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Home-garden Agroforestry Practice for Food Security Resilience in Ethiopia

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ABSTRACT

Homegarden agroforestry involves cultivating diverse, multi-storied trees, crops, and livestock near the homestead. The practice is highly relevant in developing countries where increasing population density contributes to land pressure, reduced food production, and soil fertility depletion, all of which exacerbate household food and income insecurity. This study's primary objective was to assess the contribution of homegarden agroforestry practice to household food security. The research utilized a survey design in Abrha Atsbha, Eastern Tigray, Ethiopia, collecting data from 90 households (45 practicing and 45 non-practicing) using questionnaires, key informant interviews, and observation. Data were analyzed using descriptive statistics and t-tests, focusing on Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), and net income. The findings demonstrated that homegarden agroforestry practicing households achieved significantly superior food security outcomes, exhibiting higher HDDS (86.7% Medium or High vs. 24.4% for non-practicing), higher FCS (60% Acceptable vs. 15.6% for non-practicing), and significantly higher mean annual income from fruits, vegetables, crops, livestock, and fuel/trees. The high species diversity and multi-product output of homegardens enhance household resilience. This diversified system acts as a buffer, reducing the risk of complete crop failure and providing continuous food and income sources, which is crucial for adaptation and stability in areas facing increasing climate variability and drought.

Key words: Homegarden agroforestry, Household food security, Smallholder farming, Livelihood diversification

INTRODUCTION

According to Kumar and Nair (2004); (Sisay, 2020), homegarden agroforestry is deals with the cultivation of multipurpose and multistoried trees, crops, and livestock around the homestead.

Homegarden agroforestry practice are common in most tropical countries and they play a vital role in supporting households in many diverse ways such as provision of food, fuel wood, building materials, cooking utensils, fodder for livestock, and cash income among others. In Ethiopia, the most common vernacular equivalents for homegarden are *dhri-bet* and *guaro*, which literally refer to backyard farming systems located close to the household. They may be seen as a buffer to household resources providing additional food, and in some cases cash income (FAO, 2004). Homegarden ensures a sustained availability of multiple products and generate income (Kumar and Nair, 2004). Despite their small size, homegardens fulfill most of the basic food and nutritional needs of households (Kumar and Nair, 2006). The current rate of food insecure people has caught the attention of governments and development agents in the world. As the world population expands the food problem has become increasingly severe, with the number of those malnourished reaching 3 billion (Olajide *et al.,* 2010). This issue is compounded by a long-standing trend where, as reported by Bishaw and Abdelkadir (2003), Africa's rate of population growth has historically outpaced the rate of food production from 1993 to 2003, a challenge that persists in many regions today. Despite the identification of food security as an important policy goal in Africa, too many African countries continue to be food in secured especially among the urban-poor (Olajide *et al.,* 2010). This can be reversed through conscious integration of the homegarden agroforestry strategy into rural and urban development (Krishnal *et al.,* 2012). Homegarden agroforestry technologies provide an additional food supply and cash income for the people. Worldwide, homegarden agroforestry are a community's most adaptable and accessible land resources and important components in reducing vulnerability and ensuring food security (Gifawesen*et al.,* 2020). The features of homegarden agroforestry are year-round production of food, decreased risks of production failure due to high diversity of species, increased resource productivity over time, expansion of the amount and quality of labour applied in the farm, provision of output flexibility and alternative production. "Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." as stated in FAO (2019). The Food and Agriculture Organization (2018) reported that 10.9% of the world, 20.4% of Africa and 31.4% of Eastern Africa people were undernourished in 2017. In Ethiopia, about 80% of the society lives in rural areas where there are not sufficient infrastructural facilities and also where the majority of the households are smallholders

(Ethiopian Central Statistical Authority, 2016). Exacerbated by the lack of infrastructural facilities, drought, weather variability, and others, food insecurity becomes a major challenge in rural Ethiopia. Endalew *et al*. (2015), stated that about 10% of Ethiopians were chronically food insecure and this figure increased to 15% during frequent drought periods. In developing countries, food and household income insecurity are the major concerns today, which are powered by the increase in population density. High population density has put a lot of pressure on land as more of it is required for settlement and in turn has affected food production negatively; hence, resulting into food insecurity (Galhena *et al*., 2013). While the potential of homegarden agroforestry is well-documented globally, quantitative evidence on its specific contribution to multiple household food security indicators such as the Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), and household income in the unique agro-ecological context of Abrha Atsbha, Eastern Tigray, is lacking. This study aims to fill this localized evidence gap. The main objective of the study was to assess the contribution of home-garden agroforestry practice to household's food security.

