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FOOD INSECURITY AND AGRICULTURAL SHOCKS IN THE RURAL ETHIOPIA

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ABSTRACT: Agriculture; the dominant generator of means of livelihoods for the majority of people in developing countries; is obstructed by a number of both endogenous and exogenous problems. The purpose of this study is to determine whether there is an association between food insecurity and agricultural shocks and to identify the agricultural determinants of food insecurity in rural Ethiopia. The data is obtained from the Ethiopia Rural Household Survey (ERHS) conducted in 2009. The data is analyzed using both descriptive statistics, and Binary logistic regression. Based on the result, the great majority of households were found food insecure. In the adjusted analysis, The households that use fertilizer in the prior year to the survey period have 62% less likely to have food insecurity than those who did not apply fertilizer on their land. Households that have off- farm income are 86% less likely to be affected by food insecurity than those who do have off-farm income. In addition, households that have faced rain shock are 2.19 more likely to have food insecurity problem than those who do not face. It is concluded that rain shock, fertilizer use, and off-farm income are the main determinants of food insecurity. It is recommended that the adaptive capacity of individuals, households, and communities should have to be enhanced; the applicability of fertilizer and availability of off-farm income generating activities should have to be improved.

KEYWORDS: Agricultural shocks, Food insecurity, Ethiopia, ERHS

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1.INTRODUCTION

In the globe for many decades, agriculture has been the main source of livelihoods for the developing world subsisting for a significant portion of their nations. It has been the primary sector providing employment opportunities for nearly 70% of the rural population and contributing the largest share (up to 40%) to their national Gross Domestic Product-GDP. Nevertheless, its productivity has been challenged by a multitude of endogenous and exogenous shocks. These shocks arise from climate changes as well as man-made calamities of civil strife & prolonged war [1]. This, in turn, has resulted in lower agricultural outputs neither where agriculture fails to provide adequate food supply nor employment opportunities putting rural people at greater risks of food insecurities.The agricultural sector of the developing world is also characterized by dismal performance often carried out by traditional means and farming technologies. Poor infrastructural developments ensure a poor level of productivity. Productivity can be affected at different stages of the agricultural activities starting from preparations of farming land, through growing, harvesting, storing and distributions of the final outputs. This unique nature has made the sector to be more vulnerable and susceptible to wide ranges of risks (natural & artificial) which in turn increases the risks of food insecurity and malnutrition. On the other hand, population growth has been increasing since long times widening the gap between food supply and food demand. At the turn of 21st century, this gap has reached unbearable levels, where securing food supply to the most rural destitute is the most challenging part of social welfare objectives and global development endeavors. FAO's successive world food Summits since 1996 to date and the global development objectives of 2000 (goal one of the MDG) attest the above fact with their long and grip vision of" the world free from hunger and malnutrition"[2]. The impact of agricultural shocks on food security has been identified as a major area of concern owing to climatic variations in many parts of the world in general and in developing countries in particular. The predominance of rain-fed agriculture in much of the developing world especially in Sub-Saharan African has resulted in food systems that are highly reliant and sensitive to rainfall variability. Agricultural shocks, driven by climate changes, affect agricultural production and hence food security in a multitude of ways. Ethiopia is one of the poorest countries in the world with 27.8 percent of the population living below the poverty line in 2011/12. The level of poverty is more severe in rural areas than the urban aggravated by the occurrence of various both manmade and natural calamities (MoFED, 2012). The state of food insecurity in the world is increasing from time to time. According to recent estimates of FAO [3], over 870 million people are chronically malnourished and food insecure around the world. Despite significant efforts to reduce the number of food insecure people, the number of people suffering from malnutrition and hunger remains unacceptably high. The vast majority (850 million) live in developing countries, where about 15 percent of the population is estimated to be undernourished (Ibid). Similarity, Tobin et.al [4] has pointed out that the number of food-insecure people in sub-Sahara Africa (SSA) is showing unabated signs; increasing from 170

