



Impact of Armed Banditry on Agricultural Productivity Among Rural Farm Households in North Central Nigeria: A Propensity Score Matching Approach

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ABSTRACT

Armed banditry has emerged as a major threat to rural livelihoods and agricultural production in Nigeria, particularly in North Central Nigeria, a major food-producing region. Despite growing evidence linking insecurity to agricultural decline, empirical evidence on the causal effects of banditry on household's farm productivity remains limited. This study examines the impact of banditry on agricultural productivity among rural farm households in Niger and Plateau States Nigeria. A multistage sampling technique was used to select 399 households, comprising 194 from banditry-affected and 205 from non-affected communities. Total Factor Productivity (TFP) was estimated as the ratio of total output value to total input value per hectare. Propensity Score Matching (PSM), using one-to-one, nearest neighbour, radius and kernel matching, was employed to estimate the Average Treatment Effect on the Treated (ATT), while probit regression identified productivity determinants. Mean TFP was 3.83 among affected farmers compared with 5.31 among non-affected farmers, representing a 1.48-unit productivity gap. Radius matching produced an ATT of -1.2041 ($p < 0.01$), indicating that banditry reduced productivity by approximately 1.2 units. Frequency of attacks and livestock loss negatively influenced productivity, whereas: education, credit access, extension contact, farmer association membership and farming experience had positive effects. This study concludes that banditry substantially constrains agricultural productivity and recommends labour saving, climate smart technologies and secure farming systems, including home based bag farming, improved seeds, mechanisation, irrigation, dry-season farming and digital extension, to sustain productivity while reducing farmers' exposure to insecurity.

Keywords Banditry; Agricultural Productivity; Total Factor Productivity; Propensity Score Matching; North-Central Nigeria.

1.0 INTRODUCTION

Food security remains a major global development challenge, particularly in conflict-affected and predominantly agrarian economies where household food availability depends heavily on agricultural production. Conflict and violence can undermine food security by disrupting access to land, labour, markets, productive assets and agricultural inputs, thereby reducing both the quantity and reliability of food production. These effects are particularly significant in rural communities where agriculture constitutes the principal source of food, employment and household income. Within this context, the resilience of farming households depends not only on their productive resources but also on their ability to adapt to recurrent shocks and maintain access to livelihood assets.

Nigeria reflects these broader challenges. In North-Central Nigeria, agriculture remains central to rural livelihoods and food production, while insecurity has increasingly constrained farmers' access to land, agricultural inputs, markets and productive resources. Recent evidence from the region indicates that insecurity, including banditry and armed attacks, can disrupt agricultural production, reduce household income and weaken rural livelihood systems

(Ojogbaneet *al.*, 2025). Zakariet *al.* (2025) similarly found that insecurity related constraints can affect agripreneurial activities in Niger State by limiting access to farmland, agricultural inputs and markets, thereby constraining income generation and business expansion. Among the different forms of insecurity, armed banditry has become an important threat to rural farming communities, involving armed attacks, kidnapping, cattle rustling, farm invasion, extortion and the theft or destruction of productive assets. Evidence from northern Nigeria also documents the effects of cattle rustling and bandit related violence on livestock assets and rural livelihoods (Olanrewaju *et al.*, 2022). These activities can interrupt agricultural production by restricting farmers' access to their fields, disrupting input and output markets, increasing production and transaction costs, and discouraging investment in farming.

The relationship between insecurity and agricultural productivity can further be understood through the Sustainable Livelihoods Framework, which conceptualises household livelihoods around five forms of capital human, social, physical, financial and natural within a vulnerability context shaped by

shocks, trends and seasonality (Heffernan, & Misturelli 2000). From this perspective, banditry can erode livelihood assets through the loss of livestock and farm equipment, reduced income, restricted access to land and financial resources, displacement and disruption of community networks. Such asset depletion can weaken households' ability to maintain productive agricultural activities and adapt to continuing insecurity. The framework therefore provides a useful theoretical basis for explaining why households exposed to persistent insecurity may experience declining productive capacity even when they retain the skills and willingness to farm (Heffernan, & Misturelli, 2000).

The Resilience Theory provides a complementary perspective by emphasising the capacity of households and communities to absorb, adapt to and recover from shocks while maintaining essential functions. In agricultural settings, resilience involves the ability of farmers to adjust production practices, reorganise resources, diversify income and sustain productive activities following adverse events. However, repeated exposure to armed attacks may exceed household coping capacity, particularly where productive assets are depleted and access to institutional support is limited. Thus, resilience and livelihood assets jointly influence the extent to which insecurity translates into agricultural productivity losses. Empirical evidence from northern Nigeria demonstrates several pathways through which banditry affects agricultural production. Ladan & Matawalli (2021) found that persistent attacks in Katsina State forced farmers to abandon agricultural land, contributing to declining agricultural productivity. Similarly, Mohammed *et al.* (2021) reported substantial disruptions among yam farmers in Niger State, including destruction and looting of agricultural resources, disruption of supply chains and movement of farmers towards non agricultural activities. These findings indicate that the effects of banditry extend beyond immediate physical damage to influence farmers' production decisions and participation in agricultural markets.

Evidence from other conflict-affected agricultural areas further supports this relationship. Mahmud & Salihu (2024) reported that banditry contributed to food shortages in Zamfara State by interrupting agricultural production and restricting market access. Recurrent attacks encouraged farmers to leave their farms, resulting in fallow land and reduced food output. Such findings are consistent with the broader proposition that insecurity increases production uncertainty and reduces farmers' willingness and capacity to commit resources to agricultural activities. The consequences of insecurity are also reflected in farmers' access to productive inputs and institutional services. Where farmers anticipate attacks, they may reduce cultivated area, apply fewer purchased inputs or avoid some labour intensive activities because the expected return from production becomes uncertain.

Likewise, insecurity can constrain access to extension services, agricultural credit and markets. These institutional constraints can reinforce the direct effects of attacks, creating a cumulative reduction in productivity. Evidence from the present study further indicates that banditry-affected households had smaller farm sizes and substantially lower access to agricultural credit and extension services than their non affected counterparts.

Despite the growing literature on insecurity and agriculture in Nigeria, an important methodological gap remains. Much of the existing research has relied on descriptive statistics, case studies or conventional comparisons of affected and non-affected communities. While such approaches provide useful evidence of the consequences of insecurity, they may not adequately account for selection bias arising from systematic differences between households exposed and not exposed to banditry. For example, affected households may differ from non-affected households in farm size, household characteristics, education, income, access to credit or extension services. Consequently, a simple difference in productivity between the two groups cannot necessarily be interpreted as the causal effect of banditry.

This study addresses this gap by applying Propensity Score Matching (PSM) to construct a statistically comparable counterfactual for banditry-affected farming households. The approach allows the study to estimate the Average Treatment Effect on the Treated (ATT) while controlling for observable characteristics associated with exposure to banditry. The study therefore moves beyond documenting whether agricultural productivity differs between affected and non-affected households to estimating the extent to which observed productivity differences can be attributed to banditry exposure. Accordingly, the study examines the impact of armed banditry on agricultural productivity among rural farm households in North-Central Nigeria. Specifically, it: (i) assesses the productivity levels of rural farm households in banditry-affected and non-affected communities; (ii) determines the factors influencing agricultural productivity; and (iii) estimates the causal effect of banditry on agricultural productivity using Propensity Score Matching. By integrating the Sustainable Livelihoods and Resilience perspectives with a counterfactual econometric approach, the study contributes empirical evidence for designing security-sensitive agricultural policies, livelihood restoration programmes and productivity enhancing interventions in banditry-affected farming communities.

2.0 METHODOLOGY

The study was conducted in Niger and Plateau States of North-Central Nigeria, selected because of