Journal of Environment and Earth Science www.iiste.org
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.13, No.3, 2023

Assessment of Homegarden Agroforestry Practices: Case Study of Horticultural Crop Production Trends, and Contribution towards Biodiversity Conservation and Local Livelihoods

Gemeda Terfassa Fida*
Oromia Agricultural Researcher Institute/Adami Tulu Agricultural Researcher Center
P O Box 35 Adami Tulu, Ethiopia
Tel:251910090567 Email:fidakee@gmail.com

Edossa Etissa Chala
Ethiopian Agricultural Researcher Institute/Melkassa Agricultural Researcher Center
P O Box 436 Adama, Ethiopia
Tel:251911493621 Email: edossa.etissa@gmail.com

No: Fund

Abstract
Homegarden (HG) in southwestern Ethiopia is a well-known practice that plays an important role not only in socioeconomic aspects, but also in biodiversity conservation. However, increased human population in line with the scarcity of land for food production and expansion of cash crops in the area have put pressure on the component diversity of which horticultural crops are the major. The aim of this study was to examine the trends of horticultural crop production based on local's point of view and measures of plant diversity by using multistage sampling from a total of 133 households and 15 key informants using a semi-structured questionnaire with 9 FGD discussions. Descriptive statistics, multiple linear regression, and diversity index measures were used for data analysis and interpretation. Results showed that socioeconomic variables had a significant impact on farmers' perceptions of horticultural crop production trends (explaining 58% of the variance). Most of the respondents agreed that the little progress towards horticultural production was related to market efficiency. The study also revealed a total of 79 plant species, grouped in the order of herbs (42%), trees (28%), shrubs (24%), and vines (6%). The diversity index indicated that the plant species present in HG of the study area had moderately high diversity and species richness.
Keywords: Homegarden Agroforestry, production trends, Biosphere Reserve, Biodiversity
DOI: 10.7176/JEES/13-3-01
Publication date: April 30th 2023

1. Introduction

With global population growth projected to reach 9 billion by 2050, it is unclear how the current global food system will meet future food needs. Meeting these needs while conserving natural resources and preventing environmental degradation is the greatest challenge facing humanity (Bradbury *et al*., 2010). Moreover, the global economy's heavy reliance on crop diversity poses a threat to future food and nutrition security. As a result, over 75% of plant germplasm has been lost in the past century, and by 2050, one-third of today's diversity could be gone (Chappell, 2011). As a result, feeding a dramatically increasing population while conserving natural resources is one of the biggest challenges for decision makers today. The concern is even greater in regions where people depend on natural resources for their daily needs (Gbedomon *et al*., 2015).

Moreover, the success of modern agricultural and forestry production can largely be attributed to monoculture systems using a few selected species and heavy chemical inputs. This drive for maximizing yield and profit has caused serious environmental problems such as land and water degradation and increased land clearing. Modern agriculture is, as a result, threatening its own foundations: land, water, forests, and biodiversity. It has vast and adverse impacts on the earth and thus, agriculture affects the basis of its own future (Hopkins *et al*., 2006). Increased food production must therefore come from the same amount of land through what is called' sustainable intensification'. This means producing more output from the same land area while improving the flow of natural capital and environmental services while reducing negative environmental impacts (Godfray *et al*., 2010).

Agroforestry (AF), along with forest management, is one of several viable alternatives to the management of such unsustainable natural resources that have recently been proposed for tropical forest ecosystems. On the other hand, many farmers have maintained trees as part of their agricultural landscape since the dawn of agriculture. (McNealy and Schloss, 2006). AF covers a wide range of land-use practices and is practiced in modern and traditional forms worldwide (Alain et al., 2014). Combining native and exotic tree foods in AF systems can support farmers' nutrition, production, stability, and income (Jamnadass *et al*., 2011). HGs (HGs) are easily accessible, home-adjacent, and diverse crop production systems (Sunwar *et al*., 2006). They represent the most prevalent land-use systems in the world and are living evidence of the biological and sociocultural interactions that develop around local livelihoods and the pursuit of people's well-being (Lope and Howard, 2012). HG is both a food-producing and a non-food-producing crop system, and its food-producing function is considered its fundamental function (Gbedomon, 2017). It is the place with the highest biodiversity where some native, cultivated, and rare / endangered species are preserved and protected (Zimik *et al*., 2012). The composition of crops grown in HG can be grouped according to function, such as ornamental, fruit, food crops, vegetables, medicinal, spices and fodder, building materials, and firewood (Bekele, 2014).

HG can be described as a mixed cropping system that includes vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants, and livestock that serve as supplemental sources of food and income. Moreover, his HG as an ecosystem contains multiple levels of diversity, such as cultural, genetic, and agro-diversity, and the production of food, pharmaceuticals, and other products useful to humans. They are widely recognized an integral part of the local food production system, ensuring that all people always have sufficient, safe, and nutritious food to meet their dietary needs and food preferences to guide an active and healthy population. Physical, social, and economic access to high food is critical for food security. Life (Galhena *et al*., 2013).

Widespread throughout the globe, HG is a long-standing agricultural practice in countries in Asia, Latin America, and Africa, and is widely promoted to augment and supplement household food needs, particularly for resource poor communities in developing countries. In recent years, governments and other development organizations in both developed and developing countries have emphasized the importance of building local food production systems as an integrated strategy and a safety net for food security as well as poverty alleviation (Galhena, 2012).

Moreover, the effective development of HG can make a significant contribution to eco-friendly food production and make available a variety of fresh and nutritious foods, such as vegetables, fruits, spices, milk and other animal products. Improving family nutrition and health is a major goal of the Sustainable Livelihoods Framework, and HG is a strategy to combat malnutrition and micronutrient deficiencies. Vegetables and fruits may be the only reliable sources of micronutrients available to poor households (Osei *et al*., 2014).

In Ethiopia, diverse climatic and vegetation conditions allow the cultivation of a wide variety of fruit trees throughout the year. Cultural and ecological differences also lead to enormous intra- and interspecies differences in the diversity of some horticultural crops and their wild relatives (Tiruneh, 2008). In recent years, under the pressure of land fragmentation and environmental and social change, many Ethiopian smallholder farmers are in the process of adapting their agricultural strategies to meet their food security and household income needs (Vermeule *et al*., 2012). Land use change in rural farming of Ethiopian communities is being introduced as a result of these pressing immediate needs. It is mostly carried out at the expense of the diversity and stability of existing land use systems, sustainable livelihoods, and food security (Leach and Mearns, 2013).

In addition to this, the smallholder agricultural landscape surrounding the forests of the Yayo Coffee Forest Biosphere Reserve (YCFBR) is also important for the conservation of many cultivated native species in horticulture. Smallholder farmers in this zone grow cereals, legumes, coffee, vegetables, fruits, root and tuber crops, spices and herbs, and other crops as stand-alone crops or in HG with shade trees. (Etissa *et al*., 2016).

Traditional homegarden agroforestry (HGAFP), integration of diverse horticultural crops, and coffee-based agroforestry (AFP) by smallholder farmers in southwestern Ethiopia have both socioeconomic and environmental aspects. It is one of the existing agricultural systems that has played an important role in the area. However, population growth and associated development activities like urbanization and changes in cropping pattern from traditionally diversified to some particular demanded cash crops in HGAFPs are impeding a variety of production outcomes and biodiversity preservation aspects of HGAFPs.

On the other hand, the recent concerns of YCFBR as a protected area by regulation to save the region's natural resources have increased local people's reliance on using HG as an alternative livelihood option. Again, little is known about the current trends in horticultural crop production, crop diversity, and their value to local biodiversity conservation. The Objectives of the study were: (1) to examine and generate information on the current trends and status of horticultural crop production in HGAFPs of the study area. (2) to explore the currently existing plant species diversity and biodiversity conservation role of the HGAFPs in the study area. (3) to identify and document the role of HGAFPs on the livelihoods of the local communities in the study area.

2. Materials And Methods

2.1 Description of the Study Site

The YCFBR is a UNESCO Biosphere Reserve that was established in 2010 and is situated in southwest Ethiopia (Fig. 1). It is situated in the wettest region of the nation with an average annual temperature of roughly 23.76 °C and 1625 millimeters of precipitation (Mulatu and Dadi, 2018). The biosphere reserve spans approximately 2 administrative zones and 6 districts with a total size of 1670 km2.

Following its designation as a UNESCO BR, three management zones were created: core, buffer, and transition zones. The core zone (27,733 ha) is where there is no human intervention and is fully protected. The buffer zone (21,552 ha) is where limited human intervention is possible only if compatible with the conservation objectives of the reserve. The transitional zone (117,736 ha) is found adjacent to the buffer zone and includes agricultural lands, wetlands, grasslands, settlements, and forest fragments (Table 1). In this area, minimal human activities such as cultivation around homesteads are allowed. Despite its importance in terms of biodiversity, forest coffee, and ESs provision, the area is threatened by deforestation, land degradation, and conflict between LUs and users (Fischer *et al*., 2017).

Table 1: Areas of YCFBR

YCFBR	Total Area (ha)		Area (ha)	Area (%)
		Transitional	117,736	70.5
	167,021	Buffer	21,552	12.9
		Core	27,733	16.6

Source: (from Environment and Coffee Forest forum, 2017).

2.2. Livelihoods of Smallholder Farmers around YCFBR

Agriculture is the basis of rural life. The viability of rural livelihoods in many developing countries is threatened by several interrelated factors that limit opportunities for smallholder farmers and residents of rural communities. These include inadequate nutrition and nutritional imbalances in the diet; limited off-farm and off-season income opportunities, especially for women and children; thorough production systems. These negative effects of modern agriculture are exacerbated by the biodiversity loss of wild forest resources through deforestation, over-exploitation, and the 'tragedy of the commons' (Rees, 2007).

In the montane rainforest regions of SWE, where coffee (Coffea arabica) occurs naturally, communities living in and around the forests traditionally manage the forests for coffee production. The main occupation in this region is agriculture, engaging over 90% of its workforce. Agricultural practices in the region are primarily small-scale subsistence farming. Coffee production, processing, and marketing are the main sources of engagement for over 60% of the population (Gole *et al*., 2008).

The agricultural land of Yayo settlement consists of only smallholder household farms with diverse and complex crop production systems and most crops are traditional landraces, including Arabica coffee. Agricultural smallholder landscapes surrounding forest areas are also important for the protection of native species of many cultivated horticultural crops. Smallholder farmers in the area grow cereals, legumes, coffee, vegetables, fruits, root and tuber crops, spices and herbs, and other crops as stand-alone crops or in HGs with shade trees. Cultivated in combination with crops (Tadesse *et al*. ., 2009) cited in (Etissa *et al*., 2016).

