Agriculture, Forestry and Fisheries
2022; 10(2): 76-81
http://www.sciencepublishinggroup.com/j/aff
doi: 10.11648/j.aff.20221102.12
ISSN: 2328-563X (Print); ISSN: 2328-5648 (Online)

Role of Homegarden Agroforestry Practice in Climate Change Adaptation in Aleta Chuko Woreda, Sidama Region, Southern Ethiopia

Belachew Tunsisa*, Kedir Erbo, Alemnew Muchie

Ethiopian Biodiversity Institute, Hawassa Biodiversity Center, Hawassa, Ethiopia

Email address:

belachewtunsisa26@gmail.com (B. Tunsisa)

*Corresponding author

To cite this article:

Belachew Tunsisa, Kedir Erbo, Alemnew Muchie. Role of Homegarden Agroforestry Practice in Climate Change Adaptation in Aleta Chuko Woreda, Sidama Region, Southern Ethiopia. *Agriculture, Forestry and Fisheries*. Vol. 10, No. 2, 2022, pp. 76-81.
doi: 10.11648/j.aff.20221102.12

Received: January 28, 2022; **Accepted**: February 24, 2022; **Published**: March 29, 2022

Abstract: Indeed, the adverse effects of climate change are already evident in resource poor countries including Ethiopia. Southern Ethiopia is known with favorable environment for homegarden agroforestry (HGAF) Production practices. This study aimed at examining the role of HGAF practice in climate change adaptation in Aleta Chuko woreda, Southern Ethiopia. Multi-stage sampling procedures have used to select sample households. Data were collected from adopter and non-adopter categories of HGAF practice with similar socioeconomic background. A total of 141 households (68 adopters and 73 non-adopter) were involved in the household survey. The result revealed about 95% of the respondents observed the change in rainfall in the past three decades, whether decrease, late-onset or early cessation. While 87.3% of respondents perceived an increase in temperature. Farmers' adaptation strategies to climate change in the area context were soil and water conservation, application of inorganic fertilizer, use of small-scale irrigation and improved crop type were the tactical responses to climate change adaptation in the two adoption categories. It revealed that adoption of HGAF practice exhibit significance difference in terms of adaptation of climate change and sustaining of food security among the two adoption categories. From the result of analysis, access to credit and extension service, educational status, family size and membership of cooperative group shows statistically significant association in adoption of HGAF practices. The study concludes that policies that prioritize interventions to maximize the opportunities for climate change adaptation through HGAF system should been established in the context of the area.

Keywords: Adopter, Climate Change, Home Garden Agroforestry, Livelihood, Precipitation, Temperature

1. Introduction

Climate change notably; rising temperature, changes in precipitation are real, and its effects adversely affect ecosystem, biodiversity and people in the world [2]. Currently, the adverse effects of climate change are already apparent in developing countries including Ethiopia. Without any doubt, agricultural activity is the mainstay for livelihood sustainability in Ethiopia in all fronts. Large percentages of the Ethiopian population (80%) depend upon agriculture for their livelihoods and contribute 42-45% of the total GDP of the country [16]. Despite its role, agricultural activity highly affected by climate change effects recently. Rainfall variability and associated drought have been the major cause of food shortage and famine in Ethiopia [11]. Therefore, this calls for agriculture intensification with adaptation strategies particularly the homegarden agroforestry practice [10]. Homegarden agroforestry is a special category of agroforestry that accommodates trees, crops and animal husbandry around homestead [8]. In Aleta Chuko woreda was little known in detailed empirical researches, documentation and publication of major findings pertaining to the role of homegarden agroforestry system in climate change adaptation. According to Gezehagn *et al* [6], a study conducted only regarding value chain analysis of pineapple (*Ananas comosus*) production and marketing from traditional agroforestry system in Aleta Chuko *woreda*. This study provides platform information for the farmers' perception on climate change and analyze trends of rainfall and temperature, describe farmers' adaptation strategies to climate change. Also, this particular study carried out role of homegarden agroforestry practice to climate change adaptation and identify factors that affect the adoption of homegarden agroforestry practice.

