ORIGINAL ARTICLE

Perception of Small Livestock Keepers onthe Effect of Climate Related Risks and Household Food Security: The Case of Mana and Sekoru Woredas, Jimma Zone

Adugna Eneyew*, Fikadu Mitiku, and Taye Tolemariam[3]

Jimma University College of Agriculture & Veterinary Medicine, P.O.Box 307, Jimma, Ethiopia
*Corresponding author: adugna_e@yahoo.com

ABSTRACT

Climate change is among the top global challenges affecting food security in the 21st century.Ethiopia is heavily dependent on rain-fed agriculture, and highly vulnerability to the adverse impacts of climate change. The objective of this study is to explore the perception of small livestock keepers on climate change and its influence on food security. A cross sectional data was collected from 127 randomly selected small livestock keepers in south western Ethiopia. Descriptive and binomial logistic regressions were used for data analysis. The study revealed that 45.7% households are food insecure. About 96.8% and 95.2% respondents respectively believe that climate is changing and global warming is happening as has been observed from local temperature rising. Over 70% farmers faced drought and shortage of rainfall and 58.7% very worried about the future due to climate related shocks. In spite of such worry, about 57.3% reported that there has been much less adaptation responses towards climate change. Households led by female and educated heads, who received credit and participated in non-farm employment are food insecure. But, access to market information significantly improves household food security. Frequency of drought and rising temperature did not have an adverse effect on household food security. While, shortage of rain, water scarcity and livestock death reduce the likelihood of being food secure. We suggest that adaptation strategies to enhance availability of water and rainfall have to be prioritized to ensure food security and sustainable smallholder livestock systems.

Key words: adaptation, climate change, logit, drought, risk

INTRODUCTION

Climate change is among the top global challenges in the 21st century. The major concern of climate change is its treats over the poor nations. Effects of climate change tend to be more severe where people rely on weather dependent rain-fed agriculture for their livelihoods (Gentle and Maraseni, 2012). Climate change and food security are two of the most pressing challenges facing the global community. World food security is threatened by new challenges related to climate change, bio-energy and soaring food prices(FAO, 2010.)An already difficult food insecurity situation is being exacerbated by the overarching effects of climate change. It will likely depress agricultural yields and increase food production risks in many world regions in the future, particularly in many of the current food-insecure countries (IIASA, 2009). Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability (FAO,2008).According to Inter- governmental Panel on Climate Change's (IPCC), in developing countries agricultural productivity will decrease from 9-21% by 2080 due to climate change (Parry et al., 2007)

Africa is widely held to be highly vulnerable to future climate change and Ethiopia is often cited as one of the most extreme examples(Conway & Schipper, 2011). Agriculture is the main stay of African Economy and about 58% depend to varying degrees on their livestock. About two thirds of arable land in Africa is expected to be lost by 2025 due to decreased rainfall and reduce yields(Liliana, 2005). Particularly Sub-Saharan Africa remains the most food-deprived region without climate change. Under climate change, child malnutrition numbers would increase by 460,000 children by 2010, to just below 1 million children by 2030. Per capita calorie availability across Sub-Saharan Africa declines by 1.3 percent or 37 kilocalories per capita per day as a result of climate change (Ringler, Zhu, Cai, Koo, & Wang, 2010). Increasing population pressures interacting with declining rainfall and reduced pasture has already begun to impact the livestock sector negatively. Rangeland condition is directly affected by the climate and, in turn, affects the quality and quantity of small and large stock and associated livelihood activities(Ziervogel et al., 2006).Africa's livestock sector will be affected by climate changes through more frequent catastrophic events, reduced water availability, changes in the pattern and quantity of rainfall, an increase in temperature, changes in seasonality, a decrease in feed and fodder production, changing patterns and distribution of disease and altered markets and commodity prices (WISP, 2010).

Food security is highly vulnerable to climate-related risks in Ethiopia(WFP, 2014).Ethiopia is one of the most drought prone countries of the world. Severe food insecurity problems have been observed and the main cause of historical famine in the country is related to climate risks. Estimates suggest climate change may reduce Ethiopia's GDP up to 10 percent by 2045, primarily through impacts on agricultural productivity. Ethiopia will forgo more than 6 percent of each year's agricultural output if the current decline in average annual rainfall levels continues in the medium term(USAID, 2016)

Among the significant impacts of climate variability, livestock hit the hardiest. Ethiopia's livestock sector, the largest in Africa, relies heavily on climate-sensitive resources. The customary rangeland management practiced by the country's10–15 million pastoralists in over 60 percent of the country is dependent on limited water and forage availability(USAID, 2016). Ethiopia has lost a cumulative level of over 13 percent of its current agricultural output between 1991 and 2008(Aragie,

2013). Rain fall has been declining since 1980. If the current rate of decline in the average annual level of rainfall continues, Ethiopia will forgo, on average, more than six percent of each year's agricultural output(Aragie, 2013).

Within small livestock holders there is evidence that recent changes in climate have brought about large amount of loss in natural resource and livestock. In spite of this fact, much of the studies related to climate risk and food security in the country paid much attention on crop sector and little attention has been paid to link to small livestock keeper's.

A recent report released by Oxfam International shows that small-scale farmers and pastoralists in Ethiopia are likely to bear the brunt of the negative impacts of climate change in the region, which will include increased poverty, water scarcity, and food insecurity(UK8020, 2016) The country is heavily dependent on rain-fed agriculture, and its geographical location in combination with low adaptive capacity entail a high vulnerability to adverse impacts of climate change(Richardson, Steffen, & Liverman, 2011)Ethiopia has been plagued to food insecurity for the last five decades. The country's dependence on agriculture makes it particularly vulnerable to the adverse impacts of climate change on crop and livestock production (Deressa, Hassan, & Ringler, 2008). About 83% of its population is livestock dependent. The livestock sector contributes 16-20% to the GDP (Berhe, 2010).

In small holder crop-livestock systems in the Ethiopian highlands, livestock accounts for 34-87 % of total cash income from agriculture. Livestock give increased economic stability to farm households, acting as a cash buffer, a capital reserve and as a hedge against inflation. In many countries dung is valued as fuel for cooking and Biogas from manure is an excellent substitute for fossil fuel or fire wood(FAO, 2002). For many small-holder farmers livestock provide draught animal power, transportation and manure. Sustainable development of the livestock sector is of great importance for the adaptive capacity of many of the world's poorest people, and an opportunity for mitigating climate change(WISP, 2010).In terms of livestock, climate change also will affect the quality and amount of feed supply and the carrying capacity of pastureland. Small livestock keepers have been facing water shortage, increased disease prevalence; increased livestock mortality thereby reduced production and income which in turn contributes to food insecurity. Even though, the severity of the effect of climate change varies with the species of livestock (ESAP, 2009) its negative impact on cattle is severe.