Rural households have different livelihood strategies, but most rely on access to a variety of natural resources. Trees are the most important resource for diversifying and sustaining production, providing farmers with a variety of products, and contributing to improved food security. The most important and direct contributions of trees to food security come in the form of fruits, medicines, feed, and non-wood products. The Yayo area is a forest environment and its arabica varieties contribute significantly to the livelihoods of hundreds of smallholder farmers (Tadesse, 2010).

Similarly, according to Alebachew *et al*. (2016), farmers in the Yayo area grow a variety of crops. They not only depend on one crop, but combine different staple foods such as maize, sorghum, millet, wheat, barley, and teff (Eragrostis tef). Besides, they grow different pulses (beans, peas, and chickpeas), root and tuber crops (potato, sweet potato, beetroot, carrot, anchote, and enset (Ensete venricosum), vegetables (hot/green pepper, tomato, pumpkin, Ethiopian kale, cabbage, Tarro, Abrango, onion and garlic), fruits (avocado, banana, mango, papaya, orange, lemon, and jackfruit) and a variety of spices (ginger, Ethiopian cardamom (Aframomum corrorima), and turmeric. Livestock and its products are also common commodities produced in the area. The most important domestic animals are cattle (milk production), bulls, sheep, goats, poultry, and beekeeping. Maize and coffee are the dominant commodities produced with the aim of consumption and market, respectively.

Governments and development organizations encourage the production of staple foods to combat hunger and provide export crops for income generation. Nevertheless, it's not just the calories or cash count, but also the nutritional value. Fruits and vegetables are important for a healthy, balanced diet. The biosphere reserve in the Yayo Region of Ethiopia is a biodiversity hotspot. More than 90 percent of the population are smallholder farmers (Dürr, 2016).

Chora district is one of the six districts that make up YCFBR. The distance is 549 km from Addis Ababa. It borders the districts of West Yayo, East Bedel, Dega and South Gumaya. YCFBR has 33 rural villages, 5 of which are included in his YCFBR.

Table 1: Chora District Profile

SI.No	Particulars	Statistics
	Total geographical area (sq km) Agro-Ecological Region Total number of villages and Total number of towns Number of Households (Normal) Total population Sex Ratio Total male population Total female population Total rural population Total urban population Literacy rate Male literacy Female literacy	

Table 2: Description of Agro-Climatic and Population of Chora District

Agro climatic zone	Total area in ha	Temperature (oC)	Annual Rain Fall in mm	Altitude m.a.s.l.	Location	Population		
						M	F	T
Dega	2665.21	9-31	1500 - 2200	1450-2300	8o10'00''N to 8o40'00''N and 35o53'30''E to 36o20'00''E	49%	51%	105,802
Woyina	74547.46							
Colla	1175.83							

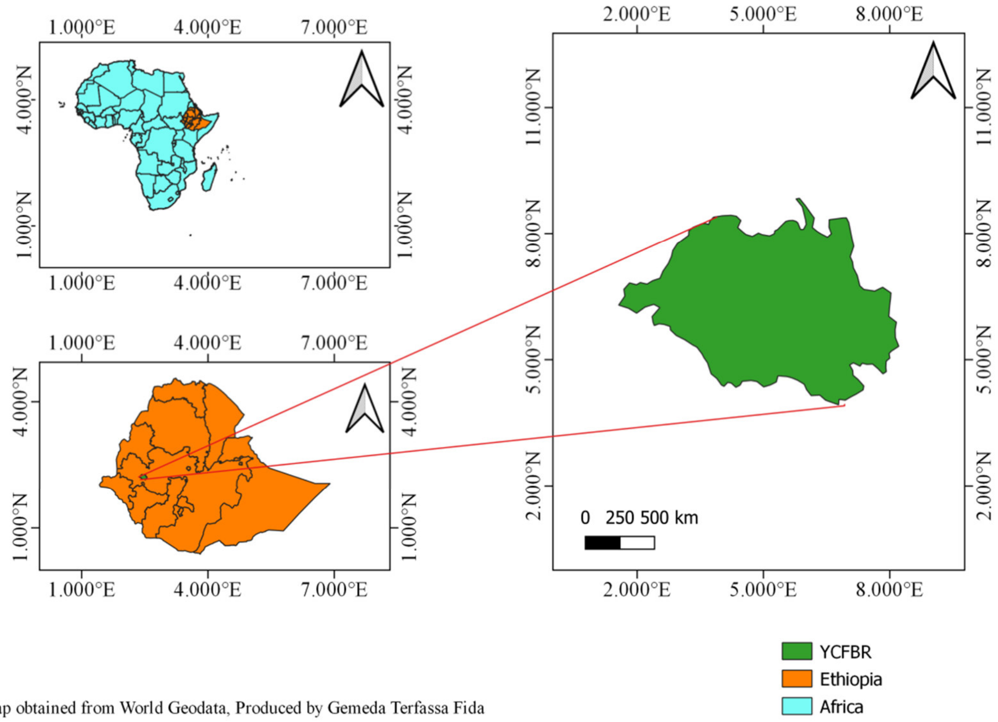
Of the total land area of the district, the largest proportion is allocated for forest and construction of residences to the total land owned by households. As a result, land scarcity and fragmentation are major problems as human and livestock populations continue to grow in the region. This problem affects food and feed security in the area. The topography of the study area is generally characterized by hills, rolling lands, and a number of permanent and temporary rivers and streams. The most common and dominating soil type is Netosol in the district.

The area is characterized by mixed cropping and animal husbandry, with harvesting being the main source of income for farmers. There is only one cropping season that is mainly rain-fed for crop production and is characterized by low productivity. The most dominant crops growing in the district are cereals (Maize, sorghum, Finger Millet, Tef, Wheat, Barely), Pulses (Haricot bean, Faba bean, Field Pea), oil crops (Noug, Sesame, Rape seed, Linseed), Horticultural crops particularly Coffee is the dominants crop in the area. Animal husbandry in the district is completely dependent on the traditional system (Gedefa, 2015).

Table 3: Kebeles encompassing of YCFBR and their households from Chora district

N0.	Name of Kebele	Distance from woreda town (Chora) in KM	Households		
			Male	Female	Total
1	Sololo	12	333	48	381
2	Hawayember	6.5	807	58	865
3	Uta None	8.5	445	22	447
4	Hadesa		551	38	589

Data Source: Office of Forest and Climate change Authority, Chora district.



Source: Map obtained from World Geodata, Produced by Gemeda Terfassa Fida

Figure 1: Map of study area

2.3. Methodology

2.3.1. Types and sources of data

Both primary and secondary data were collected. Secondary data sources were various relevant publications, seminar papers and project reports, legal documents of relevant institutions, questionnaires, interviews with individuals and key informants, focus group discussions (FRG), field observations, and other ecological surveys are the primary data sources.

2.3.2. Sampling method

Prior to specific site selection of this study, a reconnaissance survey of the study area was conducted in September 2017.Then multistage sampling methods were used for sampling methods as follows:

First, purposive sampling method was used for the selection of Chora district… and the villages encompassed by YCFBR from the district. Secondly, representative villages were selected by simple random sampling. Then, households were selected by the systematic sampling method. Finally, cluster samplings followed by systematic sampling were used for HG biophysical assessment.

2.3.3. Sample Size Determination

The total sample size of respondents from communities, was determined based on Cochran formula (Kothari, 2004).

Equation 1: $\mathbf{n = (Z\alpha/2)2 * P * Q/(W)2}$ ……………………………………………3(1)

Where n= size of the sample, Zα/2=1.96, at α=95% confidence interval.

P*q= is an estimate of marginal variance in which it is 5% a =0.5x0.5

W= Researchers willingness to accept the margin of error in which I had taken 14%,

$n = (Z\alpha/2)2 * P * Q/ (W) 2$ n0=49, if the value of n is greater than 5% of the population, we can apply the Cochran (1977) correction formula which is given by: $n1 = n0/\{1 + (n0 - 1)/N\} =$ for Sololo with the total households of 381,

n1=49/ {1+ (49-1)/381}, n1=49/ {1+ (48/381)}

n1=49/ (1+0.13), n1=49/ (1.13), n1=43.4

n1=44 implies samples from Sololo Village will be 43 households only.

n2=no/1+ (n0-1) /N, for Hawayember with total households of 865

=49/ {1+ (49-1)/865} =46

n1= no/1+ (n0-1) /N for Uta to none of the total households of 447
n1=44.2So that the total households selected from the three villages for interview will be (43+46+44) 133.

2.4. Data collection Methods

2.4.1. Household survey Methods

A semi-structured questionnaire, FRG was conducted to meet specific objectives regarding the assessment of trends in horticultural crop production, their contribution to biodiversity conservation, and local livelihood enhancement. Personal observations were used (Appendix 1). The questionnaire, written in English, was translated into the local language (Afan Oromo), the language of the people in the study area. Information on production trends for horticultural crops and other components of HG was collected from household surveys. Respondents were required to recall and describe trends in horticultural production experienced in the past few years in HG. At the same time, they were asked to comment on current observable practices, which were inventoried after the interview.

To explore the contribution of HGAFPs to protecting biodiversity and locals' livelihoods, respondents were asked to list the products they use for their use, references to products harvested from forests, if they could produce in HGAFP. In each Kebele, 3 FRGs containing 6-12 people were conducted to support and cross-check the information given by an individual respondent and obtain important information that was not covered by the individual questionnaires.

2.4.2. Homegarden observation and Biophysical Assessment

A HG observation was made with locally selected informants and with HG owners at each study site during biophysical data collection. While walking along with the informants, an attempt was made to let the informants discuss the ecological knowledge, HG practices, and temporal trends in the production of horticultural crops in the area. To assess the diversity and composition of plant species in the HG, fifteen sample plots 10x10 m (100 m2) were laid down in the HGs of each village. The first plot was randomly selected and the rest fourteen plots were systematically selected in order to cover all species typing occurring in the garden, totally 45 sample plots (Abiot and Gonfa, 2015) from randomly selected farm land owners (15 from each village). All trees, shrubs, and herbaceous plant species in each plot were counted.

The Shannon Diversity Index (H‘) and Evenness (E=H‘/Ln(S)) were used to identify level of species diversity in HG. Species compositions (richness) and their diversity indices (Shannon and Evenness) were computed. This was based on 15 plots of each kebele. The formula for this index is: H’= -Σ (Pi lnPi) with Pi = ni/N. Where N is the total number of individuals in a sample, ni are the individuals of species i, and a is the total number of species observed (Shannon and Weaver 1948).

