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Contribution of Agroforestry Home gardens to Household Income Generation in Boloso Bombe District, Southern Ethiopia

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Abstract

The present study was conducted in Boloso Bombe rural district during August to December 2016 with the main objective of determining the category of home gardens and assessing their contributions to household income generation. The study involved two altitudinal villages and sixty-one households from each village, all selected randomly. Data collection was done through field surveys using relevant social survey methods. The findings indicated that 99% of the communities in Boloso Bombe rural district practice agroforestry home gardens. Four types of agroforestry home garden technology practices are found in the study area. From them, 70.3% of household practice trees/shrubs/annual crops/animals' type of home garden technology. There was significant difference on home garden technology practices in generating income at 5% level of significance.R2 value in the regression output indicated that 62.5% of the total variations of the income were explained by independent variables land size and home garden technological practices. The findings showed that on the average, home gardens contributed over 34% of household annual income. With respect to the factors that motivate the practice of agroforestry home garden technologies, the findings showed that access to sufficient income throughout the year with diverse products in their households were the main factors that motivate them to use agroforestry home garden technologies. However, land shortage, low capital, crop competition and unreliable markets were together the main factors which negatively affected the contribution of agroforestry home gardens to income generation in the area. The communities also indicated that credit facilities, knowledge on components arrangements and market availability for home gardens products, were the main interventions required in improving the contribution of agroforestry home gardens adoption. Therefore, this study calls for further research that show the right mix of home garden component structure and identifying the type of tree species to integrate with the other herbaceous component of agroforestry and its proper management structure. This is believed to increase the contribution of Agroforestry for its economic, social and environmental component and ultimately improve the adoption of the agroforestry home gardens technologies in Boloso Bombe rural district.

Keywords: Agroforestry; Home garden; Household; Income generation

Introduction

Home gardens are common in most tropical countries and they play a vital role in supporting households (HHs) in many diverse ways such as provision of food, fodder, traditional medicine, fuel wood, building materials, cooking utensils and cash income among others. They are regarded as a source of income diversification and also play a crucial cultural and social role in rural communities. They may be seen as a buffer to household resources providing additional food and income [1]. Home gardens are the sites that have long been considered as signs of prestige and pride [2] by the community on top of their key economic roles. Engels [3] described home garden Agroforestry as logical production systems for crop plants that are consumed fresh, used on a daily basis, consumed in small quantities and requiring specific attention. Such crops include vegetables, spices, herbs, medicinal plants and special local varieties of major crops like sorghum, maize, sweet potato and enset *(ensete ventricosum)*.

Of the countries in tropical Africa, Ethiopia has a long tradition of practicing of home garden Agroforestry system. Four major agricultural systems including pastoralism, shifting cultivation, grain-based cultivation and enset-based mixed cultivation are practiced in Ethiopia [4]. Extensive areas of traditional Agroforestry home garden exist in the South and Southwestern parts of Ethiopia [5]. 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). These gardens are characterized by a unique combination of two native perennial crops; enset *(Ensete ventricosum)* and coffee *(Coffea arabica)*. Of 1.89 million hectares of land cultivated in southern Ethiopia, an estimated area of 576,000 hectares is covered by coffee *(Coffea arabica)* and enset *(Ensete ventricosum)* are often grown in association with fruits, vegetables, roots, tuber crops and pulses [6]. Coffee *(Coffea arabica)* is mainly used as cash crop, plays a major role in the regional and national economies and has not only a great contribution to environmental resilience but also for household consumptions [7].

Recently, there has been a decline in yield sand income earnings from home gardens to households. These declines required a strategic plan that will enhance the balancing of the productivity. Development and introduction of new technologies which increase productivity of labor and land are highly needed to fulfill the people's needs. These were agroforestry home gardens of trees mixed with herbaceous crops, animals/bees and the agroforestry home garden of tree/shrubs mixed with herbaceous crops and animals/fishes. Integrative and sustainable natural resources management is required to liberate the environment from destruction as well as biodiversity loss [8].

Wolayta Zone, situated within the mid highland areas of southern Ethiopia, belongs to the tropical vegeculture complex. The area has a cropping pattern with diverse combination of root-tuber crops, vegetables, legumes, fruits, spices, beverage and medicinal plants and many others complemented with livestock, poultry and apiculture [9]. Most people in Wolayta zone live in rural areas and are dependent on rain-fed agriculture and rearing of cattle for their livelihoods. The Wolayta people in the long run are limited to their home garden Agroforestry mainly for income generation. The study area, Boloso Bombe district is one of potential fruit producing areas in Wolayta zone and most of home gardens composed of fruits like mango *(Mangifera indica)*, avocado *(Persia americana)*, papaya *(Carica papaya)*, banana *(Musa paradisiaca)*, enset *(Ensete ventricosum)*, coffee *(Coffea arabica)*, shiferaw *(Moringa oleifera)*, ginger *(Zingibere officinale)*, yam *(Dioscorea esculenta)*, annual crops, seasonal crops, vegetables and spices [10]. In this district, however, little scientific study was done on systematic assessment and documentation of the home gardens potentials and contribution to income generation; and the information to that effect remains fragmented. Therefore, the present study was intended to fill this information gap and provide information on the contribution of home gardens to the livelihoods of farmer's households and to redirecting, improving and strengthening the existing home garden practices in Boloso Bombe rural district.

