Review Article

Review on Agro-forestry System and Its Contribution in Ethiopia

Endale Bekele Jiru

Department of Natural Resource, College of Agriculture and Natural Resource, Bonga University, Kafa, Ethiopia

Email address:
endalebekele42@gmail.com

Abstract: Agroforestry is an ancient practice and also the farmers are too much familiarized with it in Ethiopia. It contributes incredible benefits via socio-economic and environment. The main idea of this paper is to review Agro-forestry system/practices and its contribution in Ethiopia. Most common types of agroforestry practices are home garden, farmland, woodlot and coffee farm; however, their distribution and perception of farmer on those various practice varied. An amazing, each agroforestry practice contributes multiple benefits because it provides various services from specific unit of land. The major advantage was diversify productions, which is the best strategy, particularly for smallholder's farmer because their livelihood depending on farming system. Agroforestry practice is highly recommended and acceptable than mono-cropping consequently it provides a socio-economic benefits like tree products (Timber, firewood, construction materials and fruit for food) and income, whereas environmental services (reduce soil erosion, increase soil moisture and fertility, coffee shade, and keep micro climate balance). Generally, it is good tool for mitigating and adapting climate change. As result farmers were accounted it as a mainstay for maximizing their land productive capacity then improve the smallholder's livelihoods. Therefore, the government should encourage agroforestry practice for improving the livelihoods of farmer and smoothly to tolerate the variable of climate change.

Keywords: Agroforestry System, Socio-economic, Coffee Shade, Environmental and Income

1. Introduction

Agroforestry system is an ancient practice and the farmer also more recognized it. It is also a form of sustainable land use systems that combine tree with crop or animal husbandry simultaneously and sequentially [1]. Literature has shown that due to its economic, social and environmental benefits [2], agroforestry is the common experience that has been promoted throughout in the world [3-4]. It's also an instrument for diversifying production from a single land unit [5-6].

Agroforestry system is the basic extension package in Ethiopia [7]. Because it is highly practice in all parts of the country in different configuration like tree-enset-coffee, tree-enset, and woodlot, scattered trees on farmland and pasture land, and boundary planting [8-9].

Agriculture is the mainstay of Ethiopian economy, which accounts 42-45% of the total gross domestic product (GDP) of the country [10]. However, it is adversely affected by soil erosion and land degradation [11-13], climate change [14], shortage of land and lack of proper land use [15]. Literature shows, tree-based agroforestry systems significantly contribute in alleviating poverty [16]. Because, mixing trees with annual crops is an option for diversifying productions and increase the productivity of land, which in turn helps the farmer to overcome the crop failure due to climate change [17-18]. Furthermore, tree–based agroforestry practice, home garden, is more profitable than mono-cropping [18]. Due to its fact and incredible benefits through economic, social and environmental, almost all of smallholder farmers are more familiarly with agroforestry system or agroforestry practice in Ethiopia [19-21, 9]. Tree-based agroforestry land use practice under different land use has various forms of agroforestry practices such as home garden, coffee farm, farmland, woodlot etc. May not amazing, each agroforestry practices provide their own importance. Therefore, the main of this paper is to review kinds of agroforestry practice and its contribution and also to recommend.

Concept and Definition of Agroforestry

Agroforestry is a dynamic, ecologically based natural resource management system through, which the integration of trees/woody perennials in farm, diversifies and sustains production to increase social, economic and environmental benefits [23]. It is a new name for a traditional old land use practices, but late 1970 it's emerged as modern improved land use systems. Due to various reasons the distribution and effectiveness of agroforestry practice is different from place to place. Regard to this issues a sort of scholars had reported many reasons on why agroforestry system or practice uneven distributed. For instance, the farmer who is hold a large size of land is more participating in the practice of agroforestry system in the central part of the Ethiopia [24]. Besides, there are also others factors like management practice [25], family size and numbers of livestock holding and in-depth understanding the benefits of trees, especial income [26].