For all structured interviews and plant species diversity data parts, descriptive statistics of SPSS tool version 20, Past version 3, and Microsoft Excel version 16 were used as analyzing tools. Trends of fruit and vegetables were assumed from the frequencies of respondents on the relative importance. In this phase, the production of horticultural crops was inventoried to confirm the production trends assessed through semi-structure questions in the above phases. Then, plant species diversity in the HG was assessed by taking three sample plots 10x10 m (100 m2) per household by using Stratified Sampling Procedure. Density Relative density as a quantitative structure, the Shannon-Winner index for diversity (Magurran, 2011). Diversity index Odum (1971) as a measure of diversity was evaluated. Species Richness index and species evenness was also calculated with the help of the formula given by (Peet, 1974).

2.4.3. Density (D) of a species

Equation 2:

$$D = {}^{N}/_{45} \ldots\ldots 3(2)$$

Where D is the density of a species, N is the total number of individuals of a species in all quadrates, and 45 is the total number of quadrates studied.

2.4.4. Relative density (RD) of a species

Equation 3:

$$RD = Ni * \frac{100}{N} \ldots\ldots 3(3)$$

Where RD is the relative density of a species, Ni is the total number of individuals of a species in all quadrates, and N is the total number of individuals of all species.

The Shannon-Winner index for diversity,

$$H' = \quad Pi * \ln Pi \ldots\ldots 3(4)$$

Equation 4:

Where,

H' = Index of species diversity,

Pi = No. of an individual of one species/total no. of Individuals in the sample

2.4.5. Diversity index,

$$D = \frac{S}{N} \ldots\ldots 3(5)$$

Equation 5:
Where,
D = Diversity Index,
S = Total number of species,
N = Total number of individuals

Species richness index,

$$R = S - \frac{1}{\log N} \ldots\ldots 3(6)$$

Equation 6:
Where,
R = Species richness index,
S = Total no. of species,
N = Total no. of individuals of all species

Species evenness index,

$$E = \frac{H'}{\log S} \ldots\ldots 3(7)$$

Equation 7:
Where,
E = Species evenness index,
H' = Shannon-Winner index of diversity,
S = Total no. of species

2.4.6. Frequency (F)

Equation 8:

$$F = \text{No. of HGs in which a species occurs} * \frac{100}{\text{Total number of sampled HGs}} \ldots\ldots 3(8)$$

Relative density,

$$RD = \text{Density of a given species} \times \frac{100}{\text{Total density of all species}} \ldots 3(9)$$

Equation 9:

2.4.7. Data analysis

Descriptive analysis through frequency, mean, percentages, and standard deviation was used to analyze the data by using a computer software statistical package for social studies (SPSS version 20.0). In addition to descriptive analysis, a multiple linear regression model [significance level of $\alpha = 0.05$] was used to analyze and predict the values of the dependent variables, i.e., the views of the local people to estimate determinant factors that influence the trends of horticultural crop production in HGAFPs by individual households have been employed.

2.4.7.1. Model specification

Multiple linear regression analysis is carried out to predict the values of a dependent variable, Y, given a set of p explanatory variables (X_1, X2, Xp). The goal of multiple regression is to assess the relationship between a dependent (predicted) variable and several independent (predictor) variables. The end result of multiple regression is the development of a regression equation (line of best fit) between the dependent variable and several independent variables. (Montgomery *et al*., 2012).

2.4.7.2. Definition of hypothesis variables

Locals' views on the trends of horticultural crops and current plant species diversity in HGAFPs can be considered as having threefold: increase, decrease, or show no changes in horticultural crop production, and other trees in HGAFPs. All these trends were assumed to be influenced by several factors that are related to a farmer's objectives and constraints. The dependent and independent variables that were employed in this analysis were defined and hypothesized as below.

Dependent variable

A dependent variable is a variable that is said to be affected or explained by another variable/variable. In this study, the dependent variable is represented by the production trends of horticultural crops and current plant diversity in HGAFPs of the farmers and it was treated as a multinomial dependent variable (1 for increasing production and/or

HG plant diversity, 2 for decreasing and finally 3 for showing no change).

Independent variables

Independent variables were derived from the following eighteen questions: (1) sex, (2) age, (3) level of education, (4) marital status, (5) family size, (6) occupation type, (7) length of duration of residence in the area (in years), (8) total household land size (9) land allocated for HGAFPs, (10) annual income (ETB), (11) knowledge of the respondents on YCFBR (12) desire to plant more horticultural crops and other plant trees in the garden than had before 10 years, (13) man and biosphere program impacts towards household plant preservation in hg (14) major constraints of horticultural crop production, (15) shortage of seed/seedlings of horticultural crops, (16) distance from the local market, (17) contact with professionals in horticultural production, (18) price problem in the market.

3. Results and Discussion

Based on the objectives of the study, its research findings and discussions are given in the following sections.

3.1. Household Information

Table 5: General Study Population and Socioeconomic Characteristics

Variables	Descriptive result	Proportion (%)
Total sample size (N) 133		
Sex	Male	91.7
	Female	8.3
Age	Mean = 42.91 years; SD = 7.23	
Levels of education	No formal education	19.5
	First cycle	42.9
	Second cycle	30.1
	High school	7.5
Marital status	Married	91.73
	Divorce/Widow	8.27
Family size	Family size Mean =8.60 persons; SD = 3.06	
Occupation type	Mixed farming only	80.5
	Farming mixed with trade	19.5
Length of duration of residence in the area	Native/existed since birth in the area	94
	Nonnative	6.0
Total household land size	Total household land size mean 2.1ha;SD 1.71	
Land allocated for HG	Land allocated for HG mean 0.2720; SD 0.160	
Annual income	Annual income mean 31962.41 ETB/Year ; SD 9969.96	0.15597
Knowledge of the respondents on YCFBR	Yes	94.74
	No	5.26
Desire to plant more horticultural crops and other components in garden than had before 10 years	Yes	79
	No	18
	Not sure	3
Man and Biosphere program impacts towards household plant preservation in HG	Yes	58.9
	No	3.3
Major Constraints of horticultural crop production	Disease or insects	12.78
	Wild animals destroyances	87.22
Horticultural crops seed/seedlings shortage in the area	Yes	63.90
	No	36.10
Contact with extension agents	Yes	42.86
	No	36.84
	Not sure	20.30
Market distances from the house	Market distances from the house mean 14.40KM;SD 7.82	
Horticultural crop price problem in the market	Yes	24.1
	No	71.4
	Not sure	4.5

As shown in Table 5 above, about 91.7% of the household heads interviewed in the sample were male, and the average age of the respondents was about 43, with a standard deviation of 7.23. The average family size per household was about eight. In terms of educational background, about 19.5% of the respondents had no formal education, 42.9 attended primary school (first cycle), and 30.1 attended the second cycle and secondary school. Most of the respondents (about 94%) worked in mixed farming (ie, crop production and animal husbandry). The average annual income of the respondents was about 31962.41 Ethiopian birr (ETB). Almost all respondents (98.5%) had horticultural crops in HG. However, the majority of respondents (63.90%) indicated that sufficient seeds / seedlings, mainly improved varieties, were not available for horticulture. In contrast, a significant proportion of respondents (about 79%) felt the need to grow and grow more horticultural crops than before. Therefore, we found that more horticultural crops acted as insurance for both family consumption and household income generation, mainly in years with low coffee yields. On average, 94% of respondents have lived in the area since birth. Therefore, about 97% of respondents had comprehensive information about her YCFBR. The majority of the respondents (72.9%) viewed that horticultural crop production in their HG is on an increasing trend. On the other hand, 47.4 have an annual income of 500-2000 EB per year from general HG components outputs.

Table 4: Socio-Economic Characteristics and Descriptive Results

Variables	ß	t	p
Constant		2.571	0.011
Sex	0.028	0.199	0.843
Age	-0.109	-1.630	0.106
Level of education	0.156	2.316	0.022
Marital status	-0.044	-0.317	0.752
Family size	-0.020	-0.343	0.733
Occupation type	-0.144	-2.347	0.021
Length of duration of residence in the area	0.082	1.382	0.170
Total landholding of the household	-0.011	-0.188	0.851
Land allocated for HG	-0.076	-1.247	0.215
Estimated annual income	0.014	0.234	0.816
Knowledge of the respondents on YCFBR	-0.126	-1.381	0.170
Desire to plant more horticultural crops and other plant trees in garden than had before 10 years	0.327	4.944	0.000
Man and Biosphere program impacts towards household plant preservation in HG of the area	0.070	0.704	0.483
Major Constraints of horticultural crop production	-0.001	-0.015	0.988
Horticultural crops seed/seedlings shortage in the area	0.075	1.226	0.223
Contact with extension agents	0.009	0.139	0.890
Market distances from the residence	0.069	1.079	0.283
Horticultural crop market price problem in the area	-0.576	-8.590	0.000

($R2 = 0.640$, Adj. $R2 = 0.583$ df = 18; $F = 11.249$, overall $P = 0.000$)

A multiple linear regression model (Table 6 above) showed that the sum of hypothetical variables results had a highly significant effect in demonstrating the trends of horticultural crop production in HGAFPs of the local farmers in the study area at p=0.000, and about 58% variance is explained based on locals' point of view. As revealed from their coefficients, sex (ß=0.028), age (ß = -0.109), level of education (ß =0.156), marital status (ß =-0.044), family size (=-0.020), occupation type (=-0.144), length of duration of residence in the area (ß = 0.082), total land of the household (=-0.011) land allocated for hg (ß = -0.076), estimated annual income (ß = 0.014) knowledge of the respondents on YCFBR (ß =-0.126), desire to plant more horticultural crops and other plant trees in garden than had before 10 years (ß =0.327), man and biosphere programs impact on household plant preservation in HG of the area (ß =0.070), major constraints of horticultural crop production (ß =-0.001), horticultural crops seed / seedlings shortage in the area (ß =0.075), contact with extension agents (ß =0.009), market distances from the house (ß =0.069) and horticultural crop market price problem in the area (ß =-0.576).

On the other hand, both occupation type and horticultural crop market price problem in local market have shown significantly negative views, which imply one can add some sort of other alternative activities such as local trade to his / her farming activities and similarly perceive lower price of horticultural crops in local market, which tended to have shown horticultural crop production trends decrement on his / her HG.

Again, the rest variables were sex, age, marital status, and family size, length of, duration of residence in the area, total land size, land allocated for Hg, annual income, knowledge of the respondents on YCFBR, impact of YCFBR on plant preservation, constraints of horticultural crop production, horticultural crop seed / seedlings shortage in the area, contact with extension agents and market distances from the household residence were shown insignificant contribution in indicating the respondents views on indicating trends of horticultural crops production in HGAFPs. Yet, they might contribute to the model. These findings disagree with the findings of Gbedomon *et* *al*. (2017), that state gender as the control factor of the functional type of garden for food production and medicinal purposes.

