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ORIGINAL RESEARCH ARTICLE

Perceived Impacts of Climate Change on Food Systems in Small-Scale Farming Communities of Arsi and East Shewa (Oromia region), Ethiopia

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ABSTRACT

Weather variability has long affected food systems in small-scale farming communities, constraining seasonal food availability and contributing to food shortages at global and local levels. This study assessed farmers' perceptions of climate change impacts on the food system. Quantitative data were collected from 410 randomly selected farmers (200 from highland and 210 from lowland communities) and analyzed using descriptive statistics and Poisson regression. Most highland (59.0%) and lowland (60.5%) respondents reported a moderate negative impact on household food self-sufficiency; 59.0% and 55.2%, respectively, reported a moderate negative impact on food security. In highland communities, 31.5% and 32.0% reported low negative impacts on food self-sufficiency and food security, whereas 35.2% and 42.9% of lowland respondents reported high negative impacts, respectively. Only 37.5% of highland households and 9.0% of lowland households could meet food needs for 11–12 months from their own farms. Poisson regression indicated a positive association between food self-sufficiency and adoption of climate-smart agricultural practices, while drought frequency was negatively associated with food self-sufficiency. The findings underscore the importance of climate-smart agriculture and locally tailored policies for reducing climate-related impacts on household food systems.

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1. INTRODUCTION

The frequency and intensity of disasters related to climate change which usually recognized in the form of droughts at community level are commonly increasing an adverse impact on food security and food self-sufficiency. In this context, climate change associated disasters have the potential to devastate farm business and community assets leading to food insecurity (WFP, 2012). According to this report, climate change have already affecting the production of some staple crops and predicted further aggravate of risks in the coming future. In this regard, the higher temperature and reduced rainfall frequently affect both crop quantity and quality along the entire course of agricultural production value chain.

In congruent to food crops production, substantial crop model simulation results and integrated evaluation performed during the last decades identify a consistent overall small impact at global level in the first half of 21st century but turn progressively more negative after second half of the century, as average temperatures elevate beyond 2.5–3°c continentally and globally during the respective cropping seasons (CRGE, 2011). In this aspect, aggregated crops yield change estimation model have projected significant impact of climate change on cereal crops' yield in 2080 for selected countries, while 21% reduction in yield was predicted for Ethiopia based on baseline year yield (Tubiello, 2014).

Accordingly, an indicated reduction estimation assigned Ethiopia 5th position in the world (more than 20% reduction), coming after four countries at global level, whereas the remaining 10 other countries were found below 20% reduction or positive impacts of climate change at global scale (ibid). In this regard, significant number of study conducted in Ethiopia reported more significant proportion of households exposed to food shortage falling to fulfill from own agricultural sources as the result of climate change impacts and related consequences. For instance, Arega (2013), revealed that about 86% of households in Amhara region of Ethiopia are a net purchaser of 50% households' annual food demand for about six months which majorly caused by weather variability. The same author asserted 74% food insecurity in similar region, while of total sample households only 26% were found food secure in the study community. On the other hand, although various initiatives have been adopted by Ethiopian government to reduce negative impacts of natural disasters, impacts of climate change are significantly worsening from time to time affecting livelihood of the rural households including food system which is practically pronounced by limitation of adequate study to support the current efforts (NMA, 2007).

In this regard, except some few areas, location specific studies on estimating overall impacts of climate change implication to Food systems are inadequate. According to several studies, for instance, Mulatu et al., (2016), this is a notable gap that is yet to be sufficiently researched in the country in general and study community in particular. Specifically, selected areas specific studies in context of climate change implication on food systems and effects of adaptation strategies for reducing climate change negative impacts are limited and the concerns of this research is to identify the location specific climate change impacts which helps to set and design priority initiatives to promote efficient and effective strategic practices into farming systems.

Accordingly, the research was conducted to characterize the location specific climate change implication to food systems in comparison between the two different agro-ecologies of the study areas. Specifically, the study was aimed to assess perceived impact of Climate change and weather variability on households' food self-sufficiency and food security among small scale farming communities in selected highland and lowland districts of Arsi and East shewa zones, Oromia region, Ethiopia.

2. MATERIALS AND METHODS

2.1 Description of the Study Areas

The study was conducted in the catchment of Awash River which borders Arsi and East shewa Zones of Oromia Region (**Figure 1**). Specifically, East shewa is characterized by dry and arid climatic conditions with an abundant water source to conduct farm practices, more widely vegetable production (Gezai, *et al*, 2020). Differently, Arsi zone is characterized by four major biophysical divisions which include cool, cool temperate, warm temperate and warm lowlands agro-climatic zones (Tamirat, 2019). In summary, due to diverse set of agro-ecological zonation, Arsi zone is dominantly characterized by moderately cool (40%) and cool (34%) annual temperature (Adisu, *et al.*, 2020). Based on the nature of local weather condition, mixed farming system dominates the livelihood of the zones and land is an important asset of households for crops and livestock production. In this regard, many evidences reveal that due to strong inter-linkage between crop and livestock farming, it is difficult to consider the two livelihoods separately and the inter-linkages are related to manure production, traction power, fodder production, and income diversification.

Though mixed farming is the dominant livelihood system in the study areas, there are some arid and semi-arid areas that are predominantly pastoralist and perennial crop livelihood systems are common in the region in general and study zones in particular. Discouragingly, environmental degradations are abundant in the most part of the study areas as the result of frequent cultivation and climate change is commonly affecting the livelihoods of the farm households consequently food systems.

Specifically, Bosati and Dudga districts were selected from East Shewa, while Hetossa and Tiyo districts were from Arsi Zone representing lowland and highland communities, respectively. These four districts are located in the central rift valley (CRV) of Oromia region, where the negative influence of climate changes is severe affecting livelihoods of the local community leading to food insecurity.