2. Materials and Methods

2.1. Study Area Description

The study was carried out in Aleta Chuko woreda former Sidama Zone Southern Ethiopia. Geographically, Aleta Chuko woreda were situated between latitude of 5°45'N to 6°45'N and longitude of 38°E to 39°E [4]. Regarding soil types, the area mostly pronounced with Luvi soil to Nito soils on undulating land to steeping land.

2.2. Sampling and Data Collection Method

A multi-stage sampling procedure was practiced to select adopter and non-adopter households. At first stage, out of 18 *kebeles* found in study area, two *kebeles (Dibicha & Gambela kebele)* were selected purposively due to presence of adopters and non-adopters of homegarden agroforestry. In this particular study, adopter was defined as a farmer who established and integrated various woody perennials, herbaceous crops and animals. Then, a list of homegarden agroforestry adopter and non-adopter household heads in the selected *kebeles* were obtained from the *woreda* and *kebele* administration offices. Then, the total sample size was determined for adopters and non- adopters separately.

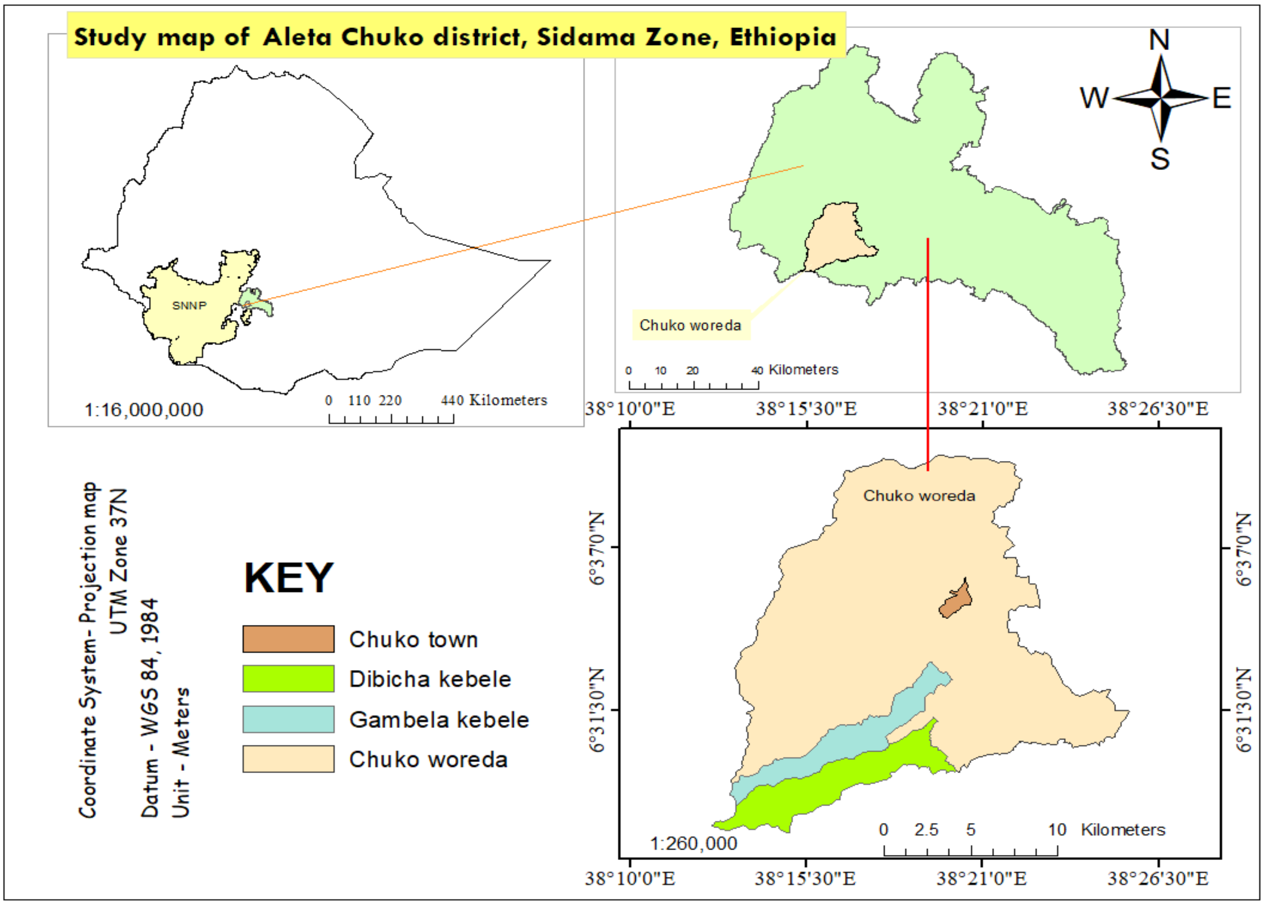

Figure 1. *Map of the study area.*

Accordingly, the number of sample households for both adopter, and non-adopter of the target population at 92% confidence level and 0.08 (8%) level of precision were determined by using a simplified formula provided by Yamane (1967) and reviewed by Israel [7];

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

Based on the above formula to get the sample size: $n=\frac{1405}{1+1405(0.08)^2}$ =141. Therefore, 141 sample respondents were selected to conduct this particular problem. Moreover, household survey, focus group discussion, key informant interview, and field observation as well.

2.3. Methods of Data Analysis

Descriptive statistics, inferential statistics like chi-square (χ^2) and sample t-test were used. Besides, Mann-Kendall (MK) test through XLSTAT16 software.

2.4. Econometric Approach

