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Effect of agricultural diversification on food security in Burkina Faso: A conditional mixed process approach

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Abstract

Food security remains a major challenge in Burkina Faso, despite national and international commitments to reverse it. This paper evaluates the effect of the combined diversification of cash crops and food crops on the food security of rural farming households in Burkina Faso. To achieve this, the conditional mixed process (CMP) model was employed on survey data collected from 210 rural farming households in the Zytenga municipality. The results show that the combined diversification of cash crops and food crops improves the level of food security. Furthermore, the findings indicate that variables such as livestock practices and the timing of the agricultural season influence the food security levels of rural farming households. These results underscore the necessity of actively promoting integrated agricultural diversification, particularly the combination of cash crops and food crops, as a strategic lever to strengthen food security and resilience among rural households.

Key words: food security, food crops, cash crops, conditional mixed process, Burkina Faso

1. Introduction

Burkina Faso is facing significant challenges regarding food security, exacerbated by rapid population growth and increasing vulnerability to climate and security shocks. According to the Ministry of Agriculture and Hydro-Agricultural Development (MAAH 2020), the number of people experiencing food insecurity rose from 153 000 in October 2016 to nearly 1.2 million in October 2019. This trend continued, reaching at least 3.4 million people in 2022 (Bureau des Nations Unies pour la coordination des affaires humanitaires [BCAH] 2022). Furthermore, around 4.9 million people required humanitarian assistance that same year (BCAH 2022).

The situation is particularly concerning given that armed conflicts have led to the displacement of over one million people, severely disrupting agricultural activities and access to markets (Plan International 2024). Agriculture is a cornerstone of the national economy, employing over 80% of the population and accounting for approximately 30% of the gross domestic product (World Bank 2023). However, this sector remains heavily reliant on rainfall and soil fertility, rendering it particularly vulnerable to climatic variabilities.

In this context, agricultural diversification is often regarded as an effective approach to enhancing food security among rural households (Waha *et al*. 2021; Alam *et al*. 2023). According to the portfolio theory developed by Markowitz (1952), this strategy reduces risks by spreading investments across different crops, helping to stabilise farmers' incomes and facilitate access to food. In addition, food systems theory (Ericksen 2008) highlights the importance of crop diversity in ensuring the resilience of food systems in the face of disruptions. Furthermore, path dependency theory (Arthur 1989) underscores that past decisions influence agricultural systems, thus explaining the persistence of certain diversification practices.

Complementing these theories, numerous empirical studies have confirmed that agricultural diversification can play a crucial role in improving food security. For instance, several studies have demonstrated that diversifying crops contributes to increased agricultural production and household incomes (Jimoh *et al*. 2024; Danso-Abbeam *et al*. 2025; Gondwe *et al*. 2025). Other research has also emphasised the importance of this diversification for enhancing resilience against climate shocks (Saboori *et al*. 2023; Javid *et al*. 2025). However, these studies have certain limitations. They tend to focus on diversification, without clearly specifying the types of crops being diversified, thereby overlooking the differentiated and synergistic effects of diversifying cash and food crops on household food security.

Moreover, specifically concerning Burkina Faso, most research has either assessed the impact of sustainable agricultural practices on household food security (Kone & Uzmay 2024), or focused on income diversification and food security (Reardon *et al*. 1992; Zoungrana 2022). There is a scarcity of studies specifically addressing the link between agricultural diversification and food security (Tincani 2010; Sanfo 2022). Furthermore, existing studies have approached this link in terms of land area (the Simpson diversity index), thus neglecting the synergistic effects resulting from the diversification of cash and food crops on food security.

This study aims to fill this gap by adopting an innovative approach. It analyses the effects of the combined diversification of cash and food crops on the food security of rural households in Burkina Faso. Moreover, it employs the food insecurity experience scale (FIES), which is an experience-based measure pertaining to the access pillar of food security, and one of the globally accepted indicators for measuring progress towards achieving Sustainable Development Goal 2, which aims to end hunger and ensure food security (Appiah-Twumasi & Asale 2022).

The unique aspect of this study lies in its integrated approach, which combines the analysis of both food and cash crop diversification to evaluate their synergistic effects on household food security. This will contribute to a better understanding of the complex links between agricultural diversification and food security in Burkina Faso and provide valuable insights for the development of agricultural policies and rural development strategies aimed at improving food security for vulnerable populations.

The remainder of this article is organised as follows: Section 2 presents the literature review, Section 3 outlines the methodology, Section 4 presents and discusses the results, and Section 5 concludes and proposes recommendations.

2. Literature review and conceptual framework

2.1 Literature review

Numerous empirical studies demonstrate that cultural diversification can enhance food security through various channels: production stability, improved agricultural incomes, increased dietary diversity and reduced climate-related risks. Several authors have examined the effect of diversification from the perspective of food consumption. In Uganda, Tesfaye and Tririvayi (2020), using an econometric model based on panel data, show that diversification enables better consumption smoothing, which is especially beneficial for the poorest households. For their part, Mengistu *et al*. (2021) observed that high levels of diversification reduce the severity of food insecurity by improving food availability and accessibility. In India, Anuja *et al*. (2022) found, through a nutritional approach, that diversification enhances the nutritional status of households. Lourme-Ruiz *et al*. (2021), by linking agricultural biodiversity and food diversity, also highlight favourable effects on the quality of diets. Other studies emphasise the effects of diversification on agricultural production and incomes. For example, Mango *et al*. (2018) demonstrate that diversification improves food security through increased production stocks and revenues from the sale of agricultural products. Di Falco *et al*. (2010) and Bozzola and Smale (2020) point out, based on stochastic production models, that diversification increases technical efficiency and reduces risks associated with agricultural income. In Ghana, Adam and Abdulai (2024) combined agricultural and climatic data using a dose-response function with instrumental variables to show that diversification improves net yields and reduces agricultural losses. In the same vein, Hashmiu *et al*. (2024) employed the IPWRA model to demonstrate that the combination of staple and cash crops (notably cocoa and cashew nuts) significantly enhances food security and incomes for farming households. Bellon *et al*. (2020), using simultaneous equations models, also show that diversified households benefit from higher levels of self-consumption and agricultural income in marginal areas.

Some authors have investigated the differentiated effects according to the socioeconomic category of households. Fujimoto and Suzuki (2025), through a threshold model applied to national Tanzanian data, conclude that poor households diversify to secure their food, while wealthier households do so in response to rising production costs. Similarly, Amfo *et al*. (2021), by combining the Margalef index and the triple least squares methodology, reveal that diversification reduces consumption expenditures for rice-growing households. Finally, several studies underscore the role of diversification as an adaptation strategy in the face of climate variability. Based on a survey in northern Nigeria, Hassan and Knight (2023) identify diversification as one of the main adaptation strategies employed by farmers facing climate change. Mzyece and Ng'ombe (2021), using a stochastic distance function and OLS regression, demonstrate that diversification not only enhances technical efficiency, but also strengthens the resilience of farmers in northern Ghana. Abdimomynova *et al*. (2019) confirm these findings in a cross-country comparative framework, concluding that diversification improves food security in low- and middle-income countries.

However, these largely positive results are not universally accepted. Indeed, other studies present significant nuances, or even contradictory results, depending on agricultural practices or the conditions of access to agricultural resources. In Burkina Faso, Sanfo (2022), using an endogenous regression model (ESR) and the Simpson index, found that households resorting to diversification are paradoxically more exposed to food insecurity. The author attributes this result to insufficient production intensity and limited use of fertilisers. Similarly, Thapa *et al*. (2018) find in Nepal that diversification into high-value cash crops has come at the expense of cereal crops, leading to a decrease in production intended for self-consumption and a worsening of poverty. Other research highlights differentiated effects based on household wealth levels. Asfaw *et al*. (2019) note that the positive effects of diversification are primarily observed among poor households, while they may become negligible or even negative among wealthier ones. Horlu (2024), analysing the effects of income and crop diversification on poverty in Ghana, observed a reduction in inequality without a clear effect on food security. Finally, some studies, such as that by Lourme-Ruiz *et al*. (2021), question the limitations of the approach by highlighting the lack of universality of the positive effects of diversification. Their analysis, while positive, remains confined to certain agroecological contexts and does not account for the heterogeneity of agricultural regions in the country.

Considering this diversity of results, this research proposes an innovative approach by combining the diversification of both staple and cash crops in the analysis of food security. While the majority of existing works focus on one type of crop or the other, or even without any specification of the type of crop, this study seeks to capture the differentiated and synergistic effects of this dual diversification on food security and incomes. It employs a robust econometric methodology based on the conditional mixed process (CMP) model, which allows for the correction of selection biases and addresses the endogeneity of agricultural decisions. By relying on primary data collected from farming households in the rural commune of Zitenga (Central Plateau region, Burkina Faso), this research provides an original and contextually relevant empirical contribution, particularly pertinent in a context of resilience to climate and economic shocks.

2.2 Conceptual framework

The conceptualisation of diversification varies across studies. It is often viewed as crop biodiversity – the cultivation of different species and varieties to improve resilience to climate shocks and increase production (Di Falco *et al*. 2010; Bozzola & Smale 2020). Other studies broaden this concept to on-farm enterprise diversification, including not only crops, but also livestock for a more holistic approach to the agricultural system (Danso-Abbeam *et al*. 2025). At a macroeconomic level, diversification is also analysed as the diversification of a country's agricultural products, using indices to measure production concentration (Saboori *et al*. 2023).

However, in this article, agricultural diversification is defined as the combination of food crops and cash crops on the same family farm. It is a key agricultural strategy that bolsters food security across all four of its core dimensions, as shown in Figure 1.

This dual-purpose approach significantly improves access to food. Food crops provide a direct and reliable supply for self-consumption (Mengistu *et al*. 2021), reducing a household's dependence on markets and protecting it from price increases. Simultaneously, the income generated from cash crops and the sale of surplus food crops provides the necessary purchasing power to buy a variety of foods from the market, which is crucial, especially during lean seasons.

Diversification also strengthens overall food availability (Bozzola & Smale 2020). By creating synergies between plants, such as improving soil fertility, it can increase the total yield of the farm (which can be used for self-consumption or for generating income through the sale of surplus). Most importantly, it acts as a safety net against climate or health hazards: if one crop fails, the survival of others guarantees a minimal level of production, making the agricultural system more resilient.

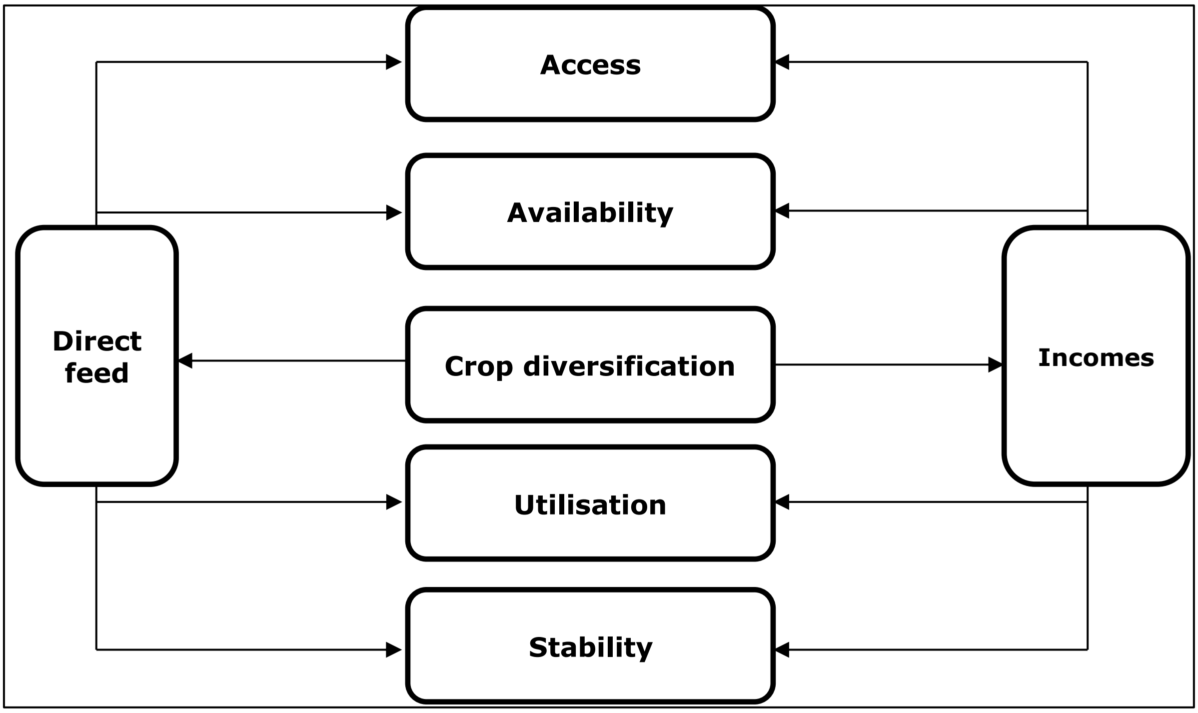

Figure1: Conceptual framework
Source: authors

Regarding food utilisation, this strategy improves a household's quality of life. The income from cash crops allows for the purchase of a wider variety of foods (Danso-Abbeam *et al*. 2025), promoting a more balanced diet. These funds can also be invested in health and sanitation, thus ensuring better absorption of nutrients by the body. Diversification also allows households to have several different foods at their disposal, further improving the utilisation dimension of food security.

Finally, combining both types of crops considerably strengthens food stability. Households benefit from two sources of income and supply, making them less vulnerable to economic shocks. If the price of one crop collapses or a food crop harvest is poor, the other source of income or food compensates for the loss, guaranteeing continuous access to food throughout the year.

3. Methodology

3.1 Theoretical framework and analysis model

3.1.1 Theoretical framework

The theoretical framework for this research is based on the utility maximisation theory, established by Rahm and Huffman (1984). The motivation for farmers to diversify their crops is grounded in utility, which is defined by the expected benefits of this diversification. Thus, the latent utility of farmer i for the diversification strategy g is denoted as U_{gi} (Equation (1)), where g takes on the values of 0 and 1 to indicate the absence and presence of combined diversification of cash and food crops, respectively. The fundamental hypothesis of this approach suggests that the net benefit a farmer gains from the combined diversification of cash and food crops depends on both a set of socioeconomic factors and specific elements related to diversification that are unique to farmer i. Despite the latent nature of utility, we propose that it can be represented as a linear function incorporating institutional variables and characteristics specific to the farmer, as well as aspects related to diversification, with a random error term having a mean of zero, as follows:

$$U_{gi} = X_i\alpha_i + \varepsilon_{gi}\ , \quad avec\ g = 0,1\ ;\ et\ i = 1,2,3,4,\dots,n, \tag{1}$$

where X_i is a (1×k) vector of the values of the factors important for explaining utility for farmer i.

There is a greater likelihood that diversified farming will be adopted if the expected profit from a non-diversified farming approach (denoted U_0) is lower than the expected profit they could obtain by integrating these two types of crops (denoted U_1). Consequently, farmer i is likely to choose diversified farming if the profit expected with the crop combination exceeds that of the non-diversified approach, i.e. $U_{1i} > U_{0i}$, or if the latent variable $CDI^* = U_{1i} - U_{0i} > 0$. The probability that farmer i will engage in this diversification, noted $CDI = 1$, depends on the explanatory variables and can be formulated as follows:

$$P_i = (CDI_i = 1) = P(U_{1i} > U_{0i})$$
$$P_i = (X_i\alpha_{1i} + \varepsilon_{1i} > X_i\alpha_{0i} + \varepsilon_{0i}) = P(\mu_{1i} < X_i\beta$$
$$P_i = F(X_i\beta),$$

where $\mu_{1i} = (\varepsilon_{1i} - \varepsilon_{0i})$; β = ($\alpha_1 - \alpha_0$) and F(.) represents the distribution function for μ_i.

3.1.2 Analysis model

This article analyses the effects of the combined diversification of cash crops and food crops on food security. As Pretty and Bharucha (2014) point out, crop choices influence food security, just as food security can affect those choices. This requires the use of a model that accounts for endogeneity. The current article therefore uses the conditional mixed process (CMP) model, developed by Roodman (2011). This model is preferred over other regression models that also address endogeneity (e.g., endogenous switching regression (ESR) and instrumental variables models) because it allows for the estimation of interconnected equations, even with heterogeneous dependent variables (binary, categorical, continuous, etc.), and does not require instrumental variables. This makes it flexible and efficient for managing endogeneity bias, which is crucial for studying the link between crop diversification and food security.

Furthermore, compared to other methods, the CMP has been widely used in research on agricultural behaviour and well-being in Africa. It allows for the analysis of the diversification of agricultural practices and their nutritional impacts, while offering a more realistic approach than traditional methods based on instrumental variables.

Empirically, the link between the combined diversification of cash and food crops (*Diverscomb*) and food security (*Statusecur*) can be estimated as follows (Alhassan *et al*. 2020; Mbudzya *et al*. 2022):

$$Diverscomb_i = \beta_0 + \beta_1 X_{1i} + \varepsilon_{1i} \tag{2}$$

$$Statusecur_i = \alpha_0 + \alpha_1 X_{2i} + \gamma Diverscomb_i + \varepsilon_{2i}, \tag{3}$$

where X_{1i} denotes a vector of explanatory variables influencing the choice of the link. X_{2i} denotes a vector of explanatory variables influencing multidimensional poverty. ε_{1i} et ε_{2i} are the error terms, while β, α and γ represent the parameters to be estimated in the equations.

In the CMP format, equations (2) and (3) are recast as follows (equations (4) and (5):

$$y_1^* = \theta_1 + \varepsilon_1 \tag{4}$$

$$y_2^* = \theta_2 + \varepsilon_2 \quad (5)$$

$$\theta_1 = \beta_1 X, \theta_2 = \alpha_1 X + \gamma y_1,$$

where y_1^* and y_2^* represent the latent factors of link choice and multidimensional poverty, respectively. Xrepresents a vector of explanatory variables.

3.2 Data source

The data used in this study come from a household survey conducted between from 20 to 29 April 2022, in the commune of Zitenga, a locality in the Plateau Central region of Burkina Faso. The survey targeted key decision-makers within households and involved a sample of 210 respondents. The approach followed is a random approach at both the village and household levels. The questionnaire administered by the interviewers to the households was structured into six sections, comprising a total of 61 questions. It was developed as part of the NUTRiGREEN project with the assistance of experts from Burkina Faso, Senegal, Sweden and Germany, and was finalised after a pre-test. Data collection was carried out using tablets and KoboToolbox software to enable efficient and digital data entry. The sample was calculated according to the formula in equation 6 below:

$$\mathrm{n} = \frac{(1{,}96)^2 * \mathrm{N}}{(1{,}96)^2 + \mathrm{I}^2(\mathrm{N}-1)}, \quad (6)$$

where n = sample size, N = total study population and I = 2ε. ε = margin of error (5%).

3.3 Presentation of variables

3.3.1 Dependent variable

In the field of food security, various measurement tools have been developed, including the Food Insecurity Experience Scale (FIES), developed by the FAO. FIES, an experience-based method, assesses access to food security and is cross-culturally validated (Ballard *et al*. 2013). This indicator is widely used to monitor progress towards Sustainable Development Goal 2, which aims to eradicate hunger and ensure improved nutrition. It assesses food insecurity at the individual or household level through yes/no responses to eight questions regarding access to food. This approach captures subjective dimensions, such as access anxiety, often neglected by traditional quantitative methods (Smith *et al*. 2023). The FIES also considers trade-offs between food quality and quantity (Ballard *et al*. 2013). Studies (Ballard *et al*. 2013) show that FIES scores reflect seasonal fluctuations in production and income, making this tool relevant for assessing the impacts of agricultural diversification. The responses, collected over a 12-month period, allow for the establishment of raw scores from 0 to 8, classifying food insecurity into three categories: food secure (0 to 3), moderate (4 to 6) and severe (7 to 8) food insecurity (Appiah-Twumasi & Asale 2022). However, for the estimates, the food security status was recoded from 0 to 2: 0 for severely food-insecure households, 1 for moderately food-insecure households, and 2 for food-secure households. The questions used for the assessment are presented in Table 1 below.

Table 1: Measures of the Food Insecurity Experience Scale

In the last 12 months, has there been a time when …?
Q1. Have you or other members of your household worried about not having enough food to eat due to a lack of money or other resources?
Q2. Still thinking about the past 12 months, was there a time when you or other members of your household were unable to eat healthy, nutritious food due to a lack of money or other resources?
Q3. Was there a time when you or other members of your household ate only a few kinds of food due to a lack of money or other resources?
Q4. Was there a time when you or other members of your household had to skip a meal because there was not enough money or resources to obtain food?
Q5. Still thinking about the past 12 months, was there a time when you or other members of your household ate less than you thought you should because of a lack of money or other resources?
Q6. Was there a time when your household ran out of food due to a lack of money or other resources?
Q7. Was there a time when you or other members of your household were hungry but did not eat because there was not enough money or other resources for food?
Q8. Was there a time when you or other members of your household went without eating for an entire day due to a lack of money or other resources?

Source: Authors, with data from the FAO

3.3.2 Independent variables

The economic literature reveals that socioeconomic, demographic and environmental factors are likely to influence crop diversification, with expected effects on food security.

Crop diversification is a binary variable that takes a value of 1 if the farmer diversifies into both cash and food crops and 0 if not. The economic literature reveals that crop diversification offers a sustainable strategy to build resilience and reduce risks associated with monoculture (Appiah-Twumasi & Asale 2022; Sanfo 2022; Mihrete & Mihretu 2025). Therefore, by adopting diversified crops, farmers can mitigate soil degradation, reduce pest infestations, and stabilise their incomes. The sign of the crop diversification variable is positive.

Gender is a binary variable that takes a value of 1 if the farmer is male, and 0 if not. Diencere (2019) reveals that the probability of a male farmer adopting adaptive measures is higher than that of a female farmer. Similarly, Kassie *et al*. (2014) estimate that households headed by women are more vulnerable to food insecurity status than households headed by men. The expected sign is undetermined for the food security equation.

Educational level is a binary variable taking 1 if the farmer is educated, i.e., is literate (medersa[1], primary, secondary, higher), and 0 if not. Farmers with formal education are more likely to diversify their crops as a sustainable resilience approach, which could increase their production capacity and improve their level of food security (Zoungrana 2022; Jimoh *et al*. 2024). The sign of this variable is positive.

Marital status is a binary variable coded 1 if the farmer is married and 0 if not. In developing countries, married individuals are more likely to have stability, which allows them to diversify their livelihoods with a significant effect on their level of food security (Mpuga 2010). In addition, households headed by married individuals may have more labour available than those headed by single individuals (Ng'ombe & Kalinda 2015).

Temperature perception is a binary variable taking a value of 1 if the farmer perceives the effect of global warming on his production activities, and 0 otherwise. The economic literature indicates that

[1] Madrasa

the increase encourages farmers to resort to adaptation strategies in the face of climatic hazards, in particular soil conservation measures and agroecological practices (Deressa *et al*. 2009). We expect a negative sign for the temperature perception variable.

Regarding the start of seasons, it is binary variable that takes a value 1 if the farmer perceives the rainy seasons to have started late, and a value of 0 otherwise. According to the literature, the fact of perceiving a late start to the rainy seasons increases the level of resilience of farmers, in the sense that a farmer who perceives a late start to the rainy season is much more likely to adopt anticipation strategies in order to improve his harvests. Authors such as Kabore *et al*. (2019) have emphasised that the perception of the effects of climate change allows farmers to adopt mitigation and adaptation strategies in order to improve their well-being. For this variable, we expect a positive sign.

Income is a continuous variable that expresses the amount of wealth generated in CFA francs from the farmer's activities. Income ownership constitutes a key portfolio to overcome liquidity constraints and promotes investment in innovative agricultural measures. This improves farmers' livelihoods and allows them to achieve better levels of food security. Reardon *et al*. (2007) argue that agricultural income is seen as an important strategy to overcome the credit access challenges faced by households in developing countries. We expect a positive sign for the variable.

Association membership is a binary variable that takes a value of 1 if the farmer is a member of a producer organisation, and 0 if not. Farmer membership in an organisation facilitates access to information and new practices or technologies (Yegbemey *et al*. 2014). It allows farmers to improve their livelihoods through increased production and agricultural income. The expected sign of this variable is positive for both the crop diversification and food security equations.

Agricultural experience is a continuous variable expressed as the number of years of experience in agricultural activity. We expected that the more years of experience a farmer has, the more efficient and productive he would be, which is likely to improve his level of food security. Jimoh *et al*. (2024) show that the number of years of experience further stimulates crop diversification in Nigeria, with a significant effect on food security.

Breeding is a binary variable that takes a value of 1 if the farmer practises breeding as his main activity, and 0 if not. Breeding represents a source of wealth for farmers in developing countries (Kinané *et al*. 2008). The expected sign of this variable is positive (see Table 2).

Table 2: Summary of explanatory variables in the model

Variables	Description	Expected sign
Crop diversification	a binary variable that takes a value of 1 if the farmer diversifies crops, and 0 if not	+
Gender	a binary variable that takes a value of 1 if the head of household is a man, and 0 if not	+/-
Income	a continuous variable that expresses the amount of agricultural income in CFA francs	+
Association member	a binary variable which takes a value of 1 if the head of the household is a member of a producer organisation, and 0 if not	+/-
Marital status	a binary variable that takes a value of 1 if the farmer is married, and 0 if not	+/-
Instruction level	a binary variable taking a value of 1 if the head of household is educated, that is to say if he is literate (medersa, primary, secondary, higher), and 0 if not	+/-
Start of the seasons	a binary variable that takes a value of 1 if the farmer perceives a late start to the rainy season, and 0 otherwise	-
Temperature	a continuous variable that expresses the level of global warming in degrees Celsius	
Agricultural experience	a continuous variable that expresses the number of years of agricultural experience	+
Breeding	a binary variable that takes a value of 1 if the head of household practises livestock farming, and 0 if not	+/-

Source: Authors

4. Analysis of results

4.1 Descriptive statistics

The descriptive statistics of the socioeconomic and environmental characteristics reveal the results presented in Table 3 below. The average age of the farmers was 52 years, with a minimum of 20 years and a maximum of 85 years, with approximately 34.76% of the farmers being educated. The average size of farm households was 13 individuals, reflecting strong pressure on the available resources. Furthermore, the average farm area exploited is 3.42 hectares, varying between one and 12 hectares, while the average monthly agricultural income is estimated at 23 988 CFA francs, with a strong disparity – ranging from 12 500 to 100 000 CFA francs. The average agricultural experience is 27 years, which demonstrates a solid anchoring in rudimentary agricultural practices. In terms of land status, approximately 84.76% of households were landowners, which could strengthen their productive stability and their propensity to invest in sustainable practices.

Furthermore, it was estimated that approximately 97.61% of farmers were married and 96.67% were engaged primarily in agriculture, with a significant proportion practising livestock farming (54.76%) and, to a lesser extent, trade (11.90%). Regarding community organisations, only 17.61% of farmers belonged to a farmers' organisation. With regard to environmental perceptions, nearly 99% of producers perceived manifestations of climate change, particularly drought, which was identified by approximately 70% of respondents. Finally, 83.8% of farmers practised crop diversification. Regarding food security, 25.23% of households were food secure, 30.95% were limitedly food secure, 20% were food insecure, while 23.80% were severely food insecure, reflecting a significant prevalence of food vulnerability in the commune of Zitenga.

Table 3: Descriptive statistics

Continuous variables	Average	Standard deviation	Minimum	Maximum
Age	52	12.40	20	85
Household size	13	8.25	2	55
Agricultural area	3.42	2.14	1	12
Number of years of experience	27	15.54	2	77
Farmer's income	23 988.1	19 633.75	12 500	100 000
Dummy variables	**Percentage**	**Standard deviation**	**1(%)**	**0(%)**
Educational level	34.76	0.0329	34.76	65.24
Gender	83.33	0.0257	83.33	16.67
Marital status	97.62	0.0105	97.62	2.38
Membership in Fos	17.62	0.0263	17.62	82.38
Perception of CC	99.05	0.0067	99.05	0.5
Perception of dryness	70	0.0316	70	30
Land status	84.76	0.0248	84.76	15.24
Agriculture	96.67	0.0124	96.67	3.33
Breeding	54.76	0.0344	54.76	45.24
Trade	11.90	0.0224	11.90	88.10
Crop diversification	83.81	0.0254	83.81	16.19

Notes: FO = farmers' organisation; CC = climate change
Source: Authors

The results of the mean comparison tests obtained in Table 4 reveal that the variables, agricultural area and the number of years of experience of the farmer, are significant at the 10% and 5% level, respectively. The significance of the variable agricultural area shows the existence of a difference in average cultivated agricultural area between farmers who diversify and those who do not diversify. Farmers who do not diversify farm 2.85 ha on average, while those who diversify farm 3.54 ha on average, with a significant mean difference of about 0.69 ha. This suggests a moderate trend according to which farmers who have diversified their crops farm slightly larger areas, but this difference remains marginally significant. Also, the number of years of experience of the farmer is significant; it implies a difference between farmers who diversify and those who do not diversify. Farmers who do not diversify have an average of 32 years of farming experience, compared to 25.7 years for farmers who diversify. This difference suggests that less experienced households are more likely to adopt agricultural diversification, which could reflect an openness to new practices or adaptation strategies in the face of constraints related to agricultural activities.

Table 4: Difference between farmers who diversify and those who do not diversify

Variables	Together	Diversified	Have not diversified		
	Average	**Average**	**Average**	**Difference**	**P-value**
Gender	83.33	81.81	91.17	9.35	0.1818
Age	52	51.44	52.5	1,0568	0.6504
Educational level	34.76	36.36	26.47	-9.89	0.2696
Experience	26.74	25.72	32.02	6.3078	0.0299**
Household size	13.27	13.52	11.97	-1.5578	0.3151
Income	23 988.1	24 786.93	19 852.94	-4 933.99	0.1804
Area	3.42	3.53	2.8529	-0.6868	0.0871*
Agriculture	96.66	96.02	1	3.97	0.2389
OP membership	17.61	18.75	11.76	-6.98	0.3301
Land status	84.76	85.22	82.35	2.87	0.6712

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively
Source: Authors

4.2 Result and discussion

The results concerning the effects of crop diversification on food security are presented in Table 5 (Model 2). The LR test (Prob > chi^2 = 0.009) indicates that, overall, the model is statistically significant. The multicollinearity test performed shows that all calculated variance inflation factors (VIFs) are below four, with a mean VIF of 1.31, which implies an absence of multicollinearity issues among the selected explanatory variables. The significance of Atanhrho (P > |z| = 0.048) at 5% indicates that the suspected endogeneity is accounted for.

In many developing countries, livelihoods are significantly affected by climate-related risks. Crop diversification is often seen as an effective strategy to enhance agricultural resilience, optimising land and resource use to reduce vulnerability to environmental shocks, promote income stability and improve nutrition. Households that diversify production are generally better prepared for unfavourable climatic conditions, strengthening their food security. A number of studies (Amfo *et al*. 2021; Adam & Abdulai 2024; Hashmiu *et al*. 2024; Fujimoto & Suzuki 2025) support these claims, although some present diverging results (Keding *et al*. 2012; Sibhatu & Qaim 2018). The coefficient related to combined food and cash crop diversification is positive and statistically significant at the 1% level (p = 0.007). This indicates a higher likelihood of improved food security for households that diversify crop production. In Burkina Faso, this strategy stabilises production against climate uncertainties and market fluctuations, while contributing to household income and food supply, reinforcing food security. These findings align with studies in Burkina Faso, Ghana and Ethiopia (Sanfo 2022; Appiah-Twumasi & Asale 2024; Mihrete & Mihretu 2025).

Breeding has a negative and statistically significant coefficient (p = 0.000) at the 1% level of significance. The practice of breeding as part of farming is associated with a lower probability of achieving better food security status. Consequently, households engaging in breeding are less likely to be food secure compared to their counterparts who do not practice livestock farming. In the Burkinabè context, this could indicate competition for resources (land, labour) between agriculture and livestock farming, or that households focusing on livestock are more vulnerable to other factors. This is further verified when livestock farming is conducted extensively and traditionally, with diminishing value chains. This finding aligns with those of Inam-ur-Rahim *et al*. (2011), who found that small transhumant herders face food insecurity due to market failures and adverse climatic conditions in Northern Pakistan. However, this counterintuitive result contrasts with that found by Kinané *et al*. (2008), which shows that the development of small-scale livestock farming contributes to the improvement of farmers' wellbeing through land restoration and soil fertilisation.

Finally, the results show a negative and significant coefficient (p = 0.050) at 10% for the variable depicting the start of the agricultural seasons. Perceived difficulties at the beginning of the agricultural seasons are associated with a lower probability of having better food security status, through the implications for crop planning and agricultural investment decisions. This is logical in that a late start to the season shortens the rainy period, thereby exposing crops to drought, which will lead to poor production and consequently exacerbate food insecurity levels. Similar results have been found by Sultan and Gaetani (2016) and Zougmoré *et al*. (2019). For example, Sultan and Gaetani (2016) demonstrate that the start of seasons, as measured by intra-seasonal variability, negatively influences agricultural production in West Africa, thereby aggravating food insecurity. Zougmore *et al*. (2019) further emphasise in their work that variations in the start and end of agricultural seasons reduce agricultural yield economies, leading to further deterioration in food security.

Table 5: Results of the estimation of the effects of diversification on food security

Variables	**Model 1 (Combined diversification)**	**Model 2 (Food security)**
Combined diversification		1,148*** (0.422)
Age	0.024* (0.012)	
Gender	-0.366 (0.342)	0.292 (0.216)
Education level	0.110 (0.260)	0.027 (0.175)
Marital status	0.249 (0.659)	0.108 (0.512)
Household size	0.011 (0.017)	
Area	0.087 (0.071)	
Agricultural experience	-0.028** (0.011)	
Land ownership	0.108 (0.287)	
Association member		0.146 (0.196)
Breeding		-0.566*** (0.156)
Drought	-0.549* (0.273)	
Perception of climate change	1.756* (0.906)	
Temperature		-0.074 (0.152)
Start of the seasons		-0.864* (0.441)
Income	0.000 (0.000)	-0.000 (0.000)
Observations (no.)	210	
LR chi2 (21)	39.03	
Prob > chi^2	0.009	
Atanhrho	-0.740** (0.374)	

Note: *, ** and *** indicate significance at the 10% , %% and 1% levels, respectively
Source: authors

5. Conclusion

This article has examined the effect of the combined diversification of cash and staple crops on the food security of rural households in Burkina Faso. Using the conditional mixed process (CMP) model, the study analysed survey data from 210 households in Zitenga. The results indicate that agricultural diversification is linked to a higher likelihood of improved food security, suggesting it may effectively enhance resilience against climate-related uncertainties and market fluctuations in the country. In addition, variables like farming practices and the season's onset also influence food security among farmers. These results suggest raising awareness among farmers of the importance of diversifying cash crops and food crops, and encouraging this diversification through subsidies and training in order to improve food security for the population of Burkina Faso.

However, certain limitations must be considered. The study is limited to Zitenga, making the results less generalisable to all of Burkina Faso due to different agroecological and socio-economic contexts. Furthermore, it did not thoroughly examine specific cash and staple crops, or their interactions affecting household food security.

Future research should explore the mechanisms by which agricultural diversification affects food security, considering crop specifics and local contexts. It would also be relevant to study policies that could promote sustainable agricultural diversification for vulnerable populations in Burkina Faso

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