Journal of Food Security, 2019, Vol. 7, No. 5, 151-158
Available online at http://pubs.sciepub.com/jfs/7/5/1
Published by Science and Education Publishing
DOI:10.12691/jfs-7-5-1

Determinants of Food Insecurity among Maize Farming Households in the Southern Region of Mali

Aboubacar Diallo[1,#,*], Asiamah Maxwell Toah[2,#]

[1]Institute of Rural Economy, ESPGRN/CRRA-Sikasso, BP: 16 Sikasso, Mali
[2]Department of Agricultural Economics, Agribusiness and Extension, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[#]These authors contributed equally to this work.
*Corresponding author: dialloaboubacr44@yahoo.fr, grandboubacar01@gmail.com

Received July 26, 2019; Revised August 29, 2019; Accepted September 06, 2019

Abstract Food insecurity is one of the most serious challenges facing developing countries all over the world. In Mali, it has been revealed that many regions suffer from food insecurity including the Southern region which is known as the most valuable cereal production area. In this region, maize is one of the main crops produced and the most commonly eaten food that provides necessary calories to farmers. The present study analysed the determinants of food insecurity among maize farming households using primary data from Southern region of Mali. We employed the Household Food Insecurity Access Scale (HFIAS) to determine the prevalence of food insecurity among maize farming households. Probit Regression Model (PM) was used to investigate the determinants of food insecurity. Using HFIAS, the majority of the farming households were found food insecure. These included households ranged from mildly (41%), moderately (12%), and severely (7%) food insecure groups. Food secure households were over 40%. Using part of saving to buy food, borrowing of money, and relying on less preferred less expensive food were the major coping strategies used by farming households' heads. Focusing on the factors with high significant influence, evidence from the PM showed that maize yield, access to extension services, and off-farm employment exerted negative effects on farming households' food insecurity status whilst household size exerted a positive effect. We recommend that government should try to put in place facilities and infrastructures bringing closer extension services to farmers to increase their access to information related to agriculture and by this way improve their productivity for food security. Also, farmers should be strongly encouraged to diversify their source of income for food purchases. Furthermore, it is recommended to promote small family size to reduce farming households' food insecurity in Mali in general and the Southern region in particular.

Keywords: *food insecurity, farming households, maize, Mali, probit model*

Cite This Article: Aboubacar Diallo, and Asiamah Maxwell Toah, "Determinants of Food Insecurity among Maize Farming Households in the Southern Region of Mali." *Journal of Food Security*, vol. 7, no. 5 (2019): 151-158. doi: 10.12691/jfs-7-5-1.

1. Introduction

Food is essential for human survival. It constitutes a basic means for life's sustenance [1]. Due to its importance in man's life, food is rated as the most basic of all human needs [1]. According to FAO [2], food security occurs "*when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*." Food security has three major elements. These include food availability, food access, and food utilization. Food availability at the farming household level means assurance to get access to sufficient food through own production or through purchase from markets, given sufficient purchasing power. Food access is ensured when households, and all individuals within them, have adequate resources to obtain appropriate foods for a nutritious diet [3]. The third pillar (food utilization) refers to the frequency to which meals are eaten and of what these consist.

Today, food security is a global challenge as reflected in the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) of fighting extreme poverty and hunger. The former aimed at reducing by half the proportion of people who suffer from hunger between 1990 and 2015, and the latter to end hunger and achieve food security and improved nutrition by 2030. But still, evidence revealed that a large number of people (about 925 million) in the world were found chronically hungry or did not get enough food to satisfy their needs due to extreme poverty [4]. About 907 million out of the estimated 925 million people who were chronically hungry were located in developing countries [4].

Food insecurity happens when food systems are stressed so that food is not accessible, available, or of

sufficient quality [5]. Fawole *et al*. [6] defined it as "*a lack of sustainable physical or economic access for people to enough safe, nutritious, and socially acceptable food for their healthy and productive life*." The causes of food insecurity common to countries in the developed and developing world include climate change and variability, low income, and income inequality [7]. The root cause of food insecurity is poverty, resulting in the inability of people to gain access to food [6].

