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Review on Contribution of Homegarden Agroforestry Practices on Well- Being of Ethiopia

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Abstract

Homegarden agroforestry is special category of agroforestry that deals with the cultivation of multipurpose and multi-storied trees, crops and livestock around home. This practice of agroforestry is an old age and traditional land use systems with protection and production functions, contributing particularly to the food and nutrition security of smallholders. The main idea of this paper is to review about homegarden agroforestry practice and its contribution in Ethiopia. The high species diversity nature of homegarden agroforestry plays wide socioeconomic and ecological roles. The most common contribution of homegarden agroforestry are biodiversity conservation, climate change adaptation and mitigation, contribution to income generation and food security. More than half of the plant species in homegarden agroforestry is edible by household members and it contribute up to 30-40% of household income. Soil fertility and moisture improvement are climate change adaptation strategy of homegarden agroforestry whereas C sequestration potential (CSP) due to their forest-like structure and composition are mitigation strategy in Ethiopia. Therefore, government should do more in expand and diversify this system throughout the country. In addition, awareness rising through training about diversification of homegarden agroforestry to the farmer should be encouraged.

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Keywords

Homegarden, Diversity, Income, Climate change adaptation and Mitigation.

Introduction

Rapid population growth has resulted in reduction of land available for farming while at the same time consumption rate is increased due to increased family sizes. In Ethiopia population number is increased rapidly and most of those populations are depending on agriculture or land (Zenebe *et al.*, 2011). Due to these reason the land holding size is reduced and led unsustainable production systems and continuous nutrient mining (cultivation) on the same piece of land (Bationo , 2012). As a result of these, farmers start to adopt a more complex, and more intensive use of their lands in a bit to increase productivity, diversify income sources and also ensure sustainability in agriculture (Tesfaye Abebe, 2005). This complex and diversified system is homegarden agroforestry.

Homegardens are traditional agroforestry practices with multiple functions practiced by rural farmers around homesteads as a strategy of livelihood diversification to stabilize their sustenance (Das and Das, 2005). Kumar BM and Nair PKR (2004) define homegarden agroforestry as ‘‘a special category of agroforestry that deals with the cultivation of multipurpose and multi-storied trees, crops and

livestock around homestead.'' This practice of agroforestry is an old age and traditional land use systems with protection and production functions, contributing particularly to the food and nutrition security of smallholders (Vieira *et al.*, 2012).

Different components in homegarden agroforestry such as the tree, crop and animal units are intensively managed by family labor (Kumar and Nair, 2006), this is due to easily accessible and close to the house. Homegarden is distributed around the house in all directions close to the house that referred as backyard, front yard and side yards (Kerstin, 1999). Kang and Akinnifesi (2000), mentioned reasons for location of homegarden agroforestry; they are located close to dwellings for security, convenience and special care.

Homegardens have been considered as sustainable and productive agricultural systems supporting very dense populations as compared to other agricultural systems (Kumar and Nair, 2006). It has a lot of contribution in one way to ensure production. Due to high species diversity nature of homegardens, it has different uses and production cycles, and essential feature in terms of socio-economic and ecological roles.

The main objective of this paper is to review on contribution of homegarden agroforestry practices on well-being of Ethiopia.

Distribution of homegarden agroforestry in Ethiopia

Ethiopia has a long tradition of practicing of homegarden system and most of these gardens are located at altitudes of 1500-2300 m.a.s.l. where moisture and temperature conditions are favorable for agriculture (Tadesse, 2002). According to the study of Ketsela (2012), pasture land, farm land and home garden are the most abundant agroforestry practice in Northwestern part of Ethiopia. However, southern parts of Ethiopia is highly practiced different agroforestry practices like coffee shade tree, scattered trees on farmland, homegarden, woodlots, farm boundary and grazing lands are types of traditional agroforestry practices in Southern, Ethiopia (Tesfaye, 2005).

Extensive areas of traditional homegarden agroforestry exist in the south and south-western parts of Ethiopia. Assessment done by Tesfaye (2005) told that, homegardens in south and south-western parts of Ethiopia are dominated by two native perennial crops called coffee and enset. In Southern Nation's Nationalities and Peoples' Regional State, homegardens agroforestry practice constitutes most of the cultivated area especially by coffee and enset based agroforestry (BODEP, 1996). As stated by ZebeneAsfaw (2003) and Ewuketu *et al.*, (2014), several important studies have been done and published in Southern Nation's Nationalities and Peoples' Regional State related to homegarden agroforestry however in north part of Ethiopia, homegarden agroforestry have got little attention.