In these particular research problems, Logistic regression model also another tool that was engagement. The Logistic regression model was employed when the dependent variable is a dichotomy and the independent variables are of any type [9]. Suppose Y is the dependent variable, it can take either value of 1 (one) or 0 (zero) depending on the homegarden agroforestry system adoption. If Pi is the probability of i^{th} farmer to adopt homegarden agroforestry system. Then, the logistic regression model for estimating the probability of adopting a homegarden agroforestry practice (Pi) was specific as follows;

$$\Pr(Y=1) = Pi = \frac{1}{1+e^{-zi}} = \frac{e^{zi}}{1+e^{zi}} \quad (2)$$

Similarly, the probability of i^{th} farmer not to adopt homegarden agroforestry practice was shown as;

$$1-pi = \frac{1}{1+e^{zi}} \quad (3)$$

3. Result and Discussion

3.1. Households Perception on Climate Change and Trends of Temperature and Rainfall (1983-2016)

Farmers of the study area well perceived climate change trends. According to survey result, 123 (87.3%) of respondents perceived an increase in temperature while 13 (9.2%) perceived that temperature was decreasing over the study period, but 5 (3.5%) of respondents perceived no change in temperature. This was consistent with the study finding of Solomon Abirdew [14] reported that out of 179 respondents 82%, 6% and 12% were feeling increasing, decreasing and no change in temperature respectively. As observed from key informants and focus group discussants, there is a change not only in the total amount of rainfall but in the timing of the rains, with rain coming either earlier or later than expected and with rain ceases before the normal time. According to Mann-Kendall, test statistics result, the annual temperature trend from 1983-2016 exhibits an increasing pattern by a factor of 0.089°C $year^{-1}$. Hence, the increment showed statistically significant with $p<0.05$. The result of current study contradicts with study findings of Solomon Abirdew [14]. The annual maximum temperature at Aleta Chuko woreda showed an increasing trend by a factor of 0.08°C per year (table 1). Besides, the annual average maximum temperature reveals statistically significant trend ($p<0.05$). The results of this study agree with household's perceptions and key informant interview individuals (KII). Moreover, the results of this study agree with the findings of Awetahegn Niguse [1], Illala station Tigray Region even if there is a figurative difference.