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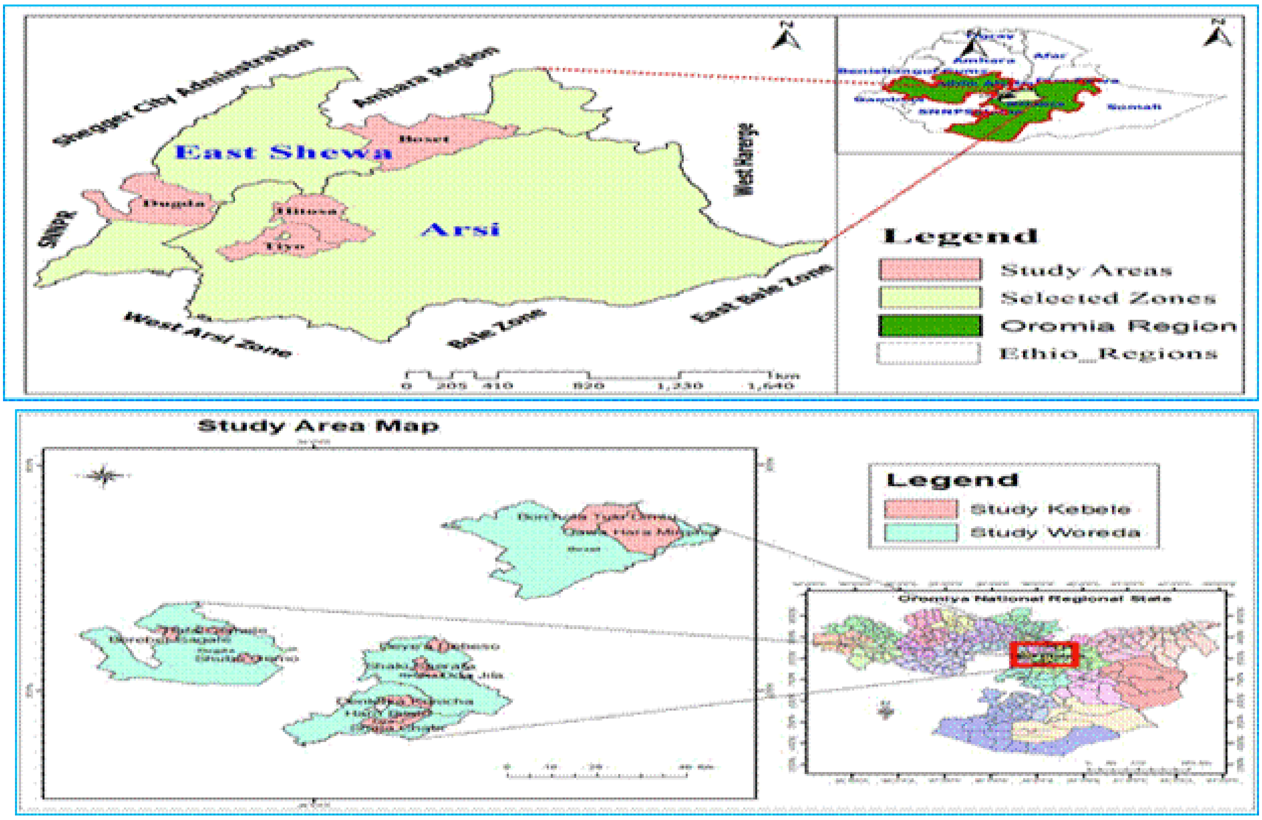

Fig. 1. Map of the study areas, showing the selected zones and districts (developed by the author using ArcGIS).

Topographically, the altitude of these two zones ranges from 500-3200 meters above sea level (masl), but the study has been conducted in the low land part of the east Shewa and relatively highland districts of Arsi zones, where majorly data were analyzed separately to describe the variation along with agro-ecological variability and aggregated only for Poisson regression analysis.

The highland has temperate and cold climate which locally called "*Badda",* ranges from 2300-3200 masl, midland which are warm, locally called "*Badda-daree"* ranges from 1500 to 2300 masl, and lowland are hot and arid areas which are locally termed as "*Gamoojjii"*, ranges from 500 to 1500 masl in the study zones. In spite of continuous prevailing drought in these areas, like most part of Ethiopia, there are three distinct seasons with two rainy seasons and one dry season. In view of this scenario, rainy *s*eason, which is locally known as "*Ganna"*, is the main rainy season, which occur from June to mid of September and early short rain season, traditionally referred as "*Arfaasaa*" is the small rainy season which takes place from February to May in each cropping year.

On the other hand, the main dry season, locally termed as "*Bona" is* the dry season of the year which commences in October and ends in January of the following year. In this aspect, the short rain and main rainy seasons contribute nearly 31% and 56% of the annual rainfall. Generally, main rainy season *(ganna) is* the main agricultural production season in Ethiopia in general and in Oromia region in particular including the study community.

2.2 Sampling Procedure and Data Collection

To acquire a reliable data for empirically grounded results and conclusions, a clear research framework which guides the methods, decisions and sets the basis for interpretation concerning the intended research problem has established at the early stage of the study. In this regard, the study was involved a structured interview in which ultimately generates the quantitative primary raw data. The target population of the study was rural community of Arsi and East shewa zones of the Oromia region and these two zones were selected purposively to represent highland and lowland agro-ecologies, where respondents of Arsi and East shewa zone were selected to represent highland and lowland agro-ecology, respectively.

Within the zones, the districts were sub-categorized into two major categories based on prevailing altitudes which are mid-highland and highland in the case of highland agro-ecology and dry and semi dry in the case of lowland context. Given the differences in agro-ecology of the study areas within the districts, stratified random sampling method was used for sampling. Two districts were selected from each zone using random simple sampling, whereas the selected districts were sub-divided into three sub-categories based on the similar criterion established for districts selection, but emphasizing on farming practices. Accordingly, the sample size required from each Peasant Association (PA) was calculated based on formula adopted from Singh and Masuku (2014) which can be stated as follow (Equation 1).

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

Where, N is total population in the selected Peasant Association (PAs), which is 10,156 households; n is desired sample size and e is required level of precision, which was set as 5% along with 95% confidence interval. In this scenario, 5% significance level was selected based on its potential capacity to decrease marginal error as compared to other levels and sample size generated at this level is manageable and appropriate to realize with manageable cost in context of financial limitation. Accordingly, the required minimum sample size is approximately estimated to be 385 which was established as starting bench mark to define sample size. Specifically, three Peasant Associations (PAs) locally termed as "*Ganda*" were randomly selected from each study district representing each of the study communities' and agro-ecology.