million in 1990 to over 200 million in 2003/4. It has been well documented in the literature that the developing regions of the world are the most vulnerable groups to food insecurity in the world. Of the developing world, SSA appears to be the hardest it to food security risks. Several factors contributing to this insecurity in the regions are identified. Tobin [4] listed poor agricultural productivity as the major factor. Agricultural productivity is constrained by poor technology, poor infrastructure, natural and manmade shocks, poor marketing, etc. The region is also lagging behind others in terms of using agricultural inputs. As a result, productivity has stagnated for several decades. Despite the rapid and impressive progress in tackling poverty in recent years, it has been reported in subsequent food security assessment studies that on average nearly 3-5 million Ethiopians or 35 % of the overall population to have been suffering from chronic food insecurity and undernourishment every year mainly caused by agricultural shocks and climate changes [5,6].Sound policy formulation with a view to reducing the level of food insecurity risks and increasing resilience in an economy requires a detailed understanding of how agricultural shocks affect the level of food security at household level. This study is important in the sense that it gives helpful insight to the true nature of agricultural shock in the country and its determinants on the level of food insecurity along with the channels through which agricultural shocks affect food security. Food security is one of the MDG that was expected to be achieved by 2015 through "Eradication of extreme poverty and hunger". Therefore, the result of this study and its resultant recommendation is very important for policy makers at all levels. The objective of the study is, to identify the agricultural shock determinants on food security in rural Ethiopia.

Concepts and Historical Development of Food security

The concept of food security is believed to have originated three decades ago in the mid-1970s in the first world food conference and was narrow in its coverage and definition. The concept initially focused on the national and international level and was defined from the perspective of the food supply with special attention to food availability and stable food price [7]. Food security is defined as a situation where all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [8]. Similarly, Oxfam defined food security as conditions when everyone has at all times access to and control over sufficient quantities of good quality food for an active healthy life [7].With increasing knowledge and dynamisms of vulnerability to risks of food shortages, a more comprehensive and multi-dimensional approach to the concept of food security became emergent. Accordingly, the concept encompasses the following four components: food availability, food access, food utilization and sustainability [9, 10].

- **Food availability** is said to be achieved when sufficient quantities of food are consistently available to all individuals within a country.

- **Food access** is ensured when households and all individuals within them have adequate resources (entitlements) to obtain appropriate foods for a nutritious diet [9, 11, 12].
- **Food utilization** refers to the utilization (consumption) of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met.
- **Food sustainability/stability** refers to a situation where the above three elements (components) of food security are fulfilled at any time. In other words, to be food secure, a population, household or individual must have access to adequate food at all times.

The access component of food security implies that people should not be under any circumstance of risks owing to sudden shocks of economic or climatic crisis or cyclical events. The concept of stability can, therefore, refer to both the availability and access dimensions of food security. Food insecurity, on the other hand, is viewed as the denial of the above rights either at household/ individual or community levels [2, 4]. Another broader concept which encompasses food security is food system. It refers to all human food chain activities of producing, processing, distributing and consuming food to a range of social and environmental contexts [13]. It is quite evident that any of the above human food chain activities are somehow affected directly or indirectly by climate changes. On the other hand, human activities of producing, processing, packaging, distributing, retailing and consuming food are partly responsible for changing the world's climate through emissions of greenhouse gasses. These activities contribute also to global climate change through changing fresh water supplies, air quality, nutrient cycling, biodiversity, and soil. All definitions imply that food security is a broad concept and requires taking into account a wide array of causes and measurements. This paves the way for approaching the issue from a different perspective and provides evidence for consideration of the wider definition given by FAO (1996) encompassing all elements of availability, accessibility, utilization and sustainability. Another important term to be defined in this study is agricultural shocks. It refers to any an unexpected, intense, and distressing experience in agricultural activities that has a sudden and often devastating effect on agricultural yield. The collapse in agricultural yields (cereals, cash crops, fruits, vegetables, animal and animal products etc) can be attributed to several underlying causes. These factors include untimely rain falls, drought (lack of water), too much rain, pest infestation, floods, and animal disease outbreaks, frost etc. The occurrences of any of the above factors profoundly affect the quantity and quality of agricultural yields leading to immediate risks of increased crop failure and loss of livestock.Generally, it is important to note that the potential impacts of agricultural shocks on food security must be viewed within the larger framework of changing global climatic dynamisms and observable changes in multiple socio-economic and environmental variables. This paper seeks to illuminate the potential impacts of such shocks on food security as viewed from availability and accessibility perspective.