Materials and Methods

Description of the Study Area

The study was conducted in Boloso Bombe district. Boloso Bombe is one of the 12 districts in Wolayta Zone, SNNPR; Ethiopia. In Boloso Bombe district there are 18 rural Kebeles and 2 town Kebeles. It is located about 325 kilometres southwest of Addis Ababa and in the North-West part of Wolayta, 54 kilometres from Wolayta Sodo town. The geographical location of Boloso Bombe is 70 1' 32''-70 11' 30'' N latitude and 370 26' 18''-370 39' 38'' E longitudes (Figure 1) [10].

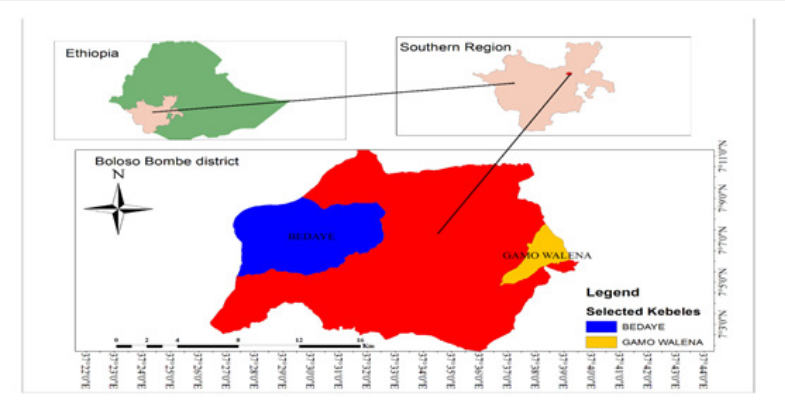

Figure 1: Location map of study area.

Topography and climate

Topography of the study area is characterized by hilly and partly flat lands. Its average altitude is 1548 m.a.s.l. The study site was divided in to two altitudinal sites such as lower altitude site (1120-1300 m.a.s.l) and upper altitude site (1700-2100 m.a.s.l). There are two main cropping seasons in the district: Belg (spring) and Meher (autumn). The Belg season begins from late February to late March/early April where maize, haricot bean, enset, taro, sweet potato and Irish potato are planted. The Meher cropping season begins late June and continues up to end of September.

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Crops like teff, wheat, Irish potato, haricot bean and sweet potato are planted in the Meher season. The mean annual rain fall of the area 1520mm and mean annual temperature is 24.4°C. The district experiences Kolla 75%, Weina dega 20% and Dega 5% of climate [10].

Vegetation

Historically, the district was covered by dense natural forests, but the distribution of natural forest is declining from time to time owing to human interference. Currently, forest coverage of the district is only 11% of the total land area [10]. The common species encompassing the vegetation in the area include *Faidherbia albida*, *Cordia africana*, *Acacia tortilis*, *Albizia gummifera*, *Leucaena leucocephala*, *Millettia ferruginea*, *Moringa oleifera*, *Croton macrostachyus* and *Sesbania sesban*.

Population

According to the CSA data for the 2007, the total population of the district is 109,921 from which 53,551 are males and 56,370 are females. The population density of the area is about 404 persons per square kilometer. Number of households is 22315; Male headed is 18445, Female headed is 3870; there are five people per household in average. From the total population of the district, about 98.3% of the district population is rural dwellers [10].

Economic activities

The livelihood of the people in the district depends mainly on mixed agriculture (crop-livestock production). It is characterized by subsistence level mixed farming of rain-fed crops and livestock production associated with trees planted for Agroforestry. Animals such as sheep, goats, cows, oxen, donkeys and poultry are reared. Fruits such as avocado *(Perseaamericana)*, banana *(Musa paradisiaca)*, mango *(Mangifera indica)* and papaya *(Carica papaya)* are also cultivated for household consumption and to some extent for income generation [10].

Research Design

This study has assessed the home garden and its relation to household income generation while considering the role of the market, farm and other off-farm activities that may also be used to generate income. The income determination was based on product of farm yield estimates and its farm gate prices used at the time of selling and sources of household income generation were identified based on the homestead closeness (i.e. those products around homestead were here after termed as home gardens and outside homestead as other sources). More focus was put on quantification of the home garden outputs. The outputs of farms in terms of yield were estimated and the major inputs to farms such as labor were also estimated. Income generated from off-farm sources were also is assessed. The total income generated per year was estimated and home garden incomes were calculated as a proportion (in %) of the total.