Contribution of homegarden agroforestry

The contribution of homegardens agroforestry practices is well appreciated throughout the world (Kebebew *et al.*, 2011). Homegarden agroforestry practice is common in most tropical countries and they play a vital role in supporting households in many diverse ways, including provision of food, biodiversity conservation, income, and climate change adaptation and mitigation (Saka *et al.*, 1990).

Contribution for biodiversity conservation

Homegarden agroforestry systems in the tropics are known for their structural complexity and diversity in crop and other plant species (Kumar and Nair, 2006). This is due to the presences of plant associations of various trees and crops, and consequent multi-story canopy configuration around the homestead. Farmers grow different plant species in satisfying there subsistence and for income generation as a result, the diversity of plant species in homegarden agroforestry got high and complex.

In Ethiopia a number of researches were done related to plant species diversity in homegarden agroforestry. However most studies were done in south part of Ethiopia this is due to the distribution of homegarden agroforestry practice is high in south Ethiopia (Zebene Asfaw, 2003 and Ewuketu Linger *et al.*, 2014).

In table 1, Shannon index, evenness and richness show the level of species diversity. Shannon index is more explanatory than Simpson index and richness so the value of Shannon index can express highly and low diversity respectively when the value between 4.5 and 1.4. So that, the result of the above research were

showed that homegarden agroforestry have higher species diversity than other land use and species are equally distributed through the surveyed area. Within small land size much more of plant species both exotic and indigenous species are exist, this shows that homegarden agroforestry play important role in conservation of different plant species. In general, biodiversity in agroforestry systems especially in homegardens agroforestry practice is typically higher than in conventional agricultural systems.

Contribution for food supply (food security)

As a result of population increment throughout the world famine and starvation are knocking with speed (Olajidetaiwo *et al.,* 2010). In solving such problem homegarden agroforestry play a vital role. It has been identified as a means of providing all year round access to food for rural households (Kebebew *et al.,* 2011; Kumar, 2006) that helped smallholder farmers to support their family (Kalaba*et al.,* 2009). Plant products harvested from homegardens improve the family food security and potential means of poverty alleviation (ZemedeAssefa, 2001). Homegarden has led to nutritional benefits to families living in slum areas by increasing the availability of carbohydrates as well as nutrient-rich vegetables and fruits that are not economically accessible for poor slum dwellers (Ninez VK, 1985).

Different studies in Ethiopia also showed that homegarden agroforestry have a great contribution in solving shortage of food by providing different edible products to the community. Studies in Yayu area, south-western Ethiopia in 2018, showed that a number of plant species are exist in homegarden agroforestry from that almost 46.6% of plant species are used as food for homegarden owner. Similar studies by Tesfaye Abebe (2005) showed that in Southern Ethiopia 88.8% of the surveyed households were food secured throughout the year due to extensive presence of homegardens agroforestry. In comparison with other countries like Tanzania, contribution of homegardens is higher than Ethiopia.in Tanzania homegardens agroforestry contribute up to 98% for food security (Billes Luka, 2013).

Table 2 showed that, diversity of edible plant species in homegarden agroforestry. In general, almost 40-50% of plant species in homegarden agroforestry are edible by community so that, those species are highly contributed for food security to the local community.

Contribution for income generation

The primary purposes of homegardens are subsistence of the households, and next to this, it act as income generation (Mendez *et al.,* 2001). Homegardens can contribute to household income in several ways. Selling cereal crops, fruits, vegetables and other cash crops (e.g., lime, rambutan, jackfruits, durian, cloves, and coffee) to local brokers or merchants are the major source of Income from homegardens (Christanty *et al.,* 1986; Marsh, 1998).

With related to income contribution of homegardens agroforestry, a number researches were done in Ethiopia and other countries. Research in Mbeya rural district, Tanzania reported that homegardens have 25% income contribution (Billes Luka, 2013). Similar studies in Ethiopia showed that, homegardens offer economic stability to farmers and provide a significant amount (30-50%) of household income (Mattsson .E *et al.,* 2013).

The table 3 showed that, different studies in Ethiopia in different regions, those studies were proof that homegardens agroforestry have its own contribution in generating income for house hold.