The Link between Agricultural Shocks and Food Security

The impact of agricultural shocks on food security has been identified as a major area of concern owing to climatic variations in many parts of the world in general and in developing countries in particular. The predominance of rain-fed agriculture in much of the developing world especially in Sub-Saharan African has resulted in food systems that are highly reliant and sensitive to rainfall variability. Agricultural shocks, driven by climate changes, affect agricultural production and hence food security in a multitude of ways. Recently, one sixth of humanity is undernourished, more than ever before [5, 14]. Changing climatic conditions are projected to affect food security through their impact on local food systems. Climate change will generate significant and intensified weather events such as floods, tornados and hurricanes; increased drought; loss of coastal areas and water shortages; and changes in the incidence of disease.

Causes of Food Insecurity (developing world and SSA)

It has been well documented in the literature that the developing regions of the world are the most vulnerable groups to food insecurity in the world. Of the developing world, SSA appears to be the hardest it to food security risks. Several factors contributing to this insecurity in the regions are identified. Tobin [4] listed poor agricultural productivity as the major factor. Agricultural productivity in the region is constrained by poor technology, poor infrastructure, and poor marketing. The region is also lagging behind others in terms of using agricultural inputs As a result; productivity in the region has stagnated for several decades. In addition to poor agricultural productivity, limited rural development (weak infrastructural development of power, road and market accesses), is another factor aggravating food security in SSA. Weak government policy that adversely afflicted the agricultural sector is another factor contributing to food insecurity in the region. Poor health condition also poses its impact to food insecurity. The region is also characterized by the prevalence of contagious and fatal but preventable diseases of HIV/AIDS, malaria, TB and other diseases. This reduces rural labor participation in agriculture and off-farming activities contributing to food insecurity. Moreover, rising global commodity prices and climate change will likely further exacerbate food insecurity in the region. Agricultural productivity in sub-Saharan Africa, as measured by grain yield, is only about 40 percent of that of the rest of the world's developing countries, and the gap has widened over the years [4, 12].

Food Security in Ethiopia

Although the issue of food security is a century old concern for FAO and other donating institution in the country, food insecurity emerged as a key problem and development challenge in Ethiopia in the early 1970s and became pervasive in the subsequent decades. More importantly, since the mid-1980s the occurrence of severe drought and large-scale starvation ignited the need for food security and food aid initiatives in the country. However, the concept has become more complex due to a shift in the level of analysis from global and national to household and individual levels [15]. Special

programs for food security (SPFS) in the country began to be operational in 1995 in two regions (Amhara and Tigray). The food security strategy, first launched in 1996 and revised in 2002, has elements of environmental rehabilitation, water harvesting, and the introduction of high-value crops, livestock and agro-forestry development. The project continued by Italian support in 1998 supporting 4062 participating households (24500 beneficiaries). The project was further expanded to other regions of the country in 2001 with a view to improving the nutritional status and food security of the population. New Coalition for food security was established in 2003 with the aim of supporting chronically food insecure households to reach a level of food security necessary to survive and thrive. In 2004, GoE designed and implemented New Collusion strategies/program of Food Security Program (FSP), and expanded its endeavor to fight against food insecurity, malnutrition and hunger by allocating more resources. Later on in March 2005; the national program for food security (NPFS) was launched focusing on three broad components: i) Productive safety nets (PSN) where people were provided with food for work, ii) Household asset building (HAB) where households are provided temporarily with cash to build communal asset through which they are anticipated to escape food insecurity and iii) Voluntary resettlements; where households, especially in drought-prone areas, were moved to fertile areas so that they can subsist their household members through rural farming