MATERIALS AND METHODS

Study Area Description

The study was conducted at Abrha atsbha which is located in Wereda Kelte Awelalo (WKA), eastern zone of Tigray, Ethiopia. It is located between longitudes of 39° 28' 17.1444"E and 39° 33' 24.5664"E; and latitudes of 13° 48' 44.586" N - 13° 52' 29.2944" N. Its elevation ranges from 1907 to 2462 m.a.s.l.

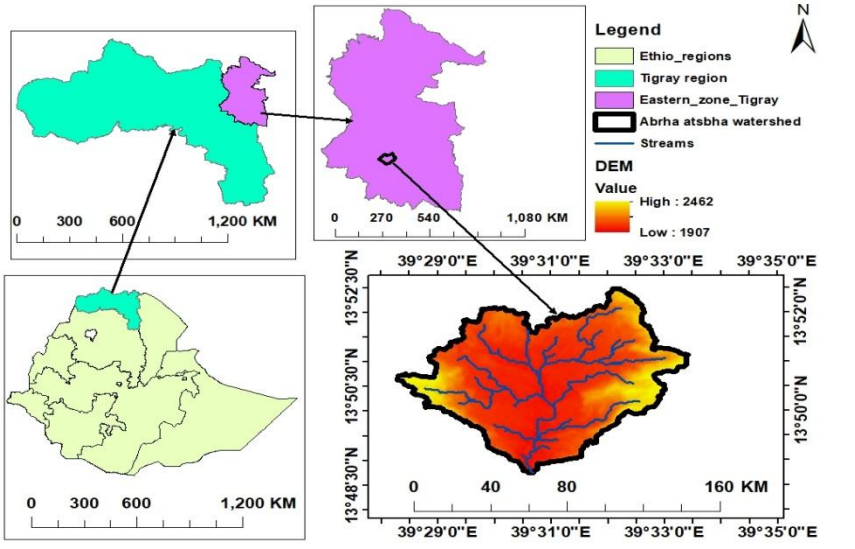


Figure 1: Location map of the study area (Abrha Atsbha, Eastern Tigray, Ethiopia).

Data Types and Sources

The study utilized both primary and secondary data, which included a mix of quantitative and qualitative information. Primary data were collected through household surveys (structured questionnaires), key informant interviews, and field observations. Secondary data were gathered from relevant published academic literature, as well as local administrative and Woreda Agriculture Office reports.

Research Strategy, Survey Design, and Sampling

Survey Design

This study employed a comparative cross-sectional survey design to assess the contribution of homegarden agroforestry practices to household food security. The design enabled the comparison of two groups of households: those practicing homegarden agroforestry and those not practicing the system. Data were collected from both groups at a single point in time to evaluate differences in key food security indicators, including the Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), and household income. This approach allowed the study to determine whether households practicing homegarden agroforestry exhibited better food security outcomes compared to non-practicing households.

Target Population and Sampling Techniques

The target population of this study consisted of all household heads residing in Tabia Abrha Atsbha, located in Kelte Awelalo Woreda of Eastern Tigray, Ethiopia. According to the tabia administrative records, the total number of households in the study area was 1060, distributed across three qushets[1]: Abrha Atsbha (478 households), Selam (261 households), and Mendae (321 households). A multi-stage sampling procedure was used to select respondents for the study. In the first stage, three qushets (Abrha Atsbha, Selam, and Mendae) were purposively selected because homegarden agroforestry practices were widely observed in these areas. In the second stage, households were categorized into two groups based on whether they practiced homegarden agroforestry or not. A stratified sampling technique was applied to ensure representation from both groups. In the final stage, the selected sample was distributed proportionally across the three qushets based on their total household population done using

[1] Wereda, tabia and kushet are the administrative structure of the Ethiopia EFDRE government.

done using systematic random sampling. Accordingly, 41 households were selected from Abrha Atsbha, 22 households from Selam, and 27 households from Mendae. Within each qushet, individual households were selected using systematic random sampling from the household lists obtained from the tabia administration.