Contribution to climate change adaptation and mitigation

Mitigation and adaptation are the two main strategies that are used effectively to address climate change. Mitigation is an intervention to reduce the sources of emissions or enhance the GHG sinks whereas adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli, which moderates harm or exploits beneficial opportunities (IPCC, 2006).

Homegarden agroforestry to climate change adaptation

Adaptation strategies are intended to reduce vulnerability and build resilience to the impacts of climate change that can no longer be reversed (ECA, 2009). Agroforestry practice plays a great role as adaptive strategies for climate change, integration nature of trees on farm (Verchot *et al.,* 2007) and there

are many types of agroforestry systems that are employed in a number of regions of the world at different levels (Montagnini and Nair, 2004).

Homegarden agroforestry is one of the practices that contribute for climate change adaptation mechanisms through soil and water conservation, reducing soil erosion and increase percolation of water to soil, biodiversity conservation and soil fertility improvement. Different Research findings in different area (India, Ethiopia and other) reported that, homegarden can contribute substantially to the agro-ecological sustainability through reducing soil erosion, provides habitat to soil micro-organisms and promote a favorable microclimate for the household (Tynsong and Tiwari, 2010). Other studies by Fernandes and Nair (1986) also reported that, the presence of multi-layered structure of homegarden is an indicator of ecological function through environmental protection and efficient use of resource.

In Ethiopia, studies by Ewuketu Linger (2014) in Jabithenan District, North-Western Ethiopia, reported that homegardens agroforestry have a great role in adapting climate change through soil fertility maintenance out of the garden/other farm field and saves soil moisture through composting.

Homegarden agroforestry to climate change mitigation

Climate change is the most important global environmental challenge which is facing by all living organism including humans and disturb natural ecosystems, agriculture and health. This change in climate and weather patterns results agricultural production in unsustainable. In this situation, agroforestry plays a viable option to mitigate climate change and reduce global warming by absorbing greenhouse gases (CO_2) through the process of carbon-sequestration.

Carbon-sequestration potential of agroforestry systems involves the net removal of CO_2 from atmosphere and storage in long-lived pools of C. Such pools include the aboveground plant biomass; belowground bio-mass such as roots, soil microorganisms, and the relatively stable forms of organic and inorganic C in soils and deeper subsurface environments, and the durable products derived from biomass. This practice has indirect effects on carbon sequestration because they reduce harvesting pressure on natural forests which are the largest sinks for terrestrial carbon (Kumar, 2015a).

A number of studies indicated that agroforestry in the tropics has higher C densities than field crops or pasture (Albrecht and Kandji, 2003; Nair *et al.*, 2009; Nair, 2012). Currently, agroforestry is estimated to be practiced on 1000–1023 M ha^{-1} globally and to sequester from 30 to 322 C Pg yr^{-1} (Zomer *et al.*, 2009; Jose and Bardhan, 2012). Due to high diversity nature, homegarden agroforestry has its own role in sequestering carbon from the atmosphere.

Table 4 showed that the contribution of homegardens agroforestry for climate change mitigation through carbon sequestration. In addition to economical benefit of homegardens agroforestry, it has high potential in mitigating climate change. Homegardens are considered to have high C sequestration potential (CSP) due to their forest-like structure and composition (Kumar, 2006) and also due to specific management practices that tend to enhance nutrient cycling and increase soil organic matter.

Depending upon the type of the system, species composition, and age of component species, geographic location, environmental factors, and management practices, the carbon stock potential different agroforestry systems are varies (Jose, 2009). The study done by AkliluBajigo *et al.*, (2015) reported, homegardens can sequester high amount of carbon (86.4Mg/ha) than parkland agroforestry practices (51 Mg/ha) but it is less than woodlot (448 Mg/ha).

In conclusion, homegarden is one of the most elaborate systems of indigenous agroforestry practice found most often in tropical and sub-tropical areas. Ethiopia also has a long tradition of practicing of homegarden agroforestry system however, South and Southwestern parts of Ethiopia are extensive practice this system. This system is mostly constitutes complex multi-strata than other agroforestry systems, a result of this, it is complex in structure and diversify by crop and other plant species. The high diversity of species in homegarden has wide socioeconomic and ecological roles. It has high contribution to biodiversity conservation, food supply, income generation, and climate change adaptation and mitigation strategies.