Based on the above presented formula, it was planned to include 385-420 households in the survey, whereas 410 respondents (200 highland and 210 lowland respondent) were managed to be included in the survey and available best alternative of all sampling frame was the list of farmers registered in registration sheets found in each PA offices, where farmers were selected randomly from the list of the community members.

In brief, a total of twelve PAs were selected (three from each four Districts) and then simple random sampling method was used to select the respondents for face-to-face structured questionnaire interviews to generate quantitative primary data. The sample size allocation and sex distribution for each agro-ecology and PA were performed based on the proportion of the each category in the total population obtained from sample frame. In addition to structured interview, existent study findings and literatures review were comprehensively conducted in context of climate change impacts on food availability and accessibility at global and national scale to compare and contrast field data result implication.

2.3 Methods of Data Analysis and Management

2.3.1 Descriptive Statistics

The main objective of the study is to analyze the perceived impact of climate change on food supply system in smallholder farming system in context of the study community. In this regard, the first major component of the research was completed during quantitative data collection using structured questionnaire. Based on the objectives of the study, the appropriate analytical tools and techniques were selected and employed against each variable and study context, where among the analytical techniques; descriptive statistics were widely used for almost all study variables and indicators. Accordingly, the collected data were content analyzed, cleaned, coded and categorized based on the patterns of the data following key themes as outlined in the interview guide and entered into selected Statistical Package for Social Sciences (SPSS) computer program.

Consequently, descriptive statistical techniques were used extensively for the majorities of the data presented in this paper along with predictive statistical techniques. In brief, the descriptive statistical techniques were widely employed to analyze perceived Food self-sufficiency, Food security, level of climate change impact on food systems, drought frequency and socio-demographic characteristics of the respondents in context of study community. The descriptive statistical analysis were mainly emphasized to generate means, frequency (absolute and relative frequency) and test statistics (majorly Chi-Square test) in context of selected variables using measure of frequency and cross-tab techniques, where the outputs of the data analysis were summarized and presented in the table format for quantitative interpretation.

2.3.2 Predictive Model Specification

In Addition to descriptive statistics discussed above, Poisson regression model was selected and employed on agro-ecologically aggregated (Merged) data to determine the determinants of households' seasonal food self-sufficiency in the study community, where the model have specified according to the below shown formulae (Equation 2). In context of this study, food self-sufficiency level was estimated by the number of the households covering yearly food demand for household members from households own agriculture related sources out of twelve months of the year.

Specifically, number of households covered household's food demand for specified months categories (3months, 6months, 9months and 12months) from households' agriculture related food sources has been taken as a response variable (events occurred during each category of the years), while socio-economic and weather (specifically perceived drought frequency) are defined and considered as predictors (independent variables) in Poisson Regression model analysis and estimate. In this regard, the respondents were managed by the enumerators to assign his/her household in one of the categories (number of months assumed household is food sufficient) in each year based on seasonal production of food crops from household farm considering past ten years into account.

For the Poisson regression analysis purpose, households' socio-economic characteristics were adequately identified and collected in the course of survey process to make result meaningful and precise estimate. The Poisson regression model described by Yang and Berdine (2015) was selected among a range of models available in the literature environment. According to this author and many more documents, count data follow a Poisson distribution which is positively skewed and Logarithmic transformation can linearize the distribution, thus the link function is log. The log outcome rate is then expressed as a linear function of a set of predictors (ibid). Thus, based on this author, Poisson regression model selected for this study mathematically can be expressed as:

$$log_e(\mu_i) = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \cdots + \beta_k\chi_k \quad (2)$$

Where β_0 is the vector (intercepts) reflects the amount of change in the logarithm of predicted number of events when no change in each X_k predictor (independent variable) included in the specified model and $\beta_1 \ldots\ldots B_k$ are the coefficient of the predictors used to estimate the probability of change in the log of response variable as the result of change in particular predictor, while $X_1 \ldots\ldots X_k$ are predictors selected and included in the model. Moreover, the independent socio-economic, agro ecology and Climate Smart Agriculture Practices (CSAP) were identified and selected for regression analysis, where perceived drought frequency among weather related parameters (commonly considered as primary indicator for climate change at community level) was also included as the part of predictors in the Poisson regression analysis.

In this aspect, rate of climate smart Agriculture practices adoption and household's incomes were indexed using Principal Component Analysis (PCA) technique and generated index values were inserted for each respondent along with other non-indexed independent variables in respective of each respondent. The Climate Smart Agriculture (CSA) practices that were indexed are rate of adoption of Crops rotation, intercropping, fallow farming, Minimum Tillage, Crops residue management, climate change adaptable Varieties, agricultural insurance, small scale irrigation, water conservation, Water harvesting, planting time adjustment and crops varieties diversification. Similarly, agriculture and non-agriculture sources of households' incomes were indexed using similar technique in the computer program where the indexed value was inserted for each respondent.

In this regard, dimension reduction technique along with Principal Component Analysis (PCA) method and Varimax rotation method was employed to perform the extraction where the factors Loadings (coefficients assigned to original variables) were generated for further use in Poisson regression. Accordingly, 2 and 4 component level factor loading for households' income and CSAP adoption, respectively, were generated along with factors' values which were used in Poisson regression analysis instead of original variables value which were larger and complex to manage in regression analysis. Furthermore, along with factor value generated, the model generated about 67% and 55% Variance proportion explained for households' income and CSAP adoption, respectively, in context of original variables. Accordingly, the selected variables for Poisson regression analysis and associated assumptions are presented in the below (**Table 1**) along with description of variables type and coding.