2. Agroforestry System in Ethiopia

Agroforestry system is an ancient land use practice in Ethiopia. There is an abundant type of agroforestry practice in Ethiopia. For instance, Kidanu and Mekonnen (2006) acknowledged three types of agroforestry practice such as pasture land, farm land and home garden in Northwestern Ethiopia as cited by [27]. Also, coffee shade tree, scattered trees on farmland, home garden, woodlots, farm boundary and grazing lands are types of traditional agroforestry practices in Southern, Ethiopia [28, 8]. The enlargement of tree-based agroforestry land use practice under different landforms is the alternative method of increasing the efficiency of land because planting or maintaining of tree or shrub on farmland, roadsides, pasture land, and farm boundary use to minimize a shortage of

wood products and improve the production ability of land simultaneously [29].

Both coffee-enset-based and parkland agroforestry practices are commonly known as an economical eye-catching. However, coffee-enset-based agroforestry practice is the best economical presentation than parkland agroforestry practices and accepted as the best strategy for improving the livelihood of smallholder farmers in Yirgachefe district of Gedeo Zone, Ethiopia [30]. Woodlot of *Eucalyptus* is also the most agroforestry practice in Ethiopia, because it playing a vital role in improving the livelihood of the farmer [31-32].

Home Garden Agroforestry System

Home garden agroforestry practice can be defined as a land use system, which involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably livestock within the compounds of individual houses, the whole tree-crop–animal unit being intensively managed by family labor (Fernandes and Nair, 1986) as cited by [33]. Tree, livestock and crops are the most commonly known as three stable ecosystems of home garden agroforestry, which is related to three scientific disciplines of forestry, animal rearing and agronomy, respectively [28]. As a result, it can improve the livelihoods of the farmer through providing multiple services like food/fruit, timber, firewood and fodder [34].

However, home garden agroforestry land use practice has varied from place to place depending on its goal and types of tree species, farmer's interest and management system. For example, home garden agroforestry in the south nation nationality people region state (SNNPRS) was recognized by a unique combination of two native major perennials coffee (*Coffea arabica* L.) and Enset (*Enset ventricosum* Welw. Cheesman) [35] (Figure 1).

Figure 1. Enset-Coffee agroforestry home garden with different configurations [35].

There are various driving forces, which lead the transition of home garden agroforestry to a mono-cultivation of cash crop and its result affecting the people in SNNPRS [36].

According to his finding population pressure, reduction of land size, poverty and the market situation were some of the driving forces, which push home garden agroforestry land use

practice to monoculture production of Khat and *Eucalyptus* species. He also added that this shift toward monoculture of crop production has affected an economic gain and the socio-cultural benefits derived from the traditional home garden agroforestry system in the region. The study conducted on functional identification and analysis was differentiated three functional groups in agroforestry system such as ecological, conservation and livelihoods [37]. Accordingly, they found that under functional group they not only include food, cash, and vegetable but also fruit trees. A fruit tree is the mainstay home garden agroforestry, which assists the smallholder household as subsistence and source of cash. Thus, *Mangifera indica* is also helping the farmer through providing additional income in Eastern, Southern and Southwestern Ethiopia [38].

Farmland Agroforestry System

This is a type of tree-based agroforestry land use system whereby a tree is always growing associated with a cereal crop such as maize, teff, sorghum etc. It's also known as a parkland farming system [30]. This practice involves the growing of individual trees (*Syzygium guineense)* in wide spaces or scattered and distributed on the farmland and without preventing other crops grown. Such types of tree species growing dispersed on cropland may be based on protection and careful managing of either naturally regenerated or planting trees. Tree planting on farmland does not have any specific pattern, for instance, *Acacia albida, Croton macrostachyus* and *Ficus* species are the most common tree

species on farmland in central highlands of Ethiopia [31]. Besides, *Croton macrostachyus, Ficus sure, Albizia gummifera, Cordia africana, Acacia abyssinica, Rosa abyssinica, and Erthrina abyssinica* are also the most common tree species available on farmland in Jabithenan district, Northwestern Ethiopia [18], whereas *Eucalyptus spp.* and *Grevillea robusta* are grown as live fences, boundaries and small-scale woodlot.