Most of the respondents believed horticultural crop production is being increased as a result of production market efficiency and they strongly agreed that their livelihood circumstances pulled them to sustain the production due to the crops sign determination of finance to the farming family with greater frequency of output in HG than in the others farming systems. At the same time, they confirmed that others HG component compositions are more or less in increasing condition, being inclined that more focus be given towards enriching the gardens for the reason that people entering the forest areas are frightened as they are already occupied and getting increasingly focused than before in the current time by man and biosphere reserve conservation program. Thus, a majority of the respondents expressed their interest and readiness to incorporate more horticultural crops, mainly fruit trees, of high value to their HG.

As hypothesized, the results revealed that there was a difference in the views of local people on the trends of horticultural crop production based on socio-economic variables. The results revealed that among the selected variables expected to affect the trends of horticultural crop production in HG, education level and households' desire to plant more horticultural crops and other plants in the garden than had before 10 years had a positive significant effect. This could be attributed to the fact that educated households with greater interest in planting more valuable plants may tend to have greater horticultural crops in the surveyed villages.

Age proved to have a negative effect on respondents' perception on trends of horticultural crop production. This could be explained by the exploration as household age has gone to the oldest stage, and the inactivity to incorporate more horticultural crop varieties in HG might decline. Hence, a garden managed by an older household head might show a little bit smaller horticultural crop diversity in HG than the one that managed by the youngest household head, even if the difference is insignificant statistically. The results also revealed that the level of education had a positive significant effect on their views on the trends of horticultural crop production. This could be due to the interest in planting horticultural crops and in attracting more newly emerging plant crops to their gardens and they might be probably know how they have the resources conservation and preservation in the garden.

Moreover, respondents who reflected a shortage of seeds or seedlings had positive views on trends of horticultural crop production. This could be attributed to the fact that, if improved varieties of horticultural crop seed / seedling supply are secured in the area, the trends of horticultural crop production would be enhanced . They will benefit from lack of money, for example, when there is low coffee yield for household income. However, family size and respondents who had enough chat and coffee plantation had negative effects on views of intensifying horticultural crops and diversifying components in HG. This could be attributed to the fact that when family size increases, households want to expand their agricultural land to seek more family food production and, thus, they are not interested in supporting the concepts man and biosphere reserve in place of resource preservation like YCFBR, which restricts getting access to the forest land for expanding agriculture. Moreover, those that had shortage coffee and chat plantations assumed that they could easily benefit from incorporating more horticultural crops into HG.

Furthermore, respondents that had a large family size, lived in the area for a long period of time, and inherited their land from their ancestors perceived various problems in production of horticultural crops due to increments in the number of wild animals in connection with the recent concerns on natural resources conservation in the area. Hence, finding mechanisms for saving production from these production destroyances by wild animals and more awareness creation is required about YCFBR program and the role of HG component diversification in compensating local resources needed from the surrounding forest.

Again, the results revealed that respondents with high annual income had positive attitudes towards incorporating horticultural crops or onhand farmers with low annual income favor intensifying Hg with cash crops like chat edulis and coffee arabica rather than diversifying HG components with many crop types . This is because they have less emphasis on incorporating horticultural crops and diversifying HG components by only considering its economic importance linked with cash crops, suggesting that the respondents need awareness about the different values of plant diversity preservation in HG.

Similarly, those respondents who had enough coffee plantation land had negative attitudes towards the concept of enriching HG with horticultural crops. One possible explanation is that it may depend on their income. Moreover, respondents who allocated considerable land for HG had less emphasis on diversifying HG with different multipurpose trees and this could be. They fear that the introduction of man and biosphere reserve in the area has inevitably maximized the wildaniamals destroying the horticultural crops, especially fruit production in HG of area. In addition, the lack of detailed information about the concept of YCFBR and its exceptional tangible provision to locals could be another possible reason.

Generally, the multiple linear regression model revealed that the examined variables had significant effects on indicating the trends of horticultural production in the area based on the attitudes of the local producers (about 58% variance explained) (Table 6).Additionally, the respondents' view on horticultural crop production trends in HGAF practices and/ or components as general, specifically can be positively influenced by increasing their knowledge on the role plant crop diversity in HG/ plant diversity preservation for livelihood improvements. More importantly, public awareness programs and conservation education can assist in improving the knowledge of local people towards increasing trends of horticultural crop production for both to boost valuable food sources of HG components and as well as its plant diversification. Concurrently, this could be taken as alternative way of compensating local resources needs in favor of biosphere reserve program effective implementation.

Generally, the multiple linear regression model revealed that the examined variables had significant effects on indicating the trends of horticultural production in the area based on the attitudes of the local producers (about 58% variance explained) (Table 6).Additionally, the respondents' view on horticultural crop production trends in HGAF practices and/ or components as general, specifically can be positively influenced by increasing their knowledge of the role plant crop diversity in HG/ plant diversity preservation for livelihood improvements. More importantly, public awareness programs and conservation education can assist in improving the knowledge of local people towards increasing trends of horticultural crop production for both to boost valuable food sources of HG components and as well as its plant diversification. Concurrently, this could be taken as alternative way of compensating local resources needs in favor of biosphere reserve program effective implementation.

3.2. Horticultural Crop Production Trends

Although this secondary data assessment was aimed to see different reports on the trends of both horticultural crops and coffee production changes in the district, there is no ample documented information found for the years before 2016, particularly for horticultural crops, except the last two years (2016 and 2017), as the report from the Agricultural office of the district. Still, the two year report showed a little increment in both horticultural crop yields along with its production area. However, the five years report of the Agricultural office of the district revealed that coffee production in the district showed annual production areas increased consecutively, while the annual production yield has been increasing with once flux in the year 2016 from reports of the five years (2013-2017).

Table 5: Horticultural Crops Production Area and Yield Changes of the District in Year 2016 And 2017

Year	Area in ha	Annual production Area change in ha	Area changes in %	Annual yield in (q)	Annual yield change in (q)	Annual yield change in %
2016	219.9			55448		
2017	223.15	3.25	1.48	57540	2092	3.77

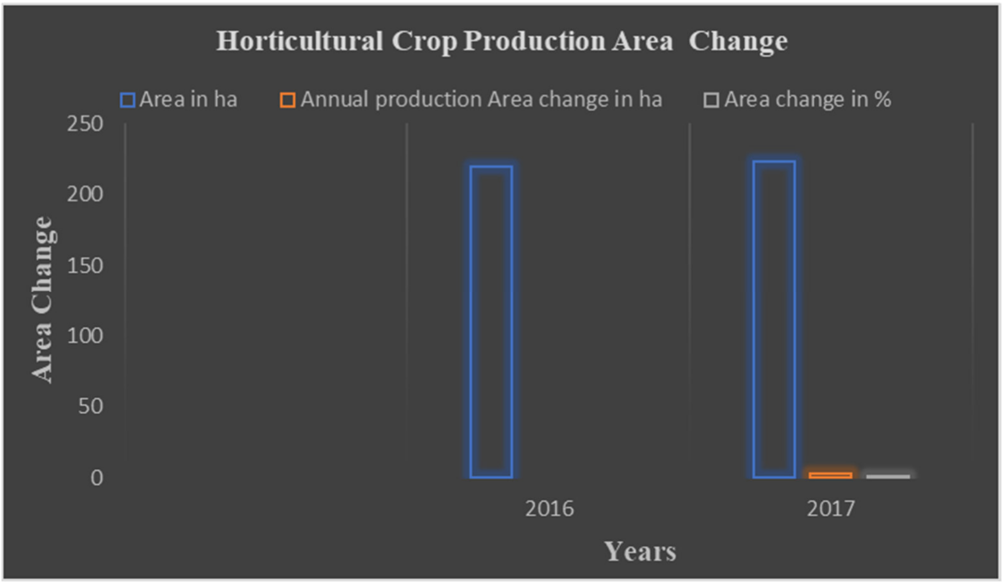


Figure 2: Horticultural Crops Production Area Changes of the District in Year 2016 And 2017
Data source: Reports from Chora District

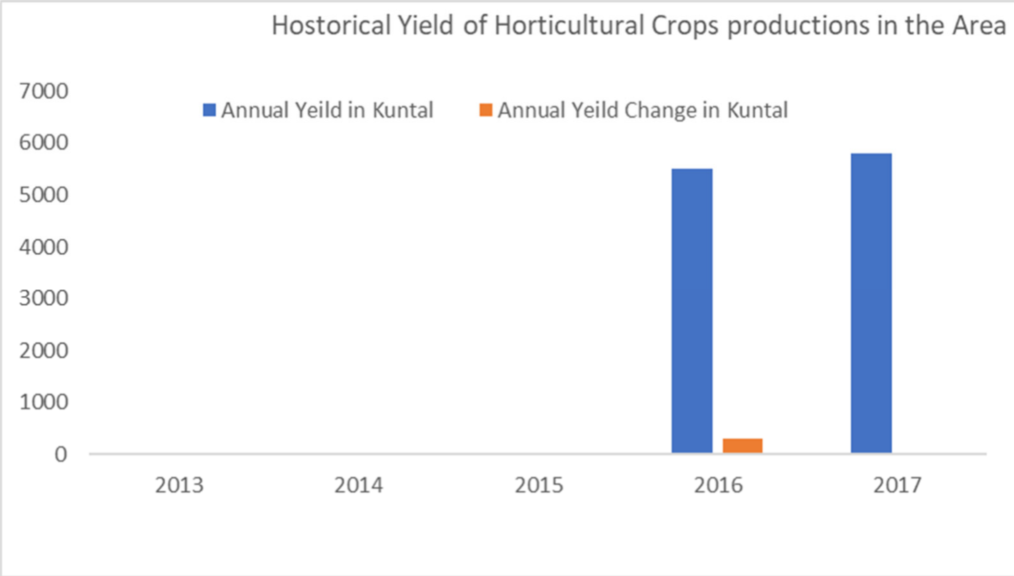


Figure 3: Horticultural Crops Production Yield Changes of the District in Year 2016 And 2017
Data source: Reports from Chora District

3.3. Coffee Production Trends

Table 6: Coffee production trends of the last five years in Chora district

Year	Area in ha	Area changes in ha	Area changes in %	Yield in (q)	Yield change in (q)	Yield change in %
2013	21957			18448		
2014	22861	904	4.21	62188	43740	237.10
2015	23839	978	4.28	159390	97202	156.30
2016	25350	1511	6.34	128324	-31066	-19.49
2017	29914	4564	18.00	156170	27846	21.70