Table 1. Variable Definitions and Assumptions

Variables	Description and Coding	Assumption
Food self-sufficiency	Number of Farm household food sufficient	
	Independent Variables	
Agro-ecology	Dummy (1 if highland and 0 lowland)	+/-
Gender of households	Dummy (1 if male and 0 Female)	+/-
Age of Households heads	Numerical Scale (Age in years)	+
Education level	Numerical Scale (Years of Schooling)	+
Family size	Numerical scale (Family members in household)	+/-
Farming Experiences	Numerical scale (Experience in years)	+
Farmland size	Numerical scale (Land holding in Hectare)	+
Crop diversification	Numerical Scale (Number of crops)	+
Livelihood diversification	Dummy (1 if there is diversification and 0 otherwise)	+
Drought frequency	Number of Drought years in six years	-
Extension Support	Numerical Scale (Frequency of Visit)	+
Project Support	Dummy (1 if supported and 0 otherwise)	+
FTC Distance from home	Numerical scale (Distance in km)	-
Credit accessibility	Dummy (1 if credit accessible and 0 otherwise)	+
CSAP adoption Index	Numerical Scale (indexed value)	+
Household income index	Numerical scale (indexed value)	+

Based on technical requirement, *equi-dispersion* check was performed using crosstab technique for the fit of Poisson distribution which traditionally explained by equivalence of mean and variance in a particular dataset**.** The model fattiness check performed by crosstab technique generated mean value of 8.256 and variance value of 8.812 that are closely similar to each other and the difference is not greater than one indicating the absence of over-dispersion and proofed Poisson distribution fitness in the dataset**.** In this regard, complete variables re-selection and re-arrangement was made to avoid over-dispersion and well fitted model (variables combination which fit Poisson distribution) was established for data analysis and predictors effect estimation. Finally, based on scholars' recommendations and suggestions, the result interpretation was made emphasizing/using incidence rate ratio (IRR) or relative risk ratio instead of model coefficients.

3. RESULTS AND DISCUSSION

3.1 Conceptual Overview of Food Security and Food Self-Sufficiency

Based on the fundamental nature of food security and food self-sufficiency, several organizations and individuals have elucidated and used numerous conceptual frameworks and definitions to explain food security and food self-sufficiency. Regarding to food security, the most commonly used definition is based on the 1996 World Food Summit: "Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economical access to sufficient, safe and nutritious food to meet the dietary needs and food preferences for an active and healthy life" while food insecurity is the absence of one or more of these conditions in a particular community (Andrew, et al., 2013). Primarily, in several perspectives, Food balance sheet data (supply side data) are basic to measure the total quantity of calories available to a particular population in the form of foodstuffs produced or imported into a country (ibid).

On the other hand, food self-sufficiency is generally taken to mean the extent to which a country can satisfy its food needs from its own domestic production or a country producing sufficient food to cover its own needs and this basic definition can apply at the individuals, countries, or regional level (FAO, 2015:in Clapp,2016). Meaning, Food self-sufficiency can achieved when domestic production equals or exceeds domestic consumption for a particular country or community. In this regard, a key indicator that captures more practical concept is the self-sufficiency ratio (SSR), which expresses food production as a ratio of available supply for consumption which can be measured in either calories or volume of food produced by a country, where it is typically calculated for a specific commodity or class of commodities.

3.2 Sociodemographic Context of the Study Groups

The purpose of this sub-section is to articulate and presents the socio-demographic characteristics of respondents. In this regard, the finding indicates that the age of respondents in the two agro-ecologies varied between 20 and 71 years age categories and average age are 46 and 40 years for the highland and lowland agro-ecologies, respectively. Almost all respondents (about 91% of highland and 99% of lowland) were within the age range of 20 - 60 years. Similarly, of total respondents, only few farmers were above 60 years old, while most of the older farmers were found in the highland areas, precisely about 10%, while it is only 1% in the case of lowland community context (**Table 2**). In age scenario, an aged (above 60) respondents group constitutes less proportion in both highland and lowland, where the majority were within the 15-60 years age category which are productive and responsive to technology adoption that help to improve production ultimately food security and food self-sufficiency. On the other hand, this low proportion of elders in the community adequately indicates low dependence ratio which leads to food insecurity if all are non-productive in farm business in context of agriculture.

Regarding to family size, about 34% of the Households' family size falls under the range of 1-5 persons, while about 63% of the Households has a family size ranging from 6-10 and remaining proportion of the family size within the range of above 10 members accounts to 4.4% of the community. More importantly, an average family size of respondents is high as compared to national average which indicates the population pressure as an important factor in context of the survey households and community. In this aspect, an average of family size was found 6.1 for highland and 5.9 for lowland communities, while an aggregated average family size for both agro-ecology is 6.0 which is relatively higher than the national average that estimated to about 5 family sizes per households. The larger family size in the survey community in context of national average indicates quite high population growth in the areas which could affect the natural environment, particularly vegetation leading to negative impact on agricultural production and Food system. Certainly, several study findings ascertained that the higher family size indicates fast population growth that could negatively impact the environment which ultimately has negative implication for food security resulting from declined farmland soil fertility which commonly leads to low productivity that exacerbates food insecurity.

The findings related to educational background reveals that only 6% and 29.5% of respondents have not attended any kind of formal education in the highland and lowland agro-ecology, respectively, while 6.5% of the respondents attended the adult education schooling in highland, 25.7% are found in lowland farming community. Thus, this result indicates, better schooling profile of the study community than what is reported at the national level, which confirms that in Ethiopia 58% of women and 44% of men are illiterate (Gebrie, 2015).

Table 2. Sociodemographic Characteristics of Respondents

Demographic Characteristics	Highland		Lowland	
	Frequency	Percent	Frequency	Percent
Age categories (Total for categories)	**200**	**100**	**210**	**100**
20-30 years	13	6.5	25	11.9
31-40 years	53	26.5	91	43.3
41-50 years	75	37.5	73	34.8
51-60 years	40	20	19	9.0
Above 60	19	9.5	2	1.0
Family Size (Total for category)	**200**	**100**	**210**	**100**
Less 5 Family	47	23.5	34	16.2
5-10 Family	149	74.5	167	79.5
11-15 Family	2	1.0	8	3.8
Above 15 Family	2	1.0	1	0.5
Gender (Total for categories)	**200**	**100**	**210**	**100**
Female	24	12.0	19	9.1
Male	176	88.0	191	90.9
Total	**200**	**100.0**	**210**	100
Marital status (Total for category)				
Married	179	89.5	205	97.6
Single	21	10.5	5	2.4
Educational Level (Total of all level)	**200**	**100**	**210**	**100**
No-formal education	12	6.0	62	29.5
Adult education	13	6.5	54	25.7
Primary level	79	39.5	57	27.2
Junior-secondary	48	24.0	25	11.9
Secondary level	48	24.0	12	5.7

Encouragingly, of total households, about 65.6% of respondents attended and completed primary and above educational level while specifically 17.8% and 14.6% identified among group attended junior secondary and secondary level education, respectively in sample households. The educational level of the respondents identified in current study is on average and better than the national average which is important to enhance awareness of farmers about natural resource degradation, contributing to knowledge regarding to climate change, which particularly requires for building of adaptation skills and resilience at community level.