For instance, changes in climate have brought about large amount of loss in natural resource and livestock(FSS and Cordaid, 2009; Yesuf & Bluffstone, 2007); which further challenges the food security level (Deressa et al., 2008). Future climate variability and change are expected to worsen. The repercussions of climate change on livestock sector manifests in changes in quality and quantity of vegetation, availability of fodder and water and increase in climate related diseases (WISP, 2010). This can further result in losses of genetic diversity, and overall productivity of livestock. Such problems are serious especially in pastoral community of Ethiopia (Borana, Afar, etc) who are mainly dependent on livestock rearing regardless of various coping strategies by the community (Eriksen & Marin, 2011; Gebre Michael & Kifle, 2009). Specific to the study area; Jimma zone, it is evidenced that due to the prolonged dry spell in 2000 there was a severe shortage of animal feed that led to (reportedly a loss of over 6,000 cattle), which is a significant livestock mortality in the study areas(Dechassa, 2000).

Many livestock keepers have traditionally been capable of adapting to

threats to their livelihood. Adaptive capacity, at individual, community or national levels, is poorly understood (WISP, 2010). Although there is research on the impact of climate on food production, there is limited understanding on rural households' adaptation to climate variability. Nationally, the link between climate change and crop production is widely recognized, but there is no research conducted to understand how livestock keepers cope with climate variability. Despite the importance of livestock to poor people and the magnitude of the changes that are likely to befall livestock systems, the intersection of climate change and livestock in developing countries is a relatively neglected research area. Therefore, this study is aimed at exploring the challenges of small livestock keepers' in the context of climate change, food security and their perception on its consequences in south western Ethiopia.

METHODOLOGY

The study area

For this study, Mana and Sekoru woredas are purposively selected for their representing diverse patterns of livelihood zones in Jimma. There are two broad livelihood zones in Jimma. Cereal based and coffee based livelihood zones, Sekoru is part of Maize, Tef and Sorghum livelihood zone, while Manna from Coffee, Khat, and forest based livelihoods. Livestock are an integral part of rural livelihoods in Jimma zone. The major livestock includes cattle, shoats and poultry. According to 2007 national census Sekoru woreda has a total population of 136,320, of whom 68,469 were men and 67,851 were women (CSA, 2007). The main livelihood category is mixed farming. The major crops include Tef, Maiz and sorghum, while cattle, goat, sheep and poultry are sources of livelihoods. Mana with a total population of 146,675, of whom 74,698 (CSA, 2007)were men and 71,977 were women; Khat and coffee is an important cash crop in this woreda.

Conceptual framework of the study

This research applied a mix of qualitative and quantitative research methods. The research design is cross sectional in nature. Fig. 2 indicates the link between climate risk asset endowment and food security of small livestock owners. The ability of a community to cope with and respond to change depends heavily on access to, and control over, assets. Capability to adopt the chosen strategy relies to a large extent on the core livelihood assets: human, social, physical, financial and natural capital (WISP, 2010). Typically, it is the poorest that are most vulnerable to the impacts of climate change and many of the basic capabilities of livestock keepers are weak, leading to their underdevelopment and contributing to their vulnerability to climate change and other threats. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods as in the case of small livestock keepers.

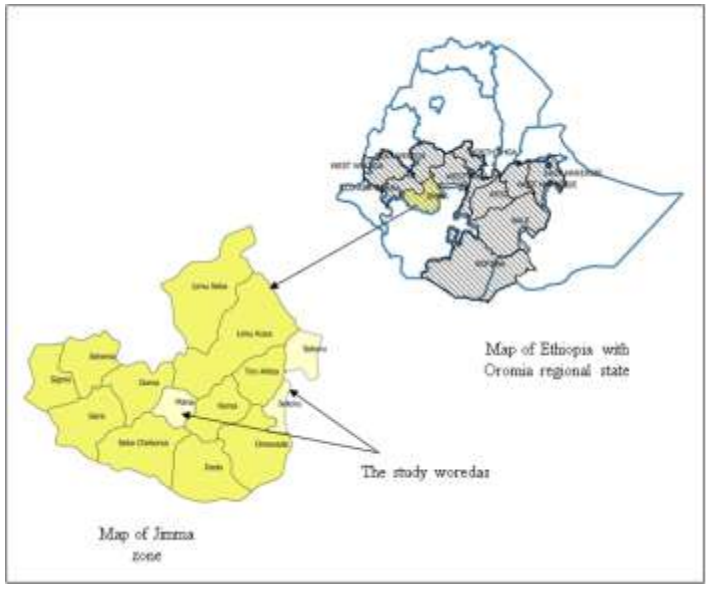

Figure1. Map of the study areas regional, zonal and study woredas

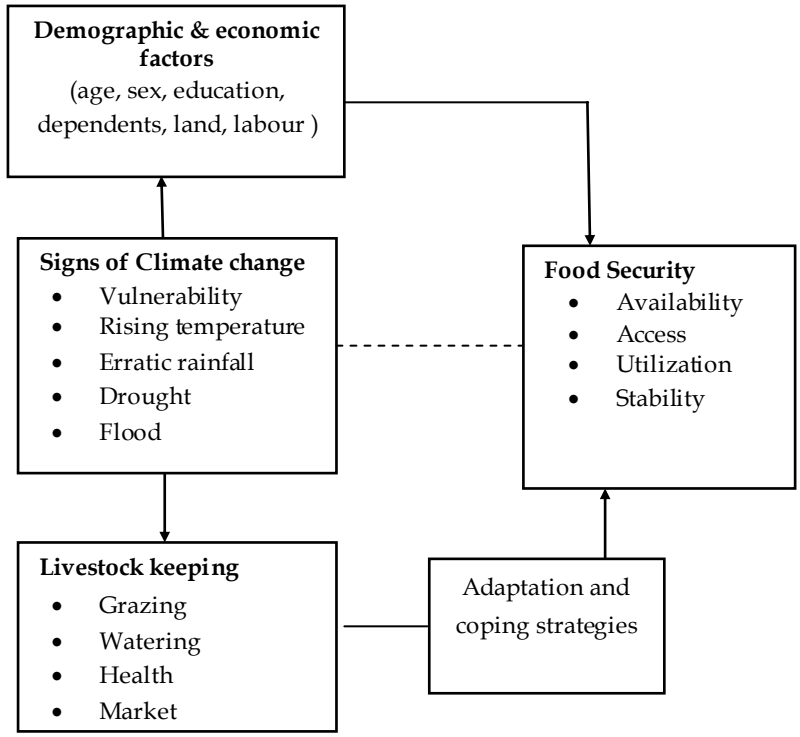

Figure 1.Conceptual framework of the study

Data sources and sampling procedure

Both primary and secondary data were collected to attain the objectives of this study. Primary data were collected from community and households using PRA tools (focus group discussions and key informant interviews) and face to face interview research techniques. The households were the units of analysis, as the household level tends to be where decisions about household production, investment, and consumption are made in most agrarian societies, particularly under long-lasting drought conditions. Data consisting of household characteristics, livestock production and management, climate risk perception and adaptation mechanisms were gathered from smallholder farmer households. Whereas, secondary data on the situation and trends of climate risk, its impact on livestock production (feed, water, disease, productivity etc) was collected from available literature.