Around half (42%) of farmers are interested in dispersible tree planting on their farmland in central highland of Ethiopia [31]. Inter-cropping of maize with *Cordia africana* in western Ethiopia, *Acacia albida* in Hararghe Highlands and Debrezeit area are common practices [39] (Figure 2). Currently, integrating of tree species with annual crops is accounted as the modern ways of increasing the production capacity of single land through diversifying the production with higher yields. Because of their multipurpose benefits, the farmer is purposefully retaining or planting different tree species on their farmland. Some of their benefits are conserving soil erosion, enhance the water holding capacity of soil and improving soil fertility through nitrogen fixation [40]. Besides, tree on farms improve soil nutrient, particularly *Croton macrostachyus Del.* and *Cordia africana Lam.* through reducing the removal of nutrients and accumulating a leaves in soil and by decomposed in Badessa, Eastern Ethiopia [41]. Furthermore, tree available on the farmland provides socio-economic benefits like medicinal, fodder and fuel wood in Southeast Langano of Ethiopia [42].
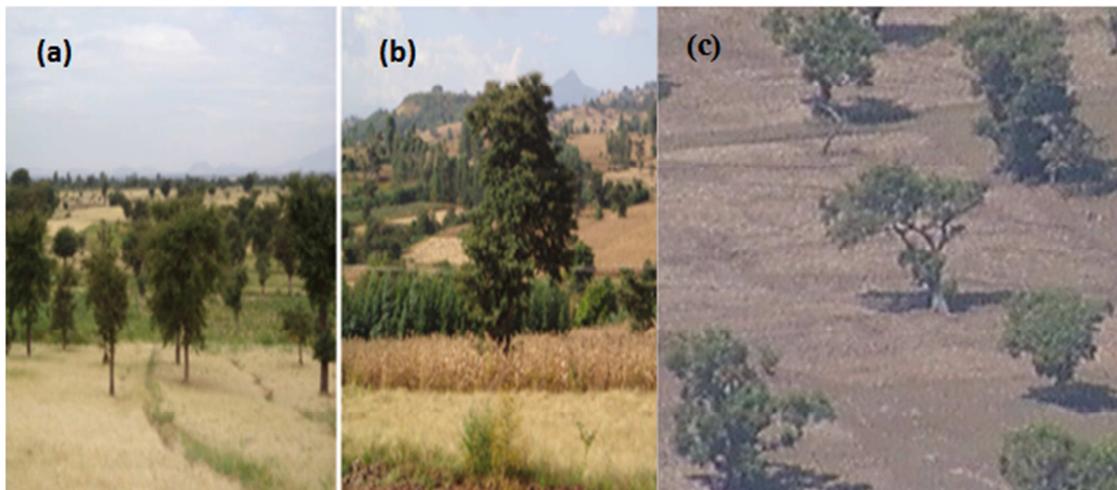
Figure 2. Typical agroforestry practices observed in semi-arid and sub-humid zones of Oromia State, (a) Faidherbia albida amongst teff in semi-arid (b) Ziziphus Mauritania and Acacia abysinica in maize fields in semi-arid [43] (c) Cordia africana in a maize field in sub-humid [30].

Coffee Farm Agroforestry System

Coffee farm is the types of agroforestry land use, which various tree species used as a coffee shade combined with coffee planting [28]. In Ethiopia, the farmer has experience of cultivating coffee crop under different shade trees. *Albizia schimperiana, Albizia gummifera, Millettia ferruginea, Cordia africana* and *Erythrina abyssinica* are the most compatible trees for coffee shade in Southwestern Ethiopia. In addition, to shade services, they also offer various tree products like firewood, timber, construction materials and

lastly improving soil fertility and reduction of soil erosion [44-45]. Besides, *Acacia abyssinica* is also the most favorable tree species for coffee shade in Southwestern Ethiopia [46]. This highly coincided with the coffee farm around Jimma town [47] (Figure 3). Most of the scholar was agreed for the criticality of shade for coffee productions but in case of favorite tree species they had various ideas. *Croton macrostachyus* is accepted as the most advantageous shade tree than others trees species, which existed as agroforestry for coffee production in Manasibu District, Ethiopia [48].

Figure 3. Coffee farmer Agroforestry practice around Jimma town [47].