Consistent with other developing countries, the government of Ethiopia (GoE) applied a wide array of strategies to reduce incidences of food insecurity risks to ensure food security at household, local and regional levels. Furthermore, improving food security was recognized within the framework of Sustainable Development Poverty Reduction Paper (SDPRP) in 2006 as a central concern of government [16].The food security program in the country was motivated and guided by two fundamental principles: the first is the principle of reliance where rural food insecure farmers are made reliant on food aid to help them use their own resources to overcome food insecurity. The second principle is guided by breaking away the perpetual food aid dependence so that they become food self-sufficient. As a cause of food security combinations of natural and man-made factors have resulted in this serious and growing food insecurity problem in many parts of the country. The immediate causes of food insecurity include frequently recurring droughts and erratic rainfall patterns. Ecosystems degradation, rapid population growth, poor rural infrastructure and legacies of the past policy constraints are also considered as basic causes of food insecurity and widespread poverty in the country. Source: [17-19].

THEORETICAL FRAMEWORK OF THE STUDY

Agricultural shocks and food insecurity act in a vicious circle way. Agricultural shocks drive to food insecurity and food insecurity causes malnutrition and mortality. Food insecurity may cause irreparable damage to livelihoods, thereby reducing food self-sufficiency. In addition, the state of being food insecure directly contributes to destitution and loss of livelihood assets in the long term. As a result, households are trapped in a vicious circle of food insecurity and poverty. This research

tries to identify the major causes of agricultural shocks and its impacts on food security of the rural people.

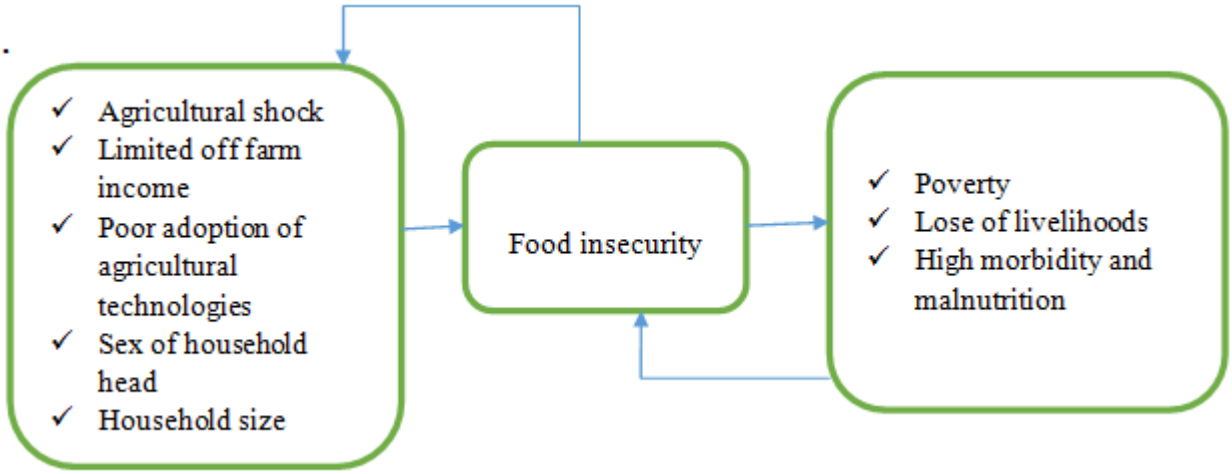

Figure 1: Theoretical framework

2.MATERIALS AND METHODS

Study design and Data source

A cross-sectional study was conducted using the 1577 rural households in Ethiopia. The source of the data for this study was the secondary data from the Seventh round cohort data of the Ethiopian rural Household Survey (ERHS).