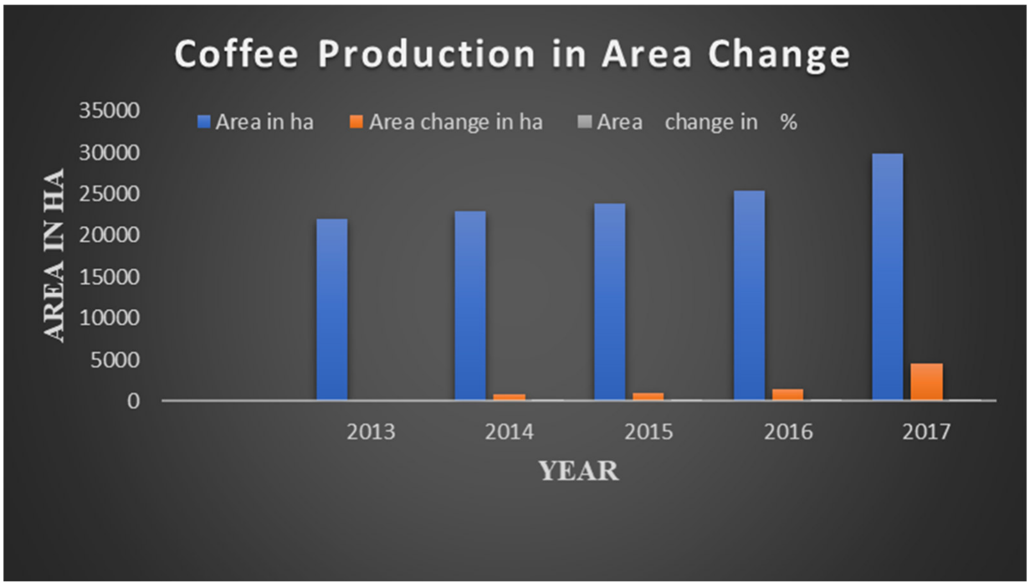


Figure 4: Coffee Production Area Changes of the Chora District for the last five years

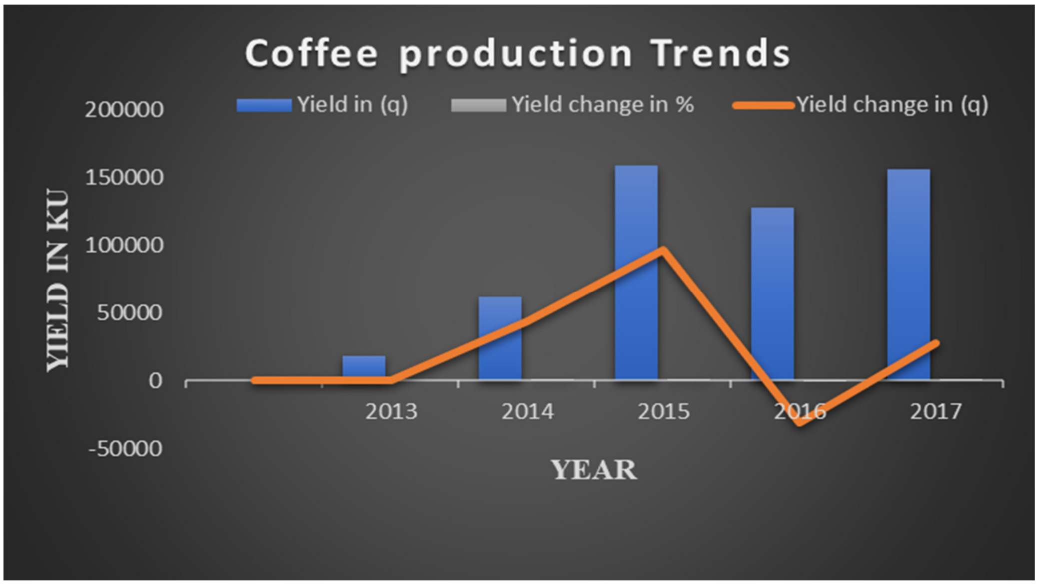


Figure 5: Coffee yield changes of the Chora District for the last five years
Data Source: Reports from Chora District

3.4. Analysis Of Floristic Diversity

3.4.1. Species Diversity in Homegardens

The survey of 133 households in the three villages (Sololo, Hawayember, and Uta to none) of Chora District indicated that all households were practicing homegardening with varying degrees of plant species diversity including horticultural crops of different varieties. HGs in the study area are contributing well enough for biodiversity conservation and local livelihoods through providing paramount outputs for various components of the practice such as fruit trees, multipurpose trees, vegetables and spice plants, roots and tubers, agricultural crops, medicinal plants, ornamental plants, shrubs, herbs, grasses etc.

3.4.1.2. Density and relative density

Density is the average number of individuals of a species on a unit area basis. It is closely related to abundance but more useful in estimating the importance of a species.

Density = Number of stems of a given species in the HG/ Total area of the 45 sample plots (4500m2)

Relative density is the number of individuals of a species as a percentage of the total number of individuals of all species in that HG.

Relative density = Density of a given species x 100/Total density of all species

For both the density and relative density of plant species of this study, the number of stems of species was found in the 45 plots of 45 HGs of the study area (the sample plot was 10 X10 or 100 m2).

Table 7: Ten plant species with the highest number of stems, density and relative density in the study area

Scientific name	Number of stems	Density	Relative density of Percentage (%)
Coffea arabica	1168	0.260	8.614
Ensete ventricosum	1132	0.252	8.348
Hypoetes trifolia	916	0.204	6.755
Brassica carinata	908	0.202	6.696
Maxxannee	692	0.154	5.103
Ethiopian candimon	640	0.142	4.720
Catha edulis	624	0.139	4.602
Colocasia esculenta	408	0.091	3.009
Brassica oleracea	392	0.087	2.891
Musa acuminata	364	0.081	2.684

Table 8: Species richness, diversity index, Shannon Wiener diversity index, and species evenness for each of the study sites

Study sites (Kebeles)	N is the total number of all species	Number of species (richness) (S)	Diversity index, D = S/N	Shannon Wiener index, (H')= - Σ Pi* lnPi	Species evenness (E)=H'/lnS
Hawayember	930	38	0.041	3.278	0.901
Sololo	1115	44	0.039	3.231	0.854
Uta None	1369	48	0.035	3.190	0.824

From the above diversity analysis (table 10), the highest value of Shannon index was found in Hawayember followed by Sololo and Uta None villages, respectively. This result revealed that in all three diversity measurements (diversity index, Shannon Wiener diversity index, and species evenness), Hawayember was the highest in species biodiversity following Sololo and Uta to none villages. This could be due to the proximity of the village to local town Chora either for services like different plant seed/seedlings variety supply for HG enrichment or relatively low problem of wildlife destroying HG plant crops as the two villages, Sololo and Uta None those are far away from the woreda town Chora, 12km and 25km respectively. This is supported by a study of Mitchell and Hanstad (2004) which state gardens are complex and may resemble ecological agricultural production systems that sponsor biodiversity conservation. The rich diversity and composition of species and the dense distribution of faunal and floral strata denote extraordinary features of HG ecology.

3.4.1.3. Frequency and relative frequency

Frequency (F) describes the distribution of a species through a stand. Frequencies were determined by calculating the percentage of plots/quadrats in a sample area on which a given species occurs. Frequency classes were calculated to estimate the heterogeneity and homogeneity of species by following Lamprecht (1989).

F = Number of HGs in which a species occurs x 100 /Total number of sampled

Relative Frequency (RF) is the distribution of one species in a sample relative to the distribution of all species. This was calculated by the formula:

RF = Frequency of a species in the HG A x 100 /Total frequency of all species in the sampled

Frequencies and relative frequencies were calculated for all identified plants from 45 representatives (HGs) and the results were used as inputs for computing frequency classes by grouping all species into four frequency classes. These frequency classes are: B = 61-80, C = 41-60, D = 21-40, E = 0-20, according to the recommendation suggested by Lamprecht (1989).

Table 9: Plant species with the highest frequency and relative frequency of occurrence in Chora district, HGs

S /No.	Scientific Name (English)	Local name (Afan Oromo)	Number of HGs in which a species occurs	Frequency	Relative Frequency	Frequency Class
1	Coffea arabica	Buna	32	71.11	7.60	B
2	Persia americana	Avokaadoo	23	51.11	5.46	C
3	Ensete vetricosum	Qoccoo	22	48.89	5.23	C
4	Catha edulis	caatii	21	46.67	4.99	C
5	Mangifera indica	Mangoo	17	37.77	4.04	D
6	Vernonia auriculifera	Reejjii	16	35.55	3.80	D
7	Papaya carica	Paappayyaa	14	31.11	3.33	D
8	Hypoetes trifolia	Derguu	13	28.88	3.09	D
9	Veninia amalgadalina	Eebicha	12	26.67	2.85	D
10	Brassica carinata	Raafuu Habashaa	11	24.44	2.61	D
11	Tragus berteronianus	Maxxannee	11	24.44	2.61	D
12	Ethiopian candimon	Kororiimaa	11	24.44	2.61	D
13	Gravelia robusta	Giraaviiliyaa	11	24.44	2.61	D
14	Colocasia esculenta	Goodarre	10	22.22	2.38	D
15	Annona reticulata L	Gishxaa	10	22.22	2.38	D
16	Justicia schimperiana	Dhummuugaa	10	22.22	2.31	D
17	Jacfruitii	Jacfruitii	9	20.00	2.08	E
18	Abiraangoo	Abiraangoo	8	17.78	1.85	E
19	Albizia gummifera	Ambabbeessa/ Mukarbaa	8	17.78	1.85	E
20	Musa acuminata	Muuzii	7	15.56	1.62	E

This study revealed that despite the occurrence of several species in the studied sites, only a few of them occur at a higher frequency. As shown in the above Table 11 (not all species are indicated), Coffea arabica (7.60%)

and Persia americana (5.46%) appear to be species of higher relative frequency that occurred in 32 and 23 of the 45 HGs respectively. Similarly, among those species that occurred in the higher frequency classes, Coffea arabica and Catha edulis were the most familiar cash crop species of the area. While Persia americana and Mangefera indica were among the most prominent fruit tree species followed by Vernonia auriculifera and Veninia amalgadalinashrubs in the area. This finding is supported with the findings Regassa (2016) from HG of Hawassa, Ethiopia, stating that the majority of food crops cultivated and used by the HG owners are fruit species like Papaya (Carica papaya), Banana (M. paradisiaca), Avocado (P. americana), Guava (Pisdium guajava), Mango (M. indica), and Roman (Punica granatum).Similarly, the above findings are in line with the findings of (Dagar and Tewari, 2017) stating that the main structural arrangements in most HGs are primarily coffee mixed with trees and shrubs, fruit trees or planted in strips, or planted as a boundary and fence, edges of plots and fields mainly for coffee shades, and live fence.

On the other hand, this study was found out that Catha edulis is one of the top five most abundant HG component species in the area. This imply that farmers of Chara District are giving priority to grow cash crops such as Catha edulis in their HGs that could be considered as one of the recent days HGs' plant diversity impairing factors. And this could be more importantly regarded to the destroyances by wildlife to other food crops in the system in which horticultural crops are highly exposed to. This result is supported by a similar study conducted in Jibithenan District, Ethiopia, which showed that Catha edulis as one of the top five most abundant species in HGs, and consequently, as reported by Mekonen *et al*. (2015), HG owners focus to grow cash crop by neglecting other beneficial crops could reduce the diversity of species managed in HGs.