Woodlot Agroforestry

A woodlot is a piece of forest land, which is developed for various purposes including firewood and construction [31]. They also verified that many farmers were separately planting tree on a small-scale woodlot as the best alternatives of land use practices. Because, it provides firewood, construction materials, and income, which reversely help smallholder farmers to meet their family's needs in Eza district of Ethiopia [49].

In Ethiopia, particularly in rural areas, woodlot tree-based agroforestry land use is cultivated by smallholder farmer [31-32]. The main purpose of *Eucalyptus* introduced into Ethiopia is to improve the supply of tree products and to reduce natural forest degradation. But, currently this perception is gradually changed to more benefits market-oriented [50]. Planting of *Eucalyptus* woodlot is the best strategy for improving the livelihoods of smallholder farmer, because it offers income and woody products for house consumption in Arsi Zone of Oromia [51]. Moreover, the amount of income contributed by *Eucalyptus* woodlot is relatively more income (e.g. 50%) than the income obtained from cereal crops and livestock in the central highland of Oromia, Ethiopia [32]. Due to this fact reason, the farmers are allocated their land for *Eucalyptus* cultivation. *Eucalyptus camaldulensis* and *Cupressus lusitanica* tree species are the most trained tree, which more preferred for woodlot agroforestry practice around Jimma town [47] (Figure 4).
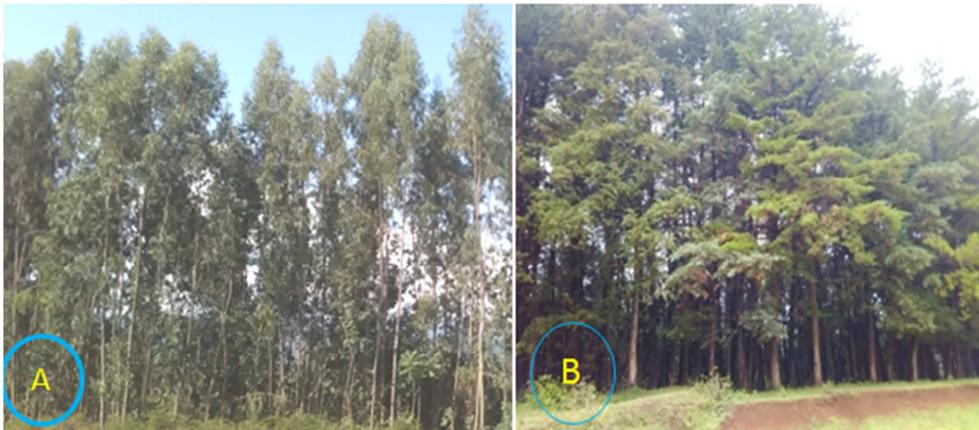
Figure 4. Eucalyptus camaldulensis (a) and Cupressus lusitanica (b) woodlot tree based agroforestry [47].

3. Socio-economic Benefits

All most all livelihoods of the country people are depended on rain fed agriculture in which agroforestry practice is footprint. Income earned from tree products is calculated from both non-timber forest product (NTFP) and timber forest products (TFP) such as fruit, firewood, honey, spices, timber, pole and charcoal [22, 52]. Even if the amount of income obtained is varying from place to place, that extra income is playing a great role for improving the livelihoods of farmers', particularly during some risks occurred related to crop production due to climate changes [21]. Furthermore, the farmer obtains 47% income from

NTFPs in Kaffa Zone [52], 800 to 1500 ETB in Wolaita Zone [53] and 1683 ETB an annual average income from home garden agroforestry practice in Jimma Zone, southwest, Ethiopia [21].

However, the amount of income derived from tree product is influenced by various factors. According to some literature experiences of tree planting, age of farmer, household wealth status, land size and education level are positively influencing the income of households [54-55].