Multistage stage sampling technique was used to select the respondents. In the first stage, we chose Jimma zone purposively due to proximity and access to our university. In the second stage two districts were purposively selected. Following the selection of districts, since almost all kebeles are known for mixed farming systems, one kebele from each district were randomly selected. Finally, 65 and 62 sample households were drawn from each kebele respectively based on proportional sampling of number of households who keep livestock in each kebele.Our sampling frame includes all households who keep livestock in each kebele, while household heads are sampling units. Totally, 127 households are interviewed. To decide the sample size formula(1) below was used(Krejcie & Morgan, 1970).

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)} \quad \ldots\ldots(1)$$

Where; s = required sample size.

X^2 = the table value of chi-square for 1 df at the desired confidence level (3.841).

N = the population size.

P = the population proportion (assumed to be .50)

d = the degree of accuracy expressed as a proportion (.05).

Method of Data Analysis

The commonly accepted definition of food security is "access by all people at all times to enough food for an active and healthy life" (World Bank, 1986). The essential elements in this definition are the availability (adequate supply of food); food access through home production, purchase in the market or food transfer; stability, when availability and access are guaranteed at all times; and utilization which refers to the appropriate biophysical conditions (good health) required to adequately utilize food to meet specific dietary needs and security, as the balance between vulnerability, risk and insurance. To capture a wide range of food security dimensions, household food consumption and caloric levels were assessed to determine the household status of food security level. Household food consumption measures the number of calories consumed by household members over seven days (Hoddinott, 1999). Accordingly, the person responsible for preparing meals in the house hold was asked a set of questions regarding food prepared for meals over for 7 days before the time of interview. Then, converting each kilogram of food items into energy level kilocalories; and dividing this to adult equivalent household size gives average level of energy consumed per household in that particular household. The universal subsistence daily energy requirement per

person per day was 2100 kcal(WFP, 1997).This 2100 kcal per person per day is can be used to group households into food secure (greater or equal to 2100 kcal per person per day) and, mild to severe food insecure, otherwise(Devereux, 2006). This cut point is also set for use in Ethiopia assuming all energy comes from cereals (CSA, 2014). Hence, we apply the 2100 kcal/day/person cut point for food security analysis.

Descriptive statistics like mean, standard deviation, tabulation and cross tabulations, graphs and percentages are used to describe socio-economic factors, climate related shocks and situation of food security in the study areas.

Econometric model specification

We consider the response y_i is binary, assuming only two values that a household is food secure (1) or food insecure (0)

Yi = 1 if the i^{th} household is food secure, 0 other wise

We view y^i as a realization of a random variable Y_i that can take the values one and zero with probabilities ρ_i and $1-\rho_i$, respectively. The functional form of logit model is specified as follows(Damodar, 2004): The logistic model (the log-odds ratio) takes the form:

$$\rho_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1+e^{-(\beta_0+\beta_i X_i)}} \quad \text{.....(1)}$$

For ease of exposition, the probability that a given household is food insecure is expressed as: $\rho_i = \frac{1}{1+e^{-(Z_i)}}$ …… …….....(2)

Probability for not food insecure is $1-P_i$

Thus,

$$\frac{P_i}{1-p_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} \quad \text{.....(3)}$$

is the ratio of the probability that a household was food insecure to the probability of that it was food secure.

Based on theoretical and empirical evidences (FAO, 2000; Mango, 2014.; Mubiru et al., 2018; Tantu, Gamebo, Sheno, & Kabalo, 2017; Zakari, Ying, & Song, 2014)we have identified 14 variables to have an influence on household food security The socioeconomic variables included are age, sex and education of head, number of dependents, access to market information and credit, non-farm employment and total household income. Climate variables include rise in temperature, frequency of drought, rain shortage, water scarcity and death of livestock due to climate related risk. Although we have data on many climate related variables such as farmers' perception on climate change, global warming, disease incidences and others.

We only included those variables for which we have observed variations.

RESULTS AND DISCUSSION

Descriptive statistics results

Socio-demographic profiles of respondents

The sex composition of respondent indicates those 92.1% men and 7.9% women. The majority of respondents (96%) are married; the health conditions of 75.8%, 17.5% and 6.7% is respectively reported to be good, moderately good and with severe problem. The later indicates conditions in which the household head faced series illness at least for more than a month. The average age of the respondents is 45 years and seven months with minimum and maximum ages of 25 and 84 years respectively. The average family size is 7.1 with the minimum and maximum children of 2 and 16 respectively. The average family member for this area is above the national average which is 4.9. The other important factor is the number of dependents in the family of lower than 15 ages and over 65 years of age. The average number of dependent is 3.4 with minimum1 and maximum 9 (Table 2).

Number and trends of livestock ownership

Livestock production is a major component of livelihoods in parts of southwestern Ethiopia. Sales of livestock and their products provide direct cash income to farmers. They are also closely linked to the social and cultural lives of stallholder farmers. The major livestock owned by the stallholder farmers are shoats, cow, oxen, poultry, donkey and mule. About 92.9% of the households owned cows, while 89.1% owned oxen (Table 3).On the other hand, only less than one third of the respondents owned goat, donkey and mule. This implies oxen and cows are the key physical capital and sources of livelihoods for majority of the respondents. In terms of the average size of livestock owned poultry, goat and sheep respectively are high. While, the biggest number of livestock owned are poultry, cows and goats respectively. Regarding the trends of livestock ownership, about half of the respondents indicated that size of livestock owned has been declining, while one third reported their livestock ownership has been increasing. Only 3% of the respondents indicated that livestock ownership is not changed. During the focus group discussions farmers have indicated that the major cause of livestock decline is shortage of grazing land and degradation of the available grazing land due to both human and natural effects.