Sampling Procedures and Sample Size

This study employed a multistage sampling technique because study needs sampling in different stages. In the first stage, Boloso Bombe district was selected purposively due to presence of large number of Agroforestry home gardens. In the second stage, two altitudinal sites were purposively selected because traditional home garden practices often vary with altitudinal difference [11]. The two sites' difference in altitude (lower altitude from 1120-1300 m.a.s.l and upper altitude from 1700-2100 m.a.s.l) was considered. In the third stage, stratified random sampling was used to select households based on home garden size they have; small, medium and commercial [12]. The sample size that was used to develop a deeper understanding of the phenomena that studied was selected using a combination of purposive and systematic sampling techniques to fulfill the goal of selecting the household heads that are likely to be information rich. In order to generate the required sampling units, the determination of sampling method was essential. According to the CSA data of the 2007, total number of district household heads was 22315. The sample size was selected based on the following formula given by [13].

$$n = \frac{N}{1 + N(e)^2}$$

where; n = sample size

N = the total household head

e = Level of Precision

According to the formula which is important to determine and calculate the sample size; at 91% confidence level and precision level of ±9%. The level of precision is the range in which the true value of the population is estimated to be it is expressed in percentage points (±9%).

Based on the above formula the investigator selected 122 individuals house hold heads for the study. N =22315. That is:

$$n = \frac{N}{1 + N(e)^2} = \frac{22315}{1+22315(0.09)^2} = 122$$

Sources of Data

The primary data sources for this study were individual household heads of the selected study area. Review of secondary data relevant to the topic under study (like reports, census data, research findings and municipal statistics) [14].

Data Collection Tools

In order to attain the stated objectives, the investigator used household survey, observation and key informant interviews as data gathering tools for this study.

Household Survey

A household survey is a data collection tool used to gather information about individuals. Surveys are based on the desire

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to collect information about a well-defined population usually by using questionnaire. The investigator used similar questions for all the respondents of the sample and collected data from the sample household heads through the uses of open ended or close ended format questionnaire.

Observation

Using indicators related to the issue under investigation, the investigator noted down things as they happen at every moment. Observation also gives the investigator the opportunity to get access to some events that are otherwise inaccessible to scientific investigation [15]. The investigator lived in the community and interacted with the local people in several social activities such as markets, funerals and communal labor during which several things were observed. Throughout the investigation, the investigator has intensely observed all happening around to compare with the information obtained, for example, from household surveys.

Key informant interviews

These are interviews with specially selected individuals who have a long period of experience in a certain community or specialized knowledge or skills in a certain topic [14]. According to Jackson and Ingles [16], people like village elders, local leaders or schoolteachers, are very knowledgeable about issues, local needs and interests hence are very valuable sources of information. The objective of using key informants is to collect information and more understanding of issues in a short period of time. However, care must be taken when selecting key informants to ensure that various categories of people in the society are represented [14].

Data Validity

One difficulty in data collection during investigation is the ability to ensure that the information gathered is valid, accurate and a true representation of the population from which the investigation sample is drawn. In this study, a number of measures were put in place to ensure validity of data. Firstly, the use of more than one method of data collection ensured triangulation of information gathered from various sources.

Method of Data Analysis

The data gathered through household survey and key informant interview was analyzed by using the qualitative and quantitative data analyses methods. Before analyzing the data, raw data was processed (coded, edited, ordered and organized) to generate relevant information. To accomplish the analysis of the data for better understanding of the issues covered in the study, the investigator analyzed using descriptive statistical technique like (in terms of frequency distribution and percentage),ANOVA and regression analysis were provided by the statistical package for social sciences (SPSS version 16).

Results and Discussion

Types of Home garden Agroforestry Systems and technologies Practiced in Boloso Bombe District

The result in Table 1, showed that the extent of home gardens practiced by smallholder farmers in the area. That is, almost all households (99%) in the study area were practicing agroforestry home gardens. The findings indicated that the adoption was more or less evenly spread throughout district. The results on the types of Agroforestry home garden technologies practiced in Boloso Bombe district were presented in Table 2. Four types of agroforestry home garden practices were found in the study area. This include trees/shrubs/annual crops/animals, trees/shrubs/perennial crops/ annual crops, trees/annual crops/animals/bees and trees/shrubs/annual crops. From them, 70.3% of household practiced trees/shrubs/annual crops/animals type of home garden technology. The multiple production function from those technologies assured them access to food and income throughout the year. Also, the biophysical advantages offered by those multi-species composition (efficient cycling of nutrients) and conservation of bio-cultural diversity. The results were in line with report given by Bassullu and Tolunay [17] that traditional Agroforestry home gardens involving animal component with growing various trees, shrubs and similar wood-like species and agricultural products had high output compared to those without it if were well managed. Also, Hassanuzzaman [18] reported that, diverse production from various components (tree/shrub/annual crops/animals) provided food security to a large low-income population particularly during periods of drought and works as an insurance against famine and crop failure.