The sample size of the study was determined using Kothari (2004) formula in the following manner.

$$n = \frac{z^2 p.qN}{e^2(N-1)+z^2 p.q}$$

Where: N= Size of Population

P= Sample proportion of success

q=1-p

n=size of sample

z= value of the standard variety at a given confidence level

e= Tolerance at desired level of confidence (take 0.05 at 95% confidence level)

Then $$n = \frac{1.96^2 * 0.95 * 0.05 * 1060}{0.05^2(1060-1)+1.96^2 * 0.95 * 0.05} \quad n = \frac{193.42456}{2.829976}$$

n=90

Therefore, the sample of participants for the questionnaire was **90** household heads from both homegarden practicing **(45)** and non homegarden practicing **(45).** Following this, proportional sampling technique was found to be appropriate in distributing the Questionnaire among the house hold heads. Therefore, the proportional sample size for Abrha Atsbha, Selam and Mendae qushets was **41, 22** and **27** respectively.

Data Collection Instruments

There are several ways of collecting appropriate data which differ considerably in context of Money costs, time and other resources at the disposal of the researcher (Kothari, 2004 In this study, both primary and secondary data sources were used. Field observations were conducted during the survey to assess the structure and characteristics of homegarden agroforestry systems. The observations focused on the types and diversity of crops and tree species grown, livestock integration, spatial arrangement of plants, and the management practices applied by households. In addition, soil samples were collected from representative homegarden plots using standard

soil sampling procedures. The samples were taken from selected plots at appropriate depths and analyzed in the laboratory to determine selected soil physico-chemical properties in order to evaluate the soil fertility status of the homegarden systems. Primary data were collected from household heads using structured questionnaires consisting of both open-ended and closed-ended questions. The questionnaires were administered through face-to-face interviews. Additionally, Key Informant Interviews (KIIs) were conducted with selected informants, including experts from the Woreda Agriculture Office, development agents, kebele administrators, and community elders, to obtain qualitative information about homegarden agroforestry practices and food security conditions in the study area.However; secondary data were also collected from the documents and articles. Data collections from households were carried out by enumerators (DAs) and the researcher by applying face to face interview. Through such instrument, data regarding the views of experts from Woreda Agriculture Office, DAs from kebele, from Kebeles administrator's representatives, and from community elders was collected.

Food Security Measurements

Food security indicators mainly food consumption score, dietary diversity indicators and net income were measured for contribution of homegarden agroforestry practices to house hold food security.

Food Consumption Score (FCS)

The FCS is an index developed by the World Food Program in 2018. The FCS sums household food consumption data in terms of diversity and frequency of food groups consumed over the previous week which is weighted according to the relative nutritional value of the groups. Households were asked how many days in the week preceding the survey they had eaten a food item from a list of various food items eaten commonly in Ethiopia. Those items are divided into eight standard food groups: main staples (such as teff, maize, millet, rice, bread and cassava); pulses (including beans and nuts); meat, fish, poultry and eggs; vegetables (including green leafy vegetables); fruits; oils and fats; milk and other dairy products; and sugar. Once the items were categorized into the appropriate food groups, the relative nutritional value of each group (Table, 1) and the frequency of consumption (with a maximum of seven days per group) were used to calculate the FCS. This was done by multiplying each food group frequency by each food group weight, and then summing these scores into one composite score.

$$FCS = \sum xi * ai$$

Where: FCS = Food consumption score, xi = Frequencies of food consumption (number of days each food group was consumed during the past 7 days) and ai = Weight of each food group (see table below)

Table 1. Food groups and weights used to calculate Food Consumption Score (FCS).

Food items	Food groups	Weight
Maize, millet, rice, cassava, bread, roots and tubers, plantain	Cereals, tubers and crops	2
Pulses, beans and nuts	Pulses	3
Vegetables	Vegetables	1
fruits	Fruits	1
Fish, poultry, red meat and bush meat	Meat and fish	4
Milk and milk products	Milk	4
Sugar ,honey and sweets	Sugar	0.5
Oil, butter and shea butter	Oil	0.5

Based on this score, a household's food consumption can be classified into three categories: poor (0–21), borderline (21.5–35) and acceptable above (35). The FSC is indicator of household caloric availability (Wiesmann *et al.,* 2009).

The Household Dietary Diversity Score

Categorical variable in which a HDDS value of less than 4 is considered poor, HDDS between 4 and 6 is considered medium, and HDDS values greater than 6 are categorized as good dietary diversity. In these measurements, households were asked about different food items that their families consumed in the past 24 hours to see the discrepancy in dietary intake among households. Simply HDDS summing the number of different food items eaten by the families during the last 24 hours. Each food group was only counted once when calculating the dietary diversity score. The nine groups used were: 1) cereals, roots, and tubers; 2) meat, poultry, and fish; 3) dairy; 4) eggs; 5) vitamin-A-rich fruits and vegetables; 6) legumes; 7) other fruits; 8) other vegetables; and 9) fats and oils. In this case, household family members who consume a high variety of food are considered food secure based on the categorical arrangement given, and those who consume fewer food types are considered food insecure.