Table 1. Variable definition and hypothesis

	Definition	Hypothesis	Expected sign
Agehead	Age of household head in years	Young heads are expected to be food secure than old ones	–
Sexhead	Sex of household head (1, men, 0 women)	Female headed households are more vulnerable to food insecurity	+
eduhead	Education level of head in years	Higher education of heads is related with higher food security	+
ndepend	Number of dependents	Households with more number of dependents are more vulnerable to food shortage than their counterparts	–
mrktinfo	Access to market information (1, 0 otherwise)	Households who have access to marketing information tend to be food secure than those who do not have access to market information	+
nonfarm	Participate in nonfarm employment (1, yes, 0 No)	Households who participate in nonfarm activities such as wage are more vulnerable to food insecurity	–
crediuse	Have access to credit (1, yes, 0 No)	Access to credit enhance food security	+
farmsize	Farm size owned	The larger the farm size owned the better household food security	+
income	Total household income in ETB	Higher household income increases the probability of food security	+
LSdeath	Livestock death due to climate change (1, yes, 0 No)	Households whose livestock died due to climatic shocks more likely be food insecure	–
freqdrout	Frequent drought occurred (1, yes, 0 No)	Frequent drought is inversely related with Households food security	–
temprise	Temperature rises (1, yes, 0 No)	Rises in temperature tend to reduce food security	–
shortrain	Shortage of rain occurred (1, yes, 0 No)	Shortage of rain likely reduces households food security	–
waterscarc	Water scarcity occurred (1, yes, 0 No)	Water scarcity due to climate change likely induce food insecurity	–

Table 2. Socio-demographic profile of respondents

	Minimum	Maximum	Mean
Age of respondent	25.0	84.0	45.7
Family size	2.0	16.0	7.1
Level of education of head	0.0	10.0	4.2
Level of education of spouse	0.0	10.0	3.7
Number of dependent	1.0	9.0	3.4

Knowledge and awareness on climate change

At the local level, there is evidence that people are aware about the fact that climate is changing and global warming is happening. During the focus group discussions and interview, farmers indicated that they have noticed climate is changing (96.1%) and global warming is occurring (95.2%). About 93.6% of them disclosed that they get information related to climate through early warning systems from office of agriculture. Almost all of the farmers reported that climate change has happened due to human actions (deforestation, agricultural expansion, settlements), whereas 82.5% believe that climate change has occurred due to natural factors such as wind, volcanic eruptions, changes in solar intensity. Above half of the respondents attribute that climate change has occurred due to punishment of God as human beings are violating God's rules (Table 4). This indicates the importance of religious philosophy towards crisis from climate change. Much of the literature about the major causes of climate change indicated that it is caused by the increase of carbon dioxide (CO2) and other greenhouse gas emissions by humans. Human activities, such as the burning of fossil fuels and changes in land use, deforestation, land clearing, agriculture release large amounts of CO2, causing concentrations in the atmosphere to rise (UK8020, 2016)

Table 3. Size of livestock owned sample households

Livestock type	N*	Minimum	Maximum	Mean	Std. Deviation
Goat	52	1	18	5.38	3.43
Sheep	72	1	21	3.94	3.01
Cow	118	1	20	2.08	1.96
Calf	94	0	8	1.82	1.18
Oxen	113	1	16	2.25	1.59
Poultry	96	1	30	8.57	6.01
Donkey	36	1	4	1.33	0.755
Mule	6	1	2	1.16	0.4

*N is number of respondents owning the type of livestock indicated

During the survey focus group discussion participants reported that deforestations alarming due to new settlements and farming expansion although treeplanting is increasing. According to evidences from (UK8020, 2016); forests reduce greenhouse gas emissions to combat global warming. 20% of global greenhouse gas emissions result from deforestation and degradation of forest, more than all the world's cars, trucks, ships and planes combined. Climate information reduces uncertainty and can help farmers make better use of new seeds and technologies. Climate information should be accompanied by services that communicate, train and help users understand how to interpret and act on the information. About 93.6% of the farmers reported that they have access to weather forecast and climate information.

Table 4. Rural households perception about the nature and causes of climate change

Perception on dimate changes	%	Perception on causes of dimate change	%
Climate is changing	96.8	Human activities	93.3
Global warming is happening	95.2	Natural factors	82.5
Had access to climate information	93.6	God punishment	55

Climate related risks

The most important risk repeatedly reported during focus group discussions are long dry seasons that has been happening, increased hot days, fluctuation of rainfall patterns including late rains. The majority of households indicated declining quality of grazing land (93.7%); erratic rain (91.3); increased hot days (89.6%); unstable temperature (88%); delayed rain (85%); less rain(81.9%) water quality degradation (73.2%); disease incidence (73.2%); drought (71.7%); water scarcity (71.7%) and livestock death (54.3%) as a major climate related risks. The major frequently reported pests and diseases are rust and smut attacks maize and teff, aphids damage pulses, and coffee berry disease (CBD) which affect coffee are the major crop pest and diseases. Trypanosomiasis, Black leg, internal & External parasites are the most prevalent livestock disease affecting the livestock and limiting production. Literature also report that rainfall patterns in Ethiopia are predicted which may generate locally more drought and decrease production of maize by 17% to 30% per year. Acritical observation from this year as the number of people facing severe water shortages in different parts including the study areas indicates the likely effect of climate change. Climate-related risks are a major threat for all developing countries because of the socio-economic stresses that these countries are already experiencing, such as increasing levels of poverty, food insecurity, land degradation, water shortages and declining water quality(UN, 2008).

Several indicators such as increased temperatures, changes in rainfall amounts and patterns, and increased incidence of drought and flood events. Drought was a major problem in almost all sites, while floods affected localized areas in some of the sites. Air temperatures have increased globally, by around 0.85 degrees Celsius since 1880, with most of the warming occurring since the 1970s(AGDEE, 2016). For the past four decades, the average annual temperature in Ethiopia has been increasing by 0.37^{o}C every ten years,

which is slightly lower than the average global temperature rise(Emerta, 2013). Due to temperature rise, 89.6% of respondents reported that there is an increase in hot days and 71.1% faced drought shocks. Moreover, 69.3% reported that the temperature is unstable during day times and seasons, while 709% perceived cold days and periods are increasing.

Rainfall patterns are changing around the world(AGDEE, 2016). Ethiopia has experienced both dry and wet periods over the past four decades. However, precipitation has shown a general decreasing trend since the 1990s(Emerta,2013).Small-scale subsistence farming is mainly rain fed and therefore highly exposed to climate variability and extremes. Over 80% sample households indicated that the rain fall pattern has been erratic with frequent delays and they experienced receiving less or inadequate rain. As a result, 93.7% and 73.2% reported that quality of grazing land and water has been declining. Water scarcity and flood were reported by 71.1% and 40.2% of the respondents.

Small livestock keeper's vulnerability to climate risks

The word vulnerability is related to natural hazards like drought, flood and food shortage shocks. This paper pay attention to external side of vulnerability to which every household perceived exposed to. Weather and climate shocks like rainfall fluctuations, temperature rises were expected to affect livestock production and household food security. While asked small livestock holders whether they have notices indicators of climate change and related risks within the last 10 years or not. Figure 3 shows that above 70% of the respondents have recognized that less rain, frequency of drought, erratic rain, pest and disease incidence, temperature and short rain season to witness climate is changing. In spite, of respondents' variation in terms of their perception all households reported that they are highly sensitive to climate given their dependence on rainfall. They experienced irregular rainfall patterns during the rainy seasons, less/ inadequate, erratic and delayed start of the rainy season, and long dry spell length that could affect availability of grazing and water.