3.3 Perceived Impact of Climate Change on the Food System

In general, an immediate impact of climate change is usually recognized on food items production and distribution by breaking supply system and value chain which affects national food security and family level food self-sufficiency. In this regard, while agricultural development is source for poverty reduction and food security cannot be gainsaid without it, the prevalence of climate change severely affecting the Agricultural outputs and its tailgating consequences have resulted in national food insecurity and household level food self-insufficiency (Tubiello et al., 2014).

Based on this view and scenario, community perception was assessed, where the findings of the survey summarized in the below Tables (**Table** 3a, 3b and 4) in context of perceived impact of climate change on food system emphasizing on drought among several weather parameters. In this context, several studies revealed that Drought is important among weather parameters at community level to understand and detect its occurrence and related consequences immediately without requiring complex data and interpretation process and drought selected in this study also considering this scenario and criterion.

In this regard, **Table 3a and 3b** presents the perceived drought frequency and perceived negative impacts of climate change on food security and food self-sufficiency, respectively in the study communities which usually recognized through drought at community level, while **Table 4** shows food sustainability within the cropping seasons.

In context of drought, significant majority (52.4%) of lowland community respondents perceived highly increase in drought frequency events, while this scenario is negligible (5.5%) in context of highland community, indicating catastrophic situation in the lowland community (3a). Commonly, droughts events are frequent phenomenon in traditional farming systems of study community and beyond affecting food item production and distribution in the farming community and elsewhere. In this regard, several study findings indicate that the traditional farm business and community that exposed to frequent droughts are certainly vulnerable to food self-insufficiency and food in security resulting from food crops production failure and this finding is also certain of food self-insufficiency in the study community exposed to recurrent drought.

On the other hand, as indicated in **Table 3b**, relatively the majority of respondents, which accounts for 59% of highland and 60.5% of lowland study community observed moderate negative impact of climate change and weather variability on households' food self-sufficiency, while relatively nearly similar proportion of respondents which constitutes 58.5% of highland and 55.2% of lowland farming community perceived similar moderate negative impacts of climate change and weather variability on households' food security.

The second majority of 31.5% and 32% of respondents indicated low negative impacts of climate change on households' food self-sufficiency and food security, respectively in highland farm households. Whereas, in context of lowland community, the second majority of 35.2% and 42.9% of respondents suggested high negative impacts of climate change on households' food self-sufficiency and food security, respectively, in contrary to highland community which is negligible as compared to lowland situation.

According to several study findings, climate change and weather variability practically affects food availability constraining seasonal food supply systems, leading to seasonal food shortage. For instance, Puma et al. (2015) tracked trends using self-sufficiency ratios and concluded that 83% of countries have low or marginal food self-sufficiency ratio for the 2005–2009 period. More similarly, Fader et al. (2013)**,** conclude that 66 countries are currently unable to achieve food self-sufficiency due to land, water, and fertile soil related constraints that compounded by climate change.

Furthermore, FAO et al. (2020) also suggested that Sub-Saharan Africa is the worst of all regions in prevalence of food insecurity; among which Ethiopia is the worst of all African countries ranking 1st level, as nearly 33 million people are suffering from chronic undernourishment and food insecurity. In this regard, Ethiopia has been identified among one of the highest levels of food insecurity countries in the world, in which more than 35% of total population is chronically undernourished (Birara, Gashaw and Solomon, 2015).

On the other hand, traditional farming community usually covers seasonal food demand for households consumption from household's farmlands produces and **Table 4** attempted to present the potential capacity of the study community to cover seasonal household's food demand from own farmland sources. In this regard, of total respondents, 37.5% of households in the highland agro-ecology feed family members for 11-12 months, where only 9% of lowland households cover seasonal food demand from produces of households' farmlands. On the other hand, relatively the majority (40%) of respondents are able to cover seasonal food demand for 8-10 months per annum in the lowland agro-ecology, which is better as compared to 25.5% of highland community seasonal coverage.

Table 3a. Perceived Frequency of Drought Occurrence in the Study Community

Drought Frequency	**Highland**		**Lowland**	
	Frequency	**%**	**Frequency**	**%**
Negligible change	78	39	1	0.5
Low level increased	61	30.5	18	8.6
Moderately increased	50	25.0	81	38.6
Highly Increased	11	5.5	110	52.4
Total	**200**	**100**	**210**	**100**
Chi-Square (X^2)	**185.158*****			

Furthermore, the proportion of lowland respondents covering households' seasonal food demand from own farm sources for more than 11 months identified to be insignificant (9%) indicating the devastating situation related to food shortage catastrophe in the community. Whereas, the second majority of the lowland respondents are capable to cover seasonal households' food demand for 5-7 months (33.8%), while 15.5 percent of the highland respondents are covering households' food requirement for similar number of months in the cropping years.

Differently, non-negligible proportions (21.5%) of the highland respondents are identified to have potential capacity to cover households' seasonal food demand for the 2-4months as compared to small proportion (17.6%) of lowland respondents. However, some study reported more significant proportion of households' exposure to food shortage falling to fulfill from own agricultural sources. For instance, survey conducted by Arega (2013), revealed that about 86% of the households in Amhara region of Ethiopia were a net purchaser of households' food demand for about six months during survey period. The same author asserted 74% food insecurity; while of total sample households only 26% were food secured in the study community of similar Region.