Data Analysis

The contribution of homegarden agroforestry practices to household food security was analyzed using descriptive statistics and t-tests. The analysis involved several interconnected steps, including the establishment of categories, coding of raw data, tabulation, and drawing statistical inferences. Large and complex datasets were condensed into manageable groups and tables to facilitate analysis and interpretation. Quantitative data collected through semi-structured questionnaires were coded and entered into SPSS version 26. Descriptive statistics, including averages, standard deviations, variance, percentages, figures, and tables, were used to summarize and present the data. Tabulation was widely employed to organize and analyze the quantitative data in line with the study objectives. Qualitative data obtained from open-ended questionnaires and interviews were analyzed using thematic analysis. Responses were transcribed, coded, and organized into recurring themes and patterns. The findings were then presented descriptively in sentence form to provide insights into participants' perspectives and experiences.

RESULT AND DISCUSSION

Demographic and Socio-Economic Characteristics of Respondents

Table 2: Demographic and socio-economic characteristics of respondents

Variables	**Homegarden Practicing**		**Non-Homegarden Practicing**	
	Frequency	Percent (%)	Frequency	Percent (%)
Gender				
Male	40	88.9	41	91.1
Female	5	11.1	4	8.9
Age (years)				
<30	2	4.4	0	0
30–40	2	4.4	2	4.4
40–50	12	26.7	2	4.4
50–60	12	26.7	9	20
60–70	16	35.6	13	28.9
Marital Status				
Single	2	4.4	0	0
Married	41	91.1	43	95.6
Divorced	2	4.4	2	4.4
Educational Status				
Informal education	7	15.6	15	33.3
Adult education	13	28.9	24	53.3
Primary education	10	22.2	6	13.4

Secondary education	10	22.2	0	0
Diploma colleges	1	2.2	0	0
University level	4	8.9	0	0
Occupation				
Agriculture	45	100	45	100
Employee	2	4.4	3	6.7
Trade	3	6.7	1	2.2

Gender status of household heads: The demographic characteristics of the respondents indicate that the majority of households in both groups were male-headed. Among homegarden practicing households, 88.9% were male-headed and 11.1% were female-headed, while 91.1% of non-practicing households were male-headed and 8.9% were female-headed. This suggests that male-headed households dominate agricultural decision-making in the study area (Table, 2**)**. The finding is consistent with some earlier studies (Nigussie *et al.,* 2017; Embaye *et al.,* 2018; Gezimu *et al.,* 2019; Mulu *et al.,* 2022) who found male-headed farmers are more likely to adopt agricultural practices compared with female headed farmers.

Age status of household heads: most homegarden practicing households were in the age group of 60–70 years (35.6%), whereas the highest proportion of non-practicing households was above 70 years (42.2%). This indicates that middle-aged and relatively experienced farmers are more actively engaged in homegarden agroforestry practices (Table, 2).

Marital status of household heads: In terms of marital status, married household heads constituted the majority in both groups, accounting for 91.1% of practicing households and 95.6% of non-practicing households. This reflects the importance of family labor and stability for the adoption of homegarden agroforestry practices (Table, 2).

Education status of household heads: The largest proportion of respondents in both groups had attended adult education programs. Specifically, 28.9% of homegarden practicing households and 53.3% of non-practicing households had adult education. Only a small proportion of respondents attained higher education levels (Table, 2).This indicates that most respondents possess basic literacy but limited formal education. The results indicated that educated household heads were more homegarden practicing agroforestry as compared to less or not educated households. This could be related to the awareness level of the farmers, as education is a key element in understanding new and evaluating modern useful information towards practicing of

homegarden agroforestry. Previous studies (Ferede *et al.,* 2019; Teklewold *et al.,* 2019; Abegunde *et al.,* 2020; Kebede, 2021) reported similar findings that educated farmers easily perceive climate change which enhances their adoption practice of climate-smart agricultural practices.

Occupation status of household heads: Agriculture was the dominant occupation for all respondents in both homegarden practicing and non-practicing households. A small proportion of respondents were also engaged in additional activities such as employment and trade, indicating limited livelihood diversification in the study area (Table 2).