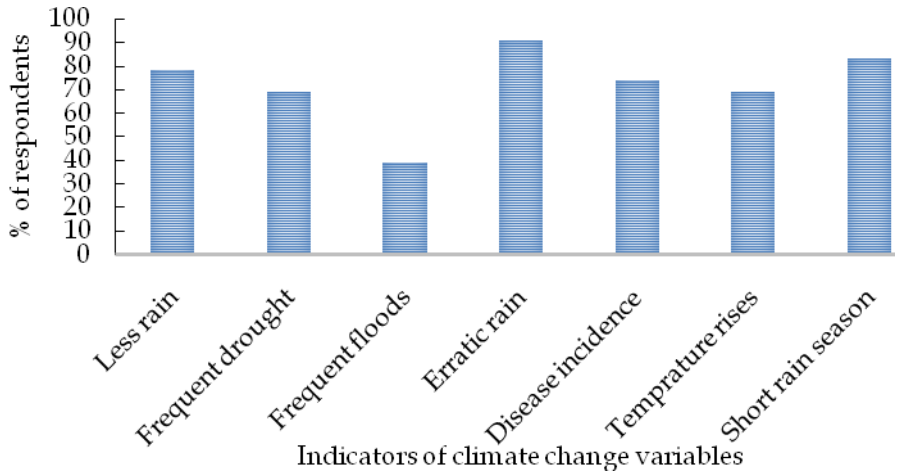

Figure 2. Indicators of vulnerability from climate change over the last 10 years

Changes in any of the variables of climate change make farmers worry about their livestock and farms. An early rain or a very hot day or a very cold day may affect their livestock and farming. We have asked how much they are worried of the risks attributed by climate change during the survey period. Accordingly, about 80percent have reported that they have been worrying about the climate related risks, of which around 58.7% of them are very worried and 28.1% worried. Although it is not well known why about 10% reported that they are not very worried while 2.5% do not worried at all (Fig 4).

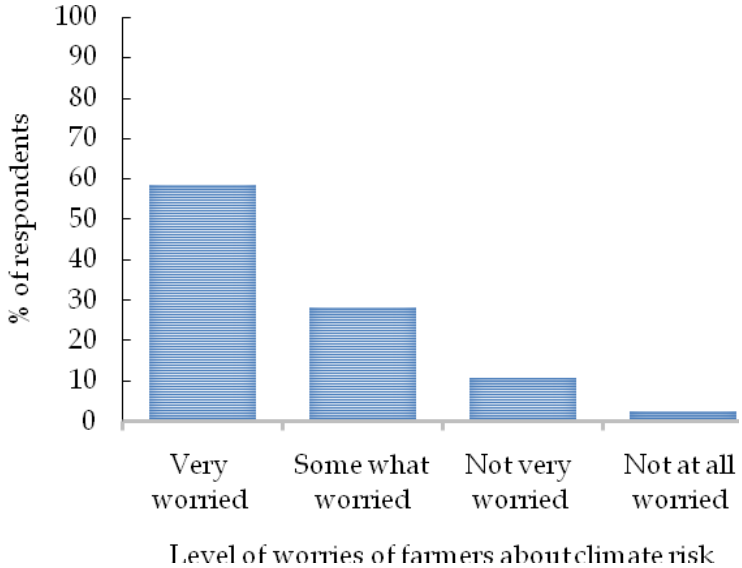

Figure 3. Psychological worries of rural households about climate change

Climate change affects different economic sectors differently. Fig 5 gives the severity of the effect of climate change on smallholders' economic activities. The highest effect falls on crops (61.7%) followed by livestock (34.2%) whereas the forests are affected to a lesser extent than the two sectors according to farmers' perception. This implies that over 90% of the respondents indicated the effect of climate change on production of livestock and crops which further affects availability of food and marketability of surplus production. Rising temperatures will lead to major disruptions in crops as it won't grow because of too little rain or too much rain. Pests will thrive in the warmer climate and destroy crops. Similarly, as most small livestock owners keep livestock on open grazing land disruptions on rain and temperature affects availability of grass and productivity of livestock.

Ethiopian government has been promoting community mobilized watershed management in recent years. There are also individual and community based efforts to conserve the natural resources in order to enhance resilient agriculture. We have asked our study farmers about the extent of

adaptation and mitigation strategies towards the negative effects of climate change and only 16.9% reported that more actions are being taken to enhance productivity and sustainability of natural resources, while 57.3% reported much less effort is exerted to combat the effect of climate change on agriculture. This indicates despite the awareness of rural communities and government policies on the importance of locally responding to climate change through adaptation and mitigation strategies smallholder farmers feel much has to be done in the future.