Table 1. *Mann-Kendall trend statistics for annual minimum and maximum temperature.*

Parameters	Years	Sen's slope	Kendall's tau	Mk statistics (s)	p-value	α
Annual av. minimum temperature	33	0.089	0.708	374	<0.0001***	0.05
Annual av. maximum temperature	33	0.08	0.669	353	<0.0001***	0.05

***, shows significant at 0.05 level of significance.

Besides, in the study area annual and seasonal rainfall trend had been conducted. Based on Mann Kendall test statistics result, the annual and seasonal rainfall reveals a decreasing pattern during the period from 1983-2016. The annual, kremit (summer) and Belg (spring) rainfall shows a decreasing pattern by an amount of 1.26, 0.949, and 0.41mm $year^{-1}$ respectively (table 2). The result of annual rainfall probability value showed non-significant trend ($p>0.05$). This implies the negative trend over the study area is statistically insignificant with significance value greater than 0.05. Hence, this entails that there is no trend for rainfall over time. The present study is conformity with Telemu Kassile [15], about trend analysis of monthly rainfall data in central zone. Also, present finding was consistent with the study finding of Conway *et al* [3] in the central Ethiopian highlands, reported that non-significant and unclear trends of annual rainfall. Similarly, the probability value of kremit rainfall does not reveal statistical significant (P=0.701). In the study area, the households' livelihood activity mostly relied on kiremt rainfall to sustain their livelihoods indeed. Thus, due to deficit of kiremt rainfall farmers faced climate change incidence. The finding of the present study consistent with the study finding of Selesh Yilma and Zanke [13], reported that kiremt rainfall variability, which is directly affecting agricultural production over most parts of Ethiopia. Besides, the trend of the parameter shows statistically insignificant in the time series (p=0.302). This study result is in agreement with findings of Solomon Abirdew [14], who reported that the trend of belg rainfall exhibits a declining pattern in Indibir station, Gurage zone by a factor of 2.23.

Table 2. *Mann-Kendall trend statistics for annual and seasonal rainfall.*

Parameters	Years	Sen's slope	Kendall's tau	p-value	ά- value
Annual	33	-1.26	-0.061	0.634	0.05
Kremit	33	-0.949	-0.049	0.71	0.05
Belg	33	-0.41	-0.129	0.302	0.05

3.2. Local Farmers Adaptation Strategies to Climate Change

The households in the study area manage the effects of climate change-driven forces through different ways. From the household survey result, extension agent and person to person contribute a role to create awareness about adaptation to climate change. According to area context, the most adaptation strategies to climate change were soil and water conservation (SWC) and agronomic practices such as intercropping, specifically homegarden agroforestry, use of diversified and improved crop types, application of inorganic fertilizer and practicing of small-scale irrigation (SSI). In case of adopter households, 80.3% of the respondents indicated that they are aware of climate change adaptation and have implemented at least one in the past. From the total households of non-adopter member counterparts, only 20.6% the respondents reported having knowledge of adaptation options while 79.4% of them have no any experience concerning the adaptation measures. This indicates that non-adopter household heads have limited access to information in adaptation access compared with the adopter households. The chi-square (χ^2) result revealed that there is a significant difference in awareness of adaptation strategies between the two adoption categories at 1% significance level.