The World Health Organization estimated that at least 80% of the populations of most developing countries rely on traditional medicine for their primary health care (WHO, 2001) as cited by [56]. There are various works of literature, which shows the benefits of tree or shrubs for traditional medicine in different parts of the Ethiopia [57-59]. For instance, *Croton macrostachyus* for malaria, diarrhea, epilepsy, ringworm and skin rush, *Cordia africana* to cure evil eyes, *Euphorbia candelabrum* for ringworm, *Millettia ferruginea* for fungal infection, *Vernonia amygdalina* for diarrhea and stomach ache. Thus, around 52 medicinal plant species was identified in Boosat district central Eastern Ethiopia [58] and also 39 medicinal plants used for the treatment of various diseases were differentiated in Jimma zone, Southwestern Ethiopia [59]. Tree-based agroforestry land use practice provides a shade service. People are assembled under a shade tree for social issues and religious purpose (e.g. playing) in Southwestern Ethiopia [25].

4. Environmental Benefit

Environmentally agroforestry system plays a great role in improving the environmental health quality, control soil and water erosion and improve soil fertility and enhance the moisture holding capacity of the soil [60]. The integration of tree with annual crops is the best alternative for enhancing the productivity of land through diversifying agriculture and sustains production of land [61].

Agroforestry can mitigate climate change through various techniques. For example, it is playing a major role in mitigating the negative impact comes due to climate change to agricultural production [62]. Because, mixing trees with annual crop is an option for diversifying productions and increases the productivity [17, 62]. Furthermore, it supports in reducing environmental degradation and provides multiple benefits to smallholder farmers [19]. This consequence will enhance the rural farmer to cope with climate change. Tree-based agroforestry land use practice is strength for attaining food security, especially to subsistence agricultural farming system through providing cash to smallholder farmer, then the farmer can purchase cereal crop for house consumption [21]. Agroforestry practice contributes incredible service in watershed management. For instance, In Wolaita Zone in Gununo Watershed, the local peoples' indigenous knowledge on agroforestry management (fertilizer application, pruning, prescribed burning, thinning, pollarding, protection from animal and human damage, grass mulch, crop residue, watering and coppicing) was accepted as the option in

reducing land degradation through modifying micro- climate and reducing soil erosion, improving soil fertility and increasing soil moisture then in turn improve the crop yields [9]. Besides, it has huge advantages in rehabilitating the degraded land in highlands of Ethiopia [63].

Agroforestry is the best alternative mechanism for resolving environmental problem. Degradation of environmental health quality is put the world under serious challenges especially in developing countries. This environmental degradation approximately articulated as land degradation, which is induced by soil erosion, deforestation, over exploitation, over grazing and increasing population growth.

5. Conclusions

Agroforestry system is the oldest traditional practice in Ethiopia, but today it is accounted as the modern land use system. The farmers are more familiarized with practicing different types of agroforestry practice, which includes home garden, farmland, coffee farm and woodlot. It plays great role in diversifying production from a single land unit. Due to this, it is more acceptable than mono-cropping from farmers point of view. Besides, it also provides multipurpose benefits like socio-economic such as tree products (Timber, firewood, construction materials and fruit for food) and income, and environmental services (reduce soil erosion, increase soil moisture and fertility, coffee shade, and keep micro climate balance).

Agroforestry can mitigate climate change through various techniques. For instance, reduce the negative impact comes due to climate change to agricultural production. Because, mixing trees with annual a crop is an option for diversifying productions and increases the productivity. This consequence will enhance the rural farmer to cope with climate change. Generally, it is an option for improving the livelihoods of smallholder farmers.

References

[1] FAO (2013). Advancing Agroforestry on the Policy Agenda: A Guide for Decision-Makers. In G. Buttoud, in collaboration with O. Ajayi, G. Detlefsen, F. Place and E. Torquebiau. Agroforestry Working Paper no. 1. Rome.

[2] Abrha BG (2016). Potential Effects of Agroforestry Practices on Climate Change Mitigation and Adaptation Strategies: A Review. Journal of Natural Sciences Research, 6 (15).

[3] Akinnifesi FK, Silashe G, Ajayi OC, Chirwa PW, Kwesiga FR, Harawa R (2008). Contributions of agroforestry research and development to livelihood of smallholder farmers in Southern Africa: 2. Fruit, Medicinal, Fuelwood and Fodder Tree Systems, Agricultural Journal, 3 (1): 76 – 88.