Table 3b. Perceived Negative Impacts of Climate Change on the Food System

Level of Impact	Highland Community				Lowland Community			
	Food self sufficiency		Food security		Food self sufficiency		Food security	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
High	6	3.0	2	1.0	74	35.2	90	42.9
Moderate	118	59.0	117	58.5	127	60.5	116	55.2
Low	63	31.5	64	32.0	9	4.3	4	1.9
Negligible	13	6.5	17	8.5	0	0	0	0
Total	**200**	**100**	**200**	**100**	**210**	**100**	**210**	**100**
		(a) Chi-Square: Food Self-sufficiency			**111.453*** **			
		(b) Chi-Square: Food Security			**153.967*** **			

Table 4. Months of Household Food Self-Sufficiency from Own-Farm Sources (N = 410)

No	Months of food demand covered	Highland Areas		Lowland Areas		Total	
		Frequency	%	Frequency	%	Frequency	%
1	2-4 Months	43	21.5	37	17.6	80	19.5
2	5-7 Months	31	15.5	71	33.8	102	24.9
3	8-10 Months	51	25.5	83	39.5	134	32.7
4	11-12 months	75	37.5	19	9.0	94	22.9
	Total	**200**	**100**	**210**	**100**	**410**	**100**
	Chi-Square (X^2)			**100.913*** **			

On the other hand, climate change and seasonal weather variability practically affects food availability and accessibility constraining seasonal food supply systems which usually caused by frequent drought related disasters. In this scenario, households with no alternative source of food rather than natural resources (especially agriculture) are more expected to be more food in-secured as compare to those with alternative sources and external support for food during crops failure in the cropping years. Accordingly, this study emphasized on external emergency aids, social help (social-interconnectedness) and alternative sources of food as indicator to gauge coping strategies importance level in context of study community to close the households' food gape occurred during agricultural production failure.

Customarily, food in-secured community commonly covers seasonal food shortage and gape for households from external aids which usually termed as emergency aids and **Table 5** endeavored to show some significant role and need of emergency aids in the study community to cover seasonal household's food shortage and demand gape of the households' seasonal consumption. In this regard, the survey data indicates that 35% of households in the highland agro-ecology rated emergency aids importance in the range of moderate and high level, while the remaining proportion rated less and negligible level in context of the same study community. Similarly, an average area majority (about 51%) of respondents of the lowland community rated importance of emergency aids as moderate and high level which is relatively higher as compared to highland community situation, indicating high level of food insufficiency in context of lowland community.

Non-debatably, the proportion of lowland respondents need and receiving social helps to cover food shortage during food shortage in the cropping seasons were found to be 81% and 69.5%, respectively, indicating devastating situation related to food self-sufficiency related crisis in the study community and beyond, while better situation was identified in context of highland community when the same scenario taken into account.

Table 5. Importance of Household-Level Food-Shortage Coping Strategies (N = 410)

No	List of Strategies	Highland		Lowland	
		Frequency	%	Frequency	%
(a)	**External Emergency aid**	200	100	210	100
1	Negligible	56	28	16	7.6
2	Less Important	74	37	88	41.9
3	Moderately important	49	24.5	85	40.5
4	Highly Important	21	10.5	21	10.0
	Chi-Square (X^2)			**38.879*****	
(b)	**Household need of social help**	200	100	210	100
1	Household need help	102	51	170	81
2	Households not needing help	98	49	40	19
	Chi-Square (X^2)		**18.799**		
(c)	**Social help recipients'**	**200**	**100**	**210**	100
1	Household receiving social help	90	45	146	69.5
2	Households not receiving help	110	55	64	30.5
	Chi-Square (X^2)		**25.22*****		
(d)	**Alternative source for Food**	**200**	**100**	**210**	100
1	Household with alternative	31	15.5	60	28.6
2	Households with no alternative	169	84.5	150	71.4
	Chi-Square (X^2)		**10.136*****		

On the other hand, the large majority (84.5%) of highland respondent operates with no alternative sources of food outside agriculture which is not helpful during agricultural production crises and failure, where similar large proportion (71.4%) in context of lowland respondents was identified as the households with no alternative sources of food indicating relatively better status as compared to highland community and all these are indication of study community vulnerability to climate change impacts in context of food availability scenario.

In general term and in all scenario several studies are consistent with the findings of current study. For instance, the study conducted in Southern Ethiopia by Mitiku and Legesse (2014) ascertained that 42 % of sampled households were not able to meet the daily recommended food requirement; while about 14.7% of food insecure households were far from the recommended daily caloric requirement level and about 7.3 % of households are the most food insecure groups. Discouragingly, research conducted by Assefa and Singh (2018) in south Wollo of Ethiopia, found 20.9% and 79.1% of the households were food sufficient and food insufficient, respectively, where the majority of the food insecure households were younger household heads, who own less than 1ha of farmlands, while on average, male-headed households were more food secure than female-headed households, comprising 20.1% and 16.1%, respectively.

More recently, study conducted by Awoke et al. (2022) affirmed that 38% of households were found food secure, while 62% were food insecure implying that the majority of households were food insecure, in which about 63.8% of farmers use the own production, while the remaining 36.2% rely on purchased, gifts from social interconnectedness and Food Support Programs in North and Central Gondar Zones of Ethiopia. Generally, in all scenario and indicators considered in the study, the findings of this study indicated high probability of being food insufficient in these two study communities with relatively higher likelihoods in context of lowland community which entail adequate policy directions and relevant strategies to moderate food insufficiency and food in security risks in the study communities and beyond.

3.4 Determinants of Food Self-Sufficiency in the Study Communities

In addition to descriptive statistics analysis conducted to determine the households' seasonal food self-sufficiency level, Poisson regression model was selected and employed to analyze and interpret the determinants of household level food self-sufficiency from own food source emphasizing on agriculture related food items (**Table 6**). In this regard, the coefficients of significant majority of predictors indicate similar characteristics reported by several study findings and in agreement with conventional assumption. Based on Technical simplicity suggested by several professionals, the exponentiated value of model coefficients (Exp(B)) which commonly known as incidence rate ratio/relative risk was selected and employed for result interpretation and presentation with less emphasis on coefficients of the models.

In generalized term, among independent variables included in the regression model, about the average (56.3%) of the predictors' effects were found statistically significant, while the effects of remaining proportion of predictors were found statistically non-significant. In this context, only the effect of agro-ecology, farmland size and climate Smart Agriculture (CSA) practices adoption index found highly significant at 1% significance level, while the effect of age, crops diversification, extension support, FTC distance and income index were found statistically significant at 5% significance level and only the effect of drought found statistically significant at 10% significance level. Differently, the effect of other remaining predictors found statistically non-significant at any statistical acceptable significance levels in context of current research findings.

The effect of Agro-ecology found positive association on seasonal food self-sufficiency and as agro-ecology changed from lowland (reference category) to highland, households food self-sufficiency tends to increase in the incidence rate ratio of food self-sufficiency by 19.2% which statistically significant at 1% level and consistent with the finding of Arega (2013), who reported similar effect of agro-ecology on households' food security.