Table 1: Distribution of respondents practicing Agroforestry home gardens with respect to sample Villages.
Source: Own field survey 2016.

Sample Villages (Kebeles)	Sample HHs	Home Garden user HHs	Percent
Gamo Walana	61	61	50
Badaye	61	60	49
Total	122	121	99

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Table 2: Proportion of households based on the categories of net annual income from home garden Agroforestry.

Types of HG Technologies	No of HHs practiced	Percentage
Trees/shrubs/annual crops/animals	85	70.3
Trees/shrubs/perennial crops and annual crops	20	16.5
Trees/annual crops/animals/bees	11	9.1
Trees/shrubs/annual crops	5	4.1

Source: Own field survey 2016.

With respect to the components in the system, the home garden Agroforestry is known for its diversity in tree species. The result in Figure 2 showed that diverse tree species characterized home garden Agroforestry system. Among the tree species *Cordia africana* was practiced by 58% of the households followed by *Faidherbia albida* (33%), *Moringa oleifera* (24%), *Leucaena leucocephala* (13%), *Grevillea robusta* (13%) and *Sesbania sesban* (9%). Among the non-tree components, *Coffea arabica* is a component practiced by almost all home gardens (99%) and it was the dominant cash crop of the area. These tree species are known for their different uses such as medicinal plants, forage, food, poles and posts, timber and firewood. The trees also provide shade for people, their livestock and also for coffee shade. Moreover, their litter falls of these species add organic matter and nutrients to soil improving the soil structure and fertility and the results agreed with those reported by Rackham and McNeilan (2001).

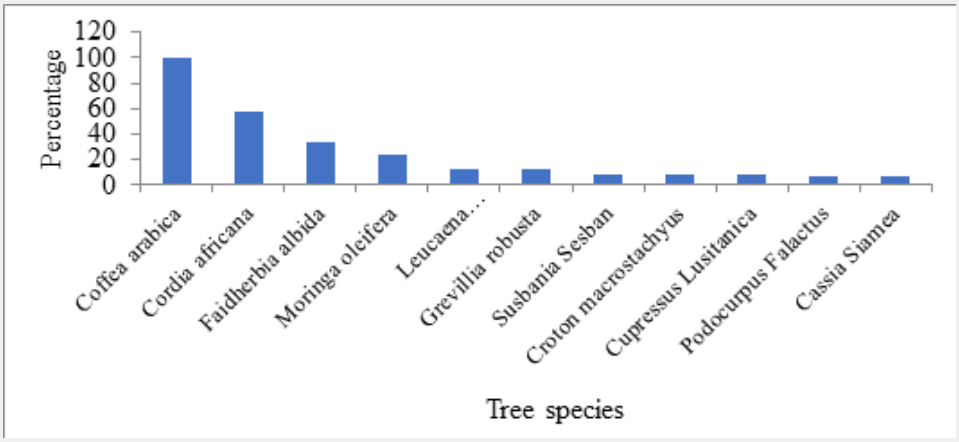

Figure 2: Proportion of households planted different tree/shrub species in Agroforestry home gardens in the study area (proportion of respondents).

The multi-layered, forest like vegetation structure of the studied home gardens in the area contributed substantially to the agro-ecological sustainability through reducing soil erosion and save soil moisture through composting. This was in line with study by Eweketu [19] indicated that compost is not only augments soil fertility and moisture conservation, but also reduces the farmer's fertilizer cost. The results in Figure 3 presented that the extent of fruit tree species found in the study area. Among the fruit trees commonly planted in the area, Mangifera indica was the most planted fruit tree species in home garden of Boloso Bombe district. That is 92% of the HHs practiced it and this was followed by Musa paradisiaca (74%), *Persea americana* (65%) and *Caricapapaya* (20%). The fruit tree species commonly grown in home gardens were indications of how farmers in the area were dependent on home garden Agroforestry products for food in addition to their cash income revenue. Furthermore, the respondents mentioned that fruit trees primarily serve for food especially during difficult time of drought. This is also due to their maturity that often concide with the dry season. Relatively, *Persea americana*, *Musa paradisiaca* and *Mangifera indica* have better market than others as these fruits are processed into other value-added products such as juice from the two fruit tree species. The results agreed with those reported by Kebebew et al. [20] and Maroyi [21] in Ethiopia and Zimbabwe, respectively.

While family especially children's consume fruit trees, it is possible to avoid (buffer) frequency of hunger. So, dependency on other cereal food crops becomes minimal. In agreement with this, Akinnifesi et al. [22] reported that, Agroforestry fruit trees play an important role especially during time of famine and other stress as food and cash income in South Africa. The composition of herbaceous plants in the home garden Agroforestry was also high. In this regard, the most common herbaceous crops grown in the study area were *Enset ventricosum* (100%), *Zea mays* (97%), *Eragrostis tef* (81%) and *Zingibere officinale* (75%). These home

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garden crops potentially provide a wide range of resources, such as nutritious foods, marketable products, firewood, herbs, spices and medicinal plants. This result is in line with that reported by Tefera [23]. Nair [24] also indicated that home gardens are aimed primarily at meeting household food needs, in the case of the Gedeo and Sidama farming systems, the herbaceous components are known to provide supplementary cash needs (Figure 4) [25].

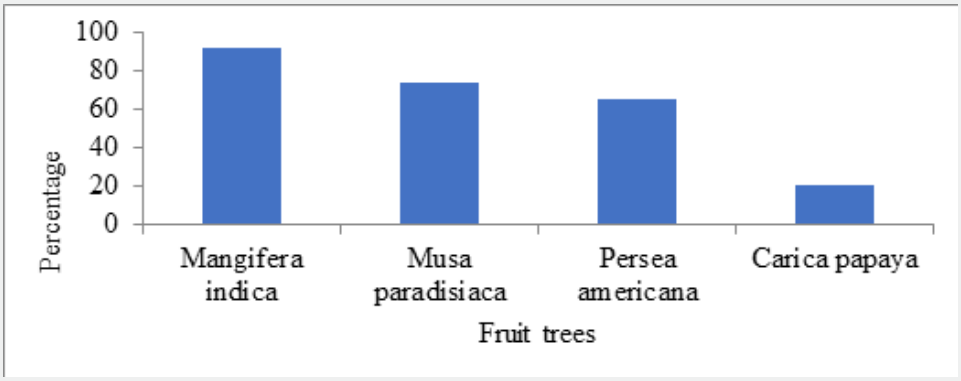

Figure 3: Fruit tree species planted in Agroforestry home gardens of the study area (proportion of respondents).

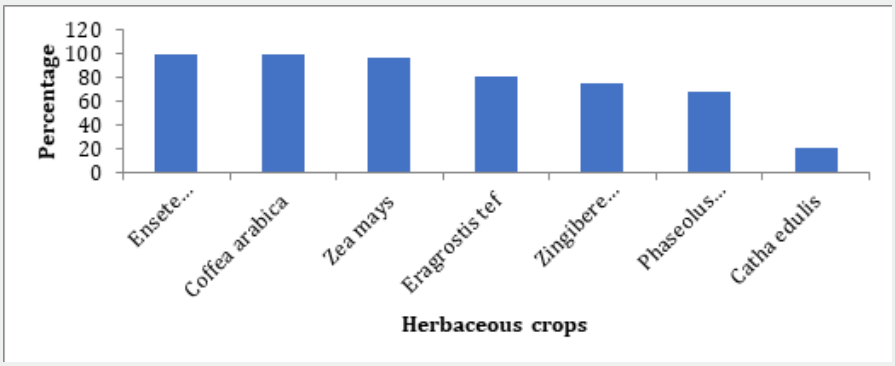

Figure 4: Herbaceous crops grown in Agroforestry home gardens of study area (proportion of respondents).

Contribution of Agroforestry Home gardens to Household Income Generation in Boloso Bombe District

Households in Boloso Bombe district depended on various types of incomes for their livelihoods. These include income from home garden, agriculture, petty business and employment. Petty business and employment (are off-farm income generating activities, where people are engaged to increase their income). The off-farm activities provide primary sources of earnings for smallholder farmers. The results on contribution of various sources of income to household total income generation are presented in Figure 5.

On average, Agroforestry home gardens and agriculture indicated high proportions on contribution to household income generation among Boloso Bombe rural communities followed by business. That is, Agroforestry home gardens contributed 42% to household income generation. Income from home gardens comes from selling cash crops (coffee, ginger, khat and spices), food crops (maize, teff, common bean and taro), fruits (mango, avocado, banana and papaya), tree products (timber and poles) and livestock products (milk and egg) are the main sources of home garden income among others. As it was indicated in the previous session most of the Boloso Bombe rural communities depended relatively on home gardens for their livelihoods and the households used the products from home gardens as source of household income. The presented results agreed with Mohan [12] which indicated that, home gardens contributed significantly (60 percent) to the household income of smallholder farmers in many developing countries.

The net annual incomes of household from home garden Agroforestry were analyzed and the result showed that, the income households got varied between 500 and 40000 with an average income of 6215 ETB. That is, some households got as low as 500 ETB from sell of products from home garden, whereas others got as high as 40000 ETB. This could be due to difference in land holding size and type of technology practice experienced in the study district.

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The result in Table 3 was about the distribution of the households with respect to income class. The result showed that more than half (52.5%) of the households had net annual income 500-5000 ETB, whereas less than five percent of the respondents got an annual income that ranged between 20001- 40000 ETB. When compared with other income categories this income level was higher. This variation could be from the difference in land holding which limits the number of fruits and other Agroforestry products such as ginger and coffee incorporated with home gardens. The fact that the study area was highly populated with land shortage might be major limiting factor. The population density of the area was about 404 persons per square kilometer. Agroforestry home gardens could be among the best ways in areas with high population like Boloso Bombe rural district to sustain the communities' livelihoods. For example in Bangladesh, a most densely populated country in the world (with 129 million people), over 76% of the population live in rural areas and they are heavily dependent on home gardens for their livelihood and serve as safety net during the time of hardship and natural disasters [26].

Table 3: Factors that motivated households to practice Agroforestry home gardens technologies in Boloso Bombe district.

Factors motivated	Frequency	Percent
Source of income	121	99
Source of food	121	99
Shade provision	119	97
Provision of diverse products	115	94
Helps in life risks reduction	112	92

Source: Own field survey 2016.

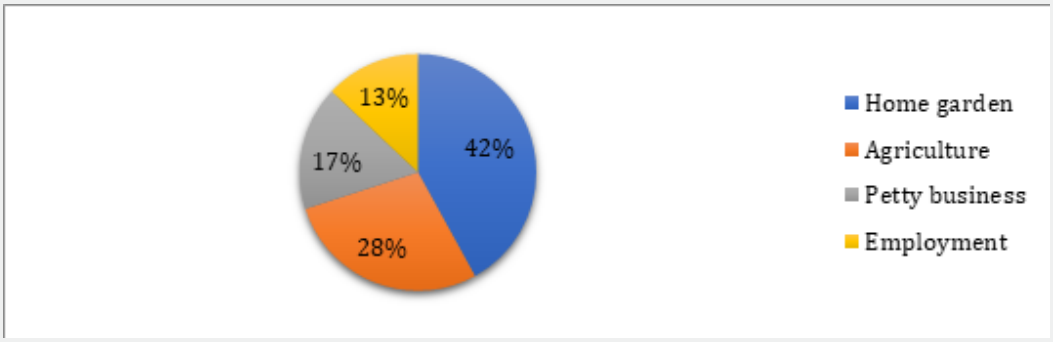

Figure 5: Types of household income sources and their contribution to household income generation.

Factors that Affect Agroforestry Homegadens Contribution to Household Income Generation in Bolosso Bombe Rural District

The factors that motivated the households in Boloso Bombe district to practice Agroforestry home gardens were analyzed and presented in Table 4. In this regard, diverse reasons were mentioned that motivated the households to practice the home garden Agroforestry. That is, the home garden Agroforestry is

a) source of household income,

b) source of food,

c) shade provision,

d) provision of diverse products

e) risk reduction

Table 4: Factors limiting the contribution of Agroforestry home gardens to household income generation in the study area.

Factors Limiting	Frequency	Percentage
Land shortage	115	94
Low capital	90	74
Crop competition	72	59
Unreliable market product	58	48
Pest & disease infestation	53	43
Low crop prices	49	40
Unreliable rain fall	47	38
High input price	32	26

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As income source, diverse home garden Agroforestry products are harvested from the home garden and sold in the market. In this regard, about 99% of the respondents indicated that home garden Agroforestry contributed for household income. In some households these products served as a sole source of cash income for the households.

The income obtained from these products is used to lessen different financial constraints of the households. Above all, the home garden Agroforestry products are the major source of cash income. Almost all (99%), according to results, households in the study area witnessed that the diverse products from home garden Agroforestry were used as source of food for their households. As the households got sufficient food throughout the year from the diverse products, these have become the major driving factors for the Boloso Bombe rural communities to adopt Agroforestry home garden technologies. The fact that the various components of the home garden Agroforestry products mature at different times of the year increased their importance. That is, the differential maturity of these home garden Agroforestry products has made farmers to get the products at different period of the year makes their importance more conspicuous. In the face of rainfall variability that resulted in frequent drought, the importance of home garden Agroforestry is magnificent in the area.

Today the extent of home garden Agroforestry is high and especially the expansion of fruit trees is omnipresent. As a result, many farmers are practicing the home garden Agroforestry dominated by fruit trees in the area. Therefore, the home garden Agroforestry in the study area was playing the role of providing cash and subsistence income and minimizing households' vulnerability to shocks. All components of home gardens in the study area helped rural household's survival strategies encompass multiple objectives in maximization of utility. In agreement with this, Nair [27] suggested that homestead gardening provide an important contribution to sustainable agricultural production because of its potential to meet economic, social, ecological and institutional conditions for sustainable livelihoods. The shade role of the home garden Agroforestry is witnessed by ninety seven percent (97%) of respondents. The respondents indicated that the tree component of the home garden Agroforestry contributes by providing shade for other herbaceous component of the system in addition to the diverse products the trees contribute such as fruits, fencing materials, firewood and other (Table 5).

Table 5: Regression results of the factors influencing the household's net income.

Model	Coef.	Std. Err.	T	P>|t|
Trees/shrubs/perennial/annual crops	4896.42	2334.91	2.1	0.038*
Trees/shrubs/annual crops/animals	519.93	3326.61	0.16	0.876
Trees/annual crops/animals/bees	5629.2	4319.44	1.3	0.019*
Trees/shrubs/annual crops	-876.04	5896.88	-0.15	0.882
Land size	5254.43	2327.14	2.26	0.026*
R Square =.625				
Adjusted R Square=.597				

*Indicates significant at 0.05.

Similarly, the factors that limit the contribution of Agroforestry home gardens in household income generation in the study area are analyzed and presented in Table 6. Among them land shortage, crop competition, limited capital and unreliable market product.These were the limiting factors that led the majority of the communities in Boloso Bombe district to be constrained not to adopt the Agroforestry home gardens technologies. Although, Agroforestry technologies are believed to be practiced in land shortage areas to relax these constraints, in Boloso Bombe district expansion of Agroforestry practices is constrained by land shortage itself. This means that the households in the area also practiced field crops that hardly demand shade and expanding the Agroforestry to such crops is hardly possible. So, the practice of Agroforestry is limited to few areas in the home gardens.

Table 6: Measures required in improving the contribution of home gardens to household income generation.

Type of Measure	Frequency	Percent
Credit facilities provision	90	74
Knowledge provision	87	71
Earlier subsidy fertilizer provision	71	58
Reduction of fertilizers price	60	49
Market availability	49	40
Agricultural extension officers to have demonstration plots	36	30
Type of tree selected	26	21
Land separation to each crop	12	10

Source: Own field survey 2016.

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Land shortage was among the limiting factors to benefit from the multifaceted impacts of home garden Agroforestry production in Boloso Bombe district. The results indicated that there was land shortage in the district and the farmland was highly fragmented with land holdings ranging from 0.065-2.5 hectares with an average of 0.5 hectare per household. Moreover, inefficient markets and seasonal variations in market prices affect the contribution of home garden technologies. Specially, ginger market fluctuation negatively influenced the farmers' annual income of the area. On the other hand, crop competitions were the main significant factor affecting the rural households to use the Agroforestry home garden technologies. This is because majority of the communities lack skills on the tree management and arrangement due to insufficient farmer training. Competition for shade, light, soil moisture and nutrients between components increased disappointment to farmers. Trees as the main component in the technologies may outcompete arable crops for nutrients, light and soil moisture and may reduce the yields of the associated crops as discussed by Kumar and Nair (2004). Therefore, this effect caused negative perception to farmers on the use of technologies. Njuki [28] reported that crop competition was the major constraint to the integration of trees into farming technologies as majority of the communities have not known the right tree species that can be used to integrate properly in their fields.

Moreover, low capital and inaccessibility to credit facilities hindered the adoption of the Agroforestry home gardens in the study area. Though there was omo-micro finance (OMF) institution in the study area, some of the communities were not aware about institution and credit facilities have helped many people to come out of poverty. The facilities lead them to increase their production by accessing the required inputs and improve the contribution of the Agroforestry home garden technologies and hence improve their household income generation. Furthermore, pest and disease infestation was also one of the factors limiting income of home garden Agroforestry. Especially, Bacteria wilt of Zingibere officinale and coffee berry disease of *Coffee arabica* are among major product limiting diseases of two cash crops.

The households in the study area were interviewed regarding how to increase the contribution of the Agroforestry home gardens in terms of income and other products and services. Table 7 showed the measures forwarded by the respondents with respect to improving the contribution of Agroforestry home garden technologies to household income generation. Among them credit facilities provision, knowledge provision and fertilizer provision via subsidy are major factors that can be used to enhance the home gardens Agroforestry productivity and contribution to household income.

Table 7: Regression ANOVA table.

	Sum of Squares	df	Mean Square	F
Between Groups	708551705	3	236183901.7	6.334
Within Groups	4400225679	118	37290048.12	
Total	5108777384	121		

Credit facilities provision was the most significant measure to improve the performance of home gardens Agroforestry technologies in the district. In agreement with this, Mrindoko [29] reported that availability and accessible credit facilities to farmers enhance production improvement by easily accessing the required inputs at right times. Knowledge through training provision to farmers on the other hand can contribute in improvement of home gardens production. Majority of home garden users lacked knowledge on component arrangement and management which lead to low yields. Therefore, provision of training to farmers will enhance home gardens production resulting into income sustainability. Nair [27] revealed that intensive tree pruning and planting of trees on proper arrangements led to increased productivity of the Agroforestry home gardens.

Fertilizers provision delaying led respondents to late sowing of crops and high fertilizer price constrained to use technology and resulted in income decline. Therefore, early provision of fertilizers and reduction of fertilizers price were measures required to improve home garden products the whole and its income. The result of the present study was in line with study by Mariro [30], which indicated that there were various factors that could be used to enhance the home gardens productivity, these include adequacy of extension services, provision of knowledge skills on home gardens management, training and provision of incentives and use of rainwater harvest (Table 8).

Table 8: Least Significance Difference (Pairwise comparison).

(I)Technology practice	(J) Technology Practice	Mean Difference (I-J)	Std. Error	Sig.
T2	T1	828.69	1514.31	0.585
	T4	6828.00*	3053.28	.027*
	T3	-6552.00**	2365.06	.007**

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T1	T2	-828.69	1514.31	0.585
	T4	5999.31*	2808.32	.035*
	T3	-7380.69**	2039.03	.000**
T4	T2	-6828.00*	3053.28	.027*
	T1	-5999.31*	2808.32	.035*
	T3	-13380.0**	3344.7	.000**
T3	T2	6552.00**	2365.06	.007**
	T1	7380.69**	2039.03	.000**
	T4	13380.00**	3344.7	.000**

*The mean difference is significant at the 0.05 level. ** The mean difference is significant at the 0.01 level. Trees/shrubs/annual crops/animals = T1, Trees/shrubs/perennial crops and annual crops = T2

Trees/annual crops/animals/bees = T3, Trees/shrubs/annual crops =T4.

In this study, the significance difference among different home garden technology practices on their contribution for household income was tested using analysis of variance. From ANOVA (with details in Table 8), the result supports that there is difference in income contribution between one home garden technologies over the other as $p<0.05$. Results in Table 8 indicated that, average income from trees/annual crops/animals/bees is highest, while average income from trees/shrubs/annual crops is lowest. Trees/annual crops/animals/bees' type of homegarden technology in the district required more attention because of its potential to livelihood improvement. According to Mwakatobe and Mlingwa [31], Agroforestry practices with beekeeping sector is an important income generating activity with high potential for improving incomes and nutritional status in households [32-35].

R^2 value in the regression output indicates that 62.5% of the total variations of the household income are determined by independent variables land size and home garden technological practices. Land size is significant and has positive effect at $p<0.05$. It implies that a one hectare increase in land size increases the mean household income by 5254.43 ETB.

Summary and Conclusion

The findings from this study showed that almost all (99%) of the households in Boloso Bombe district have been practicing the Agroforestry home garden technologies. The study identified four types of Agroforestry home gardens technologies among the various home garden Agroforestry systems identified, 70.3% of the respondents indicated that they preferred the trees/shrubs/annual crops/animals home gardens technologies over the other technologies for production diversification and profit maximization. All the Agroforestry technologies contribute to the household income in line with providing four sources of household income generation. The findings showed that on the average, home gardens contributed over 34% of household annual income and found to be of greater value than other income sources. It was indicated that Agroforestry home gardens were the main sources of sustenance both for food and income in the study area. Therefore, Agroforestry homegardens technologies were identified to be the best options to sustain the households of the Boloso Bombe rural district [36-40].

Home garden Agroforestry is significantly contributing to increased yields and income and thus income poverty reduction at household level. The trees and crops into such systems produce both foods for subsistence and cash, fodder for the livestock, and reduce the problem of soil degradation, soil erosion and soil moisture through composting. With respect to the factors that motivate the practice of Agroforestry home garden technologies, the findings showed that access to sufficient income throughout the year with diverse products in their households was the main factors that motivated them to use Agroforestry home garden technologies. On the contrary, competition by crops and inadequate knowledge/skills on tree management and appropriate integration of the tree species with their herbaceous crops were the major limiting factors to use Agroforestry home gardens technologies. Apart from this, land shortage, low capital and unreliable markets were other limiting factors to adopt the Agroforestry home gardens in the area. All of these were due to inaccessibility to credit facilities, tough entrance regulations in the credit institutions and high entrance fee rates which hinder the majority of the communities to access credits. The result indicated that there was significance difference among different Agroforestry home garden technology practices at 5% level of significance. Regression results indicated that both land holding size and Agroforestry home gardens technology practices are significant. Results indicated that, average income from trees/annual crops/animals/bees is highest, while average income from trees/shrubs/annual crops is lowest. R^2 value in the regression output indicated that 62.5% of the total variations of the income are determined by independent variables land size and home garden technological practices. The results of this study showed that size of cultivated land was positively and significantly influenced the probability of use of home garden Agroforestry and it was one of the most constraining factors [41-45].

Therefore, this study calls for further research that shows the appropriate home garden component structure and identifying the type of tree species to integrate with the other herbaceous

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component of Agroforestry and its proper management structure. This is believed to increase the contribution of Agroforestry for its economic, social and environmental component and ultimately improve the adoption of the Agroforestry home gardens technologies in Boloso Bombe rural district [46-52].

Conflict of Interests

The authors have not declared any conflict of interests.

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