[4] Mbow C, Smith P, Skole D, Duguma L, Bustamante M (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, 6: 8-14.

[5] Casey JF, (2004). Agroforestry adoption in Mexico: using Keynes to better understand farmer decision-making. Journal of Post Keynesian Economics, 26 (3), 505-521.

[6] Dwivedi RP, Kareemulla K, Singh R, Rizvi RH, Chauhan J (2007). Socio-Economic Analysis of Agroforestry Systems in Western Uttar Pradesh, 7: 18–22.

[7] MOARD (2005). Agroforestry extension package for Pastoral community (Amharic version) Addis Ababa Ethiopia.

[8] Asfaw Z, Agren, GI (2007). Farmers' local knowledge and topsoil properties of agroforestry practices in Sidama, Southern Ethiopia. Agroforestry Systems, 71 (1): 35-48.

[9] Madalcho AB, Tefera MT (2016). Management of Traditional Agroforestry Practices in Gununo Watershed in Wolaita Zone, Ethiopia. Forest Research: Open Access, 5 (1).

[10] Zenebe G, Jesper S, Alemu M, Atlaw A (2011). Climate change and the Ethiopian Economy. A computable general Equilibrium Analysis. Environment for Development, Ethiopia.

[11] Demelash M, Stahr K (2010). Assessment of integrated soil and water conservation measures on key soil properties in South Gonder, North-Western Highlands of Ethiopia. Journal of Soil Science and Environmental Management, 1 (7): 164-176.

[12] Deresa F, Legesse T (2015). Cause of Land Degradation and Its Impacts on Livelihoods of the Population in Toke Kutaye Woreda, Ethiopia. International Journal of Scientific and Research Publications, 5 (5).

[13] Fentie D, Fufa B, Bekele W (2013). Determinants of the use of soil conservation technologies by smallholder farmers: The case of Hulet Eju Enesie District, East Gojjam Zone, Ethiopia. Asian Journal of Agriculture and Food Sciences, 1 (04): 2321-1571.

[14] Yohannes H (2016). A Review on Relationship between Climate Change and Agriculture. Journal of Earth Science and Climatic Change; 7 (2).

[15] Pender J, Gebremedhin B (2008). Determinants of agricultural and land management practices and impacts on crop production and household income in the highlands of Tigray, Ethiopia. Journal of African Economies, 17 (3): 395-450.

[16] Garrity DP (2004). Agroforestry and the achievement of the Millennium Development Goals; Agroforestry Systems, 61: 5–17.

[17] Bishaw B, Neufeldt H, Mowo J, Abdelkadir A, Muriuki J, Dalle G, Assefa T, Guillozet K, Kassa H, Dawson IK, Luedeling E (2013). Farmers' strategies for adapting to and mitigating climate variability and change through agroforestry in Ethiopia and Kenya. Forestry Communications Group, Oregon State University, Corvallis, Oregon.

[18] Linger E (2014). Agro-ecosystem and socio-economic role of home garden agroforestry in Jabithenan District, North-Western Ethiopia: implication for climate change adaptation. SpringerPlus, 3: 154.

[19] Muleta D, Assefa F, Nemomissa S, Granhall U (2007). Composition of coffee shade tree species and density of indigenous arbuscular mycorrhizal fungi (AMF) spores in Bonga natural coffee forest, southwestern Ethiopia. Forest ecology and management, 241 (1): 145-154.

[20] Abebe T, Wiersum KF, Bongers F (2010). Spatial and temporal variation in crop diversity in agroforestry home gardens of southern Ethiopia. Agroforestry Systems, 78 (3): 309-322.

[21] Kebebew Z, Urgessa K (2011). Agroforestry Perspective in Land Use Pattern and Farmers Coping Strategy: Experience from Southwestern Ethiopia. World Journal of Agricultural Sciences, 7 (1): 73-77.

[22] Kebebew Z, Garedew W, Debela, A (2011). Understanding home garden in household food security strategy: Case study around Jimma, Southwestern Ethiopia. Research Journal of Applied Sciences, 6 (1): 38-43.

[23] Leakey RRB (1996). Definition of agroforestry revisited. Agroforestry Today (ICRAF).