A total of 79 species were recorded in the study site. The HG species of the study sites can be grouped in four life forms; trees, shrubs, herbs, and climbers (Figure 8). More specifically, among the recorded 79 species, 22 (28%) were found to be trees, 19 (24%) were shrubs, while the rest 33 (42%) and 5 (6%) recorded species were respectively herbaceous and climbers. This is also lined with the findings of Panda *et al*. (2018), which state that the grand total number of common plant species comprising perennials, annuals, seasonal medicinal plants, and live fence plants differed significantly among various holding sizes.

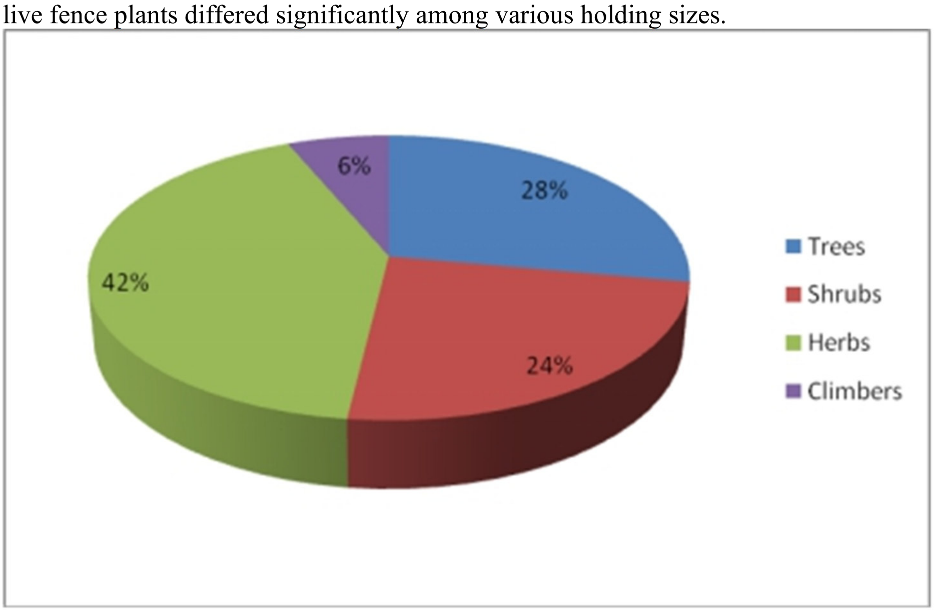


Figure 6: HG Component Categories in the Chora District

3.4. Functional groups of plants in Chora District

3.4.1. Horticultural Crop Diversity in HGs of Cora District

Among the total 79 species recorded, 16 are fruit trees and 5 vegetables, 13 spices, and six root and tuber plant species while the remaining six species were other crops like pulse, cereals, and cash crops. Again, the greater proportion of identified plant species were included under the others plant category encompassing herbs, shrubs, climbers, and trees for different purposes (Appendix 8).The majority of these horticultural crops (food and nutrition plants) were fruits and vegetables that are cultivated throughout the year and directly used for food and nutrition sources. Furthermore, from this biophysical assessment, 4 major horticultural crop categories were found in the HG of the study site, of which 16 (20.25%) fruits trees, 5 (6.33%) vegetable crops, 13 (16.46%) species 6 (7.59%), root and tubers, and the remaining 39 (49.37) were trees, shrubs and other crops such as cereals, pulses, cash crops and etc. This result is in line with the findings of Aragaw (2017) in Yayo area, stating that from the plants used for food crops in the about 8% of the species were used for their multiple edible parts (leaves, stems, fruit and seeds, stem and young shoots.

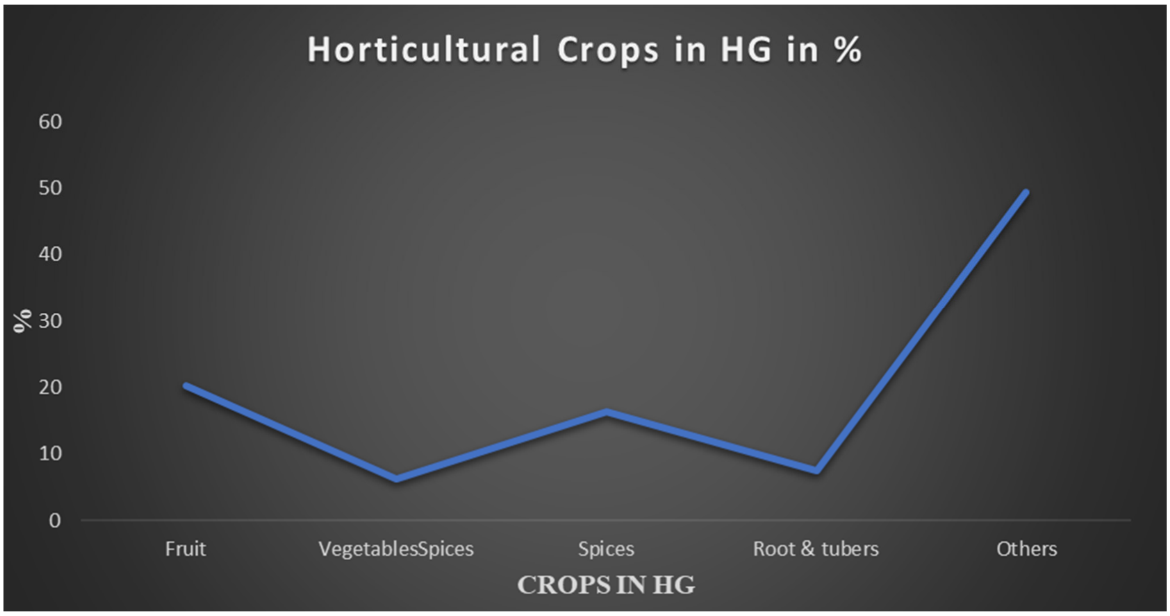


Figure 7: Proportion of overall trees and herbaceous species of HGAF in Chora district

3.4.2. Current Trends Of Horticultural Crop Production in Chora District

Results from biophysical assessments confirmed those assessment through semistructural interviews from selectively sampled concerned stakeholders' views on production trends of horticultural crops in HG. Meaning that even though the weight of HG components balanced to cash crop production in few cases, with recently appearing facts showed more or less increments in horticultural crops, mainly that are newly introduced fruit tree species like jackfruit and apple in the area. Yet, this could probably imply that the need to give more focus on future HG management aspects mainly regarding plants diversity preservation.

Table 10: Some of plant families with the highest number of edible fruit crops in Chora

Family name	Number of species	Tree	Shrub	Herb	Climber
Anacardiaceae	1	1	0	0	0
Caricaceae	1	1	0	0	0
Musaceae	1	0	1	0	0
Myrtaceae	1	1	0	0	0
Rosaceae	2	1	1	0	0
Moraceae	1	1	0	0	0
Annonaceae	1	1	0	0	0
Rutaceae	6	6	0	0	0
Lauracea	1	1	0	0	0
Asteraceae	1	1	0	0	0

As shown in the above table, the highest fruit tree species are found in the family of Rutaceae (Citrus sinensis, Jacfruit, Citrus aurantiifolia, Citrus reticulata, Citrus medica and Citrus aurantiifolia) where as the rest fruit crop families contain single species of which all are a tree growth form except one extra shrub species under Rosaceae family. This is either could be because of agro, climatic attribute of the area that is selectively favoring this family, or lack of owner practice due to the insufficiency of different production inputs such as seeds or seedlings of diverse varieties in the area.

3.5. Conclusions and Recommendations

3.5.1. Conclusions

Examining the trends of horticultural crop production and plant diversity in HGAFPs is crucial for both biodiversity conservation and socioeconomic aspects. In this study, the survey conducted in selected households revealed that horticultural crop production in HG of Chora district has been affected by several socio-economic variables as indicated by the multiple linear regression model.

At the same time, the results of the diversity measurements showed that almost all even distribution of species in the area, which included 42% herbaceous species, 28% woody trees, 24% shrubs, and 6% climbers. Again, four major horticultural crop categories were found in the HG of the study site, of which 16 (20.25%) fruit trees, 5 (6.33%) vegetable crops, 13 (16.46%) species 6 (7.59%), roots and tubers, and the remaining 39 (49.37) were trees, shrubs and other crops such as cereals, pulses, cash crops and etc. However, due to the low level of local knowledge on conservation program aspects and production, hindering constraints like wildaniamals, shortage of improved seed supply, and relatively high demand for major cash crops, particularly coffee and chat expansion in the area, the horticultural crops production and others plant diversity in HG of the future would have a fear of decline in the practice.

3.5.2. Recommendations

➢ The present study did not discuss any alternative opportunities for improved horticultural crop seed / seedling varieties supplied to the locals, mechanisms to reduce horticultural crop production that has been destroyed by wildaniamals, and enabling local farmers to production and productivity of the crops. Thus, based on the findings of this study, the following recommendations are suggested:

- ❖ Enhancing market linkage between concerned dealers on the issues of sustained horticultural crop production yield in the HGAFPs is required.
- ❖ Further study is highly recommended and needed to find available opportunities in supplying improved varieties of horticultural crop seed / seedlings and
- ❖ Finding alternative solutions for horticultural crop producers with production hindering factors, such as wildlife and etc would be necessitated.
- ❖ Improving locals' awareness of HG biodiversity preservation roles and related concerns of YCFBR program in the area should be crucial.

4. REFERENCES

Abebe, T., Wiersum, K.F. and Bongers, F., 2010. Spatial and temporal variation in crop diversity in agroforestry homegardens of southern Ethiopia. *Agroforestry systems*, **78(3):** 309-322

Abiot and Gonfa. (2015). Woody Species Diversity in Traditional Agroforestry Practices of Dellomenna District, Southeastern Ethiopia: Implication for Maintaining Native Woody Species. *International Journal of Biodiversity,* (January)

Alam, M., Olivier, A., Paquette, A., Dupras, J., Revéret, J.P. and Messier, C., 2014. A general framework for the quantification and valuation of ecosystem services of tree-based intercropping systems. Agroforestry systems, **88(4)**: 679-691

Alexandratos, 1995. World Agriculture: Towards 2010. An FAO Study. New York: FAO and John Wiley and Sons

Ashley, R., Russell, D. and Swallow, B., 2006. The policy terrain in protected area landscapes: challenges for agroforestry in integrated landscape conservation. Biodiversity & Conservation, **15(2):** 663-689

Balachandhran, 2007. IN BIOSPHERE RESERVES GUIDELINES AND PROFORMAE.

