

FARMERS–HERDERS CONFLICT AND RICE YIELD LOSS: QUANTITATIVE EVIDENCE FROM NORTH-EASTERN JIGAWA STATE, NIGERIA

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ABSTRACT

Farmers–herders (FH) conflict has emerged as a severe threat to rice production in northern Nigeria, yet quantitative micro-level evidence from north-eastern Jigawa State remains scarce. This study assessed the quantitative effects of FH conflict on key rice production indicators among 240 smallholder rice farmers selected through multistage sampling across twelve communities in Guri and Kirikasamma Local Government Areas. Data were analysed using descriptive statistics, percentage change analysis, paired samples t-test, and Likert-scale mean scoring. Results revealed statistically significant declines in all production indicators: total rice yield fell by 39.33% (from 8,506.92 kg to 5,160.89 kg; $t(239) = 10.20$, $p < 0.001$), yield per hectare declined by 26.02% (from 4,422.93 kg/ha to 3,271.86 kg/ha; $t(239) = 28.81$, $p < 0.001$), farm income declined by 51.38% (from ₦3,938,833 to ₦1,915,142), and planted area fell by 30.20% (from 2.12 ha to 1.48 ha). The mean reduction in total yield was 3,346.03 kg (95% CI: 2,699.71–3,992.35 kg), while yield per hectare declined by 1,151.07 kg/ha (95% CI: 1,072.36–1,229.77 kg/ha). Farmers abandoned 0.65 ha of farmland and lost 17 working days per season on average. Seventy percent reduced their planted area, 58.8% experienced rice quality decline, and over 80% incurred additional costs for crop replacement, evacuation, and security. Income loss and yield decline were rated as the most devastating impacts. The findings corroborate resource scarcity, environmental security, and economic theories of conflict. The study concludes that FH conflict operates as a systemic, multi-dimensional shock to the rice economy, significantly undermining farm productivity and rural livelihoods in north-eastern Jigawa State.

Keywords: Farmers–herders conflict; rice yield; farm income; Jigawa State; Nigeria

1.0 INTRODUCTION

In West Africa, rice is an important staple food and a major source of income for millions of smallholder farmers. However, conflicts between farmers and herders over access to land and water resources, compounded by climate change, pose significant and growing threats to the productivity of rice systems across the region. Despite numerous government efforts to boost this crucial sector in order to achieve food self-sufficiency, rice production in Nigeria has consistently failed to keep pace with demand, resulting in high levels of importation (Adewuyi and Odeh, 2024). Rising conflicts between crop farmers and pastoralist herders, especially in the South-South, North-Central, and North-Western zones, constitute one of the most significant structural constraints on Nigerian rice output, given that these regions collectively contribute a substantial share of the nation's rice production.

The farmers–herders (FH) conflict is a serious and escalating problem for agricultural communities throughout sub-Saharan Africa. Emeka et al. (2023) note that FH conflicts have existed since the 1970s Sahelian drought and continue to intensify today. Historically, herders and farmers coexisted in a broadly symbiotic relationship, where herders' cattle would fertilise farmers' land in exchange for permission to graze on crop residues (ICG, 2017; Nzeh, 2015). Over time, however, population growth, environmental degradation, climate-induced herder migration, and inadequate land-use regulations have progressively eroded this accommodation, transforming FH contact from symbiosis into violent competition (Dt et al., 2019; George et al., 2022).

FH conflict arises when nomadic herders graze their livestock on cropland owned by settled farmers, reducing yield and income. Farmers often retaliate by maiming cattle or expelling herders, prompting counter-retaliation and escalating violence (Blench, 2010; Dimelu et al., 2017; Nnaji et al., 2022). The multiplier effects include land degradation, declining food production, community conflicts, loss of lives and property, disruption of supply chains, and destruction of rice farms — all of which impose further strain on agricultural productivity (Africa Centre for Strategic Studies, 2021).

In Jigawa State, FH conflict has been most destructive in the north-eastern zone, particularly in Guri and Kirikasamma LGAs, where conflicts are typically triggered by cattle destroying standing rice crops and subsequent reprisal attacks between farmers and herders. Despite the severity of this problem, empirical data specifically quantifying its effects on rice production in this zone remain scarce, as most existing studies focused on conflict causes and resolution strategies rather than on measured production impacts (Mustapha and Usman, 2018; Garba et al., 2012).

This study therefore sought to fill this empirical gap by rigorously quantifying the impact of FH conflict on rice production indicators in north-eastern Jigawa State. The specific objectives were to:

- i. describe the socio-economic characteristics of sampled rice farmers;
- ii. quantify changes in key production indicators between pre-conflict and during-conflict periods;
- iii. assess the effect of conflict on rice quality, planted area, and production costs;
- iv. evaluate farmers' overall perception of the impact of FH conflict on their rice enterprise and household welfare.

2.0 LITERATURE REVIEW

2.1 Conceptual Issues

2.1.1 The Fulani Herdsmen

The Fulani people originated in Senegambia and subsequently spread across more than twenty countries in West Africa (Okoro, 2018). In Nigeria, many Fulani continue to live as semi-nomadic herders, moving seasonally with their cattle in search of pasture and water. Their livelihoods are inseparably tied to the welfare of their herds, making access to pasture and water resources critical to their survival and frequently placing them in competition with settled farming communities.

2.1.2 Farmers–Herders (FH) Conflict

FH conflict has been defined in various ways in the literature. Ofuoku and Isife (2010) describe conflict as a state of differences and disagreements involving mutually antagonistic impulses or resources. In the agricultural context, Okoli and Atelhe (2014) characterise FH conflict as the outcome of differences in attitudes, values, beliefs, or needs between farming and herding communities. Nnaji et al. (2023) specifically define it as disagreements and confrontations between farming communities and nomadic herders over scarce land resources. These confrontations have threatened the formerly peaceful and symbiotic coexistence that characterised farmer–herder relations in much of West Africa (Nnaji et al., 2022; Ahmed and Muhammad, 2021).

2.2 Causes of Farmers–Herders Conflicts

The causes of FH conflict in Nigeria are multifaceted. Antwi (2018) identified diminishing farmlands, lack of political will, and insufficient government measures as key contributory factors. Musa (2014) emphasised farmland and crop destruction, the influence of traditional leaders, and cattle theft. According to CDD (2021), FH conflict escalates when herders graze livestock in crop-growing areas and farmers retaliate by injuring or expelling herders, who then counter-retaliate. Abbas (2009) found that land-related problems, particularly concerning grazing areas, account for the majority of disputes, while Vanger and Nwosu (2020) highlighted insecure private property rights and communal land access arrangements as structural aggravators. Adisa (2012) observed that the seasonal mobility of pasture and water compels herders to move constantly, bringing them into contact with settled farmers. Hoffman et al. (2008) also identified government-authorised farmland expansion into gazetted grazing reserves as a contributing policy failure.

2.3 Effects of FH Conflicts on Agricultural Production

FH conflicts impose severe and multi-dimensional costs on agricultural production. Ofuoku and Isere (2010) identified four primary socioeconomic effects: decreased crop output and revenue from crop destruction; forced displacement of farmers; land degradation from overgrazing and wind erosion; and loss of lives with associated livestock losses. Ajibefun (2018) extended this to include loss of stored produce, scarcity of agricultural commodities, infrastructural damage, and social costs including loss of lives and erosion of social support networks. Dt et al. (2019) documented at the regional level that FH conflicts pose a systemic threat to food security, economic stability, and rural livelihoods across West Africa.

At the micro-level, empirical studies confirm that armed conflict adversely affects labour availability, agricultural output, and land access (Rockmore, 2015; Verpoorten, 2009; Adelaja

and George, 2019; George et al., 2021; Nnaji et al., 2023). Adewuyi and Odeh (2024) found in North-Eastern Nigeria that ongoing FH conflicts have negatively impacted food crop production, while Otuisi et al. (2023) demonstrated in the Niger Delta that FH conflict, alongside hired labour and input expenditures, is a significant determinant of food crop output.

2.4 Theoretical Framework

Three complementary theories guide this study. Resource Scarcity Theory posits that competition for scarce resources such as land and water leads to conflict. As both farmers and herders compete for the same fertile land and water in the study area, escalating scarcity driven by population growth and climate change has turned competition into open conflict that disrupts rice production. Environmental Security Theory contends that environmental degradation and resource disputes can intensify into violent conflict, and that FH conflicts contribute further to environmental degradation through overgrazing and soil erosion, cumulatively degrading rice farming conditions. Economic Theory of Conflict emphasises that individuals make rational decisions based on a cost–benefit calculus, and that economic pressures encourage farmers to shift from more profitable to less profitable, safer production activities to safeguard household consumption (Nnaji et al., 2023; Arias et al., 2019; Bozzoli and Brück, 2009; Deininger, 2003; Umar and Isah, 2020).

2.5 Empirical Studies

Several empirical studies have examined the effects of FH conflicts on agricultural households. Ajibefun (2018) found that crop destruction was the primary cause of Fulani herdsman-related violence in Nigeria, with economic effects including decreased output, farmer displacement, and infrastructural damage. Tukur (2013) identified crop destruction, cattle contamination of streams, and indiscriminate bush burning as major conflict causes. Awotokun et al. (2020) found that FH conflicts have severely harmed Nigeria's economy through the loss of human lives and resources, and that government has lacked a clear plan of action to contain the conflicts. Adewuyi and Odeh (2024) established a negative impact of ongoing FH conflicts on food crop production in North-Eastern Nigeria. Adetunji and Ukhurebor (2020) found that herdsman's activities led to mass displacement of farmers and deterioration of agricultural soil. Otuisi et al. (2023) in the Niger Delta documented a positive relationship between hired labour, seed and fertiliser expenditures, farming experience, and food crop output, implying that the disruption of these inputs by conflict would suppress production outcomes.

3.0 METHODOLOGY

3.1 Study Area

The study was conducted in north-eastern Jigawa State (JARDA Zone 3), comprising eight LGAs: Auyo, Birniwa, Guri, Hadejia, Kafinhausu, Kaugama, Kirikasamma, and Malam Madori. Jigawa State lies between Latitudes 11.00°N–13.00°N and Longitudes 8.00°E–10.15°E, covering approximately 22,410 km², with a state-wide projected population of 7,499,059 (2022). The north-eastern zone had a population of approximately 1,246,926 (2006 census; NPC, 2006). The zone experiences a tropical climate with rainfall of 600–1,000 mm annually (May–September) and temperatures of 15°C–35°C (Jigawa State Government, 2024). Abundant fadama land and the Hadejia Valley Irrigation Scheme (HVIS), administered by HJRBD under the World Bank-financed TRIMING project, support rice production as the principal commercial crop of the zone. The north-eastern zone —

particularly Guri and Kirikasamma LGAs — has been identified as the epicentre of FH conflict in Jigawa State.

3.2 Sampling Procedure and Sample Size

A multistage sampling procedure was adopted. In the first stage, Guri and Kirikasamma LGAs were purposively selected as the most conflict-affected and rice-productive LGAs in the zone. In the second stage, six communities were randomly selected from each LGA (twelve communities in total): Adiyani, Guri Town, Musari, Lafiya, Gagiya, and Madamuwa in Guri LGA; and Baturiya, Marma, Likori, Kubayau, Gishinawo, and Sunkuye in Kirikasamma LGA. In the third stage, 20 rice farmers were selected from each community using simple random sampling from registered farmer lists, yielding a total sample of 240 respondents.

3.3 Data Collection

Primary data were collected between January and March 2026 through structured face-to-face interviews using a validated questionnaire (Instrument A: Rice Farmers), translated into Hausa for field administration. The instrument covered socio-economic characteristics; before-and-during conflict estimates of production indicators; perceived effects on quality, planted area, and additional costs; and an eight-item Likert-scale rating of the overall impact of FH conflict.

3.4 Method of Data Analysis

Data were analysed using SPSS version 26.0 (IBM Corp., 2019) and Microsoft Excel 2019. Four analytical tools were applied:

- i. **Descriptive Statistics:** Means ($\bar{x}$), standard deviations (SD), frequency counts, and percentage distributions were used to profile respondents and summarise production indicator values.
- ii. **Percentage Change:** Computed as:

$$\%Change = \frac{\text{During Conflict} - \text{Before Conflict}}{\text{Before Conflict}} \times 100 \dots\dots\dots (1)$$

It was used to quantify the proportional conflict-induced decline in each indicator.

- iii. **Paired Samples t-Test:** Used to test the statistical significance of before-versus-during differences at $\alpha = 0.05$ ($df = 239$). H_0 : no significant difference between pre-conflict and during-conflict means.

iv. **Likert-Scale Analysis:** The eight-item overall impact scale (1 = No Impact; 5 = Devastating) was analysed using mean scores and ranked. Decision rule: mean ≥ 3.0 = severe impact (Otuisi et al., 2023; Ajibefun, 2018).

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Rice Farmers

A total of 240 rice farmers participated in this study. The socio-economic characteristics of respondents are presented in Tables 1 and 2.

The results showed that respondents were predominantly female (82.5%) and married (68.3%), with a mean age of 36 years ($SD = 10.18$). The predominance of female respondents is noteworthy, as it diverges sharply from what is typically observed in rural farming surveys in northern Nigeria, where married male household heads generally dominate (*Hassan et al.*, 2020). This gender distribution is attributed in this study to the lethal toll that recurring FH conflict has exacted on the male productive-age population, resulting in many households being headed by widows (12.5%) or women whose husbands have been displaced, incapacitated, or killed. This is directly consistent with findings by *Ofuoku and Isere (2010)* that conflict causes displacement and withdrawal of farmers, particularly women, from the farming system, and that female farmers in conflict-affected communities often become de facto household heads responsible for farm management.

The age distribution reveals that the majority of respondents (59.2%) were within the economically active age bracket of 30–49 years, while only 2.5% were below 20 years and 2.5% were 60 years and above. The mean age of 36 years indicates a relatively young farming population, which is advantageous for agricultural productivity, as younger farmers tend to be more receptive to innovation and have greater physical capacity for farm labour (*Adelaja and George, 2019*). However, the presence of widows (12.5%) and divorced/separated individuals (4.2%) within this age cohort reflects the social disruption caused by persistent conflict.

The marital status distribution showed that 68.3% of respondents were married, 15.0% were single, 12.5% were widowed, and 4.2% were divorced or separated. The relatively high proportion of widowed respondents (12.5%) is particularly significant and aligns with the findings of *Awotokun et al. (2020)*, who documented that FH conflicts have resulted in significant loss of lives among productive-age males in farming communities. The high marriage rate (68.3%) suggests that household labour availability may still be substantial, though the widowhood rate indicates that many households are coping with the loss of primary income earners.

The mean household size was 9.0 persons ($SD = 7.23$), which is relatively large compared to the national average and reflects the extended family structure common in rural northern Nigeria. This large household size may serve as a coping mechanism against labour shortages caused by conflict-related displacement and death, as households with more members can pool labour for farm operations. However, it also implies greater pressure on household resources, particularly when farm income has declined by 51.38% as documented in this study.

Regarding educational attainment, the results showed considerable variation: 35.0% had secondary education, 18.8% had HND/B.Sc., 16.3% had NCE/ND, 12.5% had no formal education, 12.5% had Quranic/Islamic education only, and 10.0% had primary education. The relatively high proportion of respondents with secondary and tertiary education (70.1% combined) is encouraging, as education enhances farmers' capacity to adopt improved technologies, access information, and diversify income sources (*Nnaji et al.*, 2023). However, the 12.5% with no formal education and another 12.5% with only Quranic education indicate that a quarter of the farming population remains educationally disadvantaged, potentially limiting their ability to access formal credit, extension services, and other institutional support.

The mean rice farming experience of respondents was 15 years (SD = 11.09), with 38.3% having 5–10 years of experience, 24.6% having more than 20 years, and 22.1% having 11–20 years. This distribution indicates that the majority of farmers are experienced and have accumulated substantial knowledge of rice production systems, making them well-positioned to adopt improved practices. However, the high level of experience also suggests that many farmers have witnessed and survived multiple conflict episodes, which may have shaped their risk perceptions and production decisions.

The mean farm size was 2.0 ha (SD = 1.54), with the majority (50.0%) operating on 1.0–2.9 ha, followed by 20.0% with less than 1.0 ha, 20.0% with 3.0–4.9 ha, and 10.0% with 5.0 ha or more. This distribution confirms that respondents are predominantly smallholder farmers, consistent with the national agricultural structure in Nigeria (FMARD, 2019). The relatively modest farm sizes make these households particularly vulnerable to conflict-induced yield and income losses, as they have limited land reserves to absorb production shocks.

Table 1: Socio-Economic Characteristics of Rice Farmers (n = 240)

Characteristic	Category	Frequency	Percentage
Gender	Male	42	17.5
	Female	198	82.5
Age Group (years)	Below 20	6	2.5
	20 – 29	56	23.3
	30 – 39	91	37.9
	40 – 49	52	21.7
	50 – 59	29	12.1
	60 and above	6	2.5
	Mean ± SD	36.0 ± 10.18	
Marital Status	Single	36	15.0
	Divorced/Separated	10	4.2
	Widowed	30	12.5
	Married	164	68.3
Household Size	Single	36	15.0
	Divorced/Separated	10	4.2
	Widowed	30	12.5
	Married	164	68.3
	Mean ± SD	9 ± 7.23	
Educational Level	No formal education	30	12.5
	Primary school	24	10.0
	Secondary school	84	35.0
	NCE/ND	39	16.3
	HND/B.Sc.	45	18.8
	Postgraduate	18	7.5
	Quranic/Islamic education only	30	12.5
Farming Experience (years)	Less than 5 years	36	15.0
	5 – 10 years	92	38.3
	11 – 20 years	53	22.1
	More than 20 years	59	24.6
	Mean ± SD	15.0 ± 11.09	
Farm Size (ha)	< 1.0	48	20.0
	1.0–2.9	120	50.0
	3.0–4.9	48	20.0
	5.0+	24	10.0
	Mean ± SD	2.0 ± 1.54	

Source: Field Survey, 2026.

Despite the conflict context, farmers showed remarkably high input adoption rates: 100% used mineral fertiliser, 96.7% used improved seed varieties, and 87.5% relied on supplementary irrigation. These adoption rates are substantially higher than typical figures reported for smallholder farmers in northern Nigeria (*Hassan et al., 2020*), suggesting that rice farming in the study area is relatively intensive and that farmers are committed to maintaining productivity despite conflict pressures. The universal adoption of fertiliser (100%) indicates that farmers recognise the importance of soil fertility management for rice production, while the high adoption of improved seeds (96.7%) suggests good access to agricultural input markets or distribution programmes. The reliance on supplementary irrigation (87.5%) underscores the critical importance of irrigation infrastructure in the study area, making the protection and maintenance of irrigation systems essential for food security and livelihood sustainability.

However, institutional support was extremely limited. Access to formal credit was alarmingly low, with 74.2% having never accessed credit, 20.8% accessing occasionally, and only 5.0% accessing regularly. This credit constraint is particularly problematic in a conflict context, where farmers need additional financial resources to replace destroyed inputs, hire security, and cope with income losses. The credit access gap is consistent with findings by *Ofuoku and Isere (2010)*, who observed that conflict adversely affects farmers' capacity to save and repay credit, creating a vicious cycle of reduced investment and declining productivity.

Access to extension services was similarly limited: 47.5% had never received extension visits, 11.7% rarely received them, 35.8% occasionally, and only 5.0% regularly. This extension gap means that over half of farmers (59.2%) lack regular technical guidance on improved production practices, pest management, and post-harvest handling. Given the 39.33% yield decline documented in this study, the limited extension access likely compounds the negative effects of conflict by preventing farmers from adopting yield-enhancing technologies and coping strategies (*George et al., 2021*).

Membership in farmer cooperatives was reported by only 32.5% of respondents, while 67.5% were not members. Cooperatives play important roles in facilitating input access, collective marketing, credit access, and risk sharing. The low membership rate indicates weak collective action capacity among farmers, which may reduce their bargaining power and limit their ability to access government programmes and support (*Nnaji et al., 2023*). Strengthening cooperative membership could enhance farmers' resilience to conflict through collective security arrangements and shared resources.

Regarding labour sources, 60.8% of farmers used both family and hired labour, 30.0% used hired labour only, and only 9.2% relied exclusively on family labour. The high reliance on hired labour (90.8% using hired labour either exclusively or in combination with family labour) indicates that rice production in the study area is labour-intensive and that hired labour is essential for completing critical operations. This finding has important implications for conflict impacts, as hired labour availability is often disrupted by violence, displacement, and fear of attack, contributing to the 17 working days lost per season documented in this study.

The land tenure system showed that 60.8% of respondents owned inherited land, 15.0% owned purchased land, 19.2% rented land, and 4.6% used borrowed/pledged land. The predominance of inherited land ownership (60.8%) suggests relative tenure security for the majority of farmers, as inherited land is typically held under customary tenure arrangements

that are recognised and respected in rural communities. However, the 23.8% who rented or borrowed land (19.2% rented + 4.6% borrowed/pledged) may face greater tenure insecurity, as conflict can disrupt rental agreements and displace tenants. This tenure diversity suggests that conflict affects farmers across different land access arrangements, though landowners may have more secure access to compensation and recovery options.

The high proportion of farmers relying on hired labour and supplementary irrigation, combined with the low access to credit and extension services, presents a paradoxical situation: farmers are making substantial investments in purchased inputs (fertiliser, improved seeds) and hired labour while lacking the institutional support systems that would help them manage risks and access markets effectively. This institutional deficit likely amplifies the negative effects of conflict, as farmers have limited safety nets to absorb production shocks and limited guidance on conflict adaptation strategies.

Table 2: Input Adoption and Institutional Support among Rice Farmers (n = 240)

Variable	Category	Frequency	Percentage
Use of Mineral Fertiliser	Yes	240	100.0
	No	0	0.0
Use of Improved Seed Varieties	Yes	232	96.7
	No	8	3.3
Use of Supplementary Irrigation	Yes	210	87.5
	No	30	12.5
Access to Formal Credit	Never	178	74.2
	Yes, occasionally	50	20.8
	Yes, regularly	12	5.0
Access to Extension Services	Never	114	47.5
	Rarely	28	11.7
	Yes, occasionally	86	35.8
	Yes, regularly	12	5.0
Membership in Farmer Cooperative	Yes	78	32.5
	No	162	67.5
Main Source of Labour	Family labour only	22	9.2
	Hired labour only	72	30.0
	Both family and hired labour	146	60.8
Land Tenure System	Owned (inherited)	146	60.8
	Owned (purchased)	36	15.0
	Rented	46	19.2
	Borrowed/pledged	11	4.6

Source: Field Survey, 2026.

4.2 Changes in Core Rice Production Indicators Before and During Conflict

Table 3 shows substantial declines in all major rice production indicators during the farmers–herders conflict period. The mean area cultivated decreased from 2.12 ha before the conflict to 1.48 ha during the conflict, representing a 30.20% reduction. Similarly, the mean total rice yield declined from 8,506.92 kg to 5,160.89 kg, a reduction of 39.33%, while rice yield per hectare decreased from 4,422.93 kg/ha to 3,271.86 kg/ha, representing a 26.02% decline. Farm income experienced the greatest reduction, falling by 51.38% from ₦3,938,833 to ₦1,915,142, whereas expenditure on farm inputs declined by 27.70%, from ₦1,542,708 to ₦1,115,408.

Table 3: Rice Production Indicators Before and During Conflict (n = 240)

Production Indicator	Before Conflict (Mean)	During Conflict (Mean)	% Change (Before vs During)	t-value	p-value
Total area of rice planted (ha)	2.12	1.48	30.20		
Total rice yield obtained (kg)	8506.92	5160.89	39.33	10.198	<0.001*
Rice yield per hectare (kg/ha)	4422.93	3271.86	26.02	28.810	<0.001*
Total farm income from rice sales (Naira)	3,938,833.33	1,915,141.67	51.38		
Total expenditure on farm inputs (Naira)	1,542,708	1,115,408.33	27.70		
Area of farmland abandoned due to conflict (ha)	-	0.65	-		
Working days lost due to conflict-related disruptions (days)	-	17	-		

Source: Field Survey, 2026. Means were derived from respondents' estimates. Percentage change compares before- and during-conflict values. Statistical significance was assessed using paired-samples t-tests (df = 239); p < 0.05 indicates a statistically significant difference.

To determine whether the observed reductions were statistically significant, paired-samples t-tests were conducted comparing production indicators before and during the conflict. The results showed that both total rice yield ($t(239) = 10.20$, $p < 0.001$) and rice yield per hectare ($t(239) = 28.81$, $p < 0.001$) declined significantly during the conflict period. The mean reduction in total rice yield was 3,346.03 kg (95% CI: 2,699.71–3,992.35 kg), while rice yield per hectare declined by an average of 1,151.07 kg/ha (95% CI: 1,072.36–1,229.77 kg/ha). These findings indicate that the observed reductions in rice production were statistically significant and unlikely to have occurred by chance.

The decline in total yield reflects not only the reduction in cultivated land but also lower productivity on the land that remained under cultivation, as evidenced by the significant decrease in yield per hectare. The marked reduction in farm income, which exceeded the decline in physical output, further suggests that conflict affected farmers through multiple pathways, including reduced market participation, disruption of value chains, increased production risks, and constrained access to profitable markets.

These findings corroborate those of Ofuoku and Isife (2010), who reported that farmers–herders conflicts reduce agricultural output and household income through crop destruction, displacement, and disruption of farming activities. They are also consistent with the findings of Rockmore (2015), Verpoorten (2009), Adelaja and George (2019), George et al. (2021), and Nnaji et al. (2023), all of whom documented significant reductions in agricultural production, labour utilization, land access, and farm productivity in conflict-affected farming communities. Collectively, the present findings provide empirical evidence that farmers–herders conflict significantly undermines both the scale and productivity of rice farming, thereby threatening the livelihoods of rural households and food security.

From a theoretical standpoint, the planted-area decline (30.44%) reflects the resource scarcity theory's prediction that competition for land access compresses cultivation. The 17 working days lost per farmer illustrates the environmental security theory's contention that conflict degrades the human management input to agriculture. The disproportionately large income decline relative to yield decline is consistent with the economic theory of conflict: conflict simultaneously reduces output and depresses effective prices by restricting market access, compressing farm household income from both sides (Umar and Isah, 2020).

Furthermore, the during-conflict yield per hectare (3,271.86 kg/ha) falls substantially below the national paddy rice yield benchmark of 4,500–5,000 kg/ha achievable under improved management (FMARD, 2019), confirming that conflict has pushed this important rice system well below its productive potential. The 39.33% reduction in total rice yield and 51.38% decline in farm income represent not just temporary setbacks but systemic shocks that could have long-term implications for household welfare, food security, and agricultural investment in the region.

4.3 Effect on Farmland Abandonment and Working Days Lost

The mean farmland abandonment of 0.65 ha directly explains a significant share of the 30.44% area decline, while 17 working days lost per farmer represent missed critical operations including transplanting, weeding, fertiliser application, and harvesting. *Ofuoku and Isere (2010)* specifically observed that female farmers in conflict-affected communities stop travelling to distant farms out of fear of attack — a pattern directly reflected in the study area, where 82.5% of respondents were female. The labour loss finding corroborates *Rockmore (2015)*, who identified reduced labour availability as a central mechanism through which conflict suppresses agricultural productivity in rural Africa.

4.4 Effect on Rice Quality and Planted Area Reduction

Table 4 presents the farmer-reported effect of conflict on rice quality and planted area. In total, 58.8% of respondents reported at least a moderate decline in rice quality, while 70.0% reported that conflict forced them to reduce their planted area. Among those who reduced their area ($n = 168$), 52.5% reduced by 25–50% and 7.5% reduced by more than 50%.

Table 4: Effect of Conflict on Rice Quality and Planted Area ($n = 240$)

Category	Frequency	Percentage
Rice Quality Effect		
Yes, severely affected	60	25.0
Yes, moderately affected	81	33.8
Slightly affected	36	15.0
Not at all affected	63	26.3
Reduction in Planted Area		
Yes — reduced planted area	168	70.0
No — area maintained	72	30.0
Extent of reduction ($n = 168$ affected)		
Less than 10%	24	10.0 (of affected)
10 – 25%	24	10.0 (of affected)
26 – 50%	126	52.5 (of affected)
More than 50%	18	7.5 (of affected)

Source: Field Survey, 2026.

Rice quality degradation (58.8%) extends the production costs identified by Ajibefun (2018), who listed loss of produce in storage as a key economic effect of FH conflict. Degraded or prematurely harvested rice commands a lower farm-gate price and is more susceptible to storage losses, deepening income losses beyond what yield reduction alone would predict. The 70.0% of farmers who deliberately reduced their planted area illustrate the rational risk-avoidance mechanism predicted by the economic theory of conflict: pre-emptively limiting production exposure at the cost of foregone output (Nnaji et al., 2023; Bozzoli and Brück, 2009).

4.5 Additional Costs Incurred Due to Conflict

Table 5 presents the additional conflict-related costs incurred by respondents. Replacement of destroyed crops/equipment was reported by 83.8% of respondents, transportation costs of early produce evacuation by 80.8%, and farm security costs by 80.0%. Only 4.6% reported incurring no additional conflict-related costs.

Table 5: Additional Costs Incurred by Rice Farmers Due to FH Conflict

Additional Cost Category	Frequency*	Percentage*	Rank
Replacement of destroyed crops or equipment	201	83.8	1st
Transportation for early produce evacuation	194	80.8	2nd
Hiring security/watchmen for the farm	192	80.0	3rd
Legal fees for conflict resolution	22	9.2	4th
Medical expenses from injuries	14	5.8	5th
No additional costs incurred	11	4.6	—

*Note: Multiple responses allowed; percentages do not sum to 100%. Source: Field Survey, 2026.

The near-universal incidence of additional conflict-related costs (95.4% of respondents) demonstrates that FH conflict imposes a pervasive financial burden across virtually the entire farming population. These cost categories directly correspond to the infrastructural damage and property loss identified by *Ajibefun (2018)* and corroborated by *Awotokun et al. (2020)*, who found that FH conflict has severely harmed Nigeria's economy through the loss of human lives and resources. Critically, these costs are borne by farmers whose gross income has simultaneously fallen by 51.38% — a double financial compression consistent with *Ofuoku and Isere's (2010)* observation that conflict adversely affects farmers' capacity to save and repay credit.

4.6 Farmers' Overall Rating of Impact of FH Conflict

Table 6 presents farmers' Likert-scale ratings of the overall impact of FH conflict across eight dimensions of their rice enterprise and household welfare.

Table 6: Farmers' Overall Rating of the Impact of FH Conflict on the Rice Enterprise

Impact Dimension	Mean ($\bar{x}$)	Std Dev (SD)	Rank	Decision
Reduction in total income from rice sales	4.32	0.81	1 st	Severe
Loss of rice yield (quantity produced)	4.13	0.94	2 nd	Severe
Increased cost of rice production	4.09	0.88	3 rd	Severe
Overall reduction in household livelihood	3.90	1.02	4 th	Severe
Household food insecurity and reduced meals	3.85	0.97	5 th	Severe
Psychological stress and loss of motivation to farm	3.67	1.11	6 th	Severe
Loss of farmland or reduced cultivated area	3.25	1.21	7 th	Severe
Reduced investment in farm inputs	2.93	1.18	8 th	Not Severe

Note: Scale 1 = No Impact; 5 = Devastating/Farm-Ending. Decision: mean ≥ 3.0 = Severe. Source: Field Survey, 2026.

Seven of the eight impact dimensions were rated as severe (mean ≥ 3.0). Reduction in total income from rice sales was the most severely rated (mean = 4.32; ranked 1st), followed by loss of yield (4.13; 2nd) and increased production costs (4.09; 3rd). The convergence of these subjective ratings with the objective percentage changes in Table 3 — where income recorded the largest percentage decline (51.38%) of all five indicators — substantially strengthens the internal validity of the findings, and is consistent with Ofuoku and Isere's (2010) observation that diminished output and revenue are the most keenly felt economic consequences of FH conflict for crop farmers.

The severity ratings for household food insecurity (mean = 3.85; 5th) and overall livelihood reduction (mean = 3.90; 4th) confirm that the damage extends well beyond the farm gate into household welfare. This directly corroborates Dt et al. (2019) at the regional level and Adetunji and Ukhurebor (2020) at the national level, both of whom documented the food security threat posed by FH conflict in Nigeria and West Africa. Psychological stress (mean = 3.67; 6th), though less visible in aggregate production statistics, reduces farmers' motivation and decision-making capacity, further suppressing long-term productivity and investment (Ajibefun, 2018). Notably, only reduced investment in farm inputs fell below the severe threshold (mean = 2.93; 8th), consistent with the very high input adoption rates already documented (100% fertiliser, 96.7% improved seeds), indicating that conflict has compressed the scale of production rather than the technical quality of practices on land still under cultivation.

5.0 CONCLUSION AND POLICY RECOMMENDATIONS

This study provides rigorous, quantitative micro-level evidence that farmers–herders conflict has inflicted severe and statistically significant damage on rice production in north-eastern Jigawa State, Nigeria. The paired samples t-test results confirmed that the observed declines were statistically significant and unlikely to have occurred by chance: total rice yield fell by 39.33% ($t(239) = 10.20$, $p < 0.001$), rice yield per hectare declined by 26.02% ($t(239) = 28.81$, $p < 0.001$), farm income fell by 51.38%, and planted area contracted by 30.20% during the conflict period relative to the pre-conflict baseline. The mean reduction in total rice yield was 3,346.03 kg (95% CI: 2,699.71–3,992.35 kg), while yield per hectare declined by an average of 1,151.07 kg/ha (95% CI: 1,072.36–1,229.77 kg/ha), demonstrating the precision and robustness of these estimates. Farmers additionally abandoned a mean of 0.65 ha of farmland and lost 17 working days per season, experienced rice quality decline (58.8%), were forced to reduce planted area (70.0%), and bore additional conflict-related costs across three major cost categories (over 80% of respondents each). The marked reduction in farm income, which exceeded the decline in physical output, further confirms that conflict affected farmers through multiple pathways including reduced market participation, value chain disruption, increased production risks, and constrained market access.

These findings are consistent with the resource scarcity, environmental security, and economic theories of conflict, and closely corroborate the broader conflict-agriculture literature for Nigeria and sub-Saharan Africa. The during-conflict yield per hectare (3,271.86 kg/ha) falls substantially below the national paddy rice yield benchmark of 4,500–5,000 kg/ha, confirming that conflict has pushed this important rice system well below its productive potential. The study concludes that FH conflict operates as a systemic, multi-dimensional shock to the rice economy of north-eastern Jigawa State that requires an equally multi-dimensional policy response.

The following policy recommendations are proffered:

- i. **Seasonally targeted security deployment:** The Jigawa State Security Trust Fund should establish a formal harvest-season security deployment protocol for the September–November high-risk period in the study area, when conflict is most frequent and rice crops are most vulnerable. Given the significant working days lost (17 days per farmer) and farmland abandonment (0.65 ha), enhanced security during critical production periods would directly address these conflict-induced disruptions.
- ii. **Conflict-linked crop insurance:** The Nigerian Agricultural Insurance Corporation (NAIC), in partnership with the Jigawa State Government, should introduce a subsidised crop insurance product covering conflict-related yield and income losses, thereby protecting farmers' capacity to reinvest in subsequent seasons. The statistically significant yield losses (39.33%) and income losses (51.38%) documented in this study provide an empirical basis for designing appropriate premium and compensation structures.
- iii. **Post-harvest storage and market access:** The Jigawa State Agricultural Supply Company (JASCO) in collaboration with Jigawa Agricultural Transformation Agency (JATA) should establish secure community-based storage and aggregation centres in conflict-affected communities to reduce produce theft and distress sales. This would address the 83.8% of farmers who incurred costs for crop replacement and the 80.8% who faced transportation costs for early produce evacuation, thereby mitigating the disproportionate income losses experienced by farmers.
- iv. **Extension and credit access expansion:** The Jigawa Agricultural and Rural Development Authority (JARDA) and the Bank of Agriculture (BOA) should deploy additional extension agents to conflict-affected communities and create a simplified low-collateral credit facility for conflict-exposed rice farmers, addressing the 47.5% zero-extension and 74.2% zero-credit access gaps documented in this study. Strengthening institutional support would enhance farmers' resilience and capacity to cope with conflict-induced shocks.
- v. **Conflict-sensitive agricultural planning:** The Jigawa State Ministry of Agriculture should integrate conflict risk assessment into agricultural development planning, including the establishment of early warning systems for conflict hotspots and the development of contingency plans for production disruptions. This would enable proactive rather than reactive responses to FH conflict, reducing the 30.20% reduction in planted area and 26.02% decline in yield per hectare documented in this study.

The implementation of these recommendations requires sustained political will, adequate budgetary allocation, and multi-stakeholder collaboration involving federal and state governments, development partners, traditional institutions, and farming communities. Without decisive intervention, the systemic damage inflicted by FH conflict on the rice economy of north-eastern Jigawa State will continue to deepen, with severe consequences for food security, rural livelihoods, and agricultural development in the area.

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