According to the finding, a unit increase in the frequency of drought tends to reduce the relative risk of food self-sufficiency of the housed by 4.6% in the event counts which is statistically significant at 10% level. In this regard, the negative association of the drought frequency is consistent with most of the findings and prior assumption. For instance, Birara, et al (2015) reported that the seasonal food availability could be negatively and extensively constrained by unpredictable weather variability which is mainly expressed in drought in addition to inappropriate agricultural technologies application and farm management.

On the other hand, the positive relationship identified in the case of other variables, like education level and livelihood diversification are what expected and consistent with extent findings and prior assumption, where a unit increase in educational level of a particular household tend to increases the incidence rate ratio of being food self-sufficient by 0.5% which is significant at 10% significance level. This finding is consistent with the Arega (2013), who revealed food in secured 60% vulnerable illiterate households indicating positive influence of education level on food security and further indicated an increase in the food security as the result of a unit increase in educational level of household heads, which is statistically significant at 5% significance level.

On the other hand, the effect of Farmers' Training Centers (FTCs) is postulated to have negative influence on food self-sufficiency. However, in current study, a unit increase in FTCs distance from farm households home found to increase the incidence rate ration of Food Self-sufficiency by 1.4% and significant at 5% level. Unusually, positive association observed in the case of FTC distance from respondents' home is not common finding and by far different from conventional assumption, because traditionally, when the distance of the households home from service center like that of FTCs increased, technical and technological supports provided by extension service delivery system will be decreased which practically have negative impacts on agricultural production and ultimately on food self-sufficiency.

Table 6. Poisson Regression Parameter Estimates (Highland and Lowland Data Combined)

Parameters	B	Std. Error	P-Value	Exp(B)	95% Confidence Interval	
					Lower	Upper
Agro-ecology	0.176	0.0551	0.001	1.192	1.070	1.328
Gender of household head	0.083	0.0562	0.139	1.087	0.973	1.213
Age of household head	-0.007	0.0032	0.033	0.993	0.987	0.999
Educational level HHH	0.005	0.0174	0.756	1.005	0.972	1.040
Family Size	-0.015	0.0117	0.212	0.985	0.963	1.008
Farming Experiences	0.004	0.0034	0.240	1.004	0.997	1.011
Farmland Size	0.053	0.0121	0.000	1.055	1.030	1.080
Crops diversification	0.035	0.0149	0.019	1.035	1.006	1.066
Livelihoods diversification	0.001	0.0181	0.953	1.001	0.966	1.037
Drought frequency	-0.048	0.0251	0.058	0.954	0.908	1.002
Extension Support	0.062	0.0257	0.016	1.064	1.012	1.119
Project participation	-0.035	0.0465	0.454	0.966	0.882	1.058
FTC Distance	0.014	0.0068	0.046	1.014	1.000	1.027
Credit accessibility	0.056	0.0386	0.148	1.057	0.980	1.140
CSAP adoption index	0.053	0.0193	0.006	0.949	0.913	0.985
Income index	0.045	0.0201	0.025	1.046	1.006	1.088
Constant	**1.874**	**0.1796**	**0.000**	**6.516**	**4.583**	**9.265**
Likelihood Ratio Chi-Square	143.153***					
Goodness of fit (deviance)		0.813				

Response Variable: Number of households Food Self-Sufficient during specified interval of Months in the year

As to finding of current study, a unit increase in particular households family size tend to increase the incidence rate ratio of Food Self-sufficiency by 5.5% and significant at 1% level. The positive association in context of family size most probably possible when number of family members increased on sufficient resources (sufficient farmland, livestock holdings, productive assets and etc) with adequate diversification of the livelihoods and income sources, which logically reduce the dependence ratio in the households and ultimately increase the likelihoods of food self-sufficiency in a particular household.

On the other hand, the positive association of family size effect in current study is inconsistent with the works of Bekele, Jema and Mirzabaev (2023), and Arega (2013), who reported negative relationship and statistically significant at 5% significance level. Like many variables, a unit increase in the age of household heads and project participation in the study community, the incidence rate ratio of food self-sufficiency found to be reduced by a 0.7% and 3.4%, respectively, in which the former one is statistically significant at 5% level while the later found non-significant at any acceptable statistical significance level and this finding is consistent with prior assumption and hypothesis.

As to the model result, a unit increase in the credit availability scale, tend to increase the incidence rate ratio of food self-sufficiency of households by 5.7% and this positive influence of credit is in line with the several findings and different in some few studies. Furthermore, as the CSA practices adoption index increased by a unit of its scale, the incidence rate ratio of food self-sufficiency level for particular household increased by 5.1% when all other variables assumed constant and statistically significant at 1% level. Additionally, with a unit increase in a crops diversification, extension support and income index an incidence rate ratio of household's food self-sufficiency increased by 3.5%, 6.4% and 4.6%, respectively, in perspective of each unit of count scale.

4. CONCLUSION AND RECOMMENDATIONS

The study examined food self-sufficiency and food security in perspective of climate change impacts, in context of East shewa and Arsi Zones of Oromia Region. As to the study data implication and empirical literatures reviews, there are several evidences suggesting detrimental impact of Climate change through weather variability on food security of the most vulnerable community. Apparently, the finding of this study and empirical literatures suggest that climate change affecting the food security and food self-sufficiency negatively impacting the entire course of food production value chain. Specifically, relatively the majority (61%) of highland and 95.7% of lowland respondents perceived high and moderate negative impact of climate change and weather variability on households' food self-sufficiency, while nearly similar proportion of respondents which constitutes 59.5%

of highland and 98% of lowland community perceived similar high and moderate negative impacts of climate change and weather variability on households' food security.

The result indicated that the significant number of respondents (44.4%) identified to cover households' seasonal food demand from own farm land sources only for not more than 7 months, which climate change contributes significant share for the failure as the result of frequent variability in seasonal weather (commonly drought), particularly the problem is reasonably high in the lowland community. Briefly, while agricultural sector is most imperative for food self-sufficiency and food security cannot be achieved without it, the prevalence of climate change and its impacts on food insecurity and failure in food self-sufficiency are adequately revealed by current study findings.

