


Effects of the Availability of Food Stocks on Household Food Consumption in Burkina Faso

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Abstract

Burkina Faso derives most of its resources from various agricultural activities. The number of people suffering from food and nutritional insecurity rose from 294,500 in 2014 to over 3.4 million in 2022. This article aims to determine the effects of food stock availability on household food consumption in Burkina Faso in order to better understand the persistent and high prevalence of food insecurity in Burkina Faso. The methodology used is the multinomial logistic regression model, which uses secondary data from the February 2022 Integrated National Food and Nutrition Security Survey. The results show that having food stocks available for more than six months improves household food consumption. In addition, households headed by a male civil servant with a higher level of education, who owns animals, lives in an urban area, and heads an ordinary household are more likely to have improved food security. These findings suggest the implementation of food stock management policies to strengthen food resilience. This could be achieved by extending the duration of stocks for vulnerable households, targeting displaced and poor households with specific economic and food assistance programs. Promoting education and economic diversification could help reduce rural households' dependence on agriculture.

Keywords

Food Consumption Score, Availability of Food Stocks, Multinomial Logistic Regression Model, Burkina Faso

1. Introduction

Household food insecurity is increasingly known as a global public health problem [1]. The prevalence of food insecurity remains stable over the last two years at around 25.3%, but still higher than the period before the global COVID-19 pandemic, with a proportion of some 29.6% of the world's population, or 2.4 billion people, affected [2]. In Africa, food insecurity remains a major challenge, with the sub-Saharan part of the continent struggling with hunger since the 2008-2009 global food crisis. Recent estimates indicate that approximately one in five Africans suffered from undernourishment in 2023 [3]. Factors contributing to its worsening on this continent include chronic hunger, which remains the highest in the world [4] and the socio-economic status of households [1]. Undoubtedly, food insecurity leads households to consume food of poor quality and quantity [5]. Hunger in Africa continues to increase in number. More than 20% of Africans were undernourished in 2021 [6] and the sub-Saharan region is the worst affected, with more than 37.8% of people undernourished. In addition to hunger, almost 200 million people in sub-Saharan Africa suffer from nutrition problems with micronutrient deficiencies, while overweight and obesity are a public health concerns in many countries [7]. For example, according to the World Bank, nearly 43 million people will be facing micronutrient deficiency in West Africa in 2023.

Food security exists when people have sufficient, sustainable and socially acceptable physical and economic access to an active and healthy life [8]. The conceptual framework of food security [9] describes these main dimensions, which include the availability, accessibility, stability and use of food. The physical availability of food implies a sufficient supply of foodstuffs to meet everyone's needs, through stocks of food from national production, donations and imports. Economic and physical access to food implies stable markets, accessible prices for local populations, decent incomes and sufficient purchasing power [10]. As for use, this involves providing an adequate and balanced diet that meets the physiological needs of the population. Finally, the stability of the food supply over time must ensure that access to food is not threatened by the emergence of a sudden shock or by cyclical events. This is the spatial and temporal regularity of food availability.

This article looks at food storage as a very important factor contributing to food security [11] through three of the four dimensions, namely availability, accessibility, and stability [12]. The storage of agricultural food products meets the challenges of product security, social security and food security [12]. Research linking food stocks and food security has produced ambivalent results [13], indicating the importance of exploring the issue in other contexts, and Burkina Faso was chosen as the field of study for several reasons.

In Burkina Faso, the number of people suffering from food and nutritional insecurity has risen from 294,500 in 2014 to over 3.4 million in 2022 [14]. In addition, the results of the 2018 Harmonized Survey of Household Living Conditions show that a large proportion of the population, particularly in rural areas, is poor and suffers from chronic food insecurity [15]. Besides, Burkina Faso, like other

Sahelian countries, derives most of its resources from various agricultural activities. Agriculture in Burkina Faso employs more than 80% of the working population and is the main source of food and household income. However, agricultural production is performing poorly compared with the sector's potential, leading to high levels of poverty and food insecurity in rural areas [16]. These production constraints also explain the poor results in terms of nutrition [9] and provide a better understanding of the persistently high prevalence of stunting in the Sahel and northern regions of Burkina Faso [17].

Monitoring the food security of the population of Burkina Faso is therefore one of the challenges to be met to assess the link between agricultural intervention and nutritional outcomes [18]. Since the food crises of 1970 and 1980, food storage has been one of several strategies used by Sahelian countries, including Burkina Faso, to deal with the risk of food insecurity [19]. This practice therefore remains essential. The aim of this research is to use statistical evidence to highlight the extent to which the existence of food stocks affects food consumption.

This will enable us to answer the question: what is the impact of household food stocks on improving food consumption? The answer to this question will be the subject of this article.

2. Methodology

2.1. The Multinomial Logistic Regression Model

In this research, analyzing the determinants of food consumption, we use a multinomial logistic model to simulate the food consumption score, a variable with several categories.

2.1.1. Formulation of the Model

The multinomial logistic regression model models the probability of being in a given category of the food consumption score Y as a function of several independent variables X_1, X_2, \dots, X_n .

It is formulated as follows for each category i with respect to a reference category k :

$$\ln \frac{P(Y = i)}{P(Y = k)} = \beta_{i0} + \beta_{i1}X_1 + \beta_{i2}X_2 + \dots + \beta_{in}X_n$$

where $P(Y = i)$ is the probability that the observation is in category i , $P(Y = k)$ is the probability of the reference category k , $\beta_{i0}, \beta_{i1}, \beta_{i2}, \dots, \beta_{in}$ are the parameters to be estimated for each category i .

2.1.2. Model Assumptions

The multinomial logit model has assumptions. The dependent variable is categorical and nominal; observations are independent; the relationship between the continuous independent variables and the logit of each category is linear: the addition or deletion of a category from the dependent variable must not modify the probability ratios relative to other categories; the independent variables must not be

highly correlated with each other; the relationship between the food consumption score and the independent variables is logistic and the model requires a sufficiently large sample to avoid biased estimates.

2.1.3. Estimation Procedure

The estimation procedure follows the maximum likelihood method, which consists of maximizing the likelihood function measuring the probability of observations as a function of the model parameters. The likelihood function is:

$$L(\beta) = \prod_{i=1}^n P(Y_i = y_i / X_i, \beta)$$

where y_i is the observed category of the food consumption score for the i -th observation.

2.1.4. Chi-Square Test

The chi-2 (χ^2) test of independence is used to assess the dependence of one qualitative variable on another qualitative variable. It expresses a significant statistical relationship between these two nominals (categorical) variables.

The null hypothesis (H0) states that there is no significant relationship between the variables.

2.1.5. Interpretation of Results

To interpret the results, we set out the coefficients, which are the log-odds of the categories in relation to the reference category, to obtain the odds ratios.

$$OR = \exp(\beta)$$

Odds ratios indicate the chances of belonging to a given food consumption score category compared with a reference for a unit increase in the independent variable under consideration. To predict the probabilities of belonging to each category, we can use the values of the coefficients for each observation and transform them into probability via the logistic function.

2.1.6. Probability Prediction

After estimation, the predicted probabilities of belonging to each food security category are calculated. This creates new variables with the probabilities of belonging to the different categories. Marginal predictions are used to measure the impact of each variable on the probability of belonging to a given food security category. In contrast to odds ratios, marginal effects offer a more intuitive interpretation in terms of probabilities, making it possible to be more precise and to provide a better understanding that facilitates decision-making based on more effective policies. The relative importance of the determinants of food security is then assessed and the effects between the different categories can be compared.

2.2. Data

The data used are secondary data from the February 2022 Integrated National Food Security and Nutrition Survey of the General Directorate of Sectoral Statis-

tics of the Ministry of Agriculture in Burkina Faso. It has provincial relevance and concerns a sample of 6578 households. Geographically, the study covers both rural and urban areas, covering all 45 provinces of Burkina Faso. The observation unit for this study is the household. This is a cross-sectional and analytical study. The information collected relates to food consumption, income and sources of income (agricultural and non-agricultural), food and non-food expenditure, household survival strategies (agricultural and non-agricultural), assessment of the season about the previous one and those of the last 5 years, assessment of commodity prices (cereals, animal products), assessment of fertiliser prices, assessment of risk factors, etc. The study population that took part in the INFNSS survey consisted of ordinary households and/or IDP households in urban and rural areas of Burkina Faso. The data were collected over the period February 2022.

2.3. Definition of Variables

2.3.1. Explained Variable

Food consumption is approximated by the food consumption score (FCS), an indicator of household food security. This is a polytonic variable determining the level of household food consumption. It measures diet diversity, the frequency of food intake, and the nutritional value of the food eaten [20].

The FCS measures both the types of food groups consumed and the frequency of the intake of these food groups. These foods include starches, legumes, vegetables, fruits, meat, dairy products, fats and sugar. Each food group is associated with a coefficient. This method provides key information on household food consumption based on caloric intake. The method simplifies data collection and calculation, and takes into account the nutritional value of foods consumed by the household, but it is limited in that it only takes into account consumption over a 7-day period, leaving aside the consumption of household members outside the household [21]. Moreover, it is subject to seasonal variations. Foods consumed outside the household may lead to an excess bias in the results. However, this indicator is widely used by institutions such as the WFP, humanitarian NGOs and researchers. In Ethiopia, for example [22], the FCS has been used to measure the impact of agricultural technologies on household food security.

The FCS is calculated on the basis of a number of foods over a period of 7 days using the following formula:

$$\text{FCS} = 2 * \text{Starches} + 3 * \text{Nlegumes} + \text{Nvegetables} + \text{Nfruits} + 4 * \text{Meats} + 4 * \text{Nmilk} + 0.5 * \text{N Oils} + 0.5 * \text{N Sugar},$$

The FCS value is always between 0 and 112 ($0 < \text{SCAi} \leq 112$). The score has three categories: 0 if the head of household has poor food consumption, 1 if the head of household has borderline food consumption and 2 if the head of household has acceptable food consumption. These modalities represent the food consumption classes [23]:

- The Poor food consumption class (≤ 21).
- The Borderline food consumption class (≤ 35).

- The Acceptable food consumption class (35).

Food consumption is a multi-modality variable and is also considered to be the outcome variable.

2.3.2. The Interest Variable

The availability of food stocks is one of the dimensions of food security. It applies if there is a sufficient quantity of food of appropriate quality in the household, whatever its source (local production or food aid) [24]. This is a very important aspect of household food security [12].

2.3.3. Control Variables

The socio-demographic characteristics of heads of household are represented by the following variables:

- Age: continuous variable representing the age of the head of household in years.
- Gender of the head of household: binary variable depending on whether the head of household is male or female.
- Marital status: categorical variable depending on whether the head of household is married, divorced, widowed or single.
- Level of education: categorical variable depending on whether the head of the household has no education, primary education, medersa education, secondary education or higher education.
- Occupation: variable with the following modalities: none, civil servant, farmer, craftsman, gold panner, shopkeeper, breeder.

Household characteristics are represented by:

- Type of household: binary variable comprising the categories: ordinary household and displaced household.
- Place of residence: binary variable depending on whether the household lives in an urban or rural area.
- Ownership of animals: binary variable equal to 1 if the household owns animals and 0 otherwise.
- Household economic level: a categorical variable based on whether the household has a poor, average or rich standard of living.
- Household size: a continuous variable representing the total number of household members.

The unit of analysis in this study is the household and its members. This allows us to define the household as the group of people, relatives or not, who live in the same compound, who generally eat their meals together from a common stock and who are under the authority of a single head of household, who may be a male or female [25].

3. Results Presentation

3.1. Descriptive Statistics

The number of households observed in February 2022 is 6550. The distribution of

households according to the Socio-demographic characteristics of the heads of household and the characteristics of the households are shown in **Table 1** and **Table 2**, respectively.

The Socio-demographic characteristics of the head of household are key to understanding the structure and dynamics of a household. The main information that can be gathered and analyzed is shown in **Table 1**.

Table 1. Socio-demographic characteristics of the head of household.

Characteristics	N = 6550 ¹	Characteristics	N = 6550 ¹
Age	46 (37 - 56)	Profession	
Gender		None	355 (5.4%)
Female	770 (12%)	Civil Servant	99 (1.5%)
Male	5 780 (88%)	Farmer	4 760 (73%)
Marital status		Craftsman	102 (1.6%)
Single	128 (2.0%)	Other	439 (6.7%)
Divorced/Widowed/Widow	362 (5.5%)	Trader	404 (6.2%)
Married	6 060 (93%)	Breeder	243 (3.7%)
Level of education		Gold panner	148 (2.3%)
None	4 196 (64%)		
Primary	1 483 (23%)		
Merdersa	266 (4.1%)		
Secondary and more	605 (9.2%)		

¹Mean (Q1 - Q3); n (%).

- **Age of heads of household**

Using descriptive analysis tools, the median age of the head of household is 46, with an interquartile range of 37 to 56. It therefore appears that the heads of household in the sample are in an active age bracket, with older people aged between 37 and 56. In economic terms, this means that the population is active and engaged in productive activities.

- **Gender**

According to **Table 1**, women account for 770 or 12% of the workforce and men for 5780 or 88%. The vast majority of households are thus headed by men. Socio-cultural dynamics mean that men are predominantly responsible for household management.

- **Marital status**

Most heads of household (93%) are married, which reflects the predominant social standard. The minority of unmarried heads of household (5.5%) might indicate a certain precariousness in family responsibilities.

- **Level of education**

Heads of household with no education represent more than half of the sample

(64%). This high proportion of illiterate people could limit their economic opportunities and their ability to access formal employment. The proportion of people with secondary and higher levels of education is low (9.3%), which could represent a major challenge in terms of education.

- Profession of heads of household

The heads of farming households represent nearly 73% of the sample, hence the predominance of farming as the main economic activity within the study population.

Table 1 gives descriptive statistics on the Socio-demographic characteristics of the head of household in this sample, showing a strong male preponderance in household management, a limited level of education and a high dependence on agriculture.

Household characteristics encompass a set of indicators that describe the composition, dynamics and living conditions of the analysis unit. **Table 2** provides a detailed presentation of the main disclosures.

Table 2. Household characteristics.

Characteristics	N = 6550'	Characteristics	N = 6550'
Type of household		Duration of stocks	
Ordinary household	4780 (73%)	Less than a month	638 (9.7%)
Displaced households	1770 (27%)	1 to 3 months	1697 (26%)
Place of residence		4 to 6 months	1545 (24%)
Rural	4936 (75%)	More than 6 months	2670 (41%)
Urban	1614 (25%)	Economic level	
Possession of animals		Average	1666 (25%)
No	1016 (16%)	Poor	3689 (56%)
Yes	5534 (84%)	Rich	1195 (18%)
Food consumption score		Household size	
Borderline	2689 (41%)	Large household	4735 (72%)
Acceptable	3103 (47%)	Average household	1144 (17%)
Poor	758 (12%)	Small household	671 (10%)

'n (%).

Table 2 provides an overview of the key characteristics of the 6550 households studied, highlighting aspects such as household type, area of residence, animal ownership, food consumption score, stock duration, economic level and household size.

- Type of household

Ordinary households account for a larger proportion (73%) of this analysis, which allows us to understand daily habits, unlike displaced households (27%)

which could reflect the potential impact of security crises (one-off situations) on the population. This is a source of fragility for these households in terms of food security and living conditions.

- **Place of residence**

Households in rural areas (75%), are a source of life gravitating around a strong dependence on agriculture. These households are often exposed to climate variability and have no access to infrastructure and services compared with urban households (25%).

- **Animal ownership**

Role in food security and economic resilience strategies. Conversely, households that do not own animals (16%) could suffer from food insecurity.

- **Food consumption score**

Household characteristics **Table 2** shows that 41% of households in the study population have a borderline food consumption score and 47% have an acceptable food consumption score. However, 12% of households in this same population are in a critical situation (poor). This reflects a high prevalence of food insecurity in this segment of the population.

- **Duration of household food stocks**

Households with food stocks for more than 6 months account for a significant proportion of almost 41% of the study population. Having longer stocks could reduce their vulnerability to food insecurity. On the other hand, almost 36% of households are estimated to have less than 1 month (9.7%) or 1 - 3 months (26%) of food stocks, which would be in a precarious situation and could require interventions to extend their stocks.

- **Economic level**

Nearly 56% of households are classified as economically poor, which could increase their vulnerability to food insecurity and economic crises. Nearly 18% of households are classified as wealthy.

- **Household size**

Households with seven or more people account for the majority of the study population (72%).

3.2. Identification of Variables Linked to the Food Consumption Score

The different variables highlighted in **Table 1** and **Table 2** could have a prominent place in this analysis. It is therefore crucial to highlight those that have an effect on household food consumption scores in **Table 3**.

The analysis in **Table 3** above involved exploring the associations between the dependent variable, food consumption score (FCS), and each of the presumed explanatory variables, *i.e.*, the various characteristics of the household and the Socio-demographic characteristics of the head of household. These associations are measured by the frequency (in %). Their accuracy is measured by the statistic

Table 3. Identification of variables affecting household food consumption scores (FCS).

Characteristics	FCS Class Level				<i>p</i> -value ²
	Poor N = 758 ¹	Limit N = 2689 ¹	Acceptable N = 3103 ¹	Overall N = 6550 ¹	
Duration of household food stocks					<0.001
Less than one month	195 (25.7%)	321 (11.9%)	122 (3.9%)	638 (9.7%)	
1 to 3 months	277 (36.5%)	967 (36.0%)	453 (14.6%)	1697 (25.9%)	
4 to 6 months	174 (23.0%)	632 (23.5%)	739 (23.8%)	1545 (23.6%)	
More than 6 months	112 (14.8%)	769 (28.6%)	1789 (57.7%)	2670 (40.8%)	
Gender of the head of household					<0.001
Female	131 (17.3%)	398 (14.8%)	241 (7.8%)	770 (11.8%)	
Male	627 (82.7%)	2 291 (85.2%)	2862 (92.2%)	5780 (88.2%)	
Age group of the head of household					0.2
18 - 34 ans	115 (15.2%)	444 (16.5%)	462 (14.9%)	1021 (15.6%)	
35 - 54 ans	387 (51.1%)	1332 (49.5%)	1630 (52.5%)	3349 (51.1%)	
55 ans et plus	228 (30.1%)	809 (30.1%)	873 (28.1%)	1910 (29.2%)	
NA	28 (3.7%)	104 (3.9%)	138 (4.4%)	270 (4.1%)	
Marital status of heads of household					<0.001
Single	14 (1.8%)	51 (1.9%)	63 (2.0%)	128 (2.0%)	
Divorced/Widowed/Widow	65 (8.6%)	157 (5.8%)	140 (4.5%)	362 (5.5%)	
Married	679 (89.6%)	2481 (92.3%)	2900 (93.5%)	6060 (92.5%)	
Profession of Head of Household					<0.001
None	65 (8.6%)	190 (7.1%)	100 (3.2%)	355 (5.4%)	
Civil servant	1 (0.1%)	15 (0.6%)	83 (2.7%)	99 (1.5%)	
Farmer	559 (73.7%)	1917 (71.3%)	2284 (73.6%)	4760 (72.7%)	
Craftsman	11 (1.5%)	48 (1.8%)	43 (1.4%)	102 (1.6%)	
Other	48 (6.3%)	227 (8.4%)	164 (5.3%)	439 (6.7%)	
Trader	41 (5.4%)	144 (5.4%)	219 (7.1%)	404 (6.2%)	
Breeder	14 (1.8%)	92 (3.4%)	137 (4.4%)	243 (3.7%)	
Gold panner	19 (2.5%)	56 (2.1%)	73 (2.4%)	148 (2.3%)	
Level of education					<0.001
None	543 (71.6%)	1823 (67.8%)	1830 (59.0%)	4196 (64.1%)	
Primary	133 (17.5%)	565 (21.0%)	785 (25.3%)	1483 (22.6%)	
Merdersa	39 (5.1%)	102 (3.8%)	125 (4.0%)	266 (4.1%)	
Secondary and more	43 (5.7%)	199 (7.4%)	363 (11.7%)	605 (9.2%)	

Continued

Household type					<0.001
Regular households	397 (52.4%)	1783 (66.3%)	2600 (83.8%)	4780 (73.0%)	
Displaced households	361 (47.6%)	906 (33.7%)	503 (16.2%)	1770 (27.0%)	
Household's area of residence:					<0.001
Rural	595 (78.5%)	1964 (73.0%)	2377 (76.6%)	4936 (75.4%)	
Urban	163 (21.5%)	725 (27.0%)	726 (23.4%)	1614 (24.6%)	
Possession of animals					<0.001
No	233 (30.7%)	540 (20.1%)	243 (7.8%)	1016 (15.5%)	
Yes	525 (69.3%)	2149 (79.9%)	2860 (92.2%)	5534 (84.5%)	
Shock experienced					<0.001
No	424 (55.9%)	1138 (42.3%)	816 (26.3%)	2378 (36.3%)	
Yes	334 (44.1%)	1551 (57.7%)	2287 (73.7%)	4172 (63.7%)	
Household economic level					<0.001
Average	148 (19.5%)	608 (22.6%)	910 (29.3%)	1666 (25.4%)	
Poor	568 (74.9%)	1698 (63.1%)	1423 (45.9%)	3689 (56.3%)	
Rich	42 (5.5%)	383 (14.2%)	770 (24.8%)	1195 (18.2%)	
Household size					0.5
Average household	144 (19.0%)	449 (16.7%)	551 (17.8%)	1144 (17.5%)	
Small household	74 (9.8%)	289 (10.7%)	308 (9.9%)	671 (10.2%)	
Large household	540 (71.2%)	1951 (72.6%)	2244 (72.3%)	4735 (72.3%)	

¹n (%); ²chi-2 (χ^2) independence test.

“ χ^2 ”, based on a theoretical significance threshold of 5%. This indicates that all the explanatory variables in **Table 3** have an effect on the household food consumption score ($P < 0.001$) except age class and household size.

Explanatory analysis methods were used to measure the net relative impact of each explanatory variable on the “household food consumption score” after controlling for the other variables. Given the nature of the variable to be explained, which has several modalities, it is necessary to use multinomial logistic regression.

3.3. Presentation of the Results of the Multinomial Logistic Regression

- Reason for choosing this model

Violation of the proportional odds assumption: The ordered logit (proportional odds) model assumes that the effect of the explanatory variables is constant regardless of the category threshold considered. Since this assumption is rejected based on the results of the Brant test (see **Table 4** below), the multinomial logit model becomes a more flexible alternative because it imposes no constraints on

the coefficients. Furthermore, it allows for the modeling of non-proportional effects in the analysis of the determinants of food security.

Table 4. Brant's test of the proportional odds hypothesis.

Variable	Brant's test			
	Khi ²	ddl	p-value	
Omnibus survey	65.37	23	0.0000	***
Stock life: 1 - 3 months	8.49	1	0.0036	**
Stock life: 4 - 6 months	0.72	1	0.3952	
Stock life: >6 months	0.10	1	0.7514	
Male	2.85	1	0.0914	
Age 35 - 54	2.97	1	0.0849	
Age ≥55	1.88	1	0.1701	
Age not available	1.28	1	0.2586	
Civil servant	0.28	1	0.5976	
Farmer	0.00	1	0.9996	
Craftsman	0.10	1	0.7556	
Other occupations:	1.50	1	0.2208	
Merchant:	1.25	1	0.2640	
Livestock farmer:	1.12	1	0.2902	
Gold panner:	1.20	1	0.2723	
Elementary education:	0.02	1	0.9009	
Merdersa education:	2.93	1	0.0870	
Secondary education and above:	0.73	1	0.3915	
Displaced household:	0.00	1	0.9613	
Urban area	6.52	1	0.0107	*
Possession animals	0.38	1	0.5378	
Shock experienced	1.00	1	0.3162	
Low income	0.08	1	0.7777	
High income	9.56	1	0.0020	**

Note: H₀: The proportional odds assumption holds. ***p < 0.001; **p < 0.01; *p < 0.05; p < 0.1.

- The multinomial logistic regression

The interpretation of results is specific to the odds ratio. The probability threshold is set at 5% for the variable of interest "household food consumption score" cross-tabulated with the explanatory factors of the Socio-demographic characteristics of the head of household and the characteristics of the household.

Odds ratio of 1 indicates that there is no association, *i.e.*, the chances of occurrence of the event studied are the same in the two groups compared. An odds ratio above 1 suggests a positive association, indicating that the presence of one of the explanatory variables is associated with a higher risk of event occurring. An odds ratio below 1 indicates a negative association, meaning that the presence of a variable is associated with a lower risk of the event occurring. The results of this study could have important implications for public policy on food security, as they provide a better understanding of the relationship between household characteristics, the Socio-demographic characteristics of the head of household, and the household food consumption score.

The results of the estimates of the multinomial logistic model are shown in **Table 5**. The Confidence Intervals (CI) of the odds ratios in **Table 5** show the individual significance of the coefficients.

Table 5. Results of the multinomial logistic regression.

Characteristics	Limit			Acceptable		
	OR	95% IC	<i>p</i> -value	OR	95% IC	<i>p</i> -value
Duration of household food stock			<0.001			<0.001
Less than one month	—	—		—	—	
1 to 3 months	1.99	1.58 - 2.50		2.28	1.71 - 3.03	
4 to 6 months	1.93	1.48 - 2.52		4.98	3.65 - 6.78	
More than 6 months	3.27	2.43 - 4.41		15.9	11.4 - 22.2	
Gender of the head of household			<0.001			<0.001
Female	—	—		—	—	
Male	0.8	0.60 - 1.07		1.26	0.91 - 1.74	
Marital status of heads of household			0.036			0.036
Single	—	—		—	—	
Divorced/Widowed/Widow	0.68	0.33 - 1.39		0.7	0.33 - 1.50	
Married	1.08	0.57 - 2.05		0.79	0.40 - 1.54	
Profession of Head of Household			<0.001			<0.001
None	—	—		—	—	
Civil servant	2.18	0.28 - 17.2		6.46	0.84 - 49.4	
Farmer	0.64	0.45 - 0.90		0.4	0.27 - 0.59	
Craftsman	1.13	0.55 - 2.35		1.15	0.52 - 2.53	
Other	1.41	0.91 - 2.17		1.44	0.89 - 2.34	
Trader	0.96	0.60 - 1.54		1.52	0.92 - 2.51	
Breeder	1.3	0.68 - 2.51		1.24	0.63 - 2.46	
Gold panner	0.95	0.51 - 1.75		1.58	0.83 - 3.03	

Continued

Level of education			<0.001		<0.001
None	—	—	—	—	
Primary	1.13	0.91 - 1.41	1.32	1.06 - 1.66	
Merdersa	0.79	0.53 - 1.16	1	0.66 - 1.51	
Secondary and more	1.22	0.84 - 1.77	1.87	1.28 - 2.72	
Household's area of residence:			<0.001		<0.001
Rural	—	—	—	—	
Urban	1.65	1.33 - 2.05	1.98	1.58 - 2.49	
Possession of animals			<0.001		<0.001
No	—	—	—	—	
Yes	1.44	1.14 - 1.81	2.38	1.82 - 3.11	
Shock experienced			<0.001		<0.001
No	—	—	—	—	
Yes	1.56	1.28 - 1.88	2.05	1.68 - 2.51	
Household economic level			<0.001		<0.001
Average	—	—	—	—	
Poor	0.9	0.72 - 1.13	0.7	0.56 - 0.88	
Rich	1.98	1.37 - 2.87	2.23	1.55 - 3.22	

Abbreviations: CI = confidence interval. OR = odds ratio.

- **Stocks duration (A variable with a very strong influence)**

The longer the duration of stockpiling, the more likely households are to have “Acceptable” consumption rather than “Normal” or even “Limited” consumption. In fact, for a stockpile level of:

- 1 to 3 months: Households are twice as likely to be in a “Limited” situation (OR = 1.99) and 2.3 times more likely to be in an “Acceptable” situation (OR = 2.28) than those with less than one month's worth of stockpiles.
- 4 to 6 months: The effect is even more pronounced, especially for “Acceptable” consumption (OR = 4.98). They are nearly 5 times more likely to have acceptable consumption.
- More than 6 months: This is the most powerful effect in the model. These households are 3.3 times more likely to have “Limited” consumption, but more importantly, nearly 16 times (15.9) more likely to have “Acceptable” consumption. Food security here is strongly linked to storage capacity.

- **Gender of the head of household**

The effect is mixed and barely significant (with confidence intervals sometimes including 1). Compared to women, male heads of household are less likely to be in a “Marginal” situation (OR = 0.80), but more likely to be in an “Acceptable” situation (OR = 1.26).

Although the confidence intervals cross the value of 1 (which makes these figures less precise), the trend suggests that male-headed households are slightly more likely to fall at the extremes (fewer in the “Limited” category, more in the “Acceptable” category), potentially indicating unequal access to resources.

- **Marital status of the head of household**

The differences are not very pronounced (wide confidence intervals). However, compared to single people, married or divorced/widowed individuals are slightly less likely to be in an “Acceptable” situation (OR < 1). The most notable finding is that married people appear less likely to be in an “Acceptable” situation than single people, but these results should be interpreted with caution given the wide confidence intervals.

- **Profession of the head of household**

Occupation is a key factor, with very significant disparities. Farmers face the greatest difficulties. Compared to the unemployed, they are less likely to be in the “Marginal” category (OR = 0.64) and, more importantly, in the “Acceptable” category (OR = 0.40). This means they are heavily concentrated in the reference category (the most disadvantaged).

As for civil servants, they are the most advantaged, with the highest ORs, especially for the “Acceptable” category (OR = 6.46), but the confidence interval is very wide (0.84 - 49.4) because the sample size is likely small. This still indicates a very high probability of food security.

Merchants, artisans, and livestock farmers appear to be in a similar or slightly better situation than the reference group (“Unemployed”), but the results are not always statistically significant.

- **Level of education of the head of household**

Education improves food security. In fact, completing primary school increases the likelihood of being in an “Acceptable” situation (OR = 1.32, significant). Secondary education and above provides the greatest protection. These households are 1.22 times more likely to be in a “borderline” situation (not significant) and, more importantly, 1.87 times more likely to be in an “acceptable” situation (significant) compared to those with no education.

- **Living environment**

Urban areas are clearly better off than rural areas. In fact, living in a city increases the likelihood of being in a “Marginal” situation by a factor of 1.65 and the likelihood of being in an “Acceptable” situation by a factor of 1.98 compared to rural areas. Access to markets and dietary diversity is likely easier there.

- **Possession of animals**

Owning livestock is a very strong protective factor. In fact, owning animals increases the likelihood of being in a “Limited” situation (OR = 1.44) and even more so of being in an “Acceptable” situation (OR = 2.38). It serves as a source of food (milk, meat) and income.

- **Shocks experienced (unforeseen events, crises)**

Contrary to intuition, having experienced a shock increases the likelihood of

falling into the “Marginal” and “Acceptable” categories. This may seem paradoxical. This result could indicate a reporting or adaptation bias. Households with higher consumption levels (Acceptable) may be more aware of shocks or have more resources to lose. Conversely, very poor households (the reference category) may be in a situation of chronic deprivation where the concept of a “shock” is less distinct from their daily lives, or they may simply have nothing to lose. The effect is strong: OR = 1.56 for “Limited” and 2.05 for “Acceptable.”

- **Economic level**

Perceived wealth is a logical and powerful predictor. Indeed, compared to the middle class, the poor are less likely to be in an “Acceptable” situation (OR = 0.70), which is consistent. As for the rich, they are about twice as likely to be in a “borderline” situation (OR = 1.98) and an “acceptable” situation (OR = 2.23). This is a very clear indicator of food security.

3.4. Identification of Typical Profiles

- **“Acceptable” Consumption Profile (Good Food Security):**

The typical household has more than six months’ worth of food reserves, lives in an urban area, owns livestock, has a high school education, belongs to the wealthy class, and is headed by a civil servant or a merchant.

- **“Borderline” consumption profile (Vulnerability):**

The factors are the same but with lower intensities. This includes households with a stockpile of 1 to 3 months, living mostly in cities, but with a lower level of education or economic status than the “Acceptable” group.

- **Reference Category Profile (Food Insecurity):**

These are most likely rural households, farmers, with no education, no livestock, less than one month’s supply, and a low economic status.

3.5. Presentation of the Results of the Marginal Prediction

Table 6 presents the marginal prediction, which is a central area in statistics. It takes into account all the associated uncertainties. It can be useful for policy makers and practitioners in our context. It simplifies complex statistical results into easily understandable probabilities that can be applied to intervention planning. The prediction takes the form of a probabilistic forecast measure. Compared to odds ratios, they offer a more practical and contextualized view. Targets are identified, such as the most vulnerable groups, to whom resources are allocated in the most effective way. Several scenarios are then predicted, each associated with a probability of occurrence [26].

- **Stocks duration**

These results highlight marked differences depending on the duration of household food reserves, with direct implications for targeted interventions:

- Households with reserves for more than 6 months: They are highly likely to have acceptable food security, estimated at 57.4% (95% confidence interval: 54.3 - 60.5). This estimate is accurate (narrow interval), which reinforces the

Table 6. Marginal to average predictions.

Characteristics	Marginal to average Predictions		Marginal to average Predictions		Marginal to average Predictions	
	95% CI'	Characteristics	95% CI'	Characteristics	95% CI'	Characteristics
Poor						
Duration of household food stock						
Less than one month	30.9%	25.7% - 36.1%	51.5%	Less than one month	46.4% - 56.7%	17.6%
1 to 3 months	17.8%	14.9% - 20.7%	59.1%	1 to 3 months	55.6% - 62.6%	23.1%
4 to 6 months	14.2%	11.7% - 16.7%	45.7%	4 to 6 months	42.3% - 49.0%	40.2%
More than 6 months	6.4%	5.0% - 7.9%	35.1%	More than 6 months	32.2% - 38.1%	58.4%
Gender of the head of household						
Female	6.6%	4.4% - 8.9%	45.3%	Female	39.3% - 51.4%	48.0%
Male	6.4%	5.0% - 7.9%	35.1%	Male	32.2% - 38.1%	58.4%
Marital status of heads of household						
Single	5.7%	2.1% - 9.3%	28.8%	Single	20.0% - 37.7%	65.5%
Divorced/Widowed/Widow	8.0%	4.8% - 11.1%	27.3%	Divorced/Widowed/Widow	21.2% - 33.4%	64.7%
Married	6.4%	5.0% - 7.9%	35.1%	Married	32.2% - 38.1%	58.4%
Profession of Head of Household						
None	3.1%	1.8% - 4.4%	26.5%	None	20.2% - 32.8%	70.4%
Civil servant	0.6%	-0.6% - 1.8%	11.2%	Civil servant	5.2% - 17.2%	88.2%
Farmer	6.4%	5.0% - 7.9%	35.1%	Farmer	32.2% - 38.1%	58.4%
Craftsman	2.7%	0.8% - 4.6%	26.3%	Craftsman	17.3% - 35.4%	71.0%
Other	2.2%	1.2% - 3.1%	26.3%	Other	20.9% - 31.7%	71.5%
Trader	2.3%	1.3% - 3.3%	18.8%	Trader	14.7% - 23.0%	78.9%
Breeder	2.5%	1.0% - 3.9%	27.6%	Breeder	21.5% - 33.6%	69.9%

Continued									
Gold panner	2.2%	0.9% - 3.5%	Gold panner	18.0%	12.1% - 24.0%	Gold panner	79.8%	73.4% - 86.1%	
Level of education			Level of education						
None	6.4%	5.0% - 7.9%	None	35.1%	32.2% - 38.1%	None	58.4%	55.3% - 61.6%	
Primary	5.2%	3.8% - 6.6%	Primary	32.2%	28.8% - 35.6%	Primary	62.6%	59.0% - 66.1%	
Merdersa	7.0%	4.2% - 9.7%	Merdersa	29.9%	23.8% - 35.9%	Merdersa	63.2%	56.5% - 69.9%	
Secondary and more	4.1%	2.5% - 5.7%	Secondary and more	27.1%	22.6% - 31.6%	Secondary and more	68.8%	64.0% - 73.6%	
Household's area of residence:			Household's area of residence:			Household's area of residence:			
Rural	6.4%	5.0% - 7.9%	Rural	35.1%	32.2% - 38.1%	Rural	58.4%	55.3% - 61.6%	
Urban	3.6%	2.5% - 4.6%	Urban	32.1%	28.2% - 36.1%	Urban	64.3%	60.2% - 68.4%	
Possession of animals			Possession of animals			Possession of animals			
No	11.6%	8.4% - 14.9%	No	44.1%	38.7% - 49.4%	No	44.3%	38.6% - 50.0%	
Yes	6.4%	5.0% - 7.9%	Yes	35.1%	32.2% - 38.1%	Yes	58.4%	55.3% - 61.6%	
Shock experienced			Shock experienced			Shock experienced			
No	11.2%	8.5% - 13.9%	No	39.3%	35.4% - 43.2%	No	49.5%	45.4% - 53.6%	
Yes	6.4%	5.0% - 7.9%	Yes	35.1%	32.2% - 38.1%	Yes	58.4%	55.3% - 61.6%	
Household economic level			Household economic level			Household economic level			
Average	5.0%	3.8% - 6.2%	Average	30.3%	27.5% - 33.1%	Average	64.7%	61.7% - 67.6%	
Poor	6.4%	5.0% - 7.9%	Poor	35.1%	32.2% - 38.1%	Poor	58.4%	55.3% - 61.6%	
Rich	2.4%	1.6% - 3.2%	Rich	28.7%	25.8% - 31.5%	Rich	68.9%	66.0% - 71.9%	

²CI = confidence interval.

reliability of this conclusion. For policymakers, this means that these households are relatively stable and could benefit from programs to maintain or strengthen resilience.

- Households with reserves for less than one month: Their probability of having acceptable food security drops to 17.2% (95% CI: 13.8 - 20.6). The confidence interval remains moderately narrow, indicating a reliable estimate. These households are clearly at high risk of food insecurity and should be prioritized for emergency assistance, social safety nets, or food supply programs.

This implies that the longer the duration of food reserves, the greater the likelihood of acceptable food security. This suggests that investing in storage, diversification of food sources, or access to non-perishable foods could have a significant protective effect.

In summary, the results of this study identify two distinct groups: a vulnerable group (reserves < 1 month) requiring rapid intervention, and a more stable group (reserves > 6 months) where preventive or reinforcement measures could be considered. The accuracy of the estimates confirms the relevance of these targets.

- **Gender**

The marginal predictions from **Table 6** refine the results of the odds ratio and offer concrete avenues for targeting interventions according to the profile of the head of household:

Households headed by men are more likely to achieve acceptable food security, with a 57.4% chance of having an acceptable food consumption score (FCS), compared to 47.3% for those headed by women. This 10-percentage point difference suggests that male-headed households are generally better positioned in terms of food security.

For policymakers, this means that these households could serve as models or control groups for understanding resilience factors.

Indeed, the marginal predictions for poor FCS are almost identical between the sexes: 7.1% for women versus 7.0% for men. This indicates that the gap is mainly due to access to the “acceptable” category, rather than greater vulnerability to moderate malnutrition.

- **Profession**

For employment, only civil servants have a marginal prediction at the mean of almost 85% in the acceptable class of the FCS. Compared to the marginal predictions of other jobs in the same FCS class, being a “civil servant” guarantees a high level of food security, although the marginal predictions for the average of the other jobs are also at an acceptable level (on average 59.3%). They are better protected against food insecurity.

- **Level of education**

Although households headed by heads with no formal education constitute the majority (64%) of the sample (see **Table 1**), it is the heads of households with secondary education and above who have a high marginal prediction at the mean in the “acceptable” household FCS class, *i.e.*, 67.6%, and 4.6% in the “poor” house-

hold FCS class (but a minority in the sample). There is therefore a very strong correlation between a high level of education and the ability to maintain food security. This may be due to their greater access to formal employment, higher incomes and better management of resources.

- **Place of residence**

The marginal predictions from **Table 6** highlight a significant advantage for urban households in terms of food security, with clear implications for resource allocation and interventions:

- Rural households, which make up 75% of the sample, constitute the majority of the population studied and have a baseline probability of 63.3% (median marginal prediction) of achieving acceptable food security. Although this level is relatively high, the gap with urban households suggests that specific constraints persist in rural areas.
- Urban households (25% of the sample): Their probability of having an acceptable food consumption score (FCS) is significantly higher than that of rural households (marginal prediction greater than 63.3%). This advantage is probably due to better access to infrastructure (markets, health, education), basic services, and economic opportunities (diversified jobs, more regular income).

- **Possession of animals**

Households owning animals represent a significant part (84%) of the total sample (**Table 2**). The marginal predictions in the “acceptable” class reveal that households with animals (57.4%) outnumber those without (43.5%). Animal ownership is a key factor in maintaining appropriate food safety. Compared to households without animals, the “borderline” FCS household class had a marginal prediction 44.2% higher than those with animals (35.6) in the same “borderline” class. This induces food insecurity at the level of these households.

- **Shocks experienced**

Households exposed to shocks are more likely to have an acceptable food consumption score (FCS) (58.4%) than those not exposed (49.5%). However, this finding should be interpreted with caution and reflects an association rather than a causal relationship.

- **Economic level**

Wealthy households dominate the acceptable FCS category with an average marginal prediction of 68.0%, indicating that these households manage to maintain adequate food security, probably as a result of sufficient economic resources.

4. Discussion of the Results

The results of the study showed that the probability for a household to belong to the acceptable food consumption class is higher when food stock availability lasts longer than 6 months. From the statistics, several control variables influence the food consumption score and are associated with greater food security. These include having a male head of household, secondary or higher education, public sector employment, living in an urban area, living in an ordinary household, own-

ing animals and having a high economic status (wealthy households).

The food consumption score is a composite indicator that depends on several factors, including availability, eating habits and food sources that affect accessibility [27]. Managing food stocks at household level is only important during the lean season, given the scarcity of food resources [12]. It is even more important when it comes to assessing a household's ability to withstand and recover from shocks [28]. It is one of the most reliable ways of ensuring household food security by guaranteeing a supply of food over an extended period [12]. Analysis of the various results shows that the probability of belonging to the acceptable food consumption class, the class containing the most households (see **Table 3**), increases with the existence of food stocks.

According to the analysis of food insecurity based on the food consumption score, over 47.4% of households are relatively food secure, despite the cross-sectional nature of this survey. These results corroborate the work of [29]. The authors found that the populations in this class had a diversified and balanced diet and an acceptable level of food consumption. In contrast, the Limited food consumption score classes (41% of households surveyed) had inadequate diets in terms of quality, while the Poor food consumption score classes (11.6% of households surveyed) contained a population with inadequate diets in terms of quality and quantity [21]. The relative food insecurity observed in this "Poor" food consumption class could also be explained by poverty, a mass phenomenon that tends to worsen and be perpetuated from one generation to the next [30]. In addition, The demographic and economic growth of recent years is also having an impact on economic, social and ecological sustainability, and is calling food security into question [31]. This confirms the findings of this study, which stipulate that the predictions marginal to the average, namely 35.6% of Borderline FCS and 7.0% of Poor FCS, are related to the economic level of the household, a conclusion also supported by [32] and [33]. These households are highly dependent on subsistence farming, making them vulnerable to climatic hazards. This could indicate that these households are in a precarious food situation, where it is difficult to meet minimum nutritional requirements [34].

This study shows that the probability of households having acceptable food consumption increases when the head of household is male (88% of heads of household are male, **Table 1**). An analysis of the situation of female heads of household shows that, although there are proportionately more men than women, this does not necessarily mean that they are better off, but rather that they are more likely to be heads of household. These results differ from those obtained by [35] or whom an increase in households belonging to the Acceptable food consumption class according to the gender of the household head was not established.

Agriculture as the main economic activity within the study population, is also justified by the large number of heads of farming households (73%). This activity generates almost 45% of farm household income in Burkina Faso [36]. On the other hand, civil servants have a higher level of food security than other occupa-

tional categories, according to the marginal prediction, which is almost 88%. This is confirmed by [37] those who have shown through their work that food insecurity in Africa is the result of low agricultural production and insufficient income, but not in isolation. This leads to heavy dependence on subsistence farming, making them vulnerable to climatic hazards [38].

The level of education of the head of household is strongly correlated with the “acceptable” class of the household’s FCS, particularly when the level of education is secondary or higher. All heads of household with secondary education and above manage to avoid food insecurity and can maintain a high level of food security, unlike heads of household with no education. This result is in line with those of [32], which suggest that food insecurity mainly affected the Gao region, particularly people with no education.

With regard to the shocks experienced by households, the results of this study showed that households experienced an improvement in food security. This is counterintuitive: food shocks (rising prices, crop losses, conflicts, drought, etc.) generally undermine food security [39] [40]. This “improvement” is not the result of a direct effect of the shock, but rather of response or adaptation mechanisms [41].

According to place of residence, the study results revealed that urban households are more capable of ensuring better food security, in contrast to rural households who may be more vulnerable to shocks (such as rising prices of inputs and foodstuffs, climate change) and often have limited access to resources, infrastructure, and basic services [42]. This aspect of food security, as highlighted by the findings of this study, is also discussed by [43] in his research on the determinants of food security in Senegal.

Livestock plays a crucial role in household food security as a source of profitable income (through sales, milk, and meat) or as a form of savings to mitigate food-related constraints. Animal ownership is often part of broader economic diversification strategies, which can improve household food security. This is corroborated by studies such as [44] “*Does livestock ownership affect food security? The case of rural Mauritania*” and [45] “*The future of African livestock: Unlocking the potential of livestock for food security, poverty reduction and the environment in sub-Saharan Africa.*”

Limitations of the study

This study has some important limitations. First, due to the cross-sectional nature of the data, the observed relationships do not allow for the establishment of a causal link. In particular, the risk of reverse causality (endogeneity) cannot be ruled out: food-secure households may be better able to accumulate food stocks, rather than the reverse.

5. Conclusions

This article aimed to assess the effects of food stocks on household food consumption in Burkina Faso. The multinomial logistic regression model was applied to data from February 2022, from the secondary database of the “ENISAN” survey.

The results showed that the probability of having an Acceptable food consumption increases when the food stock lasts in the household. Furthermore, the study found that food consumption improves, indicating better food security, when the household is headed by a man with a secondary or higher level of education, employed as a civil servant, residing in an urban area, and owning livestock. It is worth noting that households develop coping mechanisms in response to food shocks, such as crop diversification and income diversification. These strategies are associated with a relative improvement in certain food security indicators, particularly dietary diversity and household resilience. However, these mechanisms should be interpreted as factors that mitigate the negative effects of shocks rather than as direct determinants of improved food security.

Evaluating policies related to food stock management is crucial for strengthening food resilience by extending stock duration for vulnerable households. Additionally, it is essential to target poor households, implement tailored economic and food support programs, and promote education and economic diversification to reduce rural households' dependency on agriculture.

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Authors' Contributions

JSRK, EWRC and MHD, collaborated in the design and development of the study; JSRK directed the organization and selection of indicators in the databases in collaboration with TZCSC; MT carried out the statistical analysis; JSRK, NK, RPWY and IK interpreted the data; JSRK and OO wrote the first draft of the manuscript under the direction of EWRC and MHD. All authors contributed to the revision of the manuscript, and read and approved the submitted version.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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