



Determinants of agricultural commodity price volatility and livelihood vulnerability among smallholder farmers in rural Sierra Leone



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ABSTRACT

Agricultural commodity price volatility remains a critical barrier to rural livelihood resilience in Sub-Saharan Africa, yet empirical evidence examining its determinants within specific Sierra Leonean contexts remains sparse. This study investigates the drivers of price volatility and their consequent livelihood impacts among smallholder farming households in Yoni Chiefdom, Tonkolili District, Sierra Leone. Drawing on primary cross-sectional survey data collected from 202 respondents in June 2025, the study employs descriptive statistics and chi-square tests of independence to analyze the relationships between socio-demographic characteristics, price volatility determinants, and livelihood outcomes. The findings reveal that seasonal variations, transportation costs, middlemen influence, limited storage capacity, and climate change constitute the principal drivers of price instability in the study area. A substantial majority of respondents (83.2%) reported that seasonal variations exerted at least a moderate influence on agricultural prices, whilst (71.8%) characterized middlemen as highly or extremely influential in price determination. The livelihood consequences were pronounced: (72.8%) of households reported negative or very negative income impacts, and (78.7%) experienced adverse effects on their ability to meet basic needs. Chi-square analysis established statistically significant associations between occupation and the adoption of adaptive farming practices ($\chi^2 = 13.438$, $df = 4$, $p = 0.009$), as well as between occupation and exposure to market access challenges ($\chi^2 = 13.990$, $df = 4$, $p = 0.007$). Notably, (73.3%) of respondents had altered their farming practices in response to price fluctuations, with reductions in cultivated area (58.1%) and changes in crop selection (48.6%) representing the dominant adaptive strategies. These findings underscore the urgency of targeted policy interventions encompassing rural infrastructure development, storage facility provision, market information system strengthening, and institutional support for farmer collective action.

KEY WORDS: Price volatility; Smallholder farmers; Sierra Leone; Food security; Market access

1. Introduction

Agricultural commodity price volatility represents one of the most formidable challenges confronting rural livelihood systems in developing countries, particularly within Sub-Saharan Africa where

smallholder farming constitutes the primary economic activity and principal source of household income (Headey & Fan, 2010; FAO, 2023). The destabilising effects of unpredictable price fluctuations extend far beyond immediate income losses, permeating household food security, nutritional outcomes, educational attainment, and long-term asset accumulation (Ivanic & Martin, 2014; Béné *et al.*, 2021). In Sierra Leone, where approximately 60% of the economically active population is engaged in agricultural production and the sector contributes roughly 56% of national GDP, the ramifications of price instability assume particular significance for rural development and poverty reduction efforts (FAO *et al.*, 2023). Despite the centrality of agriculture to national economic performance and household welfare, empirical research examining the micro-level determinants and consequences of commodity price volatility within specific Sierra Leonean contexts remains remarkably limited.

The global food price crises of 2007–2008 and 2010–2011, followed by the supply chain disruptions precipitated by the COVID-19 pandemic, have intensified scholarly and policy attention towards the structural drivers of agricultural price instability (Gilbert & Morgan, 2010; Torero, 2020; Benson *et al.*, 2022). Tadesse *et al.* (2014) identified supply shortfalls, export restrictions, biofuel demand, and speculative financial activity as primary drivers of international food price spikes, whilst Minot (2014) demonstrated that domestic price volatility in Sub-Saharan Africa frequently exceeds international market fluctuations due to weak institutional frameworks, inadequate infrastructure, and poorly integrated domestic markets. These structural deficiencies are particularly acute in Sierra Leone, where post-

conflict reconstruction, limited public investment in agricultural extension services, and fragmented market institutions have constrained the capacity of smallholder producers to navigate volatile price environments effectively.

The livelihood impacts of price volatility among smallholder farming households are multifaceted and mutually reinforcing. Dercon and Christiaensen (2011) demonstrated that exposure to price and production risk can trap households in persistent poverty by discouraging technology adoption and productive investment. When farmers cannot anticipate returns with reasonable certainty, rational risk aversion leads to suboptimal input use, reduced cultivated area, and conservative crop selection behaviours that perpetuate low productivity and income stagnation. Aker (2010) further illustrated that information asymmetries between rural producers and urban markets exacerbate these dynamics, as farmers lacking timely price information are compelled to accept unfavourable terms from intermediaries or sell at distressed prices during periods of personal financial need.

This study addresses three interconnected research questions. First, what are the principal determinants of agricultural commodity price volatility as experienced by smallholder producers in rural Sierra Leone? Second, how does price volatility affect household income, food security, and farming practices? Third, which socio-demographic and occupational characteristics mediate the relationship between price volatility exposure and livelihood outcomes? Answering these questions, this research contributes empirically grounded evidence to inform policy design and intervention programming. The Yoni Chiefdom case is particularly informative due to its representativeness of rural Sierra Leonean

agricultural systems, its evolving market linkages, and its exposure to recent agricultural development interventions.

2. Materials and Methods

2.1 Study area and context

This study was conducted in Yoni Chiefdom, Tonkolili District, Northern Province of Sierra Leone (**Fig. 1**). Tonkolili District spans approximately 7,016 square kilometres with an estimated population exceeding 530,000, the majority residing in rural settlements and depending primarily on subsistence agriculture. Yoni Chiefdom was purposively selected due to its representativeness of rural Sierra Leonean agricultural systems and its recent exposure to agricultural development interventions. The chiefdom's agricultural economy centres on rice, cassava, groundnuts, sweet potatoes, and vegetables, cultivated predominantly through rain-fed methods with limited mechanisation. Market linkages are characterised by weakly integrated rural-urban trade networks, with surplus typically sold through local periodic markets or intermediaries who transport produce to urban centres. Road infrastructure remains inadequate during the rainy season, substantially increasing transportation costs and constraining market access.

2.2 Research design and sampling

A cross-sectional survey design was adopted to collect primary data on price volatility determinants and livelihood outcomes. The study population comprised all adult household members engaged in agricultural production or marketing within Yoni Chiefdom. A multistage sampling procedure was employed. In the first

stage, five communities were selected purposively to capture geographic diversity. In the second stage, households were identified through systematic random sampling from community household lists. In the third stage, one respondent per household was selected using the Kish grid method to avoid selection bias. The final sample comprised 202 respondents, exceeding the minimum required sample size of 196 calculated using Cochran's formula at 95% confidence level and 5% margin of error. Data collection was conducted over four weeks in June 2025 by six trained enumerators fluent in Krio, Temne, and English.

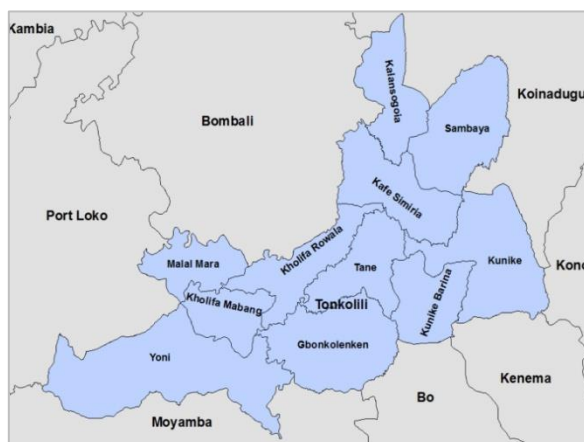


Fig. 1: Map of the study area

2.3 Data collection and analysis

A structured questionnaire was developed following an extensive review of existing instruments (Minot, 2014; Wossen *et al.*, 2021; Benson *et al.*, 2022). The questionnaire comprised five sections: (1) socio-demographic characteristics; (2) price volatility determinants including seasonal variations, transportation costs, middlemen influence, storage capacity, climate change impacts, and input cost shares; (3) livelihood impacts including income effects, basic

needs sufficiency, farming practice adaptations, and sales decision-making; (4) market access and supply chain participation; and (5) collective action and technology adoption. The instrument was pre-tested with 20 respondents and refined for clarity and cultural appropriateness. Data were entered into SPSS version 28, cleaned, and analysed using descriptive statistics and chi-square tests of independence at $\alpha = 0.05$. This study received ethical approval from Njala University research ethics committee, and all respondents provided informed consent.

3. Results

3.1 Socio-demographic characteristics of respondents

Table 1 presents the socio-demographic profile of the 202 respondents. The sample was predominantly female (73.3%, $n = 148$), with males comprising 26.2% ($n = 53$) and non-binary respondents 0.5% ($n = 1$). The age distribution was concentrated in the 31–45 years bracket (44.6%, $n = 90$), followed by 18–30 years (31.7%, $n = 64$), 46–60 years (17.3%, $n = 35$), under 18 years (5.9%, $n = 12$), and over 60 years (0.5%, $n = 1$). Educational attainment was varied: secondary education was most common (31.2%, $n = 63$), followed by no formal education (19.3%, $n = 39$), tertiary education (19.3%, $n = 39$), postgraduate qualifications (16.8%, $n = 34$), and vocational or technical training (13.4%, $n = 27$). Occupationally, business activities predominated (37.1%, $n = 75$), whilst farming constituted the primary occupation for 33.2% ($n = 67$). Unemployed respondents accounted for 15.3% ($n = 31$), formally employed persons for 12.4% ($n = 25$), and other occupations for 2.0% ($n = 4$). Housing tenure was predominantly owner-

occupied (54.5%, $n = 110$), with 29.2% ($n = 59$) renting and 16.3% ($n = 33$) in family-owned dwellings. Monthly income was concentrated in the SLL 500–1000 bracket (42.6%, $n = 86$). Infrastructure access was severely limited: 90.6% lacked electricity, 93.1% lacked piped water, and 94.6% resided in rural areas.

Table 1: Socio-demographic characteristics of respondents (N = 202)

Characteristic	Category	n	%
Gender	Female	148	73.3
Age (years)	Under 18	12	5.9
Education	No formal education	39	19.3
Occupation	Business	75	37.1
Housing	Owned	110	54.5
Monthly income (SLL)	Less than 500	41	20.3
Electricity access	No	183	90.6
Piped water access	No	188	93.1
Region	Rural	191	94.6
Household size	1–2 members	21	10.4

3.2 Determinants of agricultural commodity price volatility

Table 2 summarizes respondent perceptions of the principal factors driving price volatility in Yoni Chiefdom. Seasonal variations were identified as extremely significant by 28.7% and very significant by 26.7%, with a combined 78.2% attributing at least moderate significance to seasonal fluctuations. These patterns reflect the pronounced seasonality of rain-fed production, where harvest-period gluts and lean-season scarcities generate substantial price oscillations.

Transportation costs emerged as a major determinant, with 28.7% reporting that transport costs influence final prices by more than 30%, and

a further 25.2% estimating the influence at 15 - 30%. Middlemen influence was perceived as extremely influential by 36.1% and very influential by 28.2%, with 64.3% collectively rating middlemen as highly or extremely influential. This concentration of intermediary power reflects limited direct market linkages, asymmetric information, and the working capital advantages enjoyed by traders (Fafchamps & Gabre-Madhin, 2006).

Storage capacity was identified as important by 33.2% and critical by 24.3% of respondents, indicating that inadequate post-harvest infrastructure is widely recognised as a key contributor to price instability. Climate change impacts were predominantly associated with moderate (30.7%) or substantial (24.3%) price increases. Input costs represented less than 20% of production costs for 43.6% of respondents, 20–40% for 25.7%, and higher shares for the remainder.

Information sources for price intelligence were overwhelmingly local trader networks, with market bulletins and government reports cited minimally. Government subsidies received mixed assessments: 38.1% rated their impact as somewhat positive and 25.7% as highly positive, though 23.3% expressed negative views.

3.3 Livelihood impacts of price volatility

The livelihood consequences of agricultural price volatility were substantial and predominantly adverse. **Table 3** presents the distribution of impacts. Price fluctuations were reported as frequent or very frequent by 43.1% of respondents, occasional by 28.7%, and rare by 28.2%. Income impacts were over whelmingly negative: 38.1% characterized the effect as very negative and 34.7% as negative, yielding a combined 72.8% reporting adverse income consequences. Only 9.9% reported positive effects, whilst 17.3% perceived a neutral impact. **Fig. 2** illustrates the distribution of income impact by gender, revealing broadly similar vulnerability profiles. The non-significant chi-square association between gender and income impact ($\chi^2 = 2.554$, $df = 6$, $p = 0.862$) confirms that price volatility does not discriminate by gender; structural position within the agricultural value chain appears to be the more salient determinant of vulnerability.

The impact on ability to meet basic needs was similarly adverse, with 51.0% reporting negative effects and 27.7% very negative effects, totalling 78.7% experiencing detrimental consequences. Adaptive responses were widespread, with 73.3% reporting changed farming practices. Among adapters, the most common strategy was reducing

Table 2: Respondent perceptions of the principal factors driving price volatility

Determinant	Response Category	n	%
Seasonal variations impact	Extremely significant	58	28.7
Transportation cost influence	Major influence (>30% of price)	58	28.7
Middlemen influence	Extremely influential	73	36.1
Storage capacity importance	Critical factor	49	24.3
Climate change impact	Substantial price increases	49	24.3
Input cost share of production	<20%	88	43.6
Government subsidy impact	Highly positive	52	25.7

Table 3: Livelihood impacts of agricultural price volatility (N = 202)

Impact variable	Response category	n	%
Price fluctuation frequency	Very frequently	17	8.4
Income impact	Very negative	77	38.1
Basic needs impact	Very negatively	56	27.7
Changed farming practices	Yes	148	73.3
<i>Among those who changed (n = 148):</i>			
Reduced cultivated area	Yes	86	58.1
Changed crop types	Yes	72	48.6
Increased agricultural inputs	Yes	49	33.1
Sales decision basis	Personal financial need	99	49.0

cultivated area (58.1%), followed by changing crop types (48.6%) and increasing agricultural inputs (33.1%). These patterns suggest a conservative, risk-mitigating orientation consistent with poverty trap dynamics (Dercon & Christiaensen, 2011).

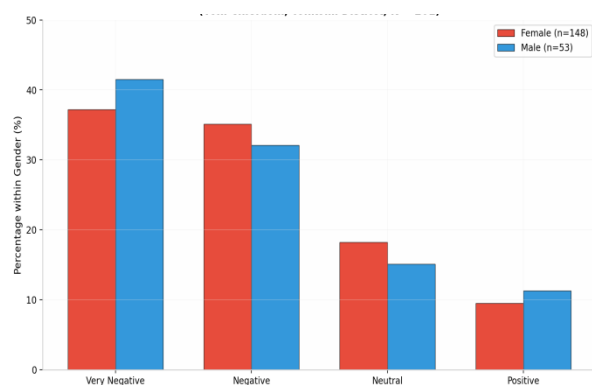
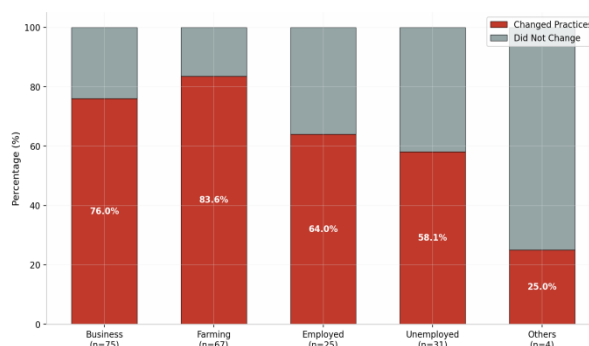
**Fig. 2:** Distribution of income impact from price volatility by gender (N = 202).

Fig. 3 displays farming adaptations by occupation, revealing notable heterogeneity. Among farming households, 83.6% reported changing practices, compared to 76.0% of business-oriented respondents, 64.0% of formally employed persons, and 58.1% of unemployed respondents.

Chi-square analysis confirmed statistical significance ($\chi^2 = 13.438$, $df = 4$, $p = 0.009$), indicating that occupational identity shapes both exposure and responsiveness to price volatility.

Sales decision-making was primarily driven by personal financial need (49.0%), followed by market price trends (36.6%) and advice from others (19.3%). The dominance of personal need over market signals reflects liquidity constraints and the absence of savings or credit mechanisms that would enable farmers to wait for favourable prices.

**Fig. 3:** Percentage of respondents who changed farming practices by occupation (N = 202, $\chi^2 = 13.438$, $p = 0.009$).

3.4 Market access, supply chain participation, and cross-tabulation results

Market access conditions are presented in **Table 4**. Overall market access was rated as good by 40.1% of respondents, fair by 19.3%, poor by 17.3%, very poor by 12.9%, and very good by 10.4%. Despite the plurality reporting good access, a substantial minority (30.2%) characterized access as poor or very poor. The majority (75.2%) reported having faced specific market access challenges. Among those encountering difficulties, lack of transportation was most commonly cited (40.6%), followed by distance to market (38.1%) and limited market information (25.7%). **Fig. 4** illustrates the distribution of market access challenges, highlighting transportation deficits as the predominant obstacle.

The influence of supply chains on income stabilisation was predominantly perceived as minimal: 53.0% reported that supply chains stabilised income only a little, 29.7% not at all, 9.9% somewhat, and 7.4% very much. **Fig. 5**

depicts the distribution of these perceptions, revealing widespread dissatisfaction with current supply chain arrangements.

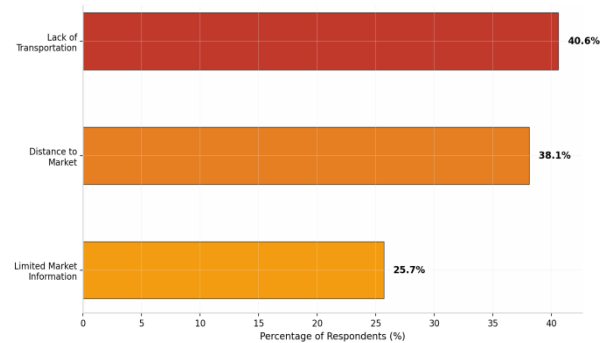


Fig. 4. Types of market access challenges faced by respondents (N = 152 who faced challenges)

Collective action was practiced by 58.9% of respondents. Among participants, knowledge sharing was most common (37.0%), followed by shared transportation (34.5%) and joint marketing (28.6%). Technology adoption for market information was modest: 25.2% used mobile price information services, 22.8% employed storage and preservation technologies, 20.8% utilized digital

Table 4: Market access and supply chain dynamics (N = 202)

Variable	Category	n	%
Market access rating	Very good	21	10.4
Faced market challenges	Yes	152	75.2
<i>Among those facing challenges (n = 152):</i>			
Lack of transportation		62	40.6
Distance to market		58	38.1
Limited market information		39	25.7
Supply chain stabilisation	Very much	15	7.4
Collaboration with other farmers	Yes	119	58.9
<i>Among those collaborating (n = 119):</i>			
Knowledge sharing		44	37.0
Shared transportation		41	34.5
Joint marketing		34	28.6
Technology adoption	Mobile price information	51	25.2

platforms, and 17.8% had adopted transport improvements.

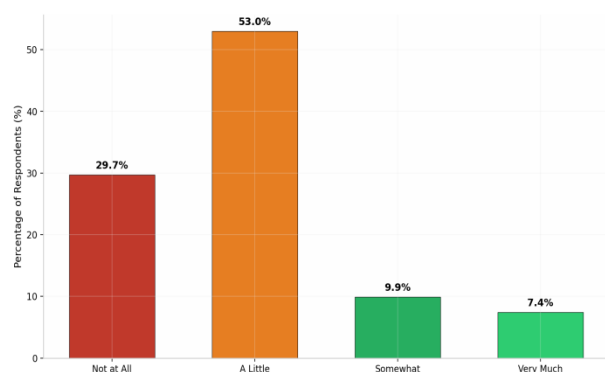


Fig. 5. Perceived influence of supply chains on income stabilisation (N = 202)

Table 5 presents the complete chi-square test results. Two associations achieved statistical significance at the 0.01 level: occupation versus changed farming practices ($\chi^2 = 13.438$, $df = 4$, $p = 0.009$) and occupation versus faced market challenges ($\chi^2 = 13.990$, $df = 4$, $p = 0.007$). The remaining five tests gender versus income impact ($\chi^2 = 2.554$, $df = 6$, $p = 0.862$), education versus income impact ($\chi^2 = 12.439$, $df = 12$, $p = 0.411$), age versus income impact ($\chi^2 = 17.537$, $df = 12$, p

$= 0.131$), gender versus changed farming practices ($\chi^2 = 0.374$, $df = 2$, $p = 0.829$), and gender versus supply chain stabilisation ($\chi^2 = 1.335$, $df = 6$, $p = 0.970$) did not approach statistical significance.

4. Discussion

The findings provide grounded insights into the determinants and livelihood consequences of agricultural commodity price volatility among smallholder producers in rural Sierra Leone, both corroborating and extending existing literature on price transmission, market structure, and rural livelihood vulnerability.

The identification of seasonal variations, transportation costs, middlemen influence, storage deficits, and climate change as principal volatility determinants aligns closely with Price Transmission Theory (Barrett, 2008) and the empirical findings of Minot (2014) and Benson *et al.* (2022). Seasonal fluctuations, reported as significant by over three-quarters of respondents, reflect the fundamental structural characteristic of rain-fed agricultural systems where production is concentrated in specific months and storage infrastructure is inadequate to smooth supply

Table 5: Chi-square test results for associations between socio-demographic variables and livelihood outcomes (N = 202)

Test	Variables	χ^2	df	p-value	Significance
1	Occupation $\times$ Changed farming practices	13.438	4	0.009	
2	Occupation $\times$ Faced market challenges	13.990	4	0.007	
3	Gender $\times$ Income impact	2.554	6	0.862	ns
4	Education $\times$ Income impact	12.439	12	0.411	ns
5	Age $\times$ Income impact	17.537	12	0.131	ns
6	Gender $\times$ Changed farming practices	0.374	2	0.829	ns
7	Gender $\times$ Supply chain stabilisation	1.335	6	0.970	ns

Note: $p < 0.01$; ns = not significant.

across the year. This finding underscores the centrality of post-harvest storage investment in any price stabilisation strategy.

The pronounced influence of transportation costs exceeding 30% of final prices for nearly 30% of respondents resonates with Aker's (2010) work on trade costs in African agricultural markets. High transport costs not only reduce farm-gate prices but also impede market integration, enabling intermediaries to extract spatial rents. The government's recent investments in rural road infrastructure have evidently not yet eliminated this structural barrier. Targeted investments in all-weather rural roads and affordable transport services could yield substantial returns in terms of price stabilisation and producer welfare.

The dominance of middlemen in price determination, with nearly two-thirds rating their influence as high or extreme, confirms Fafchamps and Gabre-Madhin's (2006) analysis of concentrated intermediary power. Middlemen perform valuable functions providing working capital, bearing transport risk, and linking producers to distant markets but their monopsonistic position enables them to capture disproportionate value, particularly during harvest gluts when farmers face urgent liquidity needs. The finding that 49.0% base sales timing on personal financial need rather than market conditions further illustrates how liquidity constraints force farmers into exploitative transactions. Institutional innovations that strengthen farmer bargaining power such as cooperative marketing and transparent price information systems could help rebalance this unequal relationship.

The predominantly negative livelihood impacts reported by over 70% of respondents are consistent with Ivanic and Martin (2014) and Béné *et al.* (2021), who documented how food price volatility erodes real incomes and exacerbates poverty. The extension of adverse effects to basic needs fulfillment reported by 78.7% highlights the severity of welfare consequences and suggests that price volatility operates as a significant determinant of multidimensional deprivation. These findings acquire additional urgency in light of FAO *et al.* (2023) observation that Sierra Leone continues to experience high rates of food insecurity and malnutrition.

The significant association between occupation and adaptive behaviour extends Dercon and Christiaensen's (2011) poverty trap framework by demonstrating that livelihood strategy fundamentally mediates adaptation capacity. Farmers' high adaptation rate (83.6%) reflects their direct control over production decisions, whilst the prevalence of area reduction as the dominant adaptive strategy suggests risk-averse behaviour that may perpetuate low productivity. This conservative adaptation pattern contrasts with the intensification strategies that agricultural development programmes typically promote, highlighting a tension between risk management and productivity enhancement. Policy design must address this tension by providing effective risk management instruments such as index-based insurance or emergency credit that enable farmers to intensify production without catastrophic exposure.

The absence of significant gender effects challenges conventional assumptions about female-headed households' disproportionate

vulnerability. Rather than invalidating gender-sensitive approaches, this suggests that in contexts of pervasive market failure and infrastructure deficit, structural factors may homogenise vulnerability across gender categories. Both male and female respondents face the same poorly integrated markets, transport constraints, and information asymmetries. Gender-sensitive interventions remain important given the female predominance in the sample, but should be complemented by structural reforms addressing the root causes of price volatility.

The modest but meaningful uptake of collective action (58.9%) and information technologies (25.2% mobile price information use) points to promising intervention pathways. Markelova *et al.* (2009) and Aker (2010) have demonstrated the potential of farmer organisations and mobile information services to improve market outcomes, and the present findings suggest these instruments are already partially adopted. Scaling up such initiatives through public-private partnerships could enhance their reach and effectiveness substantially.

5. Conclusion

This study has provided original empirical evidence on the determinants of agricultural commodity price volatility and their livelihood impacts among 202 smallholder farming households in Yoni Chiefdom, Tonkolili District, Sierra Leone. The findings demonstrate that price volatility is driven by a constellation of interrelated structural factors seasonal production patterns, high transportation costs, concentrated middlemen influence, inadequate storage infrastructure, and climate change with predominantly adverse consequences for

household income and basic needs fulfilment. Chi-square analysis confirmed that occupation significantly shapes both adaptive capacity and market challenge exposure, whilst gender, education, and age did not exhibit significant associations with livelihood outcomes.

Policy implications: Investment in post-harvest storage infrastructure including community grain banks and hermetic storage technologies should be prioritised as a direct means of reducing seasonal price volatility and enabling temporal arbitrage. Rural road infrastructure and affordable transport services require sustained public investment to reduce trade costs, improve market integration, and weaken intermediary monopoly power. Market information systems leveraging mobile telephony and digital platforms should be strengthened to reduce information asymmetries. Institutional support for farmer cooperatives and collective marketing arrangements can enhance bargaining power and capture economies of scale. Social protection instruments including emergency credit facilities and price risk insurance can buffer vulnerable households against acute price shocks and enable more productive investment decisions.

Future research should extend this analysis through longitudinal panel designs that capture dynamic adaptation processes. Investigation of specific commodity supply chains, experimental evaluation of proposed interventions, and comparative analysis across chiefdoms and districts would further strengthen the evidence base for policy design. The livelihood vulnerability documented in this study is neither inevitable nor intractable; with targeted investments and institutional reforms, Sierra Leone's smallholder farmers can be supported to

navigate price volatility and build more resilient, productive, and prosperous agricultural livelihoods.

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