Variables and variable definitions

The variables are Food insecurity, Rain shock, Extension visit, Off-farm income, Husband death, Fertilizer use, Household size, Region, and Household head

- **Food Insecurity** occurs in two forms: *chronic/permanent and transitory/temporal. Chronic food insecurity* is the most severe category where a person is unable to meet the minimum amount of food needed for healthy life over a long period usually due to poverty or lack of productive recourses to generate income to purchase food [20]. The other one is *transitory/temporal food insecurity*- inability to meet the food requirement of a household for a short period of time. It is categorized as yes or no; (yes= if there was food insecurity from any type of the above and No=if there was no any of food insecurity problem).
- **Extension visit** is simply where the household's land visited by an extension agent during the last main season. It is categorized into "yes" and "no".
- **Off-farm income** is any kind of income that they got out of farm activity including the government food aid; if they got "yes" and if not is "no"
- **Rain shocks**: unexpected event regarding rain such as over rain, less rain, the rain out of the rain period, and rain at a time of harvesting and collection of crops, and the variable is categorized "yes" if there is a rain shock and "no" if there is not.

- **Fertilizer use-** 'yes' if the household has applied fertilizer in the previous year and 'no' if the household was not a user.
- **Household size** is the number of member of families in the specific household.
- **Household head** is the head of the specific households; "yes" if the household head is male and "no" if household head is female.
- **Husband death** is the death of the husband in the households and is categorized to "yes" if the husband is dead and "No" if not.
- **Region** the corresponding region of the households.

Study Analysis

The description of the characteristics of the Households under the study is presented through the use of frequency distribution table. The Bivariate logistic regression shows the crude association between the outcome and the exposure Variables. The Multivariable logistic regression has been used to determine the adjusted association between food insecurity and the exposure variables. In the binary logistic regression, the dependent variable has only two possible outcomes, 1 or 0. We want to describe the probability that conditional on a vector of explanatory variables x_i: $P(y_i=1|x_i)$. In order to estimate this probability, we need to make an assumption about the distribution of y. While the probit model rests on the assumption that the dependent variable is distributed according to a standard normal distribution function, the logit model assumes a standard logistic distribution. Both distributions have an expectation of zero and gives estimated probabilities between 0 and 1. In applied empirical work the two models yield very similar results. Here, the logit model is chosen specified by: $P(Y_i=1|X_i) = \exp(x_i'\beta_k)/(1+\exp(x_i'\beta_k))$ and this is estimated using maximum likelihood [21]. All results from descriptive analysis to inference are done by using STATA12. This study has used the stepwise logistic regression to see the agricultural determinants of food security in the final model after including the significant variables from the bivariate analysis. At this time the researcher has checked about the confounding, interaction and there is no any confounding variable and interaction by taking the cut off point for the coefficient (β) changes if it is 15%-20% [22]. The model with the smaller Bayesian information criteria (BIC) is used to select the final best fitted logistic regression model of food insecurity. After fitting the final best model the researcher has checked also whether there is multicollinearity between the independent variables or not using the Variance Inflation Factor (VIF). Finally, to check the accuracy of the final formulated logistic model Hosmer-Lemeshow test, for overall goodness of fit is used to a level of significant value $\alpha=0.05$. To answer the question that "does the fitted model predict well?" this study was used the Receiver operating characteristic (ROC) Curve, to say well predict the dependent variable with the area under the curve of greater than 0.5.