Table.1 Summarized studies on the diversity of home garden agroforestry practice in Ethiopia

Size of homegardens sampled	**Diversity indices**			**Area of homegarden agroforestry**	**Reference**
	H'	E	Richness		
0.48 ha	**2.41**	**0.86**	**69**	Jabithenan District, North-Western Ethiopia	Ewuketu Linger *et al.,* 2014
0.72ha	**2,08**	**0.66**	**77**	Habro district, oromia regional state, Ethiopia	ShimelisDekeba, 2018
1.2ha	**2.65**	**0.83**	**57**	Gimboworeda, South West Ethiopia	GetahunYakobedo, 2011
0.28ha	**2.44**	**0.38**	**22**	Bulenworeda, North-west Ethiopia	Megabit Beyene, 2016
0.32ha	**3.18**	**0.75**	**112**	Holeta town, Oromia national regional state, Ethiopia	MekonnenAmberber*et al.*,2011
1.8ha	**1.78**	**0.56**	**39**	DillaZuria District, Gedeo Zone, Southern Ethiopia	YirefuTefera*et al.,* 2016
1.2ha	**3.42**	**0.45**	**75**	DillaZuriyaWoreda, Gedeo Zone, SNNPRS, Ethiopia	MeleseMengitu and, Daniel Fitamo, 2015
0.6ha	**2.38**	**0.31**	**62**	MishaWoreda, Hadiya Zone of the Southern Nations, Nationalities and Peoples Regional State, Ethiopia	GirmaWoldemichael*et al.,* 2018
0.96ha	**3.28**	**1.00**	**191**	Sebeta-HawasWereda, Southwestern Shewa Zone of Oromia Region, Ethiopia	TeferaMekonen, 2010
0.6ha	**2.98**	**0.92**	**76**	Eastern Hararghe, Kombolcha Town Oromia Regional State Ethiopia	ArayaselassieAbebe, 2017

Table.1 Summarized studies on the diversity of edible plant species in home garden agroforestry practice in Ethiopia

Species richness	**Edible plant species**	**Area of homegarden agroforestry**	**Reference**
127	**80**	Yayu area, south-western Ethiopia	Omarsherif Mohammed, 2018
23	**15**	Southwestern Ethiopia	OmarsherifJemal*et al.,* 2018
112	**46**	Holeta town, oromia National regional state, Ethiopia	MekonnenAmberber, 2011
191	**48**	Sebeta-HawasWereda, Southwestern Shewa Zone of Oromia Region, Ethiopia	TeferaMekonen, 2010
258	**77**	Hawassa city, Ethiopia	RetaRegassa, 2016

Table.2 Summarized studies on the income contribution of in home garden agroforestry practice in Ethiopia

Area of homegardens agroforestry	Contribution to income generation (%)	Reference/Source
Jimma, Southwestern Ethiopia	**72.6%**	Zerihun Kebebew *et al.*, 2011
Boloso bombe district of Wolaita zone, Ethiopia	**42%**	HabtewoldAtiso, 2017
Dale District, Sidama Zone, Southern Ethiopia	**17.75%**	FekedeAdane*et al.*, 2019
Review in Ethiopia	**30-40%**	Mattsson .E *et al.*, 2013

Table.3 Summarized studies on the carbon sequestration potential of home garden agroforestry in Ethiopia

Area of homegardens agroforestry	Carbon stock potential (Mg/ha)	Reference
Gununo Watershed, Wolayitta Zone, Ethiopia	**86.4±20b**	AkliluBajigo., *et al.*, 2015
South-eastern Rift Valley escarpment, Ethiopia	• **116** (Enset-coffee based homegarden system) • **79** (Fruit-coffee based homegarden system) • **49** (Enset based homegarden system)	MeseleNegash, 2013
South-eastern Rift Valley escarpment, Ethiopia	• **109–253 (soil carbon)**	MeseleNegash, 2013
Wenago District, Ethiopia	**18.66 t C ha^{-1}**	Talemos Seta and SebsebeDemissew., 2014
Lowlands of bale, Ethiopia	**107.62** (only soil carbon)	
Sidama Zone, Ethiopia	**175.3** (only soil carbon)	AbiotMolla*et al.*, 2014

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The high diversity of species in homegarden has wide socioeconomic and ecological roles. It has high contribution to biodiversity conservation, food supply, income generation, and climate change adaptation and mitigation strategies.

Recommendations

Since homegarden agroforestry has the above listed benefits, we need to expand and diversify this system throughout the country. In addition, awareness rising through training about diversification of homegarden agroforestry to the farmer should be encouraged.

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