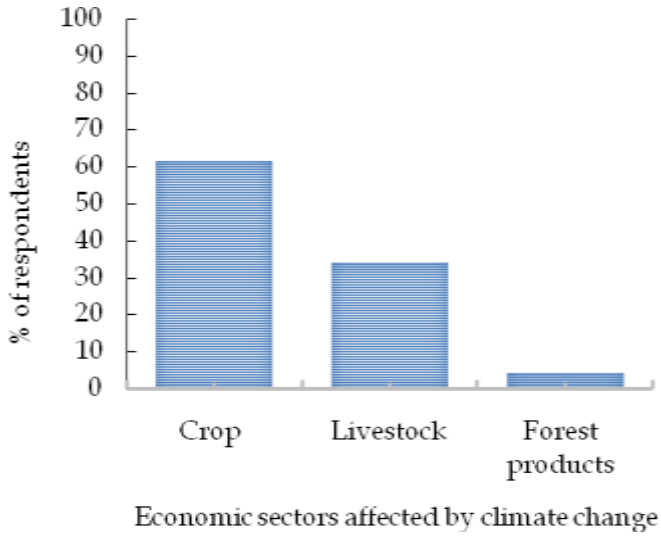

Figure 4. Economic sectors affected by climate change

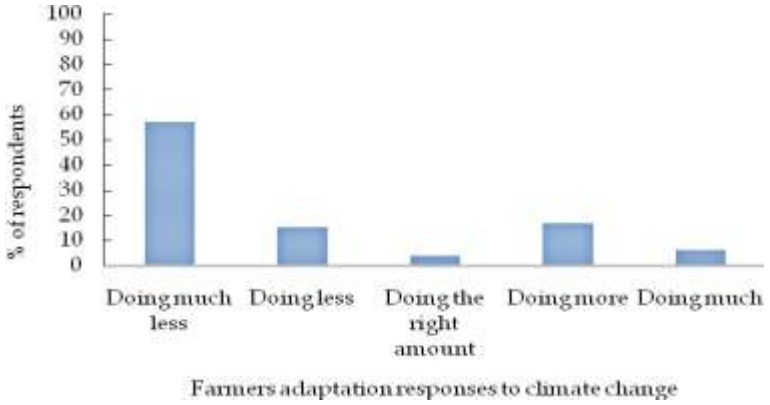

Figure 5. Farmers adaptation response rate to climate change

Food security of rural households

Ethiopian agriculture is based on land-and-water- consisting of crop and livestock husbandry. It is the base to achieve national and household level food security. Food production in any given year is affected most directly by the values of the critical climate elements (e.g. temperature, radiation, precipitation). Therefore, this study attempts to assess the link between climate risk and household food security. To do so it starts to elaborate the food diversity of sample households. Figure 7indicates the food items consumed by respondents and nearly all farmers are based on cereal consumption mainly maize and teff. As integral of cereal consumption, oil and salt plays a great role. As a place for origin of coffee Arabica, majority of the respondents consume coffee as part of their daily meal.

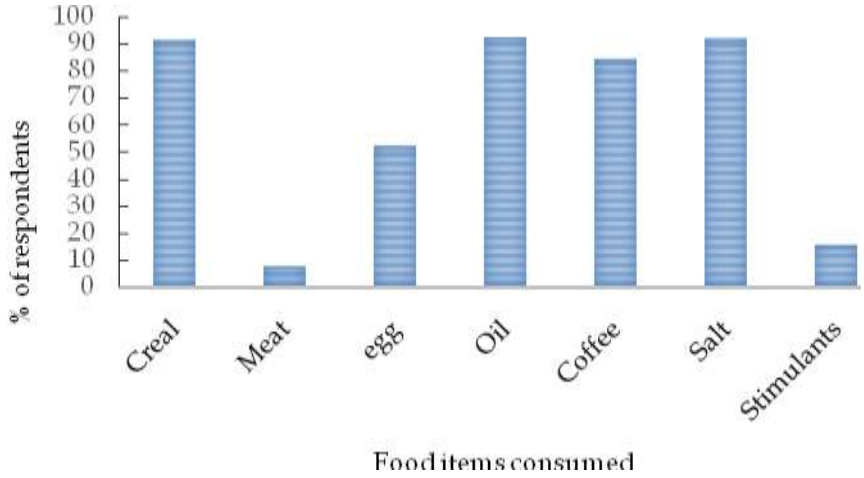

Figure 6. Food items consumed by respondents in the 7 days before the time of data collection

This study also measured the actual amount of food consumed and converted into energy level kcal per person per day. It applied a two-cut point for the nationally recommended and regionally recognized 2100 kcal and 1750 kcal per person per day rates. Accordingly, at 1750 kcal cut point the share of food secure and food insecure households is76 (59%) and 51 (40.2%) respectively. Whereas, at the 2100 kcal cut point 54.3% and 45.7% is food secure and insecure respectively (Table 5).

Table 3. Household food security status

At 2100 kcal/day/person cut point			At 1750 kcal/day/person cut point	
	N	Percent	N	Percent
Food insecure	58	45.7	51	40.2
Food secure	69	54.3	76	59.8
Total	127	100.0	127	100.0

Table 5 below showed the socio-economic factors related with being food secure or not. Regarding sex of household headship, over 60% of households leads by women are food insecure, while the figure is 40% for men headed ones although there are only 10 women in the sample. This shows women lead households have more chance of being food insecure than men lead households. Similarly, there is a clear difference between food secure and insecure with respect to marital status. Although, there are very small widow and only one divorced, all are food insecure. With respect to health condition of respondents during survey, 56% of people who are food secure are in good health condition, while 62.5% of the food insecure are in a serious health condition.

There are climate related factors influencing food security status of rural households. According to figure 9, there are no proportional difference between food secure and food insecure households at 2100 kcal with respect to shortage of grazing land and exposure to flooding. Whereas, incidence of drought, rain shortage, water shortage and livestock diseases vary between food secure and insecure. This clearly implies the number of people reporting incidence of drought, water scarcity, rain shortage and livestock disease during the survey period are higher for food insecure than the food secure ones.

Binary logit model result on the perceived effect of climate variables on household food security

Model fit information

As Damodar (2004)indicated, before running the model, collinearity diagnosis by using Variance Inflation Factors (VIF) need to be computed. As a rule of thumb, VIF of less than three are believed to have no multicollinearity. The computational results of the variance inflation variables confirmed the non-existence of association between the variables and were included in the model. By using the enter method we estimated the model as a block and the chi-square model fitting information is significant at less than one percent probability level revealing that model well fit the data. Similarly, the classification table using the count R^2 result for correct prediction rates shows that 74.8% of the sample was correctly predicted. The count R^2 result is greater than 0.50 and hence the predicted probability of the event is correctly estimated. The sensitivity (percentage of food insecure correctly predicted) and specificity (percentage of food secure correctly predicted) were 79.4 and 69.1 percent respectively. This indicates that the model has estimated the dummy food insecure and food secure correctly (Table 6).

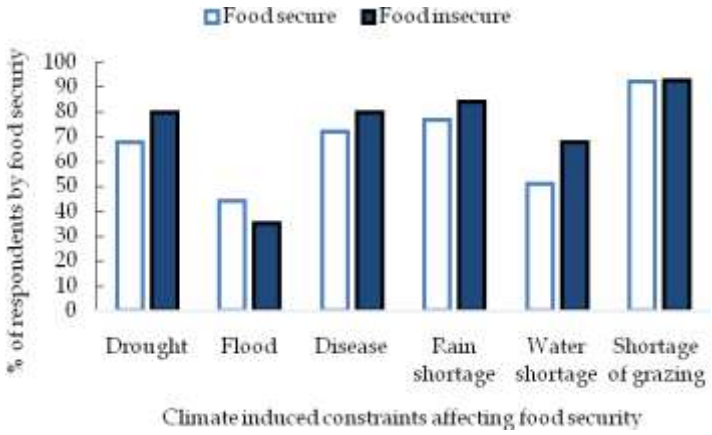

Figure 9. Climate related variables influencing food security

Empirical model results and discussions

Table 2 shows the logistic regression coefficient, Wald test, and odds ratio for each of the predictors. In the binomial logit model we have included 13 hypothesised and found eight variables to significantly influence household food security at the less than 10% probability levels. Among the significant variables participation in nonfarm employment (at 1%), livestock death and credit use(at 5%), sex & education of head, number of dependents, frequency of droughts, and water scarcity (at 10%) influence household food security.