Bekele, R., 2014. Agrobiodiversity in the Homegardens of Bishoftu Town, Oromia National Regional State, Ethiopia.

Berkes, F., 2012. *Sacred ecology*. Routledge.

Beyene, 2014. Centre for Geo-Information Thesis Report GIRS-2014-16 ASSESSING THE IMPACT OF UNESCO BIOSPHERE RESERVES ON FOREST COVER CHANGE

Bijalwan, A., Upadhyay, A.P. and Dobriyal, M.J., 2015. *International Journal of Current Research in Biosciences and Plant Biology*. Int. J. Curr. Res. Biosci. Plant Biol, **2(6):** 214-217

Bradbury, I.R., Hubert, S., Higgins, B., Borza, T., Bowman, S., Paterson, I.G., Snelgrove, P.V., Morris, C.J., Gregory, R.S., Hardie, D.C. and Hutchings, J.A., 2010. Parallel adaptive evolution of Atlantic cod on both sides of the Atlantic Ocean in response to temperature. *Proceedings of the Royal Society of London B: Biological Sciences*, ***277*(1701):** 3725-3734

Broadman, H.G., 2006. Africa's silk road: China and India's new economic frontier. World Bank Publications.

Brooks, K., Zorya, S., Gautam, A. and Goyal, A., 2013. Agriculture as a sector of opportunity for young people in Africa

Bruinsma, J., 2009, June. The resource outlook to 2050: by how much do land, water and crop yields need to increase by 2050. In *Expert meeting on how to feed the world in* (Vol. 2050, 24-26).

Calloconcha, D. (2017). Working Paper 161, (November). doi:10.13140/RG.2.2.34833.74086

CBD, 2006. Convention on Biological Diversity (CBD). 2006. Global Biodiversity Outlook 2. www.biodiv.org/GBO2 (accessed Nov 2008). Elevitch,. , (October)

Chandra, S., 2006, November. Tropical root crops: strategies for sustainable development and food security. In *Book of Abstracts of the 14th Triennial Symposium of International Society for Tropical Root Crops,* ***20*** **(251)**

Chappell, M.J. and LaValle, L.A., 2011. Food security and biodiversity: can we have both? An agroecological analysis. *Agriculture and Human Values*, ***28*(1):** 3-26

Chomicki, G. and Renner, S.S., 2016. Obligate plant farming by a specialized ant. *Nature plants*, ***2*(12)**: 16-18

Cramer, V.A., Hobbs, R.J. and Standish, R.J., 2008. What's new about old fields? Land abandonment and ecosystem assembly. *Trends in Ecology & Evolution*, ***23*(2)**: 104-112.

Dickinson, R.E., 2013. City, region and regionalism: a geographical contribution to human ecology. Routledge

ECFF, 2015. Vegetation of the Yayo forest in SW Etiopia: impacts of human use and implications for in situ conservation of wild Coffee arabica L. populations. Ecology and Development Series 10, 2003, Cuvillier Verlag Göttingen.

Ekong, 2015. Putting banana-coffee intercropping research into action. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen. Banana Systems in the Humid Highlands of Sub-Saharan Africa, **63(1):** 85–93

Eshete, 2013. Eshete, G.T., 2013. Biodiversity and livelihoods in southwestern Ethiopia: Forest loss and prospects for conservation in shade coffee agro ecosystems (Doctoral dissertation, University of California, Santa Cruz).

Etissa, E., Weldemariam, T., Teshome, A. and Gonfa, T., 2016, September. Tropentag 2016, Vienna, Austria September 18-21, 2016. In Conference on International Research on Food Security

FAO, 2011. Social and economic development. Unasylva, **237(62)**:10–25 (available at http://www.fao.org/docrep/013/i2015e/i2015e02.pdf), (April)

Fitzsimmons, M.I., 2013. UNIVERSITY OF CALIFORNIA SANTA CRUZ ETHIOPIA : FOREST LOSS AND PROSPECTS FOR CONSERVATION IN SHADE COFFEE AGROECOSYSTEMS A dissertation submitted in partial satisfaction of the requirements for the degree of Getachew Tadesse Eshete September 2013 The Diss

Flanagan, J., Bolton, D., Pettit, T., Stanton, C., Murphy, P., O'Brien, L. and Carton, O.T., 2008. The Five Scenarios

Frison, E.A., Cherfas, J. and Hodgkin, T., 2011. Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability*, ***3*(1):** 238-253

Galhena, D.H., Freed, R. and Maredia, K.M., 2013. Homegardens: a promising approach to enhance household food security and wellbeing. *Agriculture & Food Security*, ***2*(1):** 8

Galluzzi, G., Eyzaguirre, P. and Negri, V., 2010. Homegardens: neglected hotspots of agro-biodiversity and cultural diversity. Biodiversity and conservation, **19(13):** 35-36

Gbedomon, R.C., Fandohan, A.B., Salako, V.K., Idohou, A.F.R., Kakaï, R.G. and Assogbadjo, A.E., 2015. Factors affecting Homegardens ownership, diversity and structure: a case study from Benin. *Journal of ethnobiology and ethnomedicine*, ***11*(1):** 56

Gbedomon, R.C., Salako, V.K., Fandohan, A.B., Idohou, A.F.R., Kakaï, R.G. and Assogbadjo, A.E., 2017. Functional diversity of Homegardens and their agrobiodiversity conservation benefits in Benin, West Africa. *Journal of ethnobiology and ethnomedicine*, ***13*(1)**: 66

Gillespie, J., 2012. Buffering for conservation at Angkor: questioning the spatial regulation of a World Heritage property. *International Journal of Heritage Studies*, ***18*(2):** 194-208

Giovannucci, D., Scherr, S.J., Nierenberg, D., Hebebrand, C., Shapiro, J., Milder, J. and Wheeler, K., 2012. Food and Agriculture: the future of sustainability

Giovannucci, D., Scherr, S.J., Nierenberg, D., Hebebrand, C., Shapiro, J., Milder, J. and Wheeler, K., 2012. Food and Agriculture: the future of sustainability

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C., 2010. Food security: the challenge of feeding 9 billion people. *Science*, ***327*(5967)**: 812-818

Gole, T.W., Borsch, T., Denich, M. and Teketay, D., 2008. Floristic composition and environmental factors characterizing coffee forests in southwest Ethiopia. *Forest Ecology and Management*, ***255*(7):** 2138-2150

Gopinath, K.A., Saha, S., Mina, B.L., Pande, H., Srivastva, A.K. and Gupta, H.S., 2009. Bell pepper yield and soil properties during conversion from conventional to organic production in Indian Himalayas. *Scientia horticulturae,* **122(3):** 339-345

Gray, D.E., 2013. Doing research in the real world. Sage

Haileslassie, A., Peden, D., Gebreselassie, S., Amede, T. and Descheemaeker, K., 2009. Livestock water productivity in mixed crop–livestock farming systems of the Blue Nile basin: Assessing variability and prospects for improvement. *Agricultural Systems*, ***102*(1-3)**: 33-34

Herrero, M., Thornton, P.K., Power, B., Bogard, J.R., Remans, R., Fritz, S., Gerber, J.S., Nelson, G., See, L., Waha, K. and Watson, R.A., 2017. Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *The Lancet Planetary Health*, ***1*(1)**: 33-e42

Hess, T.M. and Molatakgosi, G., 2009. Irrigation management practices of cabbage farmers in Botswana using saline groundwater. *Agricultural water management*, ***96*(2):** 226-232

Hirpa, A., Meuwissen, M.P., Tesfaye, A., Lommen, W.J., Lansink, A.O., Tsegaye, A. and Struik, P.C., 2010. Analysis of seed potato systems in Ethiopia. *American journal of potato research*, ***87*(6)**: 537-552

Hodgkin, 2001. Homegardens and the maintenance of genetic diversity. In: Watson JW, Eyzaguirre PB (eds) Proceedings of the second international Homegarden workshop. Bioversity international, Rome, Italy. , 14–18.

Hopkins, A. and Holz, B., 2006. Grassland for agriculture and nature conservation: production, quality and multi-functionality. *Agronomy research*, ***4*(1):** 3-20

Hubert, B., Rosegrant, M., Van Boekel, M.A. and Ortiz, R., 2010. The future of food: scenarios for 2050. *Crop*

Science, ***50*(1):** 32-33

Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G. and Jamnadass, R., 2014. The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability, 6: 138-147.

Jamnadass, R., Place, F., Torquebiau, E., Malézieux, E., Liyama, M., Sileshi, G., Kehlenbeck, K., Masters, E., McMullin, S. and Dawson, I., 2013. *Agroforestry, food and nutritional security.*

Joshi, 2011. CLASS NOTE OF SFB 602 : AGROFORESTRY Prepared by : Murari Raj Joshi

Kathmandu Forestry College (KAFCOL) P . O . Box : 9594 Koteshwork , Kathmandu Nepal June 2011.

Kebede, T.M., 2010. Homegardens agrobiodiversity conservation in Sebeta-Hawas Wereda, southwestern Shewa Zone of Oromia Region, Ethiopia (Doctoral dissertation presented at Addis Ababa University, Ethiopia)

Kothari, C.R., 2004. *Research methodology: Methods and techniques*. New Age International.

Kumar and Nair, 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Environmental Experts, India Mcneely. , 1–9.

Kumar, B.M. and Nair, P.R., 2004. The enigma of tropical homegardens. *Agroforestry systems*, ***61*(1-3):** 135-152

Lamprecht, H., 1989. Silviculture in the tropics: tropical forest ecosystems and their tree species: possibilities and methods for their long-term utilization (No. 634.95 L239s ing.). Eschborn, DE: GTZ

Laurance, W.F., Sayer, J. and Cassman, K.G., 2014. Agricultural expansion and its impacts on tropical nature. *Trends in ecology & evolution*, ***29*(2)**, 107-116

Lavers, T., 2012. 'Land grab'as development strategy? The political economy of agricultural investment in Ethiopia. *Journal of Peasant Studies*, ***39*(1)**, pp.105-132

Leach, G. and Mearns, R., 2013. Beyond the woodfuel crisis: people, land and trees in Africa. Routledge

Lebot, 2010. TROPICAL ROOT AND TUBER CROPS Vincent.

Lindenmayer, D.B., Franklin, J.F., Lõhmus, A., Baker, S.C., Bauhus, J., Beese, W., Brodie, A., Kiehl, B., Kouki, J., Pastur, G.M. and Messier, C., 2012. A major shift to the retention approach for forestry can help resolve some global forest sustainability issues. *Conservation Letters*, **5(6):** 421-431

Lope-Alzina, D.G. and Howard, P.L., 2012. The structure, composition, and functions of homegardens: focus on the Yucatán Peninsula. *Etnoecológica*, **9(1)**: 17-41

Magurran, A.E. and McGill, B.J. eds., 2011. *Biological diversity: frontiers in measurement and assessment*. Oxford University Press.

