

Socioeconomic Characteristics of Households' Adaptive Capacity to Food Insecurity in Mali

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Abstract This article examines the socioeconomic characteristics of Malian households' ability to adapt to food insecurity through their choice of coping strategies, based on data from INSTAT's EMOP-2022 survey. The main objective is to determine households' ability to adapt to this phenomenon. The results of the logistic regression indicate that households in the Ségou region are more likely to adapt to food insecurity than those in Kayes. The ability of households in other regions and Bamako to adapt is negative. Single people and divorced heads of households, referring to monogamous individuals, are likely to adapt to food insecurity. Households that have resorted to coping strategies such as selling capital, seeking help from a relative or friend, selling livestock, taking out a loan, and receiving assistance from NGOs have a high capacity to adapt to food insecurity, with values of 0.687, 0.660, 0.601, 0.545, and 0.491, respectively. Descriptive statistics indicate that government and NGO intervention has been concentrated in the Mord region of Mali. The study recommends that government and NGOs interventions aimed at strengthening households' capacity to cope with climate variability and food shortages linked to extreme events should be geared towards the specific socio-economic characteristics of households that influence their adaptation strategies.

Keywords: Food insecurity, households' capacity, Coping strategies, Socioeconomic characteristics, Mali

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1. Introduction

Food insecurity is a major challenge in the developing world. Food is essential for human survival, growth, and health. Although the right not to go hungry is the most fundamental human right that can be realized, a considerable number of people around the world suffer from food insecurity [1]. The main causal factor behind this phenomenon is climate change, which manifests itself in the agricultural sector at the level of farmers through the scarcity or even absence of necessary rainfall. The consequences of this change include natural disasters such as droughts, floods, and hurricanes; economic disruptions such as recessions and inflation spikes; and social upheavals such as conflicts or pandemics [2]. These shocks generally disrupt the social and economic structure of communities, leading to widespread food insecurity. Other equally important factors are also significant (the quality of arable land, inputs, agricultural equipment, etc.). In such situations, households may resort to community adaptation mechanisms, such as resource sharing, participation in collective labor exchanges, or recourse to external assistance [3].

Households suffering from food insecurity use various adaptation strategies depending on the country. However,

some strategies appear to be common given their situation. These include the sale of productive and non-productive assets, irregularity in the number of daily meals, loans and borrowing, government and NGO assistance, etc. [1,4,5,6,7]. Research has consistently focused on analyzing the factors of food insecurity at different scales. It is in this context that econometric research models and socioeconomic approaches have been adopted by scientists to explain household adaptation strategies.

In Mali, in 2022, data from the modular and permanent household survey indicated that, out of a sample of 2,294 households, 34% suffered from food insecurity across all regions and the district of Bamako. Among a wide range of strategies for adapting to food insecurity, Malian households chose to overcome these difficulties by adapting to the phenomenon through assistance from a relative or friend, the sale of livestock or property, the emigration of a household member, taking out loans, and using savings, corroborating the study by [3]. Some households receive assistance from the state or NGOs. All these strategies are reactive rather than preventive.

The aim of this article is to determine the socioeconomic characteristics of households' capacity to adapt to food insecurity in Mali. In other words, it seeks to determine whether the strategies adopted by households have enabled them to effectively combat food shortages in the short term. Following the introduction, the second

section of this article reviews the literature, the third section discusses the research methodology, the fourth section presents the research results, and the fifth section presents the conclusion.

2. Literature Review

To examine the coping strategies of food-insecure households in an urban area of Addis Ababa, (Ethiopia), [8] draws on data collected from 632 mothers interviewed in 2017. A multivariate logistic regression model was used to identify factors associated with food security. The most common coping strategies used by households to deal with food insecurity were: resorting to less preferred and cheaper foods, borrowing food or money to buy food, and buying food on credit. It found that food-insecure households were three times more likely to rely on help from a relative or friend outside the household. Similarly, food-insecure households were about four times more likely to restrict meals. In addition, households without access to a bank or microcredit savings account were three times more likely to experience food insecurity than those with access to financial services. Perceptions of climate variability, agricultural assets, adaptive capacity, and access to income and food are the dimensions of resilience that make a significant contribution to household resilience [5].

In their study, [9] therefore aim to analyze the determinants of the choice of adaptation practices to climate change, which leads to a shortage of animal feed, water, and pasture for sheep and goat production. The study covered 318 households sampled in districts with potential for livestock production in Nepal. The data were analyzed using simple descriptive statistical tools, a multivariate probit model, and the ordinary least squares (OLS) method. The results showed that access to information, farming experience, the number of households in a village, distance from the main market, household income, and agroecological contexts influenced farmers' choices for adapting to climate change.

The factors influencing household food insecurity and the adaptation mechanisms adopted by households during food crises in Offa District, Ethiopia, were examined by [1]. Their study covered 144 households. The determinants of food insecurity were identified using a binary logit model. Non-agricultural income, the head of household's level of education, access to credit, livestock ownership, dependency ratio, farm size, extension services, and technology adoption were found to be statistically significant in determining food insecurity. The coping strategies used by households, such as limiting food consumption, borrowing money, rationing money, and skipping meals, were highlighted. Yohannes et al, (2023) [10] demonstrate that women, lack of formal education, lack of engagement in non-agricultural activities, lack of credit services, presence of dependent household members, and extreme poverty status were factors significantly associated with household food insecurity.

The objective of the study by [11] was to identify the adaptation strategies used by smallholder farmers to counter the negative effects of climate change in northern Uganda, as well as the factors influencing the use of

specific adaptation strategies. They found that planting different crop varieties, drought-resistant varieties, and fallowing are commonly used adaptation strategies to climate change.

In order to examine perceptions of climate change and variability, as well as the determinants of adaptation strategy choices among farming households in the North Wollo zone (Ethiopia), [12] used cross-sectional survey data on 396 farmers. The results of the multivariate probit model indicate that more male-headed households (73.78%) used at least one adaptation strategy than female-headed households (58.91%). They find that age, education level, land size, income, farming experience, training, contacts with extension services, access to climate information, access to credit, and membership in local organizations significantly influenced households' choice of climate change adaptation strategies. The study also reveals that the choice of household adaptation strategy is influenced by various factors due to gender dimensions in access to credit. The availability of credit had a significant impact on the adaptation decisions of female-headed households.

The main objective of the study of [7] was to analyze the food security situation of households and their adaptation strategies in the Kembata Tembaro area of the Kedida Gamela district. Their statistics reveal that 56.67% were food insecure. The results revealed that households used various coping strategies to deal with food insecurity, including selling livestock, selling productive assets, receiving cash transfers or food aid, engaging in small-scale trade, reducing the number of meals, temporary migration, etc. In addition, the results of the binary logit model indicated that the level of education, gender of the household, age of the head of household, size of arable land, access to extension services, livestock ownership, and access to credit positively and significantly determined household food security in the study area. To strengthen their resilience to food insecurity, households should be encouraged to diversify their sources of income and generate both financial and social assets.

How smallholder irrigation contributes to household food security in the Mberengwa district (Zimbabwe) [13]. Based on a sample of 444 households, the results of binary logistic regression reveal a significant association between food security and household size, access to irrigation, and agricultural income.

The response of households to food insecurity indicates that, despite the low level of productivity linked to local environmental constraints, adaptation strategies were unable to improve the livelihoods of poor households in the Lay Gayint district [14]. The study also revealed that short-term responses to meet consumption needs, such as selling charcoal and firewood, loans/credit, and borrowing in kind or in cash from friends, were the main ex-post adaptation strategies practiced by poor and vulnerable households.

In the analysis of the role of resilience capacity and adaptation strategy in food security using an instrumental variables approach, the results of [15] confirm that resilience and adaptation strategies increase food security, as determined by food expenditure, the adequacy of fruit and vegetable consumption within the household, and the share of household food expenditure. In addition,

resilience capacity plays a moderating role in mitigating food insecurity.

Cappellari & Jenkins, (2003) [16] used a sample of 260 households to assess the determinants of climate change adaptation choices in the dry agro-pastoral lands of northeastern Ethiopia. Multivariate probit regression and descriptive statistics were used for data analysis. They found that most households diversified their portfolios and diversified their non-agricultural income choices to adapt to climate change. They reveal that education level, gender, farming experience, household size, farm size, goat herd size, agricultural and non-agricultural income, access to credit, and access to climate information were significant in households' adaptation choices.

Education, access to credit and insurance facilities, and drought frequency significantly influenced the diversity of adaptation strategies in drought conditions [17]. The use of cash reserves and investment stocks also significantly influenced the extent of diversity in adaptation strategies.

Using a unique dataset on households in Mali, combined with probit models, [3], examines household adaptation strategies and food security outcomes in a context of multiple and concurrent shocks, including conflict, food price volatility, climatic events, and economic instability. The results show that preventive measures, such as income diversification, strengthen resilience, while reactive strategies, such as selling productive assets or borrowing money or food, provide only short-term relief. They compromise long-term sustainability. The impact of adaptation strategies on food security measures, including the food consumption score (FCS), the household dietary diversity score (HDDS), and the household hunger scale (HHS), reveals the trade-offs Malian households make between immediate needs and future stability.

Using a survey report on household food insecurity and adaptation strategies (Central Division of Tharaka, in the southern district of Tharaka, Kenya) [18] found that 44.7% were food insecure and 43.3% were vulnerable to food insecurity. Reducing meal sizes was the main coping strategy, and coping strategies did not adversely affect livelihoods. The nature of employment, the practice of secondary activities, the level of education of the head of household, the type of activity practiced by the household, the size of the household, and the share of food expenditure in total expenditure significantly increase the probability of a household falling into food insecurity [19]. These determinants work against food security.

In the study of the determinants of household food insecurity and coping strategies (Ethiopia), age and level of education, number of cattle, soil and water conservation, amount of credit, size of cultivated land, and remittances had a negative but significant impact on the level of household food insecurity [20]. They found that women and young people were more affected by the phenomenon. To adapt, households consumed less desirable and cheaper foods, participated in non-agricultural activities, and borrowed food.

In a study conducted in Bungoma County to assess the effectiveness and efficiency of household food insecurity adaptation strategies [6] found that most households worked as casual laborers to earn cash to buy food; others reduced the quantity and frequency of daily meals. The

majority of people ate only one meal a day during April, May, and June. In extreme cases, assets such as bicycles, poultry, pigs, trees, and cell phones were sold at low prices. The elderly received food donations from relatives and money from their children, while those with good credit borrowed money to buy food or purchased food on credit.

In an effort to identify the sociodemographic determinants of reducing meal size and frequency as a coping strategy for food insecurity in Tajikistan, [21] surveyed 15,159 households. Their findings indicate that 44.01% of households were food insecure. Reducing meal frequency, borrowing money and food, and receiving food and financial assistance were the main coping strategies used by households. City dwellers, households in mid-altitude areas (weyina-dega), highlands (dega), and single people were more likely to consume less when faced with food insecurity (by reducing the quantity and frequency of meals as a coping strategy).

Households in Kwale, Kenya, are facing severe levels of food insecurity caused by drought [22]. Their results showed that major droughts have a cyclical pattern of 10 to 15 years, while minor droughts occur every 3 to 4 years. Poor harvests of staple foods and livestock losses have serious negative repercussions on household well-being. According to them, income and asset diversification, resorting to wage labor, charcoal production, livestock sales, and reliance on remittances are the most common immediate mitigation measures to combat food insecurity caused by drought. Ansah et al., (2021) [4] find that when shocks are considered individually, their nature and duration influence the probability of using savings. However, when climate shocks interact with health, phytosanitary, or price shocks, there are cumulative effects that increase the probability of depleting household assets to cope with the situation.

Food insecurity remains a major challenge in the OECD. Food banks run by non-governmental organizations provide emergency food assistance, sometimes using food recovered as part of policies to combat food waste [23]. Understanding of the role that socioeconomic and demographic factors play in household food purchases and consumption is limited by insufficient and irregular food data collection, particularly on the prevalence of food insecurity.

In identifying the determinants of food insecurity among migrant households in the Gauteng City region of South Africa, [24] find that age and education level reduce the likelihood of skipping meals among internal and international migrant households. Part-time jobs and access to social and government assistance increase the likelihood of food insecurity for both categories of migrants. The study was conducted on 13,616 households selected using random sampling and a cross-sectional design.

In the study of determinants of food insecurity in Ghana, [25] find that the prevalence of food insecurity among Inuit women in Igloodik, Nunavut, is very high. To cope with food insecurity, women report skipping meals to reduce their food consumption. Food insecurity is influenced by factors such as education, preferences, food quality and availability, poverty, etc. They lament the fact that coping strategies for food insecurity are largely

reactive and short-lived.

This study enriches the literature on the analysis of the determinants of households' ability to adapt to food insecurity. It takes into account socioeconomic characteristics in addition to traditional sociodemographic determinants. One of the specific features of such a study in Mali is the empirical determination of the marginal effects of these variables on households' ability to adapt.

3. Methodology

3.1. Data Source

Table 1. Description of variables:

Variables	Obs.	Mean	Designation of variables
Household adaptability	2,294	.62	Household adapted to food insecurity (Yes=1; No=0)
Place of residence	2,294	.46	The environment where the household lives (Urban=1; Rural=0)
Region of residence	2,294	4.51	The region of Mali where the household lives (Kayes=1; Koulikoro=2; Sikasso=3; Ségou=4; Mopti=5; Timbuktu=6; Gao=7; Kidal=8; Bamako=9)
Marital status of the household	2,294	1.64	Marital status of head of household (Monogamous=1; Polygamous=2; Single=3; Divorced=4; Widowed = 5)
Gender	2,294	1.11	Gender of the head of household (Male=1; Female=2)
Household education level	2,294	.33	The level of education of the head of household (None=0; Primary=1; Basic=2; Secondary=3; Higher=4)
Household size	2,294	1.80	The number of people living in the household (Less than 5 people=1; Between 5 and 10 people=2; Between 11 and 15 people=3; More than 15 people=4)
Age of head of household	2,294	2.60	The age of the head of household (Under 35 years=1; Between 36 and 45 years=2; Between 46 and 55 years=3; Between 56 and 65 years=4; Over 65 years=5)
State aid	2294	.03	The household is assisted by the government (Yes=1; No=0)
Help from an NGO	2294	.08	The household is assisted by an NGO (Yes=1; No=0)
Livestock sale	2294	.12	Household sold livestock to cope (Yes=1; No=1)
Sale of its capital	2294	.00	The household sold its capital to adapt (Yes=1; No=0)
Sale of goods	2,294	.02	Household sold assets to adapt (Yes=1; No=0)
Use of savings	2,294	.05	The household used its savings (Yes=1; No=0)
Take out a loan	2294	.10	The household took out a loan to adapt (Yes=1; No=0)
Help from a relative/friend	2294	.30	The household was assisted by a relative/friend to adapt (Yes=1; No=0)
Emigration of a household member	2294	.05	The household has emigrated a member to adapt (Yes=1; No=0)

Source: Author based on EMOP-2022 data

The EMOP covered all eight regions and the district of Bamako. The data was extracted from the EMOP-2022 survey conducted by the National Institute of Statistics (INSTAT). After processing, the study covered a sample of 2,294 households across the country. Food security is

one of the components of the EMOP. In Mali, in 2022, 34% of the households surveyed suffered from food insecurity. They are the subject of this study.

The description of the variables, averages, and modalities are recorded in [Table 1](#)

3.2. Regression Model

In this study, we identify the determinants of households' ability to adapt to food insecurity in the Republic of Mali. There is a wealth of recent literature on the analysis of people's nutritional status. The phenomenon is modeled econometrically to highlight the socioeconomic and sociodemographic realities of households. Thus, we draw inspiration from [\[19\]](#) on Mali, [\[26\]](#) on Nigeria, [\[27,28\]](#) on South Africa.

Furthermore, the Monte Carlo method shows that the parameter estimates and their accuracies obtained by Probit models are generally not very different from Logit models. According to Greene (2002, p. 667) and Gujarati (2004, p. 612) cited by [\[29\]](#), Logit and Probit models are very similar. In this context, the question of choice is therefore irrelevant. Being more user-friendly from a mathematical point of view, Logit is used more than Probit.

We know that when the independent variables are not normally distributed, the Logit model estimators are more robust than those of discriminant analysis. In this study, we start from the basis of households suffering from food insecurity. We therefore capture the household's ability to adapt by using strategies to combat food insecurity. The key question in the EMOP-2022 survey, to which households responded, was: Over the past six months, has the household had to resort to coping strategies? If the household answers yes ($y=1$), then the household has been able to adapt to food insecurity by resorting to strategies; if not ($y=0$), the household has not been able to adapt to food insecurity. Our sample will therefore be subdivided into two categories. We seek to explain the dichotomous variable y , which refers to households' ability to adapt to food insecurity.

$$\begin{cases} y = 1 & \text{The household has adapted to food insecurity} \\ y = 0 & \text{Otherwise} \end{cases} \quad (1)$$

The probability of a household belonging to the first group ($y=1$) depends on a number of socioeconomic and demographic characteristics. An estimate of this probability is given by the following logistic function:

$$\begin{aligned} P_1 &= P(y_i = 1) = P(y^* > 1) = P(\beta_0 + \beta_1 x_1 + \varepsilon_i > 0) \\ &= P(\varepsilon_i > -\beta_0 - \beta_1 x_1) \\ &= \Lambda(\beta_0 + \beta_1 x_1) \end{aligned} \quad (2)$$

With the $\Lambda(\cdot)$ logistic distribution function

$$P_1 = P(y_i = 1) = \Lambda(\beta_0 + \beta_1 x_1) = \frac{e^{(\beta_0 + \beta_1 x_1)}}{1 + e^{(\beta_0 + \beta_1 x_1)}} = \frac{1}{1 + e^{(-\beta_0 - \beta_1 x_1)}}$$

Generalizing, we can state that:

$$P_1 = P(y_i = 1) = \frac{1}{1 + e^{(\Psi_{ij})}} \quad (3)$$

By transforming equation (3), we can predict the logarithm of the ratio between the probability of adapting to food insecurity and the probability of not adapting as follows:

$$\Psi_{ij} = \ln \left(\frac{P_{ij}}{1 - P_{ij}} \right)$$

Note that P_{ij} , being a probability, is constrained to take values between 0 and 1, while Ψ_{ij} can take any real value. The probability of adapting to food insecurity predicted by equation (3) thus also results from a transformation of Ψ_{ij} .

In fact, the Logit model is a model in which the log-odds ratio, Ψ_{ij} , is obtained by a linear combination of the explanatory variables:

$$\Psi_{ij} = \ln \left(\frac{P_{ij}}{1 - P_{ij}} \right) = (\beta_0 + \beta_{ij}x_{ij} + \dots + \beta_{qi}x_{ij})$$

Where X_{ij} represents the explanatory variables and β_{ij} the parameters to be estimated.

The econometric model to be estimated is of the form:

$$\begin{aligned} ADAP_CAP &= \beta_0 + \beta_1 REGION + \beta_2 RESID + \beta_3 MART_STATUS \\ &= \beta_4 GENDER + \beta_5 AGE_HH + \beta_6 EDUC_HH \\ &= \beta_7 SIZE_HH + \beta_8 GOUV_ASS + \beta_9 NGO_ASS \\ &= \beta_{10} SALE_CAP + \beta_{11} SALE_GOOD + \beta_{12} USE_SAV \\ &= \beta_{13} SALE_LIV + \beta_{14} HELP_PAR + \beta_{15} EMIG + \beta_{16} LOAN \end{aligned}$$

4. Presentation of Results

4.1. Descriptive Statistics

The results of the descriptive statistics relating to households' ability to adapt to food insecurity were obtained after processing the data in SPSS 27. These statistics highlight the sociodemographic characteristics (Table 2) and socioeconomic characteristics of households (Table 3).

In Mali, the majority of households live in rural areas (54.1% compared to 45.9%). Households headed by men account for 88.6%. The majority of these heads of household are monogamous (67.7%), compared to only 2.03% who are polygamous. Widowers account for 9.2%, while those headed by divorced men account for 1.6%. Households with between 5 and 10 members are the most numerous (42.9%). They are followed by those with fewer than 5 members, between 11 and 15 members, and more than 15 members, accounting for 40.8%, 12.2%, and 4.1%, respectively.

Table 2 shows that 29.1% of heads of households are between 35 and 45 years old. Approximately one in three households is between 35 and 45 years old (29.1%), compared to one in five households between 46 and 55 years old (21.1%). 10.7% of heads of households are over 65 years old. The majority of heads of households have no education, i.e., no schooling (77.5%). Those with less than or equal to 6 years of education (primary level) account

for 13.9%, 7.1% have a basic level of education (less than or equal to 9 years of schooling), 1.2% have a secondary level of education, and 0.3% have a higher level of education.

Table 2. Sociodemographic characteristics of households

Indicators	Terms and Conditions	Staff	Freq (%)
Place of residence	Urban	1053	45.9
	Rural	1241	54.1
Marital status	Monogamous	1553	67.7
	Polygamous	465	2.03
	Bachelor	28	1.2
	Divorce	27	1.6
	Widower	211	9.2
Gender	Male	2033	88.6
	Female	261	11.4
	No	2174	94.8
	Yes	120	5.2
Household size	Less than 5 people	936	40.8
	Between 5 and 10 people	983	42.9
	Between 11 and 15 people	281	12.2
	More than 15 people	94	4.1
Age of head of household	Under 35 years old	543	23.7
	Between 35 and 45 years old	667	29.1
	Between 46 and 55 years old	485	21.1
	Between 56 and 65 years old	354	15.4
	Over 65 years old	245	10.7
Level of education of the head of household	No level	1778	77.5
	Primary	320	13.9
	Fundamental	162	7.1
	Secondary	28	1.2
	Superior	6	0.3

Source: Author based on EMOP-2022 data.

Table 3. Socioeconomic characteristics of households

Indicators	Terms and Conditions	Staff	Frequency (%)
The household has adapted to food insecurity	Adapted	1424	62.1
	Not suitable	870	37.9
Sale of goods	No	2249	98
	Yes	45	2
Use of savings	No	2170	94.6
	Yes	124	5.4
State aid	No	2227	97.1
	Yes	67	2.9
Help from an NGO	No	2111	92
	Yes	183	8
Livestock sale	No	2014	87.8
	Yes	280	12.2
Help from a relative/friend	No	1605	70
	Yes	688	30
Emigration of a household member	No	2174	94.8
	Yes	120	5.2
Take out a loan	No	2071	90.3
	Yes	223	9.7

Source: Author based on EMOP-2022 data

In Mali, in 2022, 34% of households in the sample had difficulty feeding themselves and were therefore suffering

from food shortages. To alleviate this suffering, households need to resort to coping strategies. It is in this context that Table 3 shows that 62.1% of households were able to adapt to food insecurity across all regions of the country and the district of Bamako. These adaptation strategies include the sale of assets by the head of the household, which 2% resorted to, and the use of household savings, which 5.4% resorted to. Households that adapted to food insecurity by receiving assistance from the government accounted for 2.9%, 8% were assisted by NGOs, 12.2% sold livestock to adapt, 5.2% emigrated a member of the household, and 9.7% took out a loan, according to the results of [7,30]. The adaptation strategy "help from a relative or friend" is the most commonly used by households (30%). These results confirm those of [14]. This can be explained by a strong sense of compassion or sympathy and mutual aid in the country.

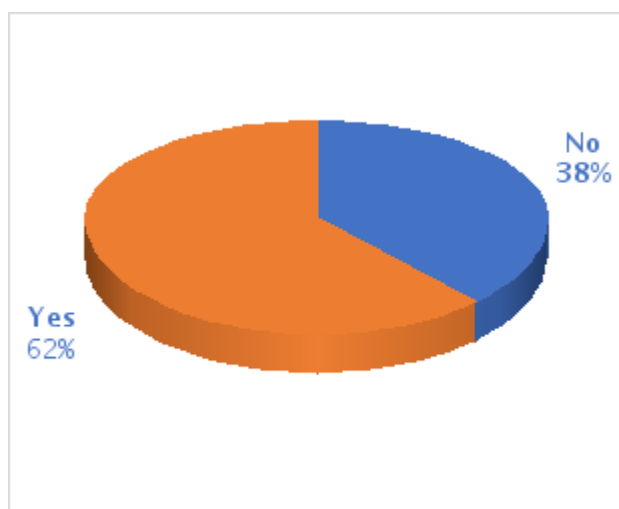


Figure 1. Household adaptation to food insecurity

Of all households in the sample, 62% reported being able to adapt to food insecurity, compared to 38%. There are many ways to adapt. These include help from a relative or friend, assistance from the government or an NGO, selling livestock, selling property, using savings, emigration, etc.

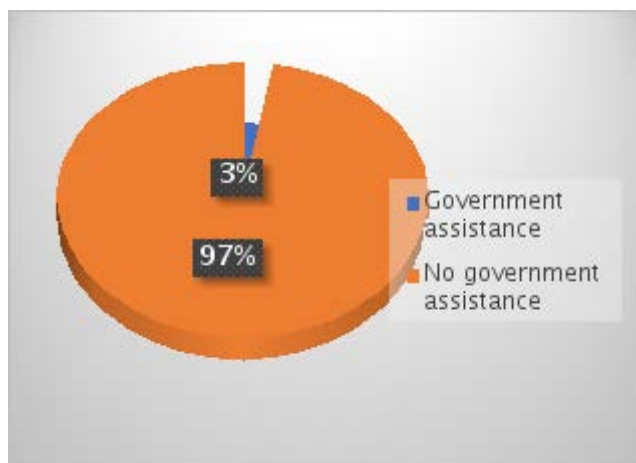


Figure 2. Households that received government assistance

Of all households suffering from food shortages, the government has intervened in 3%. The vast majority of

households receiving assistance are located in the north of the country, in the Mopti region. This can be explained by the consequences of the multidimensional war that Mali has been experiencing for some time. Other adaptation strategies informed the choices of the remaining 97% of households.

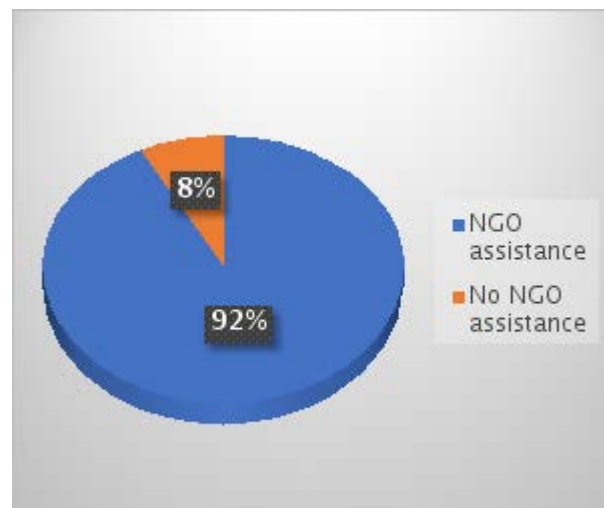


Figure 3. Households assistance from an NGO

During periods of food shortages, households (8%) in Mali's regions received assistance from NGOs. The majority of households receiving assistance are located in the Mopti and Gao regions, accounting for 41% and 41.5% respectively. The effects of the multidimensional war may explain this.

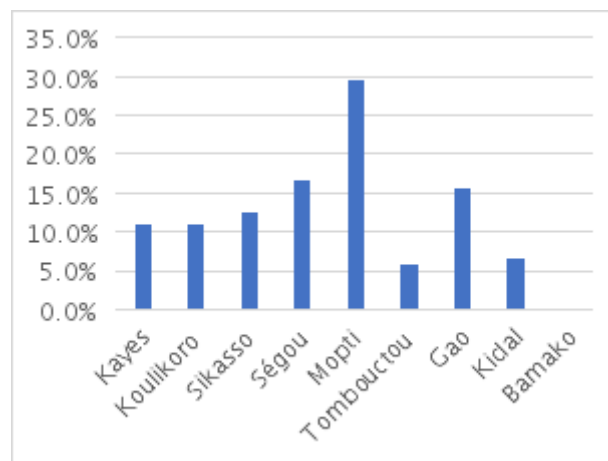


Figure 4. Sale of livestock by households by region

Of all households suffering from food insecurity in the Mopti region, 29.7% sold livestock to meet the food needs of their household members. The Mopti region is followed by the Ségou and Gao regions, with 16.6% and 15.6% respectively. These results are also consistent with those of [31,30], who argued that households often accumulate wealth in order to create a reserve that allows them to smooth their consumption after income shocks.

Parental and friendly relationships appear to be more developed in the northern regions of the country. This is supported by Figure 5. Households in Kidal and Timbuktu supported each other in the face of food insecurity. In line with the findings of [30], 63% of households in the Kidal region received assistance from relatives or friends,

compared with 44.60% in Timbuktu. Households in the Koulikoro region received the least assistance from relatives and friends (19.90%).

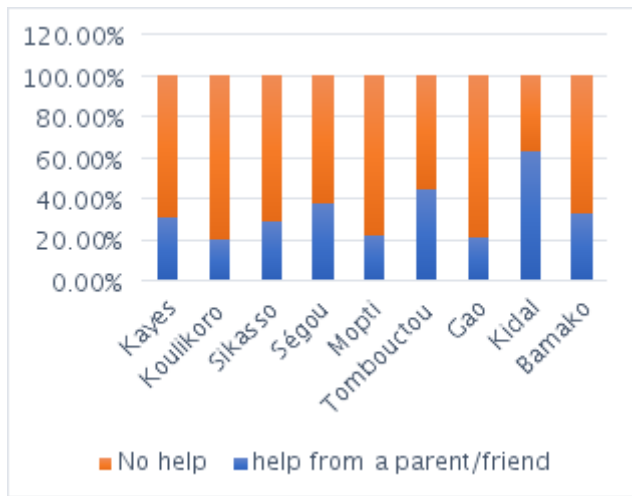


Figure 5. Households that received assistance from a parent or friend by region

4.2. Discussion of Econometric Results

In this section, we present the results of the determinants of households' ability to adapt to food insecurity in Mali. Economists are interested in the signs of the relevant variables and the proportional responses of the explained variables following proportional changes in the level of the explanatory variables, i.e., elasticities. Since the endogenous variable is a probability, calculating probabilities allows us to assess the impact of explanatory variables on the probability of household adaptation. The marginal effect coefficients of the Logit model are calculated using Stata 17.

Moving from the Kayes region to the Koulikoro region, the marginal effect is negative, which means that, compared to households in Kayes, the ability of households in Koulikoro to adapt to food insecurity decreases by 0.112, at the 1% threshold. The probability of a household in the Mopti, Timbuktu, Gao, Kidal, and Bamako regions adapting to food insecurity also decreases by 0.162, 0.117, 0.106, 0.092, and 0.103, respectively. Compared to households in the Kayes region, Table 4 shows that these households are 16.2%, 11.7%, 10.6%, 9.2%, and 10.3% less likely to be able to adapt to food shortages. The probability of adaptation to food insecurity for households in Ségou is 0.108 compared to those in Kayes.

Single heads of households have an adaptation probability of 0.173 at the 1% threshold. Thus, they are 17.3% more likely to adapt to food shortages than households headed by monogamous individuals. At the 10% threshold, moving from the group of monogamous households to that of widowers, the probability of household adaptation increases by 0.062. These widowed households need a chance to combat food insecurity. This can be explained culturally. Neighbors, friends, and relatives are motivated by a sense of compassion for the children in these households given their circumstances (the loss of a partner).

Table 4. Results of the estimation of the Logistic model

Variables	Marginal Effects	Std. Err.
Region (Ref. Kayes)		
Koulikoro	-0.112***	0.018
Sikasso	-0.012	0.020
Segou	0.105***	0.020
Mopti	-0.162***	0.025
Timbuktu	-0.117***	0.021
Gao	-0.106***	0.023
Kidal	-0.096**	0.046
Bamako	-0.103***	0.021
Place of residence (Ref. Rural)		
Urban	-0.004	0.013
Marital status (Ref. Monogamous)		
Polygamists	-0.009	0.015
Singles	0.173***	0.041
Divorced	0.086	0.055
Widowers	0.062*	0.037
Gender (Ref. Male)		
Female	-0.026	0.031
Age of head of household (Ref. Inf. less than 35 years)		
Between 35 and 45 years old	-0.003	0.016
Between 45 and 55 years old	0.014	0.017
Between 55 and 65 years old	0.021	0.019
Over 65 years old	0.042*	0.024
Level of education of the head of household (Ref. None)		
Primary	-0.030*	0.017
Fundamental	-0.048**	0.023
Secondary	-0.034	0.048
Superior	0.115	0.101
Household size (Ref. Less than 5 people)		
Between 5 and 10 people	-0.036***	0.013
Between 10 and 15 people	-0.027	0.021
More than 15 people	-0.000	0.032
Government Assistance (Ref. No)		
Yes	0.310***	0.066
NGO Assistance (Ref. No)		
Yes	0.491***	0.032
Sale of capital (Ref. No)		
Yes	0.687***	0.055
Sale of goods (Ref. No)		
Yes	0.490***	0.056
Use of savings (Ref. No)		
Yes	0.361***	0.040
Sale of livestock (Ref. No)		
Yes	0.601***	0.023
Help from a relative/friend (Ref. No)		
Yes	0.660***	0.015
Resort to emigration (Ref. No)		
Yes	0.336***	0.046
Take out a loan (Ref. No)		
Yes	0.545***	0.025
Constant	0.283***	0.021
Observations	2,294	
R-squared	0.710	

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Source: Author based on data from EMOP-2022 and STATA 17

Contrary to the results of [32] on Senegal, households whose head is over 65 years of age have a 0.042 increase

in their chance of adapting to food insecurity. This can be explained by their experience and know-how.

The effect of education should, first and foremost, prevent households from falling into food insecurity. Secondly, it should enable households to increase their capacity to adapt. Education has a positive effect on the behavior of heads of households. It should enable better integration into the labor market, good account management, and good organization of their multidimensional environment. In Mali, Table 4 shows the opposite situation. Households with higher levels of education find themselves in a situation of food insecurity; in extreme cases, their chances of adaptation decrease. From the group of heads of households with no education to those with primary education, the probability of household adaptation decreases by 0.030 and 0.048, respectively. Thus, households whose heads have these different levels of education have a decreasing probability of adaptation of 0.030 times and 0.048 times, respectively. It would be desirable to review the education system to better adapt the content of the curriculum to the socio-economic realities of the country.

Household size reduces the likelihood of adaptation to food insecurity. From households with fewer than five people to those with more than five people, the probability of adaptation decreases. It is significant at the 1% threshold and decreases by 0.036 for households with between five and ten people. These households are less likely to be able to combat food insecurity. Large households are more exposed to food insecurity and also have difficulty adapting.

Moving from the group of households that received no government assistance to those that did, the marginal effect is positive and significant at the 1% threshold. Assisted households are thus 31% more likely to combat food insecurity. Referring to households that received no assistance from NGOs compared to those that did, the ability of households to adapt to food insecurity increases by 0.491. The interventions of these actors have been very useful in combating household food deficits.

From the group of households that did not sell any assets to those that sold their assets to combat food shortages, the head of household's ability to adapt increases by 0.687. These households have a high chance of being able to adapt to the phenomenon. The likelihood of adapting to food insecurity increases by 49% for heads of households who reported having sold assets. Thus, households whose heads sold assets during this period are 0.490 times more likely to overcome the food deficit. The ability of households that sold livestock to adapt to food insecurity increases by 0.601. These results are consistent with those of [9] on Nepal, [33] on South Africa, which attest to the sale of family assets to combat food shortages.

Furthermore, when moving from the group of households that did not use their savings to adapt to food insecurity to the group of households whose head used their savings, the probability of adaptation increases from 0.361 to the 1% threshold. This can be explained by the immediacy and availability of savings. These results confirm those of [9,34].

In line with the findings of [30], parental or friendly support plays a fairly important role in Malian society, which appears to be cultural. Household heads who have

been assisted by relatives or friends have a very high capacity to adapt to food insecurity. To this end, they have a 66% chance of adapting at a reasonable threshold of 1% compared to their counterparts who have received nothing. Solidarity, mutual aid, compassion, and sympathy are part of Malian culture.

Some heads of households took out loans, while others emigrated in order to provide food for their households. Moving from the group of households that did not emigrate to those with at least one member who emigrated, and from those that took out a loan to those that did not, the ability of households to adapt to food insecurity increases by 0.336 and 0.545, respectively, at the 1% threshold. These results corroborate those of [7] on Ethiopia. Both of these strategies, like the previous ones, have enabled households to combat short-term food shortages.

5. Conclusion and Recommendations

The objective of this article is to analyze the ability of households in Mali to adapt to food insecurity by choosing from the strategies available to them. The study is based on data from the EMOP-2022 survey. The results show that in Mali, 34% of households in the sample suffered from food insecurity. Those who were able to adapt to the phenomenon are estimated at 62%. Most of the interventions by the state and NGOs are concentrated in the Mopti region. This is explained by the effects of the multidimensional war that the country has been experiencing since 2012. The strategy of seeking help from a relative or friend was more common in the north of the country (Kidal and Timbuktu). The results of the logistic regression show that, compared to the Kayes region, households in Koulikoro, Mopti, Timbuktu, Gao, Kidal, and Bamako are less likely to adapt to food insecurity. The age of the head of household and their level of education have opposite effects. All the adaptation strategies tried by households have enabled them to increase their likelihood of combating food shortages. In conclusion, the study therefore recommends that government and NGOs interventions aimed at strengthening households' capacity to cope with climate variability and food shortages linked to extreme events should be geared towards the specific socio-economic characteristics of households that influence their adaptation strategies.

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