Contribution of Homegarden Agroforestry Practice to Household's Food Security

Various Sources of Household Food Security

In the study area, households practicing and non-practicing homegarden agroforestry relied on multiple sources of food security.

Table 3: Various Sources of Household Food Security

Source of food security	HG practicing on farm (N=45)		HG non-practicing on farm (N=45)	
	Frequency	Percent	Frequency	Percent
Homegarden	45	100	-	-
Farm	45	100	45	100
Business	1	2.22	-	-
Woodlot (trees)	33	73.33	21	46.67
Livestock	45	100	45	100
Employment	5	11.11	10	22.22

Households in the study area obtained food from multiple sources, including homegardens, farms, livestock, woodlots, employment, and small businesses. However, agriculture and livestock were the dominant sources of food security for both homegarden practicing and non-practicing households. Woodlot resources and employment also contributed to household food security, while business activities were reported only by a few practicing households (Table, 3). These findings are consistent with previous studies indicating that agroforestry homegardens play an important role in supporting household food and income security (Trinh et al., 2003; Gautam et al., 2004; Bonifasi, 2004).

Production Status of Homegarden Practicing and Non-Practicing

Table 4. Production status (amount) of fruit, vegetable, crop, livestock, livestock product and trees (fuel) regarding total production, consumption and sell.

Production item	home-garden practicing			home-garden non-practicing		
	Production	consumption	Sell	Production	consumption	Sell
Fruits (kg)	550	20	530	60	10	50
Vegetables (kg)	150	100	50	90	85	5
Crop (quintal)	8.45	8.2	0.25	7.80	7.5	0.3
Livestock (No)	15	2	13	13	2	11
Trees/fuels (quintal)	15.75	4.5	11.25	14.55	5	9.55

The results show that the overall production of fruits, vegetables, crops, livestock, and fuel wood was higher among households practicing homegarden agroforestry compared to non-practicing households. This reflects the diversified production system associated with homegarden agroforestry. For fruit production, practicing households produced substantially larger quantities than non-practicing households. A large proportion of fruit production was sold in the market, indicating that fruit production contributes significantly to household income. Vegetables and crop production were mainly used for household consumption rather than sale. Practicing households consumed a larger share of their vegetable and crop production, suggesting that these products play an important role in improving household food availability and dietary diversity. In contrast, fruits, livestock, and fuel wood were more commonly sold than consumed, indicating

that these components of the homegarden system contribute more strongly to income generation (Table, 4). The reason could be home-garden agroforestry system providing fruits, vegetables, cereal crops, fodders and fuel wood at the same time than non homegarden agroforestry system. So, it can be stated that homestead agroforestry system, was more productive which contributed to food secure than that of non-practicing homegarden agroforestry. The consumption of fruit, livestock and trees/fuels was lower than selling but the consumption of vegetables and crop which are inverse which means consumption was higher than selling. Homegardens have also been identified as a sustainable income generation source as it allows selling the surplus of the production (Mitchell and Hanstad, 2004).

Household Dietary Diversity Score (HDDS) by Homegarden Practicing and Non Homegarden Practicing

Table 5. Household Dietary diversity score (HDDS) by homegarden practicing and non homegarden practicing

HDDS	Homegarden practicing (N=45)		Homegarden non-practicing (N=45)	
Categories	Frequency	Percent (%)	Frequency	Percent (%)
<4 (Low)	0	0	34	75.6
4-6 (Medium)	39	86.7	11	24.4
>6 (High)	6	13.3	0	0
Total	45	100	45	100

The results indicate clear differences in dietary diversity between homegarden practicing and non-practicing households. Most homegarden practicing households fell in the medium dietary diversity category (86.7%)**,** while a smaller proportion achieved high dietary diversity. In contrast, the majority of non-practicing households were classified in the low dietary diversity category (75.6%) (Table, 5). These findings suggest that households practicing homegarden agroforestry have better dietary diversity and improved food security compared to non-practicing households. In addition, many studies have shown that the average HDDS and FCS was recorded significantly higher in homegardens due to presence of species diversity and seasonality during planting is advisable to ensure food accessibility and availability from homegardens at any time

of the year (Ferdous *et al.,* 2016; Mitchell and Hanstad, 2004; Pandey *et al.,* 2017; Talukder et al. 2000).