Matthews, M. and Jack, M., 2011. *Spices and herbs for home and market*. FAO.

Mattsson, E., Ostwald, M., Nissanka, S.P. and Pushpakumara, D.K.N.G., 2015. Quantification of carbon stock and tree diversity of homegardens in a dry zone area of Moneragala district, Sri Lanka. *Agroforestry systems*, ***89*(3)**: 435-445

McNeely and Scherr, 2003. McNeely J.A. and Scherr S.J. Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity. Island Press, Washington

McNeely, J.A. and Schroth, G., 2006. Agroforestry and biodiversity conservation–traditional practices, present dynamics, and lessons for the future. *Biodiversity & Conservation*, ***15*(2),** 549-554

Mekonen, T., Giday, M. and Kelbessa, E., 2015. Ethnobotanical study of homegarden plants in Sebeta-Awas District of the Oromia Region of Ethiopia to assess use, species diversity and management practices. *Journal of ethnobiology and ethnomedicine*, ***11*(1):** 64.

Melkegna, T.H., Chaubey, A.K., Beyene, G.A., Bitewlign, T.A., Jonah, S.A., Ahmed, Y.A.A. and Abubakar, N., 2017. Multi elemental analysis of indigenous food spices in Southern Ethiopia using INAA technique. *Journal of Radioanalytical and Nuclear Chemistry*, ***314*(2):** 917-921

Mitchell R, Hanstad T: Small Homegarden Plots and Sustainable Livelihoods for the Poor. Rome, Italy: LSP Working Paper 11; 2004

Montgomery, D.C., Peck, E.A. and Vining, G.G., 2012. *Introduction to linear regression analysis* (Vol. 821). John Wiley & Sons

Murray, J.M., 2009. Far Above Our Poor Power to Add or Detract": National Park Service Administration of the Gettysburg Battlefield, 1933–1938." Civil War History 55.1 (2009): 56-81. Agriculture, Ecosystems and Environment, **107(1)**: 1–19.

Nair, P.R., 2008. Agroecosystem management in the 21st century: it is time for a paradigm shift. *Journal of Tropical Agriculture*, ***46*:** 1-12.

Odum, 1971. Fundamentals of ecology. W.B. Saunders and Co. Phiadelphia, *Bioscience*, ***35*(7)**: 419-421.

OFFICINALE, E.O.F.Z., 2016. *ADDIS ABABA INSTITUTES OF TECHNOLOGY SCHOOL OF CHEMICAL AND BIO ENGINEERING* (Doctoral dissertation presented at Addis Ababa University).

Panda, N. K., Bhol, N., & Nayak, A. (2018). Spatio temporal arrangement of plants and livestock in the Homegardens of coastal Odisha, *7*(1), 814–819

Panda, S.K. and Ray, R.C., 2016. Fermented Foods and Beverages from Tropical Roots and Tubers. *Tropical Roots and Tubers: Production, Processing and Technology*, 225.

Peet, R.K., 1974. The measurement of species diversity. *Annual review of ecology and systematics*, ***5*(1):** 285-307

Quandt, A.K., 2010. Agroforestry Potential on Household Lands Outside the Mt. Hanang National Forest Reserve, Tanzania: Forest Conservation And Livelihood Implications (Doctoral dissertation presented at the University of Montana Missoula)

Rawal, N., 2016. ECONOMICS OF VEGETABLE BASED CROPPING SYSTEM IN KHARGONE DISTRICT OF MADHYA PRADESH (Doctoral dissertation, RVSKVV, Gwalior MP.

Rees, 2007. INDIGENOUS FRUIT TREES IN THE TROPICS Domestication, Utilization and Commercialization

Robinson, S., Thomas, S.M. and Toulmin, C., 2010. Food security: the challenge of feeding 9 billion people. science, **327(5967):** 812-818.

Root Crops, 20–26 Nov. 2006. p. 251. Thiruvananthapuram, India: Central Tuber Crops Rese. International Journal of Food Science and Technology, **44(6):** 1073–1087

Schwab, N., Schickhoff, U. & Fischer, E., 2015. Transition to agroforestry significantly improves soil quality: A case study in the central mid-hills of Nepal. Agriculture, Ecosystems and Environment, 205, 57–69. Available at: http://dx.doi.org/10.1016/j.agee.2015.03.004

Shackleton, S., Delang, C.O. and Angelsen, A., 2011. From subsistence to safety nets and cash income: exploring the diverse values of non-timber forest products for livelihoods and poverty alleviation. In *Non-timber forest products in the global context* **(55-81)**. Springer, Berlin, Heidelberg.

Shafer, C.L., 2015. Cautionary thoughts on IUCN protected area management categories V–VI. *Global Ecology and Conservation*, *3* 331-348.

Shannon, C.E., 1948. Bell System Tech. J., 27: 379, 623 CE Shannon, W. Weaver. *The Mathematical Theory of Communication*.

Sthapit BR, Ramanatha Rao V, S.S., 2011. Tropical Fruit Tree Species and Climate Change,

Sthapit, B., Ramesh, V., Villupanoor, P., Rajan, S., Arsanti, I.W., Idris, S., Somsri, S., Lamers, H. and Rao, V.R., 2016. On-farm/In Situ Conservation of Tropical Fruit Tree Diversity: Emerging Concepts and Practices1. *Indian Journal of Plant Genetic Resources*, *29*(3), pp.285-288.Stoltzfus, 2011. Determinants of Agroforestry Practicing at Fogera District, Northwestern Ethiopia. Journal of Agriculture and Ecology Research International, **9(4):** 1–14. Available at: http://www.sciencedomain.org/abstract/16459.

Sthapit, Bhuwon, Resham Gautam, and Pablo Eyzaguirre. "The value of home gardens to small farmers." In *Home Gardens in Nepal: Proceeding of a workshop on" Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons learned and policy implications", 6-7 August 2004, Pokhara, Nepal. LI-BIRD, Bioversity International and SDC. Local Initiatives for Biodiversity*, vol. 324, p. 8. 2006.Gedefa, B., 2015. For sustainable production and utilizations of wheat in sub humid areas in Western Oromia in Sayo and Chora districts

Strang, 2010. Root Crops, 4–7.

Stringer, G., 2017. " Frack Off!" Strategic Framing in Colorado's Grassroots Challenge to Oil and Gas.

Sunwar, S., Thornström, C.G., Subedi, A. and Bystrom, M., 2006. Homegardens in western Nepal: opportunities and challenges for on-farm management of agrobiodiversity. *Biodiversity & Conservation*, ***15*(13)**: 4211-4238

Susila, A.D., Purwoko, B.S., Roshetko, J.M., Palada, M.C., Kartika, J.G., Dahlia, L., Wijaya, K., Rahmanulloh, A., Mahmud, R., Koesoemaningtyas, T. and Puspitawati, H., 2012. Vegetable agroforestry systems in Indonesia. World Association of Soil and Water Conservation and Nairobi, World Agroforestry Centre, Bangkok

Swallow, B., Boffa, J.M. and Scherr, S.J., 2006. The potential for agroforestry to contribute to the conservation and enhancement of landscape biodiversity. *World agroforestry into the future. World Agroforestry Centre (ICRAF), Nairobi*, pp.95-101.

Tadesse, 2003. Local Institutions and their Influence on Forest Resource Management in Southwest Ethiopia: The Case of Yayo Forest A.

Tadesse, M., 2010. Living with adversity and vulnerability. Adaptive Strategies and the Role of Trees in Konso, Southern Ethiopia. Department of Urban and Rural Development. Swedish University of Agricultural Sciences. Uppsala.

Talemos, S., Sebsebe, D. and Zemede, A., 2013. Homegardens of Wolayta, southern Ethiopia: An ethnobotanical profile. Acad. J. Med. Plants, **1(1):** 14-30.

Talukder, A., Haselow, N.J., Osei, A.K., Villate, E., Reario, D., Kroeun, H., SokHoing, L., Uddin, A., Dhunge, S. and Quinn, V., 2010. Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Lessons learned from scaling-up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines). *Field Actions Science Reports. The Journal of Field Actions*, (Special Issue 1)

Tesemma, 20007. Profitable agroforestry innovations for eastern Africa: experience from 10 agroclimatic zones of Ethiopia, India, Kenya, Tanzania and Udganda **(388).** Nairobi, Kenya. World Agroforestry Center

Teshome, A. and Dürr, J., 2016, September. Tropentag 2016, Vienna, Austria September 18-21, 2016. In *Conference on International Research on Food Security*.

Tewabech, T. and E., 2014. The Flora make- up and agroforestry practices in backyard in Hiwane, Hintalo Wejerat of Tigray, Northern Ethiopia, International Journal of Agroforestry and Silviculture, vol.1, no.9, pp. Socio-ecological. , (November), 101–109

Uddin and Mukul, 2004. Improving Forest Dependent Livelihoods through NTFPs and Homegardens: A Case Study from Satchari National Park. Nutrition Bulletin Vol. 8 Issue 1, **3(6):** 80–86.

van Asten, P., Ochola, D., Wairegi, L., Nibasumba, A., Jassogne, L. and Mukasa, D., 2015. Coffee-banana intercropping: Implementation guidance for policymakers and investors

Van Ittersum, M.K., Ewert, F., Heckelei, T., Wery, J., Olsson, J.A., Andersen, E., Bezlepkina, I., Brouwer, F., Donatelli, M., Flichman, G. and Olsson, L., 2008. Integrated assessment of agricultural systems–A component-based framework for the European Union (SEAMLESS). *Agricultural systems*, ***96*****(1-3):** 150-165

Vermeulen, S.J., Aggarwal, P.K., Ainslie, A., Angelone, C., Campbell, B.M., Challinor, A.J., Hansen, J.W., Ingram, J.S.I., Jarvis, A., Kristjanson, P. and Lau, C., 2012. Options for support to agriculture and food security under climate change. *Environmental Science & Policy*, ***15*****(1):** .136-144

Wiersum, 2004. Forest gardens as an intermediate land-use system in the nature-culture continuum: characteristics and future potential. Agroforestry, 101–115.

Woldemariam, 2015. Environment and Coffee Forest Forum Coffee : Ethiopia ’ s Gift to the World The traditional production

Wondimagegnhua, B.A., Nischalkeb, S., Alebachewa, M.A. and Beucheltb, T., 2016, September. Tropentag 2016, Vienna, Austria September 18-21, 2016. In *Conference on International Research on Food Security*

Zimik, L., Saikia, P. and Khan, M.L., 2012. Comparative study on homegardens of Assam and Arunachal Pradesh in terms of species diversity and plant utilization pattern. *Research Journal of Agricultural Sciences*, ***3*****(3)**: 611-