3.3. Role of Homegarden Agroforestry Practice to Climate Change Adaptation and Food Security

In fact, homegarden agroforestry practice plays an important role households adaptation to climate change. In the study area, the households confirm that homegarden agroforestry practice play an incredible role in agro-ecosystem service by providing raw material for compost production. Eventually, this practice increases the fertility of soil for long period thereby reducing adverse climate change hazards. In addition, sampled households believed that homegarden agroforestry accommodate a variety of components than non-tree based system, hence risk was lower in contrary to later practice. Ewuketu Linger [5] supported this finding, about agro-ecosystem and socio-economic role of homegarden agroforestry in Jabithenan District, North-Western Ethiopia: implication for climate change adaptation. The finding reported that homegarden agroforestry practice has diverse component than a non-tree based garden, thus risk was lower in homegarden agroforestry. Adopter households in the area produced compost from the raw material including weeds, grasses, crop residues and tree leaves that are available within a homegarden agroforestry. KIs and FGDs assured that using homegarden agroforestry for compost production enhances soil fertility status to a minimum of three years and a maximum of four years in addition to soil moisture conservation while rainfall shortage occurs. On the other hand, non-adopter households did not have the option to get compost resources in order to improve soil fertility during climate change occurred. This is due to their limited production potential of homegarden agroforestry. In addition, KIs unanimously agreed that non-adopter household has rarely relied on homegarden agroforestry due to system needs immense human workload including irrigating and managing whole year. Hence, the chi-square test result (χ^2) revealed that there is a significant difference in getting compost sources to improve soil fertility between the two adoption categories at 1% significance level.

Household's compost sources from homegarden agroforestry system.

Table 3. *Household proportion of organic fertilizer from homegarden agroforestry system.*

Compost sources	Adopters		Non-adopters			
	Frequency	**Percent**	**Frequency**	**Percent**	χ^2	**p-value**
Yes	43	63.24	25	34.24	9.594	0.002***
No	25	36.76	48	65.76		
Total	68	100	73	100		

***shows significant variation at 1% significance level across the Role of Homegarden agroforestry practice to livelihood security.

Respondents assure that fruit trees primarily serve for food especially in case difficult times of drought. In the study site, *Ananas comosus*, *Persea americana* and *Mangifera indica* have a good market in addition to their role in food source comparing with the rest. This present finding supports the study finding of Gezehagn *et al* [6], about value chain analysis of pineapple *(Ananas comosus*) production and marketing from traditional agroforestry in Aleta Chuko *woreda,* Southern Ethiopia. The finding reported that pineapple serves as emergency guaranty during the failure of annual crops to climate change. Mengistu Fentahun [11] also confirms that fruit trees from homegarden agroforestry have significant role during environmental crisis of households by climate change hazards. In the study area, from adopter households especially children's consume fruit trees. This implies that adopter household's dependency on homegarden agroforestry largely to avert climate change impacts. In contrary, non-adopter household members have no other substitution food items to save cereal crops for difficult time, and so the vulnerability becomes higher than adopter categories. Therefore, the chi-square test result revealed that there is a significant difference between the two adoption categories in household food security at 1% significance level.

Household's food security from homegarden agroforestry practice in the study area.

Table 4. *Role of cash crop tree for household's food security from agroforestry practice.*

Food security	Adopters		Non-adopters		χ^2	p-value
	Frequency	Percent	Frequency	Percent		
Yes	45	66.2	25	34.25	11.934	0.001***
No	23	33.8	48	65.75		
Total	68	100	73	100		

***shows significant variation at 1% significance level across the row
Source: field survey, 2019.

3.4. Econometric Model Result

Based on area context, 10 explanatory variables hypothesized to influence the adoption of homegarden agroforestry practice, five variables were found significantly influence the probability of adoption of homegarden agroforestry practice in the study area. The results of logit model revealed that homegarden adoption decision has influenced significantly by educational status, frequency of contact with extension agent, access to credit, membership in cooperative group, and family size. Moreover, all significant variables have positively influenced the adoption of homegarden agroforestry practice in the model.

4. Conclusion and Recommendation

Currently, the effect of climate change has been the most challenging agenda in the world. In the study area, the climate change parameters exhibit irregular pattern substantially. Notably, temperature and rainfall shows an increasing and decreasing pattern according to Mann-Kendal test statistics. Without any doubt, farmers should diversify homegarden agroforestry practice in order to halt climate change problems. In the study area, the practice of homegarden plays a lion share to combat climate change effects rather than mono-cropping practice. Therefore, government and other concerning body should work on issues of consortium to resilient the adverse effects of climate change effects.