As in many developing countries, the bulk of food consumed in Mali is produced by smallholder farmers, whose small contributions are aggregated to meet the demand for food in the country, hence ensuring food security [8]. However, the role of smallholder farmers in ensuring food security at the household level cannot be over-emphasized because of the number of mouths they feed [9]. In Mali, the large majority of the population (more than 68%), especially in rural communities, face limited access to food. This is mainly due to their low incomes [10]. Despite this situation, rural-based people spend an important part (43%) of its modest income on food versus 38% for the urban population and have a very poor consumption profile [11]. This profile is characterized by a very poor diet based on cereals which are the main food item and provide over 80% of dietary energy [11].

Food insecure households in Mali are largely focused in certain geographical regions. The most food insecure households are located in many regions of Mali including the Southern region which is already known to be the most valuable grain area [12]. In this region, cereals, in particular, maize is the most cultivated crops and constitutes the commonly eaten food that provides dietary energy to farmers [13].

While food insecurity continues to be seen as a real development issue, no much information exists on the determinants of food insecurity in Mali. Research works that have been carried out in this area dwelt mainly on characterizing food insecure households using descriptive analysis. The present paper, therefore, contributes to expanding the literature on the determinants of food insecurity among farming households in the Southern region of Mali employing Probit Regression Model. The study tried to provide answers to the following research questions: (1) What is the prevalence of food insecurity among maize farming households? (2) What are the coping strategies used by farming households to increase their access to food during the food shortage period? (3) What are the determinants of food insecurity of maize farming households?

2. Methods

2.1. Data

A mixed-method research design was employed for the purpose of this study. This is because it permits to combine both quantitative and qualitative methods within a single study [14]. Therefore, integrating qualitative and quantitative methods makes it appropriate to cover the multiple dimensions of food insecurity. Primary data was collected using a structured questionnaire. Both open-ended and closed-ended questions were contained in this questionnaire. It was made up of data on personal, household, farm, and institutional characteristics. Data on the coping strategy adopted by household heads during the food shortage period were also collected. In addition, we collected data on food insecurity prevalence of farming households using the Household Food Insecurity Access Scale (HFIAS).

2.2. Study Area

The present study was carried out in Southern region of Mali especially in Koutiala District. Maize production is very high in this district [15]. Koutiala covers an area of about 18,000 km² with a population of 575,253 inhabitants [16]. It is located in Sudano-Sahelian zone between 12° 38' N and 5° 66' W with rainfall season around 3-4 months. The dry season covers the rest of the months. The average annual rainfall is around 895 mm with a maximum temperature of about 38° C. This District was chosen for this study based on the fact that it recorded a slight increase in its food insecurity situation of late [10].

2.3. Sampling Approach

The sample size of 215 farming households from Koutiala District was determined using Yamane's [17] formula as follows:

$$n = \frac{N}{\left(1 + Ne^2\right)} \quad (1)$$

where n is the required sample size, N denotes the total population, and e represents margin of error. By using 8% margin of error, a sample size of 215 households was selected for interview. The marginal error of 8% was used because of the limitation of time and resources.

The study employed a multi-stage sampling approach. First, Koutiala District was purposively selected due to its high maize production [15]. Second, three (3) out of the six (6) agricultural subsections from Koutiala District were purposively selected. Third, two (2) communities were randomly selected from each agricultural subsection making a total of 6 randomly selected communities for the study. The final stage involved a simple random selection of maize farming households in the selected communities using the simple random sampling technique. A total of 215 households were randomly selected for the survey.

2.4. Statistical Analysis

The software Stata version 14 was employed to analyse the data.

Descriptive statistics were used to present the explanatory variables used in the regression model and to identify the coping strategies used by household's heads during the food insufficiency period.

Food insecurity prevalence of farming households was measured with the Household Food Insecurity Access Scale (HFIAS). HFIAS is a standard questionnaire of nine-item food insecurity scale developed by USAID's Food and Nutrition Technical Assistance (FANTA) Project [18]. The questionnaire estimates that food

insecurity (access) experience provokes predictable responses that can be gathered through a survey. Household Food Insecurity Access Scale score for each household was computed by adding the coded frequency of experience for all the questions as:

$$HFIAS\ Score(0-27) = \begin{pmatrix} Q_{1a}+Q_{2a}+Q_{3a}+Q_{4a}+Q_{5a} \\ +Q_{6a}+Q_{7a}+Q_{8a}+Q_{9a} \end{pmatrix} \quad (2)$$

where a denotes the coded frequency of experience. Generally, the higher the score, the higher the food insecurity status of the household. Households with HFIAS score between 0-4 are classified as food secure and those with HFIAS score above 4 are classified as food insecure.

Table 1. Household Food Insecurity Access Prevalence (HFIAP)

Food security status		Score
Food Secure		0-4
Food Insecure	Mildly Food Insecure	5-7
	Moderately Food Insecure	8-10
	Severely Food Insecure	11-27

Binary probit regression model was employed to investigate the determinants of food insecurity among maize farming households. Given the binary nature of the food insecurity status (yes/no), a discrete choice probit model is appropriate for the purpose of this study. This model is suitable in estimating the impact of the independent variables on outcome variable which in this case was the state of households being food [19].

Assuming a linear relationship between food insecurity status and various explanatory variables, the model was used to empirically test the statistical relationship between the dependent variable (food insecurity) and a set of personal, household, farm, and institutional characteristics. The dependent variable was a binary variable which took the value of 1 if a household was found to be food insecure (i.e. farming households with HFIAS score above 4), and 0 otherwise.

The probability pi of being food insecurity over not being it can be illustrated as in equation 3 below, where ϕ represents the cumulative distribution of a standard normal random variable [20]:

$$p_i = prob(Y_i = 1 \mid X) = \int_{-\infty}^{x_i'\beta} (2\pi)^{-\frac{1}{2}} \exp\left(-\frac{t^2}{2}\right) dt = \phi(x_i'\beta). \quad (3)$$

The relationship between a specific variable and the outcome of the probability is interpreted by means of the marginal effects, which accounts for the partial change in the probability. The marginal effect associated with continuous explanatory variables Xk on the probability $P(Y_i = 1 \mid X)$, holding the other variables constant, can be derived as follows [20]:

$$\frac{\partial p_i}{\partial x_{ik}} = \varnothing(x_i'\beta)\beta_k \quad (4)$$

where ∅ represents the probability density function of a standard normal variable. The marginal effect on dummy variables should be estimated differently from continuous variables. Discrete changes in the predicted probabilities constitute an alternative to the marginal effect when evaluating the influence of a dummy variable. Such an effect can be derived from the following [20]:

$$\Delta = \phi(\bar{x}\beta, d = 1) - \phi(\bar{x}\beta, d = 0). \quad (5)$$

Using sample data, the estimation method for the binomial parameter is called maximum likelihood. The idea is to use a value in the parameter space that corresponds to the largest likelihood for the observed data as an estimate of the unknown parameter. Since we are estimating the parameter for binomial function we solve for the maximum likelihood estimator for the Bernoulli Parameter Π, which have a function $f(\pi, x) = \pi^x(1-\pi)^{1-x}$. The likelihood function is given by

$$L(\pi, x) = \prod_{i=1}^{n} \pi^x (1-\pi)^{1-x} = \pi^{\sum_i^n = 1^{x1}} (1-\pi)^{n-\sum_i^n = 1^{xi}}. \quad (6)$$

3. Results

Descriptive statistics of the variables used in the regression model based on the food security status are presented in Table 2. It is deduced from the table that out of the total of seventeen variables, the difference in means of eight was statistically significant. These included gender of the household heads, age, education, plot ownership, distance from house to maize farm, asset ownership, extension service, and off-farm activity. These variables, therefore, were crucial to food security status. Evidence from the table showed that 96% of the food insecure farming households were headed by males while the entire food secure farming households were male-headed. The difference in means was statistically significant at 10%.

The same significant level was found with the difference in means age of food insecure household heads (48 years) and food secure household heads (51 years). This implies that food insecure household heads were less old as compared to those from food secure household. The average year of schooling was 2 years for food insecure household heads versus 4 years for food secure household heads. High significant difference was found between the means. The percentage of farming households who owned their plots for cultivation was higher in food secure groups (97%) than in food insecure groups (89%). Farmers from food insecure households travelled on average 3.19 kilometres from their homestead to farm versus 2.53 kilometres for those from food secure households. The difference in means was statistically significant, making this factor crucial to food security status. Household asset holding was also important to food security status since the difference in means was found to be significant. High statistical differences were found between food secure and food insecure farm households in terms of access to extension services and participation in off-farm activity.

Table 2. Definition and descriptive statistics of the variables used in the regression model by food security status

Variable Name	Variable Description	Food Insecure N=128		Food Secure N=87		Difference in means
		Mean	Std. Dev.	Mean	Std. Dev.	
Household characteristics						
Male-headed	Dummy=1, if household head is a male and 0 otherwise	0.9609	0.017	1	0	-0.039*
Age	Household head's age in years	48.7344	1.011	51.5862	1.392	-2.852*
Marital status	Dummy=1, if household head is married and 0 otherwise	0.9531	0.0188	0.9770	0.016	-0.024
Education	Number of years of schooling of the farmer	2.6172	0.263	4.2644	0.514	-1.647***
Joint-family	Dummy=1, if household is a large family and 0 otherwise	0.625	0.043	0.6437	0.052	-0.019
Household size	Number of family members in the household	23.1094	1.329	20.4253	1.389	2.684
Experience in maize production	Number of years spend in maize cultivation	16.4609	0.800	18.5402	1.012	-2.079
Farm/Plot-Level characteristics						
Plot size	Maize farm land holding in ha	2.4470	0.262	2.4195	0.267	0.028
Maize yield	Grains weight (t) per harvested area (ha)	1681.2560	70.339	1779.545	94.196	-98.289
Plot ownership	Dummy=1 if individual owns plot for maize cultivation, 0 otherwise	0.8984	0.027	0.9770	0.016	-0.079**
Distance from house to maize farm	Distance from home to maize farm in km	3.1931	0.357	2.5336	0.200	0.66*
Use of chemical fertilizer	Dummy=1 if individual uses chemical fertilizer and 0 otherwise	0.9766	0.013	1	0	-0.023
Asset ownership	Dummy=1 if individual owns asset for cultivation, 0 otherwise	0.9453	0.020	1	0	-0.055**
Institutional characteristics						
Extension service	Dummy=1 if individual has contact with extension service, 0 otherwise	0.8984	0.027	0.9885	0.0115	-0.090***
Membership	Dummy=1 if individual is member of any farm-based-organization, 0 otherwise	0.8125	0.035	0.7816	0.044	0.031
Access to credit	Dummy=1 if individual has access to credit, 0 otherwise	0.7187	0.040	0.7126	0.049	0.006
Off-farm activity	Dummy=1 if individual participates in any off-farm activity and 0 otherwise	0.6484	0.042	0.8276	0.041	-0.179***

*, **, and *** indicate statistical significance of 10%, 5% and 1% levels respectively.
Note: Mean for dummy variables indicates percent with value 1.

3.1. Prevalence of Food Insecurity among Farming Households

The food insecurity prevalence analysis in Figure 1 showed that using HFIAS, majority of farming households were found food insecure which included the three food insecure categories (41% mildly food insecure, 12% moderately food insecure, 7% severely food insecure). Food secure households represent about 40% of the total sample.

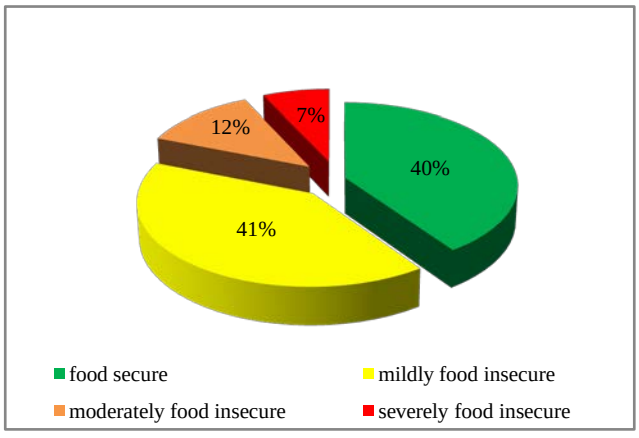

Figure 1. Prevalence of food insecurity of farming households

3.2. Food Insecurity Coping Strategies by Farming Households

Various coping strategies were used by farming household heads to be able to increase their food access during the food shortage period. Using part of savings to buy food (2.13) stood out as the topmost strategy in the study area. This was followed by borrowing of money with the mean score of 2.02, indicating that when households were faced with food shortage, one of the immediate strategies these households employed was to borrow money to buy food. Relying on less preferred less expensive food was the third topmost coping strategy. This showed that households started adjusting their dietary in the face of food insufficiency. The other most used coping strategies in order of importance included getting food on credit ranked 4th mean score (1.68), working in exchange of money ranked 5th mean score (1.28), reducing the quantity of food to be eating ranked 6th mean score (1.27), and relying on help from friends and family ranked 7th with the mean score of 1.18. Relying on government or NGO food aid, reducing number of meals to be taken, selling personal belongings, and going the whole day without food are the less adopted coping strategies in the study area.

Table 3. Coping strategies used by maize farming households during the food shortage period

Coping strategy	Mean Score	Rank
Using part of saving to buy food	2.13	1st
Borrowing of money	2.02	2nd
Relying on less preferred less expensive food	1.82	3rd
Getting food in credit	1.68	4th
Working in exchange of money	1.28	5th
Reducing the quantity of food to be eating	1.27	6th
Relying on help from friends and family	1.18	7th
Relying on government or NGO food aid	0.88	8th
Reducing number of meals to be taken	0.77	9th
Selling personal belongings	0.67	10th
Going the whole day without food	0.18	11th

3.3. Determinants of Food Insecurity among Farming Households

The binary probit model was employed to investigate the relationship between personal, household, farm, and institutional characteristics and farming households' food insecurity status. The parameter of the model was estimated with the Maximum Likelihood Estimation (MLE) technique. The estimated coefficients and marginal effects of the factors that influence food insecurity status among farming households are presented in Table 4.

Evidence estimated from the binary probit model showed that seven out of the seventeen variables hypothesized to influence household food insecurity status were found to be statistically significant. These included age, household size, education, maize yield, plot ownership, extension service, and off-farm activity. The negative sign of the coefficients denoted that the associated variable decreased food insecurity level whilst the positive sign indicated an increasing effect on food insecurity.

The results showed that the variable age had a negative effect on the probability of farming household being food insecure. Marginal effects further revealed that a unit change in the age of a household head reduced the likelihood of his or her household being food insecure by 1.51%.

However, the sign of the coefficient of household size was positive, thereby indicating a positive association with household food insecurity status. This finding implied that the likelihood of being food insecure increased with an increase in the household size. We found from the marginal effects that when the household members increased by one person, the risk of such household to be food insecure increased by 0.51%. This finding showed that the larger the household members, the greater the food insecurity level of the farming household was.

The variable education was expected to negatively influence food insecurity status. In line with this assumption, the coefficient came out with a negative sign and was statistically significant. According to the marginal effects, for every one unit increase in years of school, there was likelihood of decrease in household food insecurity by 1.56%. Maize yield was also expected to have a negative effect on food insecurity. The result was found in agreement with this assumption. The coefficient carried a negative sign and was found significant. This finding suggested that the higher farming household maize yield, the less the likelihood of food insecurity. Specifically, the marginal effects indicated that the probability of falling into food insecurity reduced by 0.02% with a unit increase in maize yield.

Plot ownership for maize cultivation decreased the likelihood of the farmers' household being food insecure. Household heads' access to extension service was found to have negative relationship with food insecurity status.

Table 4. Estimates of the binary probit model

Variable	Coefficient	Std. error	z-statistic	Marginal effects
Household characteristics				
Male-headed	-10.2652	450.40	-0.02	-3.1860
Age	-0.0618*	0.031	-2.01	-0.0151
Marital status	4.7914	240.640	0.02	1.4871
Joint-family	-0.0293	0.218	-0.13	-0.0091
Household size	0.0166**	0.009	1.87	0.0051
Education	-0.0502*	0.027	-1.87	-0.0156
Experience	-0.0038	0.014	-0.27	-0.0012
Farm/Plot-Level characteristics				
Plot size	0.0011	0.036	0.03	0.0003
Maize yield	-0.0008**	0.001	-1.96	-0.0002
Plot ownership	-0.891*	0.508	-1.76	-0.2765
Distance to maize farm	-0.0418	0.036	-1.15	-0.0130
Use of chemical fertilizer	-4.1692	474.718	-0.01	-1.2940
Asset ownership	-8.9387	349.023	-0.03	-2.7743
Institutional characteristics				
Extension service	-1.4704**	0.597	-2.46	-0.4563
Membership	0.1924	0.251	0.77	0.0597
Access to credit	-0.0248	0.238	-0.10	-0.0077
Off-farm activity	-0.6910***	0.233	-2.98	-0.2160
Constant	26.96774	954.313	0.03	
Number of observation		215		
Log likelihood		-117.48075		
Prob > chi²		0.0000		
LR chi² (17)		55.23		
Pseudo R²		0.190		

*, **, and *** indicate statistical significance of 10%, 5% and 1% levels respectively.

Off-farm activity was found to be highly significant to determine maize farming households' food insecurity status in the study area. This institutional factor showed a negative correlation with household's food insecurity status. This finding implied that farming households through their head that were engaged in off-farm activities were more likely to reduce their food insecurity.

4. Discussion

From the descriptive statistic results, it is revealed that male-headed farming households were more food secure than those headed by females. This result corroborates with the finding of Gebre [21].

The mean age for food secure household heads was higher than that for food insecure household heads. A similar result was found with Magana-Lemus *et al.* [22].

Food insecure household heads spent less time in school (2 years) relative to food secure farming household heads (4 years). The difference in means was highly significant, suggesting that education as factor was crucial to food security status. This finding is consistent with the fact that the household heads with high education level are able to cope more than those with low education level because they have great advantage of being employed. Less-educated household heads were more likely to be food insecure [22].

Farmers from food insecure households were more distant to their farm for maize cultivation than those from food secure households. This is consistent with the fact that long distance could affect farmers' capacity to undertake efficient works since they may get exhausted before reaching their farms [23].

Asset ownership and access to extension services were crucial to food security status since statistically differences were found for food insecure and secure households. Asset ownership was found to be statistically different for the two groups of households [7]. However, the study of Olagunju *et al. [7]* contradicted the finding that there was a statistical difference between the two groups regarding access to extension services.

Food secure households (82%) were more engaged in off-farm activity than food insecure farming households (64%). Alternative income generated from off-farm employment contributes to significantly improve household welfare [24].

Using HFIAS, majority of farming households were found food insecure including the three groups of food insecure households (41% mildly food insecure, 12% moderately food insecure, 7% severely food insecure), thereby not able to manage food demand for domestic consumption throughout the year. More than half percent of the world's most food insecure could be found among smallholder farm households in developing countries [23,25,26].

We found using part of savings to buy food, borrowing of money, and relying on less preferred less expensive food as the topmost coping strategies used by household heads in the study area. When they faced food shortage, farmers generally resorted to their savings to buy food [11]. Borrowing of money was also one of the immediate strategies households used to buy food in the Northern Region of Ghana [27]. Relying on less preferred less expensive food as the third topmost strategy implied that household heads started changing their consumption pattern (dietary adjustment) in the face of food insufficiency. This result agrees with Sonko [23].

Evidence from the PM revealed the variables such as age, household size, education, maize yield, plot ownership, extension service, and off-farm activity had differential influence on farming households' food insecurity status. Specifically, the result showed that the age, education, maize yield, plot ownership, extension service, and off-farm activity household size exerted negative effects on farming households' food insecurity status whilst household size exerted a positive effect.

The variable age had a negative effect on farming household food insecurity. Olagunju *et al.* [7] found similar result that there was a negative relationship between the age of household head and his or her household food insecurity status.

Contrary to the other variables, household size had a positive effect on household food insecurity status. According to marginal effects, when the household members increased by one person, the likelihood of such household being food insecure increased by 0.51%. The larger the household members, the greater the food insecurity level of the farming household was [1,7,28].

The variable education was negatively associated with the food insecurity status. This is plausible with the fact that household heads with high educational level are able to cope well as compared to those with low educational levels in food insecure situations because they have great advantage of being employed. Olayemi [1] found similar result.

Increase in maize yield reduced the risk of household being food insecure. This finding is consistent with the fact that maize in the study area is the main crop produced and constitutes the commonly eaten food that provides dietary energy to farming households. Based on that, any significant increase in yield could substantially increase households' access to food thereby reducing food insecurity.

Cultivated land ownership decreases the probability that farming household will be food insecure [29].

Household's access to extension services was found to have negative relationship with food insecurity status. Households that had access to extension services had less chance of being food insecure than those that did not have access. This may be true because access to extension services can enhance access to information related to crop production techniques, improved input, as well as other production incentives and these, go to affect their production thereby increasing their food security level.

Negative association was also found between households' food insecurity status and participation in off-farm activity. The extra income generated from off-farm employment could be used to purchase food to complement food commodities produced by farming households. Previous studies [23,7] are in agreement with this finding.

5. Conclusion

The results of the study revealed a high prevalence of food insecurity among maize farming households. The

most used coping strategies by farming households included using part of savings to buy food, this was followed by borrowing of money, and Relying on less preferred less expensive food. The variables such as age, education, maize yield, plot ownership, extension service, and off-farm activity negatively influenced farming households' food insecurity status whilst household size positively influenced.

Focusing on the variables with high significant influence on farming households' food insecurity status, the following recommendations are made:

Since the likelihood of being food insecure worsened with an increase in the household size, efforts should be made at improving programmes and policies that will ensure proper family planning and promote small family size.

Based on the findings that the increase in maize yield and access to extension services considerably reduced the likelihood of farming households being food insecure, government should try as much as possible to put in place facilities and infrastructures bringing closer extension services to rural communities and by this way increasing their access to information related to agriculture. This will also have significant effect on their productivity, thereby decreasing food insecurity.

There is also the need for government to develop and promote off-farm activities and encourage farmers on how they can be involved in these activities economically viable projects to increase household welfare and reduce food insecurity.

Acknowledgements

The authors thank the respondents in Koutiala, N'Pessoba, and Molobala communities who kindly spent their time to participate in the study. They are also very grateful to the head of the program ESPGRN/CRRA-Sikasso Mali and all colleagues (co-workers) for their support towards the success of this work.

Statement of Competing Interests

The authors have no competing interests.

Funding

This study was based upon work supported by the United States Agency for International Development, as part of the Feed the Future initiative, under the CGIAR Fund, award number BFS-G-11-00002, and the predecessor fund the Food Security and Crisis Mitigation II grant, award number EEM-G-00-04-00013.

References

[1] Olayemi, A.O, "Effects of Family Size on Household Food Security in Osun State", Asian Journal of Agriculture and Rural Development, 2 (2). 136-141. June 2012.

[2] FAO. United Nations Food and Agriculture Organization. The state of food insecurity in the world. FAO, Rome, 2002.

[3] Agada, M. and Igbokwe, E, "Influence of Food Culture and Practices on Household Food Security in North Central Nigeria", Journal of Food Security, 4 (2). 36-41. 2016.

[4] FAO. United Nations Food and Agriculture Organization. The state of food insecurity in the world. FAO, Rome, 2010.

[5] Beaumier, M. and Ford, J, "Food insecurity among Inuit females exacerbated by socio-economic stresses and climate change", Canadian Journal of Public Health, 101 (3). 196-201. January 2010.

[6] Fawole, W.O., Ilbasmis, E. and Ozkan, B, "Food Insecurity in Africa in Terms of Causes, Effects and Solutions: A Case Study of Nigeria" in 2nd International Conference on Sustainable Agriculture and Environment (ICSAE 2015), 1-9.

[7] Olagunju, F.I., Oke, J.T.O., Babatunde, R.O. and Ajiboye, A, "Determinants of Food Insecurity in Ogbomoso Metropolis of Oyo State, Nigeria", Production Agriculture and Technology Journal, 8 (1). 111-124. June 2012.

[8] FAO. United Nations Food and Agriculture Organization. Linking farmers to moving markets. FAO, Rome, 2014. [Online] Available at: http://www.fao.org/news/story/en/item/179362/icode [Accessed 25 January 2014].

[9] Prakash-Mani, K. Enabling food security through smallholder farming. 2013. [Online] Available at: http://media.cgd.swissre.com/documents/RDM_FoodSecurity_SmallholderFarming_ Prakash Mani_Jan20131.pdf.

[10] SAP., FEWS NET., INSTAT., PAM. and FAO, Enquête Nationale sur la Sécurité Alimentaire et Nutritionnelle (ENSAN), Rapport de synthese, version definitive. Mali 2016. 1-66.

[11] FAO. United Nations Food and Agriculture Organization. Review of Food and Agricultural Policies in Mali 2005-2011, Country Report Series, Mali, 2013, 1-224.

[12] Des, T, Etude diagnostique des secteurs économiques porteurs et espaces économiques partages dans la région de Sikasso, Mali, 2012, 1-100.

[13] Diallo, A.S, "An Analysis of the Recent Evolution of Mali's Maize Subsector", Unpublished Master's Thesis, Department of Agricultural, Food, and Resource Economics, Michigan State University, United States, 1-83 , November 2011.

[14] Bryman, A. and Teevan, J.J, Social Research Methods, Canadian Edition, Ontario: Oxford University Press, 2005.

[15] Makan-Fofana, M., Abdoulaye, T., Coulibaly, N., Sanogo, D. and Langyintuo, A, 2011. Characterization of Maize Producing Households in the Dry Savanna of Mali, Country Report–Mali, IITA, Ibadan, Nigeria, 2011, 1-54.

[16] INSTAT. Recensement General de la Population et de l'Habitat (RGPH)2009, Resultats provisoires, Mali 2010.

[17] Yamane, T, Statistics: An Introductory Analysis, New York: Harper and Row, 2nd Edition, 1967.

[18] Leroy, J.L., Ruel, M., Frongillo, E.A., Harris, J, and Ballard, T.J, "Measuring the food access dimension of food security: A critical review and mapping of indicators", Food and Nutrition Bulletin, 36 (2). 167-195. June 2015.

[19] Morgan, K.L. Briggs, A.C. Degner, R.L. and Stevens III, T.J, "A Probit Model Analysis of Factors Affecting Consumption of Fresh Sweet Corn in Major U.S Markets" at the Southern Agricultural Economics Association Annual Meetings (SAEAAM 2004), Oklahoma, US, 1-18.

[20] Greene, W.H, Econometric Analysis, Pearson, Prentice Hall, 7th Edition, 2011, 1-1232.

[21] Gebre, G.G, "Determinants of food insecurity among households in Addis Ababa city, Ethiopia", Interdisciplinary Description of Complex Systems, 10 (2). 159-173. June 2012.

[22] Magana-lemus, D., Ishdorj, A., Roson III, C.P. and Lara-álvarez, J, "Determinants of household food insecurity in Mexico", Agricultural and Food Economics, 4 (10). 1-21. March 2016.

[23] Sonko, B, "Food Insecurity Determinants among Farming Households in the Wa West District of the Upper West Region of Ghana", Unpublished master's thesis, Kwame Nkrumah University of Science And Technology, Kumasi, Ghana, 1-107. November 2014.

[24] Asogwa, B.C. and Umeh, J.C, "Food Insecurity Determinants among Rural Farm Households in Nigeria", in International Conference on Ecology, Agriculture and Chemical Engineering (ICEACS 2012), Phuket, Thailand, 1-6.

[25] Aidoo, R., Mensah, J.O. and Tuffour, T, "Determinants of household food security in the Sekyere-Afram plains district of Ghana", in 1st Annual International Interdisciplinary Conference (AIIC 2013), Azores, Portugal, 1-32.

[26] Wiggins, S. and Keats, S, Smallholder agriculture's contribution to better nutrition, Overseas Development Institute, London, 2013, 1-115.

[27] Osman, S, "Assessing the Food Security Status of Smallholder Farm Households in the Northern Region of Ghana", Unpublished master's thesis, University of Development Studies, Tamale, Ghana, 1-127. November 2015.

[28] Uzunoz, M. and Akcay, Y, "A Case Study of Probit Model Analysis of Factors Affecting Consumption of Packed and Unpacked Milk in Turkey", Economics Research International, 1-9. September 2012.

[29] Bogale, A. and Shimelis, A, "Household level determinants of food insecurity in rural areas of Dire Dawa, Eastern Ethiopia", African Journal of Food, Agriculture, Nutrition and Development, 9 (9). 1-13. December 2009.