3.RESULTS AND DISCUSSION

Table 1: Description of the Characteristics of the Households

Variables and their category		Frequency	Percentage
Food Insecurity*(32)	Yes	924	59.81
	No	621	40.19
Rain Shock*(16)	Yes	1355	86.80
	No	206	13.20
Extension Visit*(5)	Yes	728	46.31
	No	844	53.69
Off-farm income	Yes	807	51.17
	No	770	48.83
Sex of Household head*(222)	Yes	827	61.03
	No	528	38.97
Fertilizer use*(483)	Yes	900	82.27
	No	194	17.73
Husband Death	Yes	0	0.00
	No	1577	100.00
Region	Tigray	148	9.38
	Amhara	420	26.63
	Oromia	591	37.48
	SNNP	418	26.51
Household size*(19)	Mean(SD) = 5.68(2.57)		

*Number of missing values

Sample households are identified from the four regions based on proportional to size allocation method. As a result, 148(9.38%) households are from Tigray, 418(26.51%) are from SNNP, 420(26.63%) households are from Amhara region and the remaining 591(37.48%) households are from Oromia regional state. The average family size of the sample households is 5.68; approximated to 6 (Table 1). Based on the result, 924 (59.81%) of sample households were food insecure in the year 2009. Rain shock was one of the main constraints of agricultural productivity in the year; 1355(86.80%) being affected by the problem. The study identified that more than half of the population did not visit by extension workers; only 46.31% had the chance to be visited. Nearly half (48.83%) of the population in Ethiopia did not have off-farm income during the study period. The use of fertilizer was very high. Fertilizer as a means of improving the productivity of the land was used by 82.27% of the population. From the descriptive presentation of Table 2, among 912 food insecure households 825(90.46%) have experienced rain shock. 501(81.20%) food secured households also experienced seasonal rain shock.

Table 2: Cross Tabulation and Bivariate Analysis

Variables and their category		Food Insecurity		Crude OR(CI)	P-value
		Yes Freq. (%)	No Freq. (%)		
Rain Shock	Yes	825(90.46)	501(81.20)	2.20(1.63-2.96)	<0.0001
	No	87(9.54)	116(18.80)		
Extension Visit	Yes	408(44.25)	304(49.19)	0.81(0.668-1.01)	0.0568
	No	514(55.75)	314(50.81)		
Off-farm income	Yes	516(55.84)	274(44.12)	1.60(1.31-1.97)	<0.0001
	No	408(44.16)	347(55.88)		
Sex of the Household head	Yes	461(60.18)	352(62.63)	0.90(0.72-1.13)	0.3650
	No	305(39.82)	210(37.37)		
Fertilizer use	Yes	487(77.55)	395(88.96)	0.43(0.30-0.61)	<0.0001
	No	141(22.45)	49(11.04)		
Husband Death	Yes	0(0)	0(0)	-	-
	No	924(100)	621(100)		
Region	Tigray	144(15.58)	1(0.16)	1.05(0.99-1.14)	0.0570
	Amhara	196(21.21)	214(34.46)		
	Oromia	274(26.65)	304(48.95)		
	SNNP	310(33.55)	102(16.43)		
Household size	**Mean(SD) =** 5.68(2.57)			0.99(0.95-1.04)	0.7766

This shows that rainfall shock affected both food secured and insecure households. 77.55% of food insecure households apply fertilizer in the prior period. But the simple application of fertilizer does not boost production alone. It requires moisture and appropriate application being supplemented by extension agents. The application of fertilizer in the dry season even further aggravates the water needs of plants and crops and significantly reduces agricultural productivity. In general, food insecure households had the following characteristics; 90.46% of them experienced rain shocks, only 44.25% of them are visited by extension agents, 55.84% of insecure households have off-farm income, and 77.55% of food insecure sample households applied fertilizer in the prior period. The concentration of food insecure households across the region is 144(15.58%) in Tigray, 196(21.21%) in Amhara, 274(26.65%) in Oromia and 310(33.55%) in SNNP households were in food insecurity.The association of food insecurity with the independent variables has been identified. Accordingly, from those independent variables Rain shock with the OR(CI) l 2.20(1.63-2.96), Off-farm income 1.60(1.31-1.97), and fertilizer use 0.43(0.30-0.61)) have an association with the dependent variable; food insecurity. However, household head 0.90(0.72-1.13), extension visit 0.81(0.668-1.01), and