Acknowledgements

Above all, I would like to thank the Almighty God who made this paper possible. It‘s my honor to express my sincere gratitude to my main advisor Menfese Tadesse (Ph.D.) for his invaluable comments and excellent supervision. I am also very much grateful to Hawassa biodiversity center staff who helped me in providing genuine and relevant information. Finally, I would like to take this opportunity to thank my all friends for sharing ideas and encouraging me to work hard from the starting to ending of this paper work.

References

[1] Awetahegn Niguse. 2016. Precipitation and temperature trend analysis in Mekelle city, Northern Ethiopia, the case of Illala Meteorological Station. *Journal of earth science and climatic change* 7 (1): 324p.

[2] Case, M. 2006. Climate change impacts on East Africa: A review of scientific literature.

[3] Conway, D., Mould, C. and Bewket Woldeamlak. 2004. Over one century of rainfall and temperature observations in Addis Ababa, Ethiopia. *International Journal of Climatolog* 24 (1): 77-91.

[4] CSA (Central Statistical Agency). 2007. Central Statistical Agency Population and Housing in Ethiopia. Addis Ababa.

[5] Ewuketu Linger. 2014. Agro-ecosystem and socio-economic role of homegarden agroforestry in Jabithenan District, North-Western Ethiopia: implication for climate change adaptation. *Springer Plus* 3 (1): 154.

[6] Gezehagn Gessesse, Zerihun Demrew and Tariku Olana. 2019. Value Chain Analysis of Pineapple (Ananas Comosus) Production and Marketing from Traditional Agroforestry System, Southern Ethiopia. *Food Science and Quality Management* 84: 1-10.

[7] Israel, 2012: Israel GD, Determining Sample Size. Available at http://edis.ifas.ufl.edu/pd006. Accessed: December 7, 2012.

[8] Kumar, BM and Nair PKR. 2004. The enigma of tropical homegardens. *Agroforestry systems* 61: 135-152.

[9] Leech, N. L., Barrett, K. C. and Morgan, G. A. 2005. SPSS for Intermediate Statistics, Use and Interpretation. 2nd Edition, Lawrence Erlbaum Associates Inc., Mahwah.

[10] Luedeling E, Kindt R, Huth NI and Koenig K. 2014. Agroforestry systems in a changing climate: Challenges in projecting future performance. Current Opinion in Environmental Sustainability 6: 1-7.

[11] Mengistu Fentahun. 2008. Fruit tree species in the wild and in homegarden agroforestry: species composition, diversity and utilization in western Amhara region, Ethiopia. Doctoral dissertation. University of Natural Resources and Applied Life Sciences, Vienna. 198p.

[12] Salvatore Y, Gunnar K, Ringler C. 2012. Estimating the impact of climate change on agriculture in low income countries: Household level evidence from the Nile basin Ethiopia. *Environmental and Resource Economics* 52 (4): 457-478.

[13] Selesh Yilma and Zanke, U., 2004. Recent changes in rainfall and rainy days in Ethiopia. *International Journal of Climatology: A Journal of the Royal Meteorological Society* 24 (8): 973-983.

[14] Solomon Abirdew. 2017. Analysis of climate variability for maize (*zea mays l.*) production and characterization of local farmers' perception in Abshege *woreda*, Gurage Zone, Ethiopia. M.Sc. Thesis. Haramaya University, Ethiopia. 96p.

[15] Telemu Kassile. 2013. Trend analysis of monthly rainfall data in central zone. *Journal of Mathematics and Statistic* 9 (1): 1-11.

[16] Zeleke G., Mekonnen A., and Kassahun M. M. 2011. Crop–Livestock Interlinkages and Climate Change Implications on Ethiopia's Agriculture: A Ricardian Approach. Unpublished research, Environmental Economics Policy Forum for Ethiopia, Addis Ababa.