In this regard, climate change commonly has a significant consequence on food production system directly through recurrent droughts which need proper adaption and mitigation strategies embedded in proper policies. Hence, much effort are required to put innovative approaches in place in research and extension by redesigning policies along with appropriate strategies, emphasizing on climate Smart Agriculture Practices to ensure sustainable food items production to maintain food self-sufficiency and food security at community and national level.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest appeared to compete for information presented in the manuscript.

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ETHICAL STATEMENT

The Manuscript is the part of PhD study conducted at University of South Africa (UNISA) where ethical approval (no: 2019/CAES/050) was obtained from university ethics committee and the informed consent was obtained from all participant based on university guideline and formal format.

REFERENCES

Addisu Bezabeh, Fekadu Beyene, Jema Haji, Tesfaye Lemma and Fatih Yildiz (2020). Impact of contract farming on income of smallholder malt barley farmers in Arsi and West Arsi zones of Oromia region, Ethiopia. *Cogent Food & Agriculture*. 6 (1). 1834662, DOI: 10.1080/23311932. 2020.1834662.

Alem-meta Assefa Agidew and K. N. Singh (2018). Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed. *Agricultural and Food Economics* 6(10):1-23. https://doi.org/10.1186/s40100-018-0106-4.

Andrew D. Jones, Francis M. Ngure, Gretel Pelto and Sera L. Young (2013). What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics. American Society for Nutrition. *Advance in. Nutrition.* 4: 481–505. doi:10.3945/an.113.004119.

Arega Buzzed Berlie (2013). Determinants of Rural Household Food Security in Drought-Prone Areas of Ethiopia: Case study in Lay Gaint, Amhara Region. PhD Thesis, UNISA.

Bekele Wegi Feyisa, Jema Haji and Alisher Mirzabaev (2023). Determinants of food and nutrition security: Evidence from crop-livestock mixed farming households of central and eastern Ethiopia. *Journal of Agriculture and Food Research* 12(10). https://doi.org/10.1016/j.jafr.2023.100556

Birara Endalew, Gashaw Tenna Alemu and Solomon Bizuayehu (2015). State of household food insecurity in Ethiopia: review. *A Journal of Radix International Educational and Research Consortium* 4 (12). https://www.researchgate.net/publication/305470806.

Birara Endalaw, Maquanent Muche and Samual Tadesse (2015). Assessment of Fodd Insecurity Sitaution in Ethiopia: A Review. *Asian Journal of the Agricultuaral Research* 9(2):55-68.DOI:10,3923/ ajar.2015.55-68

Climate-Resilient Green Economy (CRGE) (2011). Green economy strategy of Ethiopia, editor. Ethiopia's Climate-Resilient. www.adaptation-undp.org · sites · default.

Dawit Woubishet Mulatu, Zerayehu Sime Eshete and Tsegaye Ginbo Gatiso (2016). The Impact of CO_2 Emissions on Agricultural Productivity and Household Welfare in Ethiopia. A Computable General Equilibrium Analysis. Environment for Development. Discussion paper. www.researchgate.net · publication · 299468283

Ethiopian National Meteorological Agency (NMA) (2007). Climate Change National Adaptation Programme Action of Ethiopia.

Fader, M., Gerten, D., Krause, M., Lucht, W and Cramer, W (2013). Spatial decoupling of agricultural production and consumption: Quantifying dependences of countries on food imports due to domestic land and water constraints. Environmental Research Letter 8(1). http/**DOI**:10.1088/1748-9326/8/1/014046.

FAO, IFAD, UNICEF, WFP and WHO (2020). In Brief to the State of Food Security and Nutrition in the World 2021. Transforming the food systems for affordable healthy diets. Rome, FAO. https://doi.org/10.4060/cb5409en.

Gebrie Alebachew Belete (2015). *Evaluating the Sustainability of Communal Land Rehabilitation*

*Practices as A Disaster Risk Reduction Strategy and Adaptation Measures to Climate Change: A Case Study Legambo District, Northern Ethiopia*_MSc Thesis, *UNISA*.

Gezai Abera a, b, Ali M. Ibrahim b, Sirawdink Fikreyesus Forsido b, and Chala G. Kuyu (2020). Assessment on post-harvest losses of tomato (Lycopersicon esculentem Mill.) in selected districts of East Shewa Zone of Ethiopia using a commodity system analysis methodology. *Heliyon* 6(4):DOI:10.1016/j.heliyon.2020.e03749

Jennifer Clapp (2016). Food self-sufficiency: Making sense of it, and when it makes sense. *Food Policy* 66 (2017): 88–96. http://creativecommons.org/licenses/by-nc-nd/4.0/.

Mitiku, A. and Legesse, W. (2014). The Determinants of Rural Households' Vulnerability to Food Insecurity in Jimma Zone, South Western Ethiopia. *Journal of Biological and Chemical Research:* An International Journal of Life Sciences and Chemistry,31(1):117-125.

Puma, M.J., Bose, S., Young Chon, S and Cook, B.I (2015). Assessing the evolving fragility of the global food system. *Environ. Res. Lett.* 10(2). http//DOI 10.1088/1748-9326/10/2/024007.

Shengping Yang and Gilbert Berdine (2015). Poisson Regression.

Singh, Ajay S and Masuku, Micah B (2014). Sampling Techniques and Determination of Sample Size in Applied Statistics Research: An overview. *International Journal of Economics, Commerce and Management* 2 (11):1-22. www.researchgate.net publication · 341552596.

Tamirat Gebiso Challa, Aman Nebo Tibesso, Ashebir Tsegayie Mamo (2019). Farming System Characterization of Arsi zone: Case of Small-Scale Farming. *American Journal of Environmental and Resource Economics*. 4(1): 12-24. DOI:10.11648/j.ajere.20190401.12

Tubiello F. and Sperling F. (2014). Agriculture, Forestry and Other Land Use (AFOLU) (2014). In: Climate Change 2014: Mitigation of Climate Change. Cambridge University Press.UK.

WFP (2012) Climate impacts on food security and nutrition. A review of existing knowledge. lucris.lub.lu.se·portal·129864479.

Wondim Awoke, Kefale Eniyew, Genenew Agitew & Belete Meseret (2022). Determinants of food security status of household in Central and North Gondar Zone, Ethiopia. *Cogent Social Sciences* 8 (1):1-12. https://doi.org/10.1080/23311886.2022.2040138.