[24] Sisay M, Mekonnen K (2013). Tree and shrub species integration in the crop-livestock farming system. African Crop Science Journal, 21 (1): 647-656.

[25] Negash M (2007). Trees management and livelihoods in Gedeo's agroforests, Ethiopia. Forests, Trees and Livelihoods, 17: 157-168.

[26] Duguma LA (2013). Financial analysis of agroforestry land uses and its implications for smallholder farmer's livelihood improvement in Ethiopia. Agroforestry systems, 87 (1): 217-231.

[27] Ketsela KH (2012). The Contribution of Eucalyptus Woodlots to the Livelihoods of Small Scale Farmers in Tropical and Subtropical Countries with Special Reference to the Ethiopian Highlands.

[28] Abebe T (2005). Diversity in homegarden agroforestry systems of southern Ethiopia. PhD thesis Wageningen University, Wageningen. 90-8504-163-5.

[29] Duguma L A, Hager H (2010). Woody plants diversity and possession, and their future prospects in small-scale tree and shrub growing in agricultural landscapes in central highlands of Ethiopia. Small-scale Forestry, 9 (2): 153-174.

[30] Ayele Y, Ewnetu Z, Asfaw Z (2014). Economic Evaluation of Coffee-Enset-Based Agroforestry Practice in Yirgachefe Woreda, Ethiopia: Comparative Analysis with Parkland Agroforestry Practice. Journal of Economics and Sustainable Developmen, 5 (27).

[31] Duguma LA, Hager H (2009). Forest products scarcity perception and response by tree planting in the rural landscapes: farmers' views in central highlands of Ethiopia. Ekológia, 28 (2): 158.

[32] Kebebew Z, Ayele G (2010). Profitability and household income contribution of growing Eucalyptus globulus (Labill.) to smallholder farmers: The case of central highland of Oromia, Ethiopia. European Journal of applied science, 2 (1): 25-29.

[33] Das T, Das AK (2010). Litter production and decomposition in the forested areas of traditional homegardens: a case study from Barak Valley, Assam, northeast India. Agroforestry systems, 79 (2): 157-170.

[34] Kumar BM, Nair PKR (2004). The enigma of tropical homegardens. Agroforestry System 61:135–152.

[35] Gebrehiwot M (2013). Recent transitions in Ethiopian home garden agroforestry (21).

[36] Abebe T (2013). Determinants of crop diversity and composition in Enset-coffee agroforestry homegardens of Southern Ethiopia. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 114 (1): 29-38.

[37] Huang W, Luukkanen O, Johanson S, Kaarakka V, Räisänen S, Vihemäki H (2002). Agroforestry for biodiversity conservation of nature reserves: functional group identification and analysis. Agroforestry Systems. 55: 65–72.

[38] Yeshitela TB, Nessel T (2004). Characterization and Classification of Mango Ecotypes Grown in Eastern Hararghe (Ethiopia). Sarhad Journal of Agriculture, 19 (2): 179-180.

[39] Hoekstra DE, Torquebiau B, Bishaw (eds) (1990). Agroforestry: Potentials and Research Needs for the Ethiopian Highlands. No. 21. Nairobi, Kenya: International Council in 22 Agroforestry (ICRAF). https://en. wikipedia. org/wiki/Jimma (Web site visited on 02/10/2018).

[40] Yadessa A, Itanna F, Olso M (2001). Contribution of indigenous trees to soil properties: the case of scattered trees of Cordia africana Lam. in croplands of western Oromia. Ethiopian Journal of Natural Resources, 3 (2): 245–270.

[41] Gindaba J, Rozanov A, Negash L (2005). Trees on farms and their contribution to soil fertility parameters in Badessa, Eastern Ethiopia. Biology and fertility of soils, 42 (1): 66-71.

[42] Asfaw B (2006). Woody species composition and socio-economic roles of traditional agroforestry practices across different agro-ecological zones in South Eastern Langano, Oromiya, M. Sc. Thesis, Hawassa University, Wondo Genet, Ethiopia.