Among socio-economic variables education of head, credit use, and non-farm activity minimizes the likelihood of rural households food security. The result of education and credit use is against our hypothesis. The odds ratio for sex indicates that when holding all other variables constant, men is 0.2 times more likely to become food secure than is a woman. This shows that women headed households are more vulnerable to food insecurity as compared to men headed household which is supported by other researchers (Abdullah et al., 2019). The probability of being food insecure increased by 0.854 for a unit increase in the average years of schooling for a given household which is against findings that reported for every one-unit increase in education, the log-odds of being food secure increases, holding all other independent variables constant(Abdullah et al., 2019; Mutisya, Ngware, Kabiru, & Kandala, 2016). People who used credit were food insecure and vice versa and this implies that rural people use credit to cover household expenses rather than investing on better opportunities. Our finding is in agreement with research which reported farmers were more likely to use the credit as a buffer against food insecurity(Twongyirwe et al., 2019)

Access to market information enhances the likelihood of being food secure by a factor of 2.362. This indicates that access to rural market information such as input and output prices, supply and demand information is a crucial factor influencing household food security. We also complement this finding with the fact that the study area is coffee growing, the role market plays in coffee marketing is vital. In rural Ethiopia, access to markets is important

for food security across the country and the poorer farmers depend on markets to meet their food requirements(WFP, 2014). Among climatic variables included in the model death of livestock due to climate shock, shortage of rain and water scarcity negatively and significantly influence household food security. The death of livestock directly reduces households probability of becoming food secure, However, frequency of droughts and rising temperature exhibits a positive association with household food security against our hypothesis. We assumed rising temperatures will pose a serious threat to grazing land and hence to livestock. However, we found this does not necessarily influence food security. Estimates on temperature effect in Ethiopia also suggest that warmer temperature may rise crop productivity(USAID, 2016).

The finding generally shows that the more frequent drought and rises in temperature has a favourable response to food security. This could be due to the fact that households adopt several coping strategies that minimizes the effect of frequent drought on food availability or the study locations are less prone to severe droughts. In line with our finding a study in Uganda find intensity and frequency of drought did not necessarily translate into food insecurity (Twongyirwe et al., 2019). However there are many studies which show drought as the major cause of food insecurity (Akwango, Obaa, Turyahabwe, Baguma, & Egeru, 2017; Mubiru et al., 2018)

In the study areas, food insecurity is more likely to be influenced by shortage of rain and scarcity of water. Evidence also shows that water storage capacity increases the Ethiopia's dependence on unreliable rainfall patterns(USAID, 2016).In south western Ethiopia, rainfall has been declining steadily since the 1960s, and this trend has accelerated since the mid-1990s(WFP, 2014). Therefore, focus should be given to strategies that enhance availability of water and rainfall. Some of such activities include water harvesting in the short run and increasing vegetation cover in the long run.

CONCLUSION

This study is conducted in southern Ethiopia, Jimma zone two woredas. About 127 small livestock keepers were sampled. Both primary and secondary data were collected through focus group discussions and interview research techniques. The food security situation as measured at 2100 kcal per adult per day showed that 45.7% households are food insecure. About 96.8% and 95.2% respondents believe that climate is changing and global warming is happening respectively. As a result, over 70% farmers were affected by drought and shortage of rainfall. About 58.7% very worried about the future due to climate related shocks although 57.3% report adaptation responses are much less than expected. Therefore, adequate adaptation and mitigation measure towards climate shocks should be promoted to ensure food security and Sustainable smallholder livestock systems. Our empirical model shows that shortage of rain, water scarcity and livestock death due to climate change negatively impacted food security. However, no evidence was observed on the perceived effect of drought frequency and rising temperature on food security. From this study we recommend that women's headed households should be targeted by agricultural extension workers particularly in livestock-focused extension activities. The fact that water scarcity and rain fall shortage significantly affected food security urges for actions on adaptation strategies to enhance availability of water and rainfall has to be prioritized. Minimizing livestock's vulnerability to death requires water harvesting and storage services. Moreover, improving access to market information need to be emphasized. We suggest future research works to focus

on the direct effect of climate change of livestock productivity. We further recommend a robust experimental study to unpack the impact of climate change on livestock productivity.

Table 6. Maximum likelihood estimation of binomial logit regression for factors influencing household food security

Model fitting information						
Pearson Chi-square	46.791***					
-2 loglikelihood	120.72					
Sensitivity	79.4					
Specificity	69.1					
% correctly predicted	74.8					
observations	127					
Model result	**B**	**S.E.**	**Wald**	**Sig**	**Exp(B)**	**VIF**
age	0.00	0.019	0.00	0.984	1.00	1.165
sex	-1.803	0.992	3.307	.069*	0.165	1.108
eduhead	-0.157	0.086	3.367	.067*	0.854	1.233
ndepend	0.148	0.135	1.205	0.272	1.16	1.123
mrktinfo	0.86	0.466	3.401	.065*	2.362	1.12
nonfarm	-1.71	0.637	7.202	.007***	0.181	1.375
farmsize	-1.142	0.289	0.242	.623	.868	1.380
income	0.00	0.00	0.00	0.99	1.0	1.320
credituse	-1.39	0.583	5.68	.017**	0.249	1.183
LSdeath	-1	0.504	3.942	.047**	2.72	1.271
freqdrout	1.423	0.785	3.282	.070*	4.148	1.28
temprise	0.473	0.513	0.85	0.357	1.605	1.196
shortrain	-0.217	0.891	0.059	0.808	0.805	1.882
waterscarc	-1.752	0.908	3.723	.054*	0.173	2.18
Constant	8.287	5.16	2.579	0.108	3972.46	

*, **, *** indicates ssignificance at 10%, 5% and 1% probability levels respectively

ACKNOWLEDGEMENT

The authors are very much grateful to Jimma University for funding and providing logistics for this research. The respondents who share their precious time also deserve appreciations.

REFERENCES

Abdullah, Zhou, D., Shah, T., Ali, S., Ahmad, W., Din, I. U., & Ilyas, A. 2019. Factors affecting household food security in rural northern hinterland of Pakistan. *Journal of the Saudi Society of Agricultural Sciences*, 18(2): 201-210.

AGDEE. 2016. Indicators of climate change: Australian Government Department for Environment and Energy

Akwango, D., Obaa, B. B., Turyahabwe, N., Baguma, Y., & Egeru, A. 2017. Effect of drought early warning system on household food security in Karamoja subregion, Uganda. *Agriculture & Food Security*, 6(1): 43.

Aragie, E. A. 2013. Climate change, growth, and poverty in Ethiopia: TEXAS UNIV AT AUSTIN.

Berhe, G. 2010. An Overview of the Ethiopian Livestock sector`s role in livelihood and food safety. . In FAO (Ed.), *Presented on: Dialogue on Livestock, Food security & Sustainability* Rome.