Household size 0.99(0.95-1.04) have no an association with food insecurity. (Table 2). In the adjusted analysis, those households who have faced rain shock are 2.19 more likely to be food insecure compared to those households without the rain shock by adjusting the other variables. The association is statistically significant with p-value=0.000 and CI (1.53, 3.14). Households that have got off-farm income are 86% more likely to be food secured than those without off-farm income by controlling the other variables and it has a significant association with food insecurity with p-value 0.000 and CI (1.42, 2.45). Fertilizer use has a statistically significant association with p-value=0.000 and CI(0.26, 0.58) and the households that use a fertilizer prior year to the survey period have 62% less likely to have food insecurity than those households that have not used fertilizer by controlling other variables (Table 3).

Table 3: The Multivariable Analysis of Food Insecurity

Variables and their category		Adjusted OR (CI)	P-value
Rain Shock	No	-	-
	Yes	2.19(1.53, 3.14)	0.000
Off-farm income	No	-	-
	Yes	1.86(1.42, 2.45)	0.000
Fertilizer use	No	-	-
	Yes	0.38(0.26, 0.58)	0.000
Household head	Female	-	-
	Male	1.09(0.82, 1.46)	0.540
Household Size		1.02(0.50, 1.63)	0.463

Household head and household size have a statistically insignificant association with food insecurity having a P-value 0.000 and AOR (CI) of 0.540 (0.82, 1.46) and 0.463 (0.50, 1.63) respectively. Being male household head have 9% more likely to have food security in that household than being the female household head. And as the household size increases by one household member, food insecurity will increase by 2%. (Table 3)

4.CONCLUSION

In this study, it is found that Rain shock, Off-farm income, and fertilizer use are the main determinants of food insecurity, having a statistically significant association. To make this study valid we are greatly worked on data cleaning before the study begins used the stepwise logistic regression. Having this, we checked about the confounding, interaction and all the changes on coefficients (β). On selection procedure, it was less than the minimum cutoff point 15% then there is no any confounding or interaction effect in the final logistic model.The model with the smaller Bayesian information criteria (BIC) was used to select the final best fitted logistic regression model of food insecurity. After fitting the final best model we checked also whether there is multicollinearity between the

independent variables or not, and then the value of the mean of VIF was 3.86, therefore, there was no multicollinearity among variables.Finally, to check the correctness of the final formulated logistic model, Hosmer-Lemeshow test, for overall goodness of fit was used to a level of significant value α=0.005 and the value became 0.1649 that is insignificant means the final fitted model was correct. And to see does the fitted model predict well the researcher was used the ROC Curve, and its value of the area under the curve was 0.6261, therefore, the independent variables well predict the Food insecurity.

When we come to the recommendation;

First, based on the result of the study, Rain-shock is found to be the main determinant for households to be affected by food insecurity. The problem of rain shock is a result of global climate change. As a result, the following points are forwarded as a recommendation:

- There is a need for an international policy regarding the adoption of mitigation strategies to control climate change; the main cause for agriculture and rainfall shock.
- Adaptation strategy should be integrated into the development planning.
- There is a great importance of not treating climate change separately from other rural development and poverty alleviation interventions.
- The adaptive capacity of individuals, households, and communities and the adoption of drought resistance varieties of crops should have to be enhanced.

Second, those households who have applied fertilizer in the prior period are less likely to be affected by the problem of food insecurity. Therefore, the availability and applicability of fertilizer should have to be enhanced. In addition, extension agents should have made a regular visit to monitor the exact application of the technology. Third off-farm income has a significant contribution in moving households out of food insecurity. As a result, off-farm employment opportunities should have to be created and expanded.

CONFLICT OF INTEREST

The authors have no conflict of interest

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