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Food price shocks and living standards of rural households in Senegal: Do non-farm diversification strategies matter?

Thierno Malick Diallo*
Laboratoire de Recherche en Economie de Saint-Louis (LARES), Gaston Berger University, Senegal. E-mail: malikidiallo@gmail.com

Malick Ndiaye
Higher Institute of Agricultural and Rural Training, Alioune Diop University of Bambey, Bambey, Senegal. E-mail: elmalickoul@gmail.com

Abdoulaye Ndiaye
Laboratoire de Recherche en Economie de Saint-Louis (LARES), Gaston Berger University, Senegal. E-mail: ablaye83.ndiaye@gmail.com

* Corresponding author

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Abstract

Food import-dependent countries are inherently vulnerable to international price fluctuations. While the effects of food price shocks on living standards have been documented extensively, strategies to mitigate them remain underexplored. This study examines the effects of rising food prices on rural household living standards, with a particular focus on the moderating role of non-farm diversification. The analysis shows that food price shocks adversely affect rural households, and that non-farm diversification alleviates this impact, but only for female-headed households. The results remain robust even after controlling for endogeneity. Supporting rural households, particularly those headed by women, to diversify into non-farm activities could be an effective policy intervention to mitigate the adverse effects of rising food prices on household living standards.

Key words: non-farm activities, food price shocks, living standard

1. Introduction

In recent years, the Russo-Ukrainian war and the Covid-19 pandemic have led to significant increases in food commodity prices (FAO 2024). These global disruptions have caused widespread supply chain issues, leading to a shortage of essential food items (FAO 2022a, 2022b; OECD 2022; Al-Rousan *et al*. 2024). According to Shen *et al*. (2024), this situation poses a direct threat to the attainment of the sustainable development goals, including the eradication of hunger and food

insecurity (SDG 2), as well as the enhancement of health and well-being in food-importing countries. (SDG 3).

The recent surge in food prices has reignited concern regarding the impact on household living standards, compelling households to allocate a greater proportion of their income to food expenses (Yovo & Gnedeka 2023; Hodjo *et al*. 2024). This article examines the impact of food price shocks on the living standards of rural households in Senegal, with a specific focus on the moderating role of diversification strategies. For the purpose of this study, diversification refers to the adoption of alternative income-generating activities outside of agriculture to mitigate risks and reduce reliance on farming income (Alobo Loison 2015). Diversification currently plays a significant role in rural areas. For example, in Africa, over 30% of rural households engage in non-farm activities, contributing to at least 30% of their overall income (Haggblade *et al*. 2010; Davis *et al*. 2017; Van den Broeck & Kilic 2019).

Within this African context, Senegal stands out as an important case study. More than 85% of rural households in Senegal have non-farm incomes (Alobo Loison & Bignebat 2017), and between 47% and 75% diversify into non-farm activities (IPAR 2015). Furthermore, the country is highly vulnerable to rising food prices due to its dependence on food imports (Resnick 2014; OECD 2022). Over the past decades, the share of food products in Senegal's merchandise imports has been more than three times higher than the global average, and nearly double the average of sub-Saharan Africa (World Bank 2024). The country is also far from being self-sufficient in terms of agricultural production, importing almost 70% of its food and agricultural needs (Bousso & Bumpas 2024). Despite the importance of subsistence agriculture in rural Senegal, rising food prices pose enormous challenges to rural households: nearly three-quarters (74.6%) of the poor live in rural areas (ANSD 2024) and practise low-productivity farming (Seck 2016).

That being said, the lack of recently generated data makes it difficult to find out how recent food price fluctuations have affected rural households in Senegal, as well as the extent to which diversification strategies have helped mitigate the impact. This challenge is common in Africa, where data is often collected at the national level, but less frequently and with lower quality at the household level, particularly in rural settings (Seidler *et al*. 2025). To compensate for this data gap, we rely on a previous survey conducted in rural Senegal in 2014. The survey was conducted after the global financial and economic crisis of 2008, a period marked by sharp food price increases, particularly between 2011 and 2014, when the FAO's food price index moved from 112.8 to 131.9. In comparison, the period from 2020 to 2023, characterised by the Covid-19 pandemic and the war in Ukraine, also saw the index vary from 98.1 to 124, showing a similar increase in food prices to that observed between 2011 and 2014 (FAO 2024). Given the similar scale of past and recent fluctuations, the 2014 survey remains relevant for understanding how rural households in Senegal respond to significant food price shocks through diversification strategies.

While many studies have examined the impact of food price shocks on household well-being (e.g. McCordic & Frayne 2017, Van Wyk & Dlamini 2018; Sossou & Igue 2019; Wang & Çakir 2021; Yovo & Gnedeka 2023; Hodjo *et al*. 2024), very few have attempted to examine the role of diversification in mitigating these shocks (see Bello 2019). Moreover, previous research has focused primarily on the role of diversification in coping with climate and agricultural shocks (Alobo Loison 2015; Kassie *et al*. 2017; Chuang 2019; Voss 2021; Khan & Morrissey 2023; Wang *et al*. 2024), paying little attention to food price shocks. Our article makes a significant contribution in these directions. First, it addresses the gap in understanding how diversification mitigates food price shocks. Second, it shifts focus from climate/agricultural shocks to the specific context of food price volatility. Third, it provides specific evidence from rural households in Senegal on their use of non-

farm diversification strategies to cope with food price shocks. Our article also has significant implications for economic policy. By investigating the moderating role of diversification in the relationship between food price shocks and households' living standards, our findings can provide valuable insights for policymakers seeking to develop more targeted and effective strategies for promoting economic diversification in rural areas.

The rest of the article is organised as follows. Section 2 discusses the literature review. Section 3 presents the data. Section 4 describes the empirical framework. Section 5 presents the results, and Section 6 concludes.

2. Literature review

Several studies, both theoretical (Ravallion & Lokshin 2004; Anríquez *et al*. 2013, Malan 2013; etc.) and empirical (Bello 2019; Iqbal 2019; Adekunle *et al*. 2020; Wang & Çakir 2021, Hodjo *et al*. 2024; etc.), have investigated the effects of food price shocks on household living standards.

Theoretically, food price shocks negatively affect household living standards by causing income loss, reducing consumption, and depleting productive assets (Dercon *et al*. 2005). However, the impact of rising food prices on household living standards is transmitted through various channels (Ravallion & Lokshin 2004). First, fluctuations in food prices significantly influence food security. In this context, local commodity markets are affected, depending on household roles and geographic locations (Headey *et al*. 2012). In rural areas, this directly affects household living standards by decreasing their purchasing power and agricultural profits (Anríquez *et al*. 2013). Secondly, in rural areas, where agriculture is the primary source of income, food price shocks can also adversely affect overall living standards (Díaz-Bonilla 2016). When faced with shocks, households may sell their productive assets, such as seeds and livestock, which jeopardises their income prospects by directly depleting future production capacity and reducing the generation of farming income (Jalan & Ravallion 2002; Ravallion & Lokshin 2004; Carter & Barret 2006).

Empirically, numerous studies have examined the impact of food price shocks on the living standards of rural households. For example, using a two-stage structural demand system approach, Wang and Çakir (2021) examined the effects of increasing cereal prices, particularly teff, on living standards in Ethiopia. Analysing data from the 2013 to 2014 and 2015 to 2016 Ethiopia Socioeconomic Survey, they found that a 10% hike in teff prices diminished rural household living standards by 0.81 birr per week, with low-income groups experiencing less severe impacts due to their minimal expenditure on teff. Using the generalised method of moments to address endogeneity issues, Bello (2019) revealed that 62.5% of the major disruptions affecting the vulnerability of rural households in Niger stem from rising food prices. Based on similar data, Hodjo *et al*. (2024) used a linear approximation of the almost ideal demand system (LA-AIDS) model to show that rising millet prices lower rural living standards, while higher sorghum prices mainly decrease urban living standards. In Senegal, Sossou and Igue (2019) examined the effects of rising rice prices on household real income and poverty using data from the second poverty monitoring survey. In their methodological approach, they simulated production and consumption price shocks to identify the response of the household demand function. They found that higher international rice prices adversely affect household real income and exacerbate poverty. Iqbal (2019) studied the impact of rice price fluctuations on the well-being and poverty of rural households in Bangladesh. He used compensating variation to estimate well-being effects and descriptive statistical analysis to study the impact on poverty. The findings indicate that a significant increase in rice prices reduces the standard of living of households and increases the poverty rate in the rural areas of Bangladesh. Adekunle *et al*. (2020) applied a similar method to Nigerian households between 2010 and 2016, revealing that 79.0% of agricultural households saw a

decrease in their well-being by spending more on food, while 21.0% experienced an improvement by selling food products. Based on three waves of household surveys in Nigeria between 2010 and 2016, Adeyonu *et al*. (2021) evaluated the response of food demand to rising food prices. The study utilised the quadratic almost ideal demand system to calculate price elasticities and expenditure, revealing that higher prices reduced demand for most foods by 70.1% of households, leading to an average 7.52% yearly budget loss. In a recent study, Yovo and Gnedeka (2023) combined a Forster-Greer-Thorbecke estimation with logistic regression to show that food price shocks deteriorate household food security in Togo. Through logistic regression analysis, Hassen and Yimam (2025) also show that food price volatility negatively affects food consumption, increasing the likelihood of food insecurity by 94% for every 0.0085 USD increase in average food prices.

On the other hand, a second strand of empirical literature highlights a positive link between food price shocks and rural household living standards. For instance, Ogundari (2018) finds, based on Nigerian data, that in the long term, maize supply reacts significantly and positively to maize and yam prices, rainfall and fertiliser use, but negatively to cassava prices. Using a cointegration approach, Sehar *et al*. (2019) found that producers in India's Jammu region typically increased their cultivated area and production based on the previous year's prices. Asif and Ahmed (2024) combined the LA-AIDS (linear approximate of almost ideal demand system) model with a comparative static analysis to study the impact of wheat price shocks on the economic well-being of agricultural households in Pakistan. They found that farming incomes rose with increasing wheat prices, which also created an indirect ripple effect by increasing demand for locally produced staple goods. Employing the impulse response functions of a VAR model with quarterly Togolese data from 1991 to 2017, Dandonougbo and Agbodji (2020) found that price shocks significantly and positively affect cereal availability. Using data from Benin, Kinkpe *et al*. (2023) showed that increasing global food prices boost local production, but negatively impact living standards. In a similar vein, Ali (2022) used the quadratic almost ideal demand system of six food groups to model the money costs of food price inflation on household welfare in Southwest Ethiopia. He found that welfare losses due to higher food prices affected urban households more heavily than their rural counterparts.

Despite this abundant literature, empirical evidence yields mixed results due to methodological differences, different well-being indicators, or the specificity of the study area. Furthermore, the aforementioned studies often overlook the role of income source diversification. Rural households adopt various resilience strategies to maintain their living standards amidst food price shocks. These commonly involve reducing food consumption, borrowing food (Avalos 2016; McCordic & Frayne 2017; etc.), and engaging in non-farm diversification (Chuang 2019; Khan & Morrissey 2023; Wang *et al*. 2024). The literature identifies various non-farm activities, including self and wage employment (e.g., trade and crafts), selling assets (e.g., livestock, seeds, and household items), and family member migration (Gebre *et al*. 2023; Rana & Qaim 2024; etc.). While non-farm diversification has been shown to positively affect household living standards (Jin *et al*. 2021; Lin & Zhao 2021; Neglo *et al*. 2021; Gebre *et al*. 2023; Salifu *et al*. 2024; etc.), very few studies have examined the role of non-farm diversification as a strategy for coping with food price shocks in sub-Saharan Africa (Bello 2019; Musungu *et al*. 2024; Wang *et al*. 2024). For example, Bello (2019) analysed the effect of income diversification on food price shocks in Niger, using the generalised method of moments to address the endogeneity of income. His findings show that households with varied income streams are more resilient to food price shocks. Wang *et al*. (2024) studied 300 small-scale aquaculture producers in Myanmar, using structural equation modelling to explore how diversification practices during the Covid-19 pandemic affected livelihood stabilisation. They found that integrating diversification into these production systems increased income and improved food availability. Using a sample of 400 farm households from southern Ethiopia, Tesfaye and Nayak (2022) examined the impact of non-farm activities on food security. By combining the endogenous switching regression

model with binary propensity score matching and inverse-probability weighting, they found that participants in non-farm work were more food secure than their non-participating counterparts. By exploiting spatiotemporal variations in drought exposure across three waves of panel data, Musungu *et al*. (2024) demonstrated that Ethiopian households respond to both short-term and persistent droughts by increasing off-farm self-employment and reducing on-farm work, all while maintaining family farming. Akosikumah *et al*. (2025) and Wirba *et al*. (2025) found similar results in Ghana and Cameroon, respectively.

To date, no study in Senegal has directly examined the effect of food price shocks on rural household living standards, or the mitigating role of non-farm diversification strategies. Although existing research has touched on related components, it lacks a unified framework to link these elements (Van Hoyweghen *et al*. 2020; Diallo *et al*. 2023). This study fills thus critical gap by investigating the impact of food price shocks on rural household living standards, specifically examining the moderating role of non-farm income diversification strategies.

3. Data

In this study, we use data collected in 2014 from a rural household survey (*Enquête Rurale sur l'Agriculture, la Sécurité Alimentaire et la Nutrition*, ERASAN). The survey was conducted in Senegal by three government bodies: the Executive Secretariat of the National Food Security Council (SE/CNSA), the Directorate of Agricultural Analysis, Forecasting, and Statistics (DAPSA), and the National Agency of Civil Aviation and Meteorology (ANACIM). ERASAN employed a detailed questionnaire to gather information on rural agricultural activities and the state of food security and nutrition among rural households. Special attention was given to the food price shocks experienced by rural households, and the strategies adopted to mitigate their adverse effects. Data collection was conducted through a three-stage stratified sampling method that included 861 census districts and 42 departments, resulting in a survey of 5 270 rural farm households (République du Sénégal 2015).

4. Empirical framework

Building on the work of Tesfaye and Nayak (2022) and Diallo *et al*. (2023), our study estimates the effect of rising food prices on the standard of living of farming households and the moderating role of non-farm activities, using the following specification:

$$W_i = \alpha_0 + \alpha_1 . Price_i + \alpha_2 . div_i + \alpha_3 . Price_i * div_i + \alpha_4 . X_i + \varepsilon_i \quad (1)$$

W_i represents the living of living standard of farming household i. This study uses annual income to measure the standard of living. We use the logarithm of income as the dependent variable to reduce the influence of extreme values. $Price_i$ is a binary variable that takes the value 1 if household i experienced an increase in food prices in the six months preceding the survey, and 0 otherwise. div_i is the moderating variable. This is a binary variable taking the value 1 if household i has diversified into non-farming activities to cope with food shocks occurring in the 30 days prior to the survey, and 0 otherwise. X_i is a vector of control variables included in the model to better isolate the effect of food price shocks on the standard of living. These include the gender and age of the household head, household size, the number of children aged six to 58 months in the household, the number of women and men active in farming activities, access to tractor services, and income quintiles. Income quintiles are generated by ranking all households in the survey from the lowest to the highest annual income, then dividing them into five equal groups, each representing 20% of the total households. ε_i represents the error term.

First, we estimated Equation (1) using the ordinary least squares method. Food price shocks were determined exogenously, meaning that the estimation of the impact of rising food prices on the living standards of farming households does not suffer from any endogeneity bias (Dell *et al*. 2014; Barua & Banerjee 2020). However, endogeneity can arise from non-farm diversification, as households may self-select and choose to diversify into non-farm activities. For example, wealthy households might be more inclined to diversify their activities to cope with food price fluctuations than poorer households. To control for this potential bias, we employed the instrumental variable approach, using the regional share of households adopting non-farm diversification strategies as the instrument for non-farm diversification ($divreg$). We assumed that the higher the level of non-farm diversification in the region, the higher it is at the household level as well. This instrument could therefore be correlated with the household's participation in non-farm activities, without directly influencing its standard of living. Due to the specification of our econometric model, we also used the vector product of $Price$ and $divreg$ ($inter\_iv$) as an instrumental variable for the interaction between food price shocks and non-agricultural diversification ($Price * div$). We follow Di Falco *et al*. (2011) to empirically test the validity of our selected instruments. If valid, the instruments should have a significant effect on diversification without influencing the standard of living of non-diversifying farm households. The first test involved running a logit model for diversification with the instruments and other variables. The second was a falsification test, which checks if the instruments played an important role in household living standards. As noted by Di Falco *et al*. (2011), this test indirectly assesses whether the instruments are correlated with unobservable factors.

5. Results

5.1 Descriptive results

Rural communities often face various shocks that can disrupt their livelihoods and well-being. These shocks may arise from economic, climate, or social factors, requiring households to adapt and develop resilience. Table 1 provides information on the incidence of shocks experienced by the rural households in the six months preceding the survey. The results show that insufficient rainfall (84.3%) and the rise in food prices (70.8%) are the shocks that affected these households the most. Following these are the increase in agricultural input prices (68.4%) and the decrease in prices of household-sold products (51.5%). Also, nearly all (96.9%) rural households experienced at least one shock in the six months preceding the survey. These results highlight the vulnerability of rural households to shocks, and the importance of implementing effective adaptation strategies.

Table1: Incidence of shocks in rural areas

Variables	Obs	Mean	Std. dev.	Min	Max
Invasion of insect pests or granivorous birds	5 270	0.455	0.4980	0	1
Plant diseases	5 270	0.401	0.4901	0	1
Flood	5 270	0.060	0.2388	0	1
Bush fires	5 270	0.035	0.1854	0	1
Insufficient rainfall	5 270	0.843	0.3634	0	1
Out-of-season rainfall	5 270	0.094	0.2922	0	1
Rising input prices	5 270	0.684	0.4647	0	1
Rising food prices	5 270	0.708	0.4543	0	1
Decreasing household-sold product prices	5 270	0.515	0.4997	0	1
Sickness/accident of a household member	5 270	0.437	0.4961	0	1
Other shocks	5 270	0.628	0.4833	0	1
No shock	5 270	0.030	0.1715	0	1

Source: Authors' calculations

Table 2 outlines the characteristics of rural farm households based on key variables used in the econometric model. The household heads were, on average, 55 years old, and approximately 5% of households were headed by women. The average household size was 12 members, with each household having about two children aged between six and 58 months. On average, households had an equal number of men and women actively involved in farming activities, emphasising the important role of women in farming. Only 7.3% of households had access to a tractor, indicating a low level of farming mechanisation. Furthermore, a significant portion (59.8%) of households fell within the three lowest income groups, making them particularly susceptible to fluctuations in food prices.

Table 2: Characteristics of rural farm households

Variable	Obs	Mean	Std. dev.	Min	Max
Level of standard of living	3 555	12.705	2.0127	0	20.5013
Male	3 735	0.955	0.2055	0	1
Age	3 735	54.684	14.7215	21	91
Household size	3 735	12.124	3.8018	1	16
Number of children aged six to 58 months	3 735	2.232	2.1514	0	24
Number of male famers	3 735	3.485	1.8822	0	6
Number of female farmers	3 735	2.830	1.9378	0	6
Access to tractor	3 735	0.071	0.2581	0	1
Quintile 1	3 735	0.210	0.4074	0	1
Quintile 2	3 735	0.196	0.3972	0	1
Quintile 3	3 735	0.179	0.3841	0	1
Quintile 4	3 735	0.219	0.4136	0	1
Quintile 5	3 735	0.194	0.3959	0	1

Source: Authors' calculations. The sample consists of only rural households facing rising food prices.

Table 3 presents the various coping strategies households adopted in response to food price shocks during the 30 days prior to the survey. The results show that 77.1% of rural households chose to buy food on credit and 72% diversified into non-farm activities to cope with rising food prices. These two coping strategies were those adopted the most by households in response to food price shocks, regardless of their income level. However, a significant number of households also opted to reduce health (52.7%) or agricultural expenses (58.7%), as well as decrease cultivated areas (48.7%) and increase animal sales (48.9%) to manage the rising food prices.

While the overall prevalence of strategies like buying food on credit and non-farm diversification appears widespread across all income levels, a closer look at the quintile-specific data in Table 3 reveals nuanced differences in adaptation patterns. For instance, buying food on credit is more prevalent among the poorest households (Quintile 1: 76.8%) compared to the wealthiest (Quintile 5: 75.2%), although the difference is not substantial. Similarly, investing in non-farming activities shows a slightly higher adoption rate among wealthier quintiles, reaching 75.1% in Quintile 4 compared to 70.1% in Quintile 1. In contrast, some of the more distress-driven coping mechanisms show clear disparities. Strategies like reducing healthcare expenses (Quintile 1: 51.5% vs. Quintile 5: 46.5%) and selling or consuming seeds (Quintile 1: 53.1% vs. Quintile 5: 37.0%) are notably more common among poorer households. Similarly, withdrawing children from school is significantly more prevalent in the lowest income quintile (21.8%) compared to the highest (8.4%), indicating a more severe impact on human capital for the poorest. This suggests that, while broad strategies are common, the poorest households resort more frequently to potentially detrimental strategies to manage food price shocks, highlighting their higher vulnerability.

Table 3: Adaptation strategies adopted by rural farm households

	(Quintile 1)	(Quintile 2)	(Quintile 3)	(Quintile 4)	(Quintile 5)	(Overall)
Variable	**Mean/(SE)**	**Mean/(SE)**	**Mean/(SE)**	**Mean/(SE)**	**Mean/(SE)**	**Mean/(SE)**
Reducing cultivated areas	0.496 (0.018)	0.528 (0.018)	0.500 (0.019)	0.445 (0.017)	0.473 (0.019)	0.487 (0.499)
Participating in a tontine in kind (cereal contribution)	0.237 (0.015)	0.179 (0.014)	0.156 (0.014)	0.128 (0.012)	0.143 (0.013)	0.168 (0.374)
Buying food on credit	0.768 (0.015)	0.819 (0.014)	0.756 (0.017)	0.763 (0.015)	0.752 (0.016)	0.771 (0.419)
Reducing healthcare expenses	0.515 (0.018)	0.623 (0.018)	0.537 (0.019)	0.502 (0.017)	0.465 (0.019)	0.527 (0.499)
Reducing agricultural expenses	0.610 (0.017)	0.655 (0.018)	0.571 (0.019)	0.548 (0.017)	0.556 (0.018)	0.587 (0.492)
Increasing firewood sale	0.308 (0.016)	0.244 (0.016)	0.162 (0.014)	0.141 (0.012)	0.153 (0.013)	0.202 (0.401)
Selling household goods/jewellery/clothes	0.241 (0.015)	0.181 (0.014)	0.164 (0.014)	0.148 (0.012)	0.142 (0.013)	0.175 (0.380)
Selling or consuming seeds	0.531 (0.018)	0.450 (0.018)	0.423 (0.019)	0.405 (0.017)	0.370 (0.018)	0.436 (0.496)
Selling more livestock than usual	0.499 (0.018)	0.501 (0.018)	0.501 (0.019)	0.469 (0.017)	0.481 (0.019)	0.489 (0.499)
Selling productive assets other than seeds	0.205 (0.014)	0.192 (0.015)	0.186 (0.015)	0.198 (0.014)	0.175 (0.014)	0.191 (0.393)
Selling productive female livestock	0.344 (0.017)	0.258 (0.016)	0.320 (0.018)	0.297 (0.016)	0.369 (0.018)	0.317 (0.465)
Withdrawing children from school	0.218 (0.015)	0.156 (0.013)	0.091 (0.011)	0.078 (0.009)	0.084 (0.010)	0.126 (0.332)
Sending household members on migration	0.442 (0.018)	0.385 (0.018)	0.362 (0.019)	0.390 (0.017)	0.396 (0.018)	0.395 (0.489)
Exchanging clothes/jewellery for food	0.229 (0.015)	0.181 (0.014)	0.137 (0.013)	0.122 (0.011)	0.110 (0.012)	0.156 (0.363)
Investing in non-farming activities	0.701 (0.016)	0.727 (0.016)	0.737 (0.017)	0.751 (0.015)	0.688 (0.017)	0.720 (0.448)
Direct or disguised begging	0.144 (0.013)	0.080 (0.010)	0.037 (0.007)	0.033 (0.006)	0.033 (0.007)	0.066 (0.249)

Source: Authors' calculations

5.2 Econometric results

Table 4 presents the OLS results for the full sample and by gender of household head. The results indicate that food price shocks have a significantly negative effect on the living standards of farming households, resulting in a 62% decrease in income among the households (column 1). Female-headed households are especially vulnerable, suffering a 112.5% reduction in income (column 7), whereas male-headed households face a 58.2% decrease (column 4). This underscores the severe impact of food price fluctuations on rural farm households, with female-headed households bearing the brunt of the shocks.

Columns 2, 5 and 8 indicate that food price shocks consistently have a negative and significant effect on the living standards of farm households. However, non-farm diversification has a positive effect, although not statistically significant, on living standards (columns 2, 5 and 8). The results also show that the interaction coefficient between food price shocks and non-farm diversification is positive and significant for all households in the sample (column 3), as well as for female-headed households (column 9), but it is not significant for male-headed households (column 6). This finding suggests that non-farm diversification can enhance the living standards of farm households and mitigate the negative effect of rising food prices on their living conditions. However, this moderating effect is only observed among female-headed households, indicating that non-farm diversification can play a crucial role in the economic empowerment of rural women, and in reducing gender inequalities in rural areas.

Table 4: OLS results – Effects of food price shocks on rural household living standards and the moderating role of non-farm activities

	Full sample			Male			Female		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Food price shocks	-0.620***	-0.612***	-0.879***	-0.582***	-0.576***	-0.805***	-1.125**	-1.012**	-1.735**
Non-farm activities		0.0615	-0.195		0.0540	-0.168		0.241	-0.403
Shocks♯ Non-farm activities			0.372*			0.319			1.031*
Sex	-0.062	-0.064	-0.068						
Age	0.003	0.003	0.003	0.003	0.003	0.003	0.005	-0.001	-0.001
Age square	-0.00002	-0.00002	-0.00002	-0.00002	-0.00002	-0.00002	-0.00008	-0.00002	-0.00002
Household size	-0.00009	-0.0003	-0.0002	0.00008	-0.0002	-0.00008	0.007	0.009	0.007
Number of children	-0.020**	-0.020**	-0.020**	-0.022**	-0.021**	-0.022**	-0.001	-0.003	-0.003
Number of male farmers	0.014	0.014	0.014	0.017	0.017	0.017	-0.028	-0.039	-0.033
Number of female farmers	-0.009	-0.009	-0.009	-0.008	-0.009	-0.009	-0.060	-0.060	-0.053
Tractor access	-0.071	-0.065	-0.063	-0.070	-0.065	-0.063	-0.250	-0.220	-0.192
Quintile 2	2.869***	2.867***	2.866***	2.917***	2.915***	2.915***	2.334***	2.334***	2.308***
Quintile 3	3.655***	3.653***	3.649***	3.693***	3.692***	3.688***	3.284***	3.228***	3.235***
Quintile 4	4.196***	4.192***	4.190***	4.233***	4.229***	4.228***	3.823***	3.759***	3.753***
Quintile 5	5.043***	5.042***	5.040***	5.082***	5.082***	5.080***	4.479***	4.462***	4.490***
cons	9.840***	9.794***	9.977***	9.717***	9.675***	9.830***	10.70***	10.66***	11.12***
N	5 020	5 020	5 020	4 768	4 768	4 768	252	252	252
R^2	0.676	0.676	0.676	0.673	0.674	0.674	0.726	0.729	0.732
pseudo R^2									

Note: * = p < 0.1, ** = p < 0.05, *** = p < 0.01

As discussed earlier, the decision to diversify into non-farm activities can be influenced by unobservable factors that may also be correlated with household living standards. To address this potential endogeneity bias, we used the two-stage least squares method. The results are presented in Table 5. The first-stage regression results show that the coefficients of the two instrumental variables are positive and statistically significant at the 1% level for all households in the sample (columns 1 and 2), as well as for male-headed households (columns 4 and 5) and female-headed households (columns 7 and 8), suggesting a strong correlation with the endogenous variables. Before discussing the second-stage estimation results, we first assessed the validity of our instruments using tests proposed by Di Falco *et al*. (2011). Table A in the appendix provides strong evidence for the validity of the instruments. In fact, we find that the instruments jointly and significantly influence the decision to diversify into non-farm activities for all households (including those headed by men and women), but do not jointly and significantly affect the living standards of households that choose not to diversify.

The results of the second stage indicate that food price shocks lead to a substantial decrease in household income: 94.1% for the overall sample, 84.7% for male-headed households, and 302.9% for female-headed households. This suggests that the OLS method underestimates the effects of rising food prices on household living standards. However, the coefficient associated with diversification remains statistically insignificant after correcting for endogeneity, regardless of the sample considered, which aligns with the OLS results. The results also show that the interaction coefficient between food price shocks and non-farm diversification is positive and significant only for the entire sample of households (column 3) and for female-headed households (column 9). This indicates that non-farm diversification can enhance the living standards of farm households and mitigate the negative effect of rising food prices on their livelihoods. The results also suggest that non-farm diversification can play a crucial role in the economic empowerment of rural women and in reducing gender inequalities in rural areas.

The negative effect of food price shocks on household living standards in rural Senegal stems from several underlying factors. Primarily, rural households are often net food buyers. As a food import-dependent country, Senegal imports almost 70% of its food needs (Bousso & Bumpas 2024), a reliance that translates directly into higher domestic food prices (Resnick 2014; OECD 2022). Furthermore, the prevalence of low-productivity farming (Seck 2016) in rural Senegal, coupled with limited access to tractors (see Table 2), indicates that many farmers operate at a subsistence or semi-subsistence level. This limits their ability to generate significant surpluses for sale, rendering them more vulnerable as consumers. The fact that 74.6% of the poor live in rural areas (ANSD 2024) also suggests limited savings, assets or access to formal credit. This lack of financial buffers means that any increase in essential expenditures like food prices immediately translates into a sharp drop in disposable income and overall living standards. Overall, the negative effect of food price shocks underscores the vulnerability of the households to market volatility, a finding broadly consistent with numerous previous studies. For instance, Iqbal (2019) similarly demonstrated in Bangladesh how higher international rice prices significantly affected household real income and exacerbated poverty. Kinkpe *et al*. (2023), drawing on data from Benin, also observed that increasing global food prices adversely affected living standards. The larger decrease in living standards among female-headed households is also particularly noteworthy, potentially resulting from several factors. In fact, women usually face greater challenges accessing productive resources such as land, credit and extension services, thereby limiting both their agricultural output and their capacity to diversify into higher-return non-farm activities (Doss *et al*. 2018; Diallo *et al*. 2023).

We also found that non-farm diversification, as a moderating factor, significantly mitigates the negative effects of food price shocks. The primary reason for this is that non-farm activities provide

alternative sources of income, thereby reducing reliance on agriculture (Davis *et al*. 2017; Alobo Loison 2019). Our finding strongly aligns with Bello (2019), who found that income diversification increased resilience to food price shocks in Niger. It also supports Tesfaye and Nayak (2022), who showed that participation in non-farm work improved food security in Ethiopia. Wang *et al*. (2024) also found that diversification practices affected livelihood stabilisation and increased income and food availability for aquaculture producers during the Covid-19 pandemic. More broadly, our finding is in line with Musungu *et al*. (2024), who found that Ethiopian households increase off-farm self-employment in response to droughts.

A critical finding is that the moderating effect of non-farm diversification is statistically significant only for female-headed households. This is consistent with Diallo *et al*. (2023), who show that non-farm diversification benefits female-headed households more than male-headed households. Given that female-headed households tend to be poorer (Quisumbing *et al*. 2001; Doss *et al*. 2018), even modest non-farm income can represent a significant improvement or buffer (Banerjee & Duflo 2011). Overall, this finding supports calls for targeted economic empowerment interventions for women. Because female-headed households often face greater constraints in accessing agricultural inputs, non-farm opportunities can offer a more accessible and impactful path to income stabilisation and resilience.

6. Conclusion

This study has examined the effect of rising food prices on the living standards of rural households and the moderating role of non-farm diversification. The descriptive statistics reveal that 70.8% of rural farm households are affected by food price shocks and, among them, 72% have shifted towards non-farm activities to cope. The econometric results show that food price shocks have a negative effect on household living standards and that adopting non-farm diversification as an adaptation strategy could mitigate this adverse effect. However, the moderating role of non-farm diversification is only observed for female-headed households. These findings remain valid even after correcting for endogeneity.

The policy implications are numerous. Firstly, it is crucial to promote non-farm diversification as a strategy to reduce rural households' vulnerability to food price shocks. Secondly, specific measures should be taken to support female household heads in accessing non-farm diversification opportunities to help mitigate the adverse effect of food price shocks. This involves providing tailored vocational training in relevant non-farm sectors, facilitating access to microfinance and small loans, and establishing robust market linkages for their products and services. Crucially, efforts must also address and dismantle gender-specific barriers that limit women's access to resources like land and credit, alongside improving their access to vital information and technology.

Table 5: Results of the two-stage least squares approach – Effects of food price shocks on rural household living standards and the moderating role of non-farm activities

	Full sample			Male			Female		
	1st stage		2nd stage	1st stage		2nd stage	1st stage		2nd stage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Non-farm activities	Shock♯ Non-farm activities	Living standards	Non-farm activities	Shock♯ Non-farm activities	Living standards	Non-farm activities	Shock♯ Non-farm activities	Living standards
Food price shocks	-0.235**	0.697***	-0.941***	-0.180	0.697***	-0.847***	-1.186**	0.683***	-3.029*
Non-farm activities			-0.283			-0.224			-1.807
Shocks♯ Non-farm activities			0.372*			0.320			1.196**
Instrument 1	2.340***	-0.641***		2.368***	-0.651***		2.370***	-0.517***	
Instrument 2		0.987***			0.992***			0.896***	
Age	-0.003	-0.0002	0.0041	-0.005	-0.0003	0.003	0.073	0.0022	-0.016
Age square	-0.000015	0.000001	-0.00002	0.000003	0.000002	-0.00002	-0.0006*	-0.00002	0.0001
Household size	0.0110*	-0.00003	-0.0008	0.013**	-0.0002	-0.0004	-0.031	0.003	0.009
Number of children	0.003	0.001***	-0.0210**	0.003	0.001***	-0.0222**	-0.0045	-0.001	-0.006
Number of male farmers	-0.0007	-0.001*	0.015	-0.0067	-0.001*	0.0183	0.149**	-0.004	-0.052
Number of female farmers	-0.003	0.0001	-0.0106	-0.004	0.0005	-0.009	0.0033	-0.008*	-0.041
Tractor access	-0.230***	-0.016***	-0.047	-0.230***	-0.015**	-0.053	-0.199	-0.054*	-0.098
Quintile 2	0.135**	0.018***	2.858***	0.129**	0.017***	2.910***	0.058	0.038*	2.252***
Quintile 3	0.080	0.024***	3.639***	0.044	0.026***	3.682***	0.811**	0.003	3.074***
Quintile 4	0.151***	0.011***	4.176***	0.111*	0.012***	4.219***	1.045***	0.010	3.538***
Quintile 5	-0.008	0.015***	5.035***	-0.032	0.0174***	5.077***	0.410	-0.026	4.493***
cons	-0.882***	-0.058***	9.996***	-0.807***	-0.045**	9.837***	-2.648*	-0.143	12.28***
N	5 270	5 270	5 020	5 007	5 007	4 768	263	263	252
*R*2		0.917	0.676		0.919	0.674		0.876	0.736
pseudo R^2	0.051			0.051			0.140		

Note: * = p < 0.1, ** = p < 0.05, *** = p < 0.01

Key stakeholders in this endeavour include government ministries (e.g., women's affairs, agriculture, finance) for policy and resource allocation. Thirdly, it is necessary to implement food price stabilisation policies to protect the living standards of rural households. This requires a multi-pronged approach that integrates trade policy adjustments, such as strategic import management (e.g., controlling customs duties or value- added taxes on essential food items like rice), and domestic supply-side measures, including supporting local agricultural production, improving storage, and enhancing market information systems to reduce losses and improve efficiency. Furthermore, it crucially involves targeted social protection programmes, like cash transfers or food subsidies, to directly buffer vulnerable households from price spikes, ensuring that assistance reaches those most in need. Lastly, the results highlight the need for a gender-differentiated approach in designing rural development policies to maximise their effectiveness.

Due to data limitations, this study could not account for the influence of key institutional variables, such as education, extension services and market access. These factors may also mitigate the effects of food price shocks, and their inclusion could provide further insights.

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Appendix

Table A: Tests for validity of instrumental variables

	Overall		Women		Men	
	Diversification	**Living standards**	**Diversification**	**Living standards**	**Diversification**	**Living standards**
Instrument 1	-0.73***	0.163	-0.698***	0.12	-0.735***	-0.228
Instrument 2	0.978**		0.834***		0.986***	
Wald test on information sources	X^2 = 17 312.06***	F-stat. = 0.51	X^2 = 425.73**	F-stat. = 0.02	X^2 = 17 344.08	F-stat. = 0.29
Sample size	5 270	5 270	5 270	5 270	5 270	5 270

Note: * = p < 0.1, ** = p < 0.05, *** = p < 0.01