Conway, D., & Schipper, E. L. F. 2011. Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. *Global Environmental Change*, 21(1): 227-237.

CSA. 2007. Population and Housing Census of Ethiopia: Results for Oromia Region, Vol. 1, Tables 2.1, 2.5, 3.4 Addis Ababa, Ethiopia: Central Statistical Agency

CSA. 2014. Comprehensive Food Security and Vulnerability Analysis (CFSVA). Ethiopia, World Food Program & Central Statistical Authority joint publication

Damodar, N. 2004. *Basic econometrics*: The Mc-Graw Hill.

Dechassa, L. 2000. Field Assessment Report: Jimma Zone of Oromia Region (Mission undertaken from 10 to14 August 2000). UNDP, emergency office Ethiopia. . Addis Ababa, Ethiopia: UNDP.

Deressa, T., Hassan, R. M., & Ringler, C. 2008. *Measuring Ethiopian farmers' vulnerability to climate change across regional states*: Intl Food Policy Res Inst.

Devereux, S. 2006. Desck Review: Distinguishing between chronic and transitory food insecurity in emergency needs assessments. World Food Programme, Emergency Needs Assessment Branch (ODAN), Rome, Italy

Emerta, A., Aragie. . 2013. Climate Change, growth and poverty in Ethiopia. The Climate Change and African Political Stability (CCAPS) Working paper No 3. .

Eriksen, S. H., & Marin, A. 2011. Pastoral pathways: climate change adaptation lessons from Ethiopia.

ESAP. 2009. Climate change, livestock and people: Challenges, opportunities, and the way forward: Erhiopian Society of Agricultural Production.

FAO. 2000. The elimination of food insecurity in the Horn of Africa. A strategy for concerted government and UN agency action. FINAL REPORT 30 September 2000.

FAO. 2002 The State of Food Insecurity in the World 2001. Rome: FAO: FAO.

FAO. 2008. Climate change and food security: a framework document: Food and Agriculture Organization of the United Nations Rome.

FAO. 2010. Collaborative change: a communication framework for climate change adaptation and food security, Food and agriculture Organization of the United Nations, Rome, Italy.

FSS and Cordaid. 2009. Climate Change-Induced Hazards, Impacts and Responses in Southern Ethiopia, carried out in the southern lowlands of Ethiopia's.: Forum for Social Studies.

Gebre Michael, Y., & Kifle, M. 2009. *Local innovation in climate-change adaptation by Ethiopian pastoralists*. Paper presented at the Final report PROLINNOVA–Ethiopia and

Pastoralist Forum Ethiopia (PFE), Addis Ababa, Ethiopia.

Gentle, P., & Maraseni, T. N. 2012. Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. *Environmental Science & Policy*, 21: 24-34.

Hoddinott, J. 1999. *Choosing outcome indicators of household food security*: Citeseer.

IIASA. 2009. . Poverty and food insecurity — A threat to billions Impacts of climate change on coffee pests and diseases in the Jimma Highlands and Mount Kilimanjaro, Tanzania.

Krejcie, R. V., & Morgan, D. W. 1970. Determining sample size for research activities. *Educational and psychological measurement*, 30(3): 607-610.

Liliana, H. 2005. The food gaps: The impacts of climate change on food production: A 2020 perspective. *Universal Ecological Fund, Alexandria, VA, USA*.

Mango, N. Z., Byron; Makate, Clifton; Nyikahadzoi, Kefasi; Siziba, Shephard. . 2014. Factors influencing household food security among smallholder farmers in the Mudzi district of Zimbabwe. Development Southern Africa.

Mubiru, D. N., Radeny, M., Kyazze, F. B., Zziwa, A., Lwasa, J., Kinyangi, J., & Mungai, C. 2018. Climate trends, risks and coping strategies in smallholder farming systems in Uganda. *Climate Risk Management*, 22: 4-21.

Mutisya, M., Ngware, M. W., Kabiru, C. W., & Kandala, N.-b. 2016. The effect of education on household food security in two informal urban settlements in Kenya: a longitudinal analysis. *Food Security*, 8(4): 743-756.

Parry, M., Parry, M. L., Canziani, O., Palutikof, J., Van der Linden, P., & Hanson, C. 2007. *Climate change 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC*: Cambridge University Press.

Richardson, K., Steffen, W., & Liverman, D. 2011. *Climate change: Global risks, challenges and decisions*: Cambridge University Press.

Ringler, C., Zhu, T., Cai, X., Koo, J., & Wang, D. 2010. Climate change impacts on food security in sub-Saharan Africa. *Insights from Comprehensive Climate Change Scenarios*.

Tantu, A. T., Gamebo, T. D., Sheno, B. K., & Kabalo, M. Y. 2017. Household food insecurity and associated factors among households in Wolaita Sodo town, 2015. *Agriculture & Food Security*, 6(1): 19.

Twongyirwe, R., Mfitumukiza, D., Barasa, B., Naggayi, B. R., Odongo, H., Nyakato, V., & Mutoni, G. 2019. Perceived effects of drought on household food security in South-western Uganda: Coping responses and determinants. *Weather and Climate Extremes*, 24: 100201.

UK8020. 2016. Causes of climate change. UK eighty twenty, is a Not for Profit Community Interest Company. http://www.climatechangechallenge.org/Index.htm.

UN. 2008. Physical and socio-economic trends in climate-related risks and extreme events, and their implications for sustainable development.

USAID. 2016. Climate Change Risk Profile of Ethiopia. Country Fact Sheet. https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Factsheet%20-%20Ethiopia_use%20this.pdf

WFP. 2014. Climate risk and food security in Ethiopia: Analysis of climate impacts on food security and livelihoods. *World Food Programme*.

WFP, U. 1997. Guidelines for Estimating Food and Nutritional Needs in Emergencies. https://www.unhcr.org/3b9cbef7a.pdfS.

WISP. 2010. Supporting adaptation to climate change in Africa's Livestock

Sector. BRIEFING NOTE: World Initiative for Sustainable Pastoralism.

World Bank. 1986. Poverty and Hunger: Issues and Options for Food Security in Developing Countries. Word Bank, Washington DC.

Yesuf, M., & Bluffstone, R. 2007. Risk aversion in low income countries: Experimental evidence from Ethiopia: International Food Policy Research Institute (IFPRI).

Zakari, S., Ying, L., & Song, B. 2014. Factors influencing household food security in West Africa: The case of Southern Niger. *Sustainability*, 6(3): 1191-1202.

Ziervogel, G., Nyong, A., Osman, B., Conde, C., Cortés, S., & Downing, T. 2006. Climate variability and change: Implications for household food security. *Assessment of Impacts and Adaptations to Climate Change (AIACC): Washington, DC, USA*.