[43] Miyuki I, Abayneh D, Kaleb K, Catherine M, Ruth K, Ermias A, Evelyn K, Kiros H, Jeremias M, Fergus L, Sinclair (2017). Understanding patterns of tree adoption on farms in semiarid and sub-humid Ethiopia. Agroforest Syst 91: 271–293.

[44] Nigussie A, Taye E, Bukero G (2014). Survey on potentials and constraints of shade tree species for arabica coffee production in South Ethiopia. International Journal of Recent Research in Life Sciences, 1 (1): 1-11.

[45] Hundera K, Honnay O, Aerts R, Muys B (2015). The potential of small exclosures in assisting regeneration of coffee shade trees in Southwestern Ethiopian coffee forests. African Journal of Ecology, 53: 389–397.

[46] Muleta D, Assefa F, Nemomissa S, Granhall U (2011). Socio-economic benefits of shade trees in coffee production systems in Bonga and Yayuhurumu districts, southwestern Ethiopia: Farmers' perceptions. Ethiopian Journal of Education and Sciences, 7 (1): 39-56.

[47] Endale B (2017). Environmental Contribution of Agroforestry Systems to Smallholder Farmers around Jimma town, southwestern Ethiopia, unpublished MSc. Thesis.

[48] Ebisa L (2014). Effect of dominant shade trees on coffee production in Manasibu District, West Oromia, Ethiopia. Science, Technology and Arts Research Journal, 3 (3): 18-22.

[49] Zerga B (2015). Ecological impacts of Eucalyptus plantation in Eza Wereda, Ethiopia. Int. Inv. J. Agric. Soil Sci, 3 (4): 47-51.

[50] Pohjonen V, Pukkala T (1990). Eucaluputs globules in Ethiopia forestry. Forest Ecology and Management, 36: 9-31.

[51] Mekonnen Z (2010). Community Opinion, Marketing and Current Debates on Eucalyptus in Huruta District, Arsi Zone of Oromia Region, Ethiopia

[52] Melaku E, Ewnetu Z, Teketay D (2014). Non-timber forest products and household incomes in Bonga forest area, Southwestern Ethiopia. Journal of Forestry Research, 25 (1): 215-223.

[53] Agize M, Chama E, Shonga A (2016). Income Generating Activities of Women on Home Garden Farming in Damot Gale District (Woreda) of Wolaita Zone, Southern Ethiopia, International Journal of African and Asian Studies, 23.

[54] 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.

[55] Gebreegziabher Z, Mekonnen A, Kassie M, Köhlin G (2010). Household tree planting in Tigrai, Northern Ethiopia: Tree species, purposes, and determinants. 2473 (432).

[56] Gidey M, Beyene T, Signorini MA, Bruschi P, Yirga G (2015). Traditional medicinal plants used by Kunama ethnic group in Northern Ethiopia. Journal of Medicinal Plants Research, 9 (15): 494-509.

[57] Fisseha M (2007). An Ethnobotanical Study of Medicinal Plants in Wonago Woreda, SNNPR, Ethiopia. Addis Ababa, Ethiopia: Msc. Thesis, Unpublished.

[58] Hunde D (2006). Use of traditional medicinal plants by people of Boosat sub district. J Health Sci, 16: 141-154.

[59] Abera B (2014). Medicinal plants used in traditional medicine by Oromo people, Ghimbi District, Southwest Ethiopia. Journal of ethnobiology and ethnomedicine, 10 (1): 1.

[60] El Tahir BA, Vishwanath A (2015). Estimation of Economic Value of Agroforestry Systems at the Local Scale in Eastern Sudan. Journal of Geoscience and Environment Protection, 3: 38-56.

[61] ICRAF (1997). "Agroforestry potentials for the Ethiopian highlands," Working Paper, International Centre for research in Agroforestry (ICRAF), Nairobi, Kenya.

[62] Mbow C, Van Noordwijk M, Luedeling E, Neufeldt H, Minang PA, Kowero G (2014). Agroforestry solutions to address food security and climate change challenges in Africa. Current Opinion in Environmental Sustainability, 6: 61-67.

[63] Bishaw B, Abdelkadir A (2003). Agroforestry and community forestry for rehabilitation of degraded watersheds on the Ethiopian highlands.