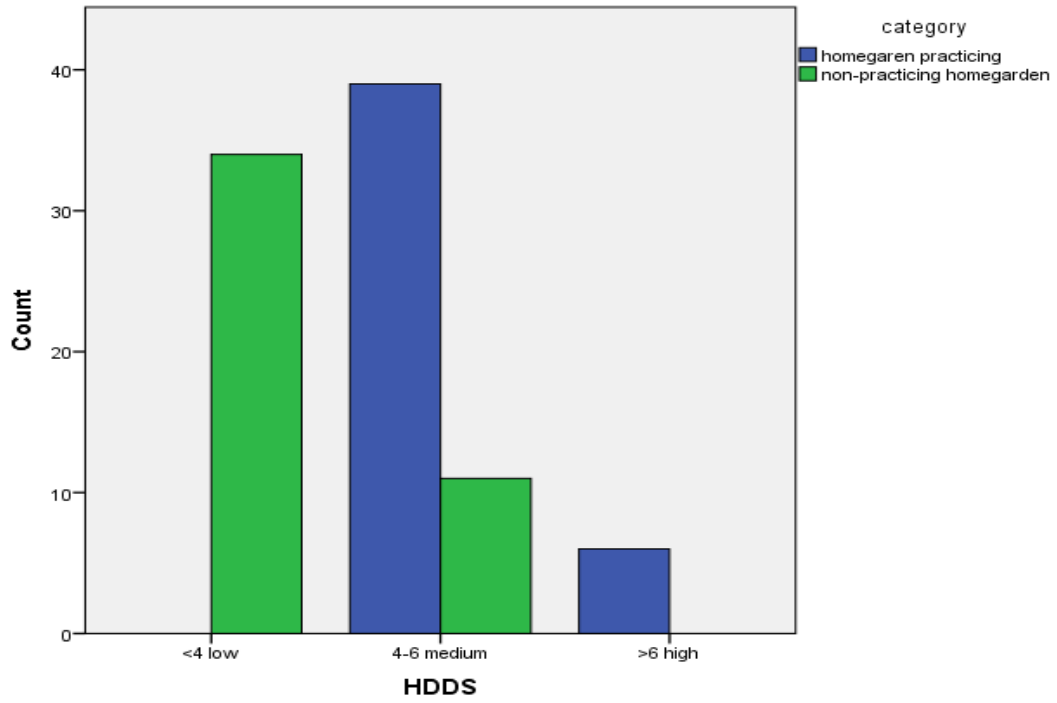


Figure 2. Comparisons of HDDS among HG practicing and non- practicing

Food Consumption Score (FCS)

Table 6. Food Consumption Score (FCS) by Homegarden Practicing and Non-Practicing Households

FCS	Homegarden practicing (N=45)		Homegarden non-practicing (N=45)	
Categories	Frequency	Percent (%)	Frequency	Percent (%)
0-20 (Poor)	4	8.9	20	44.4
21-35 (Border line)	14	31.1	18	40
>35 (Acceptable)	27	60	7	15.6
Total	45	100	45	100

The results show a clear difference in food consumption scores between homegarden practicing and non-practicing households. The majority of homegarden practicing households had acceptable food consumption scores (60%), while only a small proportion fell into the poor

category. In contrast, most non-practicing households were classified in the poor (44.4%) and borderline categories, with only a few achieving acceptable food consumption scores (Table 6). This indicates that homegarden practicing households have better food security status compared to non-practicing households. In addition, many studies have shown that the average HDDS and FCS was recorded significantly higher in homegardens due to presence of species diversity and seasonality during planting is advisable to ensure food accessibility and availability from homegardens at any time of the year (Ferdous *et al.,* 2016; Mitchell and Hanstad, 2004; Pandey *et al.,* 2017; Talukder et al. 2000).

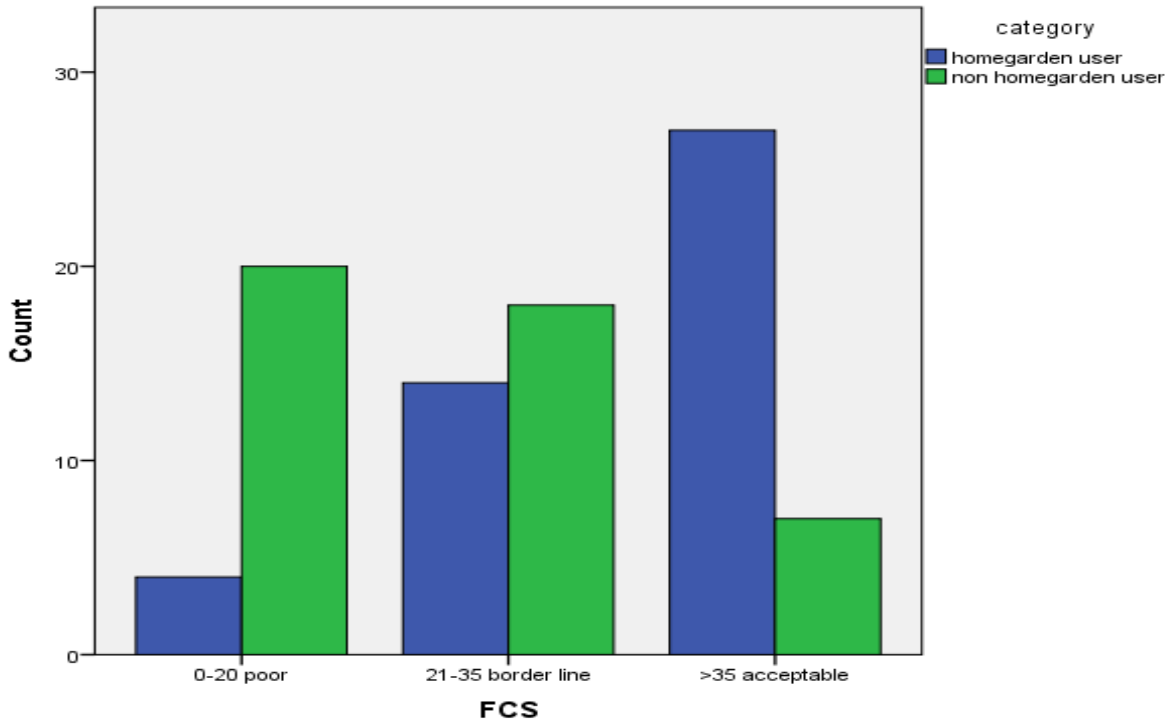


Figure 3. Comparisons of FCS among HG practicing and non-practicing.

Contribution of Homegarden Agroforestry to Household Income

In the study area, homegarden agroforestry practicing and non-practicing households' total annual income earned from the production of fruits, vegetables, crops, livestock, livestock products and trees/fuels (Table, 7).

Table 7: Households annual income homegarden practicing and homegarden non-practicing

	HG practicing (N=45)	HG non practicing (N=45)			
HHs annual income	Mean & Std. Dev	Mean & Std. Dev	Mean Differ	*t*-test	*p*-value
Fruit income	32577.78±7576.30	2320.00± 1250.13	30257.78	27.2	0 .000**
Vegetable income	1411.11± 642.871	610.78 ± 316.89	800.33	7.4	0 .000**
Crop income	5476.67±2970.79	4280.00±2331.34	1196.67	2.12	0.03**
Livestock income	8444.44±1880.58	7168.89± 1910.35	1275.55	3.1	0.002**
Livestock product income	4245.56±6260.02	2844.44±4283.414	1401.11	1.2	0 .26
Fuel income	10006.67± 2679.756	8875.56±1923.084	1131.11	2.3	0 .024**

The survey result revealed that the mean difference between the income of fruits for homegarden agroforestry practicing and non-practicing sample households was found to be 30257.78 ETB. The mean income obtained from fruits for homegarden agroforestry practicing and non-practicing households were 32577.78 and 2320.00 ETB with a standard deviation of 7576.30 and 1250.13 respectively (Table, 7). The staticall result showed there is a statistically significant mean difference between homegarden agroforestry practicing and non-practicing sample households regarding fruit income at (t=27.2, p=0 .000). The mean difference between the vegetable income of homegarden agroforestry practicing and non-practicing sample households were found to be 800.33 ETB since the mean income generated from vegetable for practicing and non-practicing was 1411.11 and 610.78 ETB with a standard deviation of 642.871 and 316.89 respectively (Table, 7). The statically result showed a statistically significant mean difference between homegarden agroforestry practicing and non-practicing sample households regarding vegetable income at (t=7.4, p=0 .000).The mean difference between homegarden agroforestry practicing and non-practicing sample households' income from crop was 1196.67 ETB. The average income from a crop for homegarden agroforestry practicing and non-practicing sample households were 5476.67 ETB and 4280.00 ETB with a standard deviation of 2970.79 and 2331.34, respectively (Table, 7). The statically result showed a statistically significant mean difference between homegarden agroforestry practicing and non-practicing sample households regarding vegetable income at (t=2.12, p=0 .03).The mean difference

between the livestock income of homegarden agroforestry practicing and non-practicing sample households was found to be 1275.55 ETB. The average income obtained from livestock for homegarden agroforestry practicing and non-practicing households were 8444.44 ETB and 7168.89 ETB with a standard deviation of 1880.58 and 1910.35, respectively (Table, 7). The t-test indicated that there is statistically significant difference between the practicing and non-practicing households regarding livestock income (t=3.1, p= 0.002). These findings align with Fregene (2007) who found that on-farm monetary benefit to be positively and significantly associated with agroforestry adoption. The mean difference between the livestock product income of homegarden agroforestry practicing and non-practicing households was 1401.11 ETB since the average income from livestock product for homegarden agroforestry practicing household heads was 4245.56 Ethiopian birr (ETB) with a standard deviation of 6260.02; whereas, 2844.44 Ethiopian birr (ETB) with a standard deviation of 4283.414 for non-practicing of household heads. The t-test indicated that there is no statistically significant difference between the practicing and non-practicing households regarding livestock product income (t=1.2, p= 0.26).The mean difference between the fuel (trees) income of homegarden agroforestry practicing and non-practicing sample households were found to be 1131.11 ETB since the mean income generated from fuel (trees) for practicing and non-practicing was 10006.67 and 8875.56 ETB with a standard deviation of 2679.756 and 1923.084, respectively (Table,7). The statically result showed a statistically significant mean difference between homegarden agroforestry practicing and non-practicing sample households regarding fuel (trees) income at (t=2.3, p=0 .024). The findings of this study are consistent with Olika and Zuberi, (2013), the average annual income per homestead is Birr 12,583.00 (= 630.00 US$); more than 50% being poor had lower income that having an average of less or equal to half a hectare of land. Field crops accounting for 41 % of this income, animals account for 15 %, 22% from homegardens (herbs), other agroforestry/trees contributing 12 %, while off farm income contributing to the rest 10% (Zuberi *et al.,* 2014). Similarly, Zerihun *et al.* (2011), indicates that, income from homegarden increases an average household income of 2100 - 3784.11 Ethiopian Birr. More than 61.2% homegardens serve as a source of cash and food for smallholder households. Smallholders can improve both their health and their incomes by growing fruit trees (ICRAF, 2008). In line with this, (Ewuketu, 2014) reported that about 67% of households generate cash income from fruit trees grown in homegardens, emphasizing their economic importance. Moreover, the production and trade of

the homegarden products like the spice producing herbal species that involve small scale producers and low income consumers that benefits the small scale producers and consumers and also contributes to the market and the economy (Zuberi *et al.,* 2014). The presence of fodder tree has also a crucial value, increases the number of livestock (important assets during times of crisis) (Ewuketu, 2014). In addition, these components are in most cases the last refuges for species that are useful, but not commercially viable for cultivation (Mahbubul and Furukawa, 2010). The presented results also agreed with Mohan (2004), which indicated that, home gardens contributed significantly (60 percent) to the household income of smallholder farmers in many developing countries.

CONCLUSION AND RECOMMENDATION

The study results also showed that home-garden agroforestry practices contributed the higher production status, house hold diet diversity scale, food consumption score and net income for rural livelihoods as compared to non-practicing home-garden agroforestry. These were home-garden agroforestry system providing cereal crops, fodders and fuel wood at the same time than non homegarden agroforestry system. So there is significant difference of households who practiced homegarden agroforestry and those who did not. This indicates that homegarden agroforestry practice has a positive impact on food security status of rural households. Therefore, it is better to handle homegarden agroforestry practices for better food security. In this study only limited socio economic data were considered. So, further research is required on detail socio economic information. The study was carried out on limited area of Tigray of Ethiopia which is not sufficient to draw the conclusion on over all of the regions. Due this further research in other areas is important to get reliable data.

Declarations

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki, and Ethical approval for the study was obtained from the Institutional Review Board (research ethics committee) of the College of Dry land Agriculture and natural resource Mekelle University (Certificate Ref. No: CDANR/ERC/08/01/16/2023). Before conducting the interviews, the purpose of the study was clearly explained to the participants and their informed consent to participate was obtained.

Consent for publication

The authors confirm that all individuals involved in this study provided informed consent for the publication of their data, including any anonymized personal information included in the manuscript. All data have been handled in accordance with confidentiality and privacy standards, and no identifying information has been disclosed.

Clinical Trial Registration

Clinical trial number: Not applicable.

Data Availability: - Data will be made available on request.

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Competing interests

The authors declare no competing interests

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