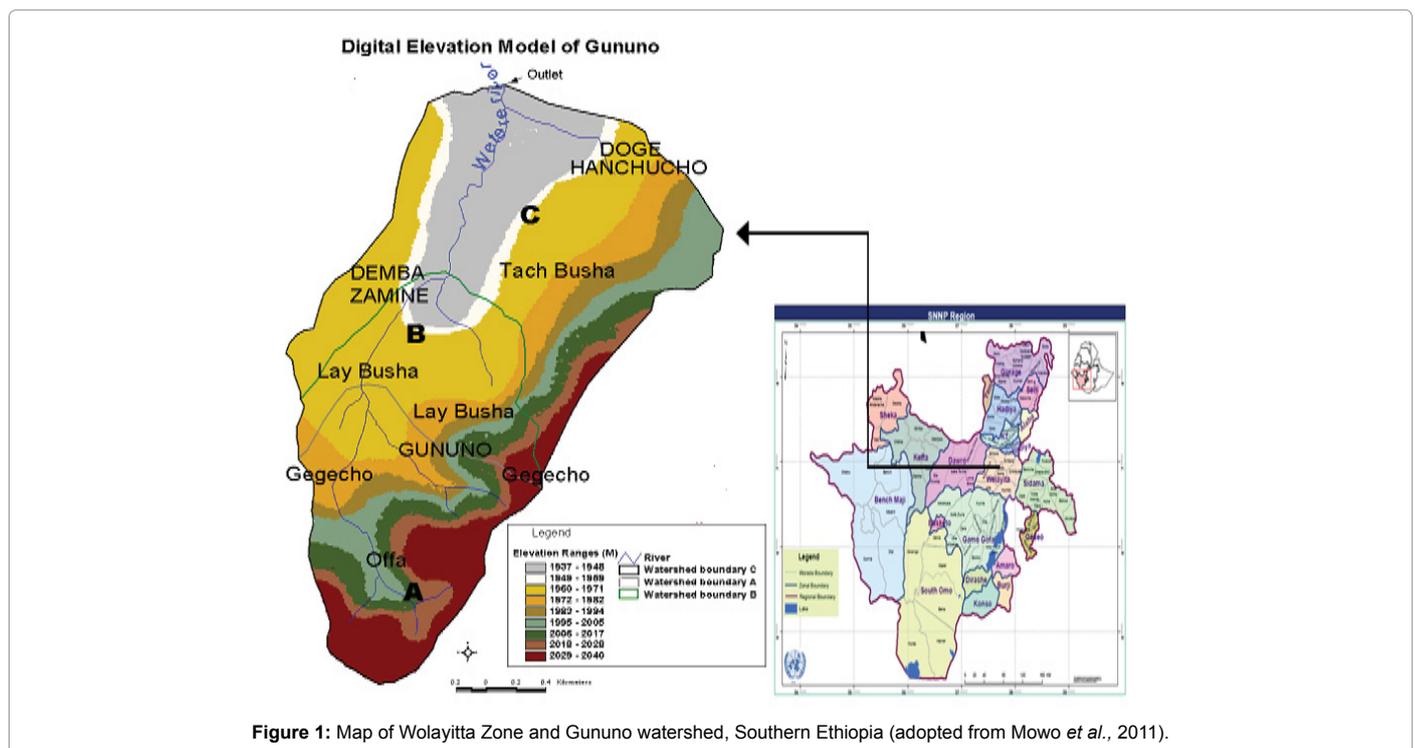


Figure 1: Map of Wolayitta Zone and Gununo watershed, Southern Ethiopia (adopted from Mowo et al., 2011).

Watershed. These managements are shown in Figures 2 and 3. About 95% respondents mentioned an existence of management variations among agroforestry practices. The common management practices include fertilizer application (mainly manure, but also DAP and urea), branch pruning and coppicing, prescribed burning, thinning, pollarding, protection from animal and human damage, grass mulch, crop residue and watering.

The main criterion for such management intensity was mentioned to be related to criterion such as the effect of these managements on agroforestry products (e.g., on fruit and crops i.e., in parkland) and on sustainable land management, to reduce and land degradation

reclaim degraded lands. In general, the criterion used to select some management practice in the watershed is mainly to reduce negative interaction between components and maximize the overall function of the system per land management unit. Consequently, management practices in home garden and woodlot are mainly given to increase fruit products and market values, respectively while in parkland it is given to increase survival and yield of agricultural products tree canopy.

From the common management practices in the watershed, 93% of coppicing, pruning and watering, 80% of protection from animal intervention and thinning, and 73% of fertilizer usage is applied in homegarden compared to parkland and woodlot agroforestry practices. In addition, 53% of grass mulch and pollarding, and 467% of crop residue application is used in homegarden compared to parkland and woodlot agroforestry practices. The common management practices such as fertilizer application (93%), pruning, pollarding and protection (87%), grass mulch and crop residue application (73%), and watering (20%) are implemented in parklands. Similarly, the common management practices in woodlot include pruning and thinning (97%), coppicing (93%), prescribed burning (44%) and fertilizer application, protection and watering (20%), (Figure 2). The application of these management practices varied among woody species and age class, however the big difference is there between agroforestry practices. Burning was given for only woodlots. It was given on dry seasons to increase the leaching of nutrients on the ground, and to facilitate the dormancy breaking after cutting the tree. Similarly, crop residue, grass mulch application and watering were given mostly in dry seasons to increase the moisture content of the soil. Thinning and coppicing was applied at the base of the bole of woody species depending on their age class i.e. species greater than three years or at their mature stage were mostly chosen for such managements.

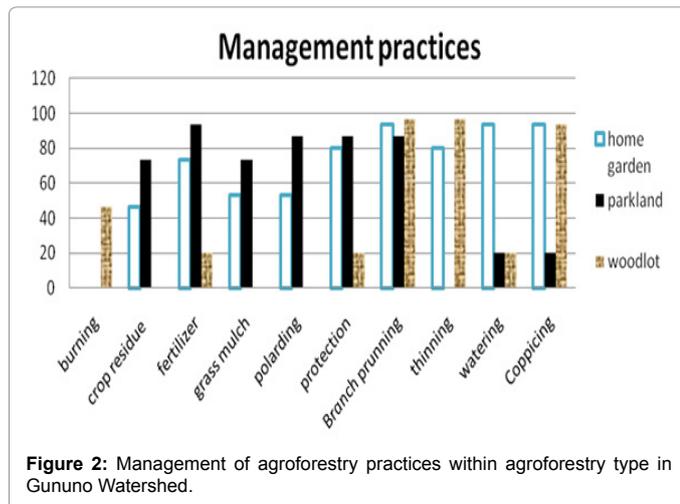


Figure 2: Management of agroforestry practices within agroforestry type in Gununo Watershed.



Figure 3: Management practices showing Grass mulch application on the top, and protection of agroforestry practices from animal damage (using of stall feeding/ partial captive grazing for animals in the system) in Gununo Watershed.

## Discussion

### Factors affecting number of trees planted in agroforestry

It is mentioned that only family size and past participation in agroforestry training were affecting the number of trees planted in agroforestry. House hold (HH) with higher family sizes was planting more trees than less family sizes. This could be attributed with labor availability, and most of the age distribution per households in the watershed was found in productive age (age between 15 to 64 years). Higher family size would have better labor to plant trees because most of household members in this family size were in productive age. People found in this productive age were younger, eager to plant trees, able to provide better management for the planted trees, better in economic condition as most of them work an off farm activities. In addition to the agricultural activities, they have different hand works as a means of income generation, which help them to buy seedlings, and participate in different agroforestry trainings that increase their knowledge about the importance of trees. Family size was previously reported to affect tree cultivation in Pakistan i.e. larger family size cultivated more trees [29].

Similarly, people who participated in agroforestry training planted more trees than who did not participate. This is related with level of knowledge i.e., different trainings given for local people would increase an understanding on agroforestry component interaction and management, importance of woody species, and ways of increasing the survival rate of seedlings/saplings. Training/lack of extension was also reported to drastically affect house hold on farm tree growing in Philippines [30].

However, other factors such as sex, land holding, house hold income, proximity to road were affecting tree growing decision in Ethiopian highlands [31] whereas, land size, age, gender, tenure security, education, income, and agro-ecology were among factors that increased the tendency to plant trees in Tigray [32]. Variation in factors affecting tree planting among different areas could be due to difference in socio economic, demographic or ecological conditions. Therefore, it is suggested that agroforestry and natural resource related trainings, incentives for tree plantings and seedling distribution need to be further given for local people in order to increase tree planting per HH.

### Management practices

The dominant management practices of the study area such as, thinning, pruning, coppicing, pollarding and others are in line with the commonly used managements in tropical agroforestry [6,18,33]. These management practices were shown to vary in intensity and existence among agroforestry practices. The application of any management scheme in the area is linked with the indigenous knowledge of the people in the watershed. They perceive how well the woody species react to different managements and its effect on different biophysical settings such as soil fertility. For instance, prescribed burning was only given for woodlot. In point view of the local people in the watershed, prescribed burning was given for woodlot to increase release of nutrients to soil and facilitate the vibrant shoots from the stump. However, it was not given on parkland and home garden due to its danger on damaging some of the components in the system as there is no clear cut of components. The burning could damage agricultural and tree crops and associated high value trees.

On the other hand, crop residue was only given in parkland and woodlot. This is attributed to availability of crop residue in these agroforestry practices: which woodlot lack as all the biomass is harvested

for eucalyptus. Fertilizer application is also relatively high in parklands because of less nutrient availability, species diversity and existence of agricultural crops in parklands. However, less attention was given for woodlot in fertilizer application as eucalyptus is deep root and can get nutrients and water from deeper soil horizons while relatively high nutrient availability in home garden makes relatively less application of fertilizers. Grass mulch was relatively highly given for parklands in order to increase the moisture availability as there is less litter accumulation unlike that of home gardens. Additionally, high practice of pollarding in parkland is attributed to the need of light by the associated crops in parklands than home garden where mostly shade tolerant species are integrated. The need for more protection for parklands is because crops associated in parklands are highly susceptible for grazing animals than home gardens and woodlots. Relatively high practice of coppicing in home garden and woodlot is taking place. Most of the tree/shrub species exist in these agroforestry practices are coppicing species. The reason of coppicing is mainly related to the desire of land owners to get regeneration of new shoots from the stump to optimize the productivity.

Relatively no thinning and less coppicing in parkland is attributed to the low tree/shrub density, and low coppice species composition in the component. The high watering on home garden is linked with the proximity of home garden to homesteads than parkland and woodlot.

In general, variation in the management intensity was observed in the watershed, and this is also true in different areas and eco regions [6,18,33]. The variation can be attributed to difference in socio economic, cultural and biophysical and environmental settings/criteria [21]. In addition, it could be related with some of the factors affecting adoption of agroforestry in tropics such as sex, age, livestock population, education level, growing of trees, species preference, market, family size, farm size, etc. [21,20,29,34].

## Conclusion and Recommendation

The common agroforestry management practices in the watershed were fertilizer application, pruning, prescribed burning, thinning, pollarding, protection from animal and human damage, grass mulch, crop residue, watering and coppicing. Additionally, only family size and past participation in agroforestry training were significantly and positively related to tree planting activities.

This study indicated that agroforestry practice could be one option to address the problems of deforestation and related resource degradations in Gununo watershed, Wolaita. The indigenous knowledge on agroforestry system and practice management being applied in the watershed should have to get recognition. However, to cop up with the dynamic situations in resource need, and the continued deterioration of the biophysical condition, it need some improvement. Therefore, the following recommendations are given based on the findings of this study:

Replacement of traditional agroforestry practices by new agroforestry technologies such as hedgerows intercropping, fodder banks, fertilizer trees along terraces and soil bunds is important.

Replacement of Eucalyptus with other suitable trees that best fit to be integrated in different agroforestry practices and valuable in terms of products and services is needed.

Promoting farmer managed natural regeneration (FMNR) by protecting cropland from animal damage to enhance natural regeneration particularly in parkland agroforestry practices is highly needed.

## References

1. Kang BT, Akinnifisib FK (2000) Agroforestry as alternative land-use production systems for the tropics. *Natural Resources Forum* 24, pp. 137-151.
2. Richard CJ (2006) Deforestation and the environmental Kuznets curve: An institutional perspective. School of Agricultural and Veterinary Sciences, Charles Sturt University. Elsevier B.V. Australia.
3. Bishaw B (2001) Deforestation and land degradation in the Ethiopian highlands: A strategy for physical recovery. *Northeast African studies*. 8.
4. USAID (2008) Ethiopia Biodiversity and Tropical Forests 118/119 Assessment. United States Agency for International Development.
5. Gustavo SG, Fonseca AB da, Harvey CA, Gascon C, Vasconcelos HL, et al. (2004) Agroforestry and Biodiversity Conservation in Tropical Landscapes. Island Press, USA, pp. 537.
6. Nair PKR (1993) An introduction to agroforestry. Kluwer Academic publisher with cooperation ICRAF, Dordrecht, London. p. 489.
7. World Agroforestry Centre (ICRAF) (2006) Agroforestry for improved livelihoods and Natural resources conservation. An Agroforestry Policy Brief. Kenya, Nairobi.
8. Gholz HL (1987) Agroforestry; Reality, possibilities and potentials, martingus, Nijhoff publishers in cooperation with ICRAF pp. 21-22.
9. Nair PKR (1984) Tropical agroforestry systems and practices. International Council for Research in Agroforestry (ICRAF) Chapter No. 14. tropical resource ecology and development. John Wiley, Chichester, England. June 1984-123.
10. Young A (1989) Agroforestry for soil conservation. International Council for Research in Agroforestry. CAB International p. 318.
11. Bekele A (2007) Profitable Agroforestry innovation for Eastern Africa: Experience from 10 agroclimatic zones of Ethiopia, India, Kenya, Tanzania and Uganda, worldagroforestry center, p. 353.
12. Abebe T (2005) Diversity in homegarden agroforestry systems in Southern Ethiopia PhD thesis Wageningen University, Wageningen.
13. Negash M (2002) Socio economic aspects of farmers eucalypt planting practice in the Enset coffee based agroforestry system of Sidama, Ethiopia: The case of Awassa and shebedino district Msc thesis.
14. Ashagre Y (1997) The contribution of tree to the soil chemical properties in the Croton macrostachyus based indigenous agroforestry system in North western Ethiopia, Msc Thesis, skinnskatteberg.
15. Jama B, Zeila A (2005) Agroforestry in the drylands of eastern Africa: a call to action. ICRAF Working Paper – no. 1. Nairobi: World Agroforestry Centre.
16. Teshome A (2006) Agriculture, Growth and Poverty Reduction in Ethiopia: Policy Processes around the New PRSP (PASDEP). A paper for the Future Agricultures Consortium workshop, Institute of Development Studies.
17. FDRE (Government of the federal democratic republic of Ethiopia) (2003) Rural development policy and strategies. Ministry of Finance and Economic Development Economic Policy and Planning Department. Addis Ababa.
18. Tengnas B (1994) Agroforestry extension manual for Kenya. Nairobi: International Centre for Research in Agroforestry. Nairobi, Kenya. P. 188.
19. Kilewe AM, Kealey KM, Kebaara KX (1988) Agroforestry Development in Kenya Proceedings of the Second Kenya National Seminar on Agroforestry held in Nairobi, Kenya.
20. Bongers G (2010) Dynamics in People-Tree Interactions in Farm Fields: Farmers' perspectives in Meskan District, Ethiopia. Master Thesis. Wageningen University.
21. RWEDP (1995) Integrating woodfuel production into agroforestry extension programs in South East Asia. RWEDP Report No.21. FAO. April 1995, West Java, Indonesia.
22. Oudwater N, Martin A (2003) *Methods and issues in exploring local knowledge of soil*. *Geoderma* 111: 387-401.
23. Miller RP, Nair PKR (2006) Indigenous agroforestry systems in Amazonia from prehistory to today. *Agroforestry systems*, 66: 151-164.
24. King KFS (1980) Agroforestry and development of tropical forestry. UNEP, meeting of experts on tropical forests. Nairobi.
25. Tegene B (1992) Farmers perceptions of erosion hazards and attitudes towards soil conservation in Gununo, Wolaita, Southern Ethiopia. *Etiopian journal of development research*, 14.
26. WZFEDD (2008) Zonal Basic Socio-Economic & Demographic Information. Wolayitta Soddo.
27. Amede T, Belackew T, Geta E (2001) Reversing the Degradation of Arable Land in the Ethiopian Highlands. *Managing Africa Soils*. No. 23. iied.
28. Jeff W (2001) How to Determine a Sample Size: Tipsheet 360, University Park, PA: Penn State Cooperative.
29. Muhammad I, Asadullah K, Mitsuhiro I, Muhammad A, Hassan S (2011) Identifying factors affecting agroforestry system in Swat, Pakistan. *African Journal of Agricultural Research*, 6: 2586-2593.
30. Denyse JS, Lasco Rodel D (2008) Smallholder Tree Growing for Rural Development and Environmental Services: Lessons from Asia. Springer Science and Business Media BV, Netherlands, p. 493.
31. Ewnetu Z, Bliss JC (2010) Tree growing by small holder farmers in the Northern Ethiopia. Small scale forestry in a changing world: opportunities and challenges and the role of extension and technology transfer IURFO conference. June 2010.
32. Gebreegziabher Z, Mekonnen A, Kassie M, Köhlin G (2010) Household Tree Planting in Tigray, Northern Ethiopia: Tree Species, Purposes, and Determinants. *Environment for development*, January, 2010.
33. Bishaw B, Abdelkadir A (2003) Agroforestry and Community Forestry for Rehabilitation of Degraded Watersheds on the Ethiopian Highlands. Wondo Genet College of Forestry Debub University Awassa, Ethiopia International Symposium on Contemporary Development Issues in Ethiopia, July 11-12, 2003, Addis Ababa, Ethiopia.
34. El Tayeb MS (2008) Factors Affecting Adoption of Agroforestry Farming System as a Mean for Sustainable Agricultural Development and Environment Conservation in Arid Areas of Northern Kordofan State, Sudan. *Saudi Journal of Biological Sciences*, 15: 137-145.
35. Mowo J, Adimassu Z, Masuki K, Lyamchai C, Tanui J, et al. (2011) The Importance of Local Traditional Institutions in the Management of Natural Resources in the Highlands of Eastern Africa. Working Paper No 134. Nairobi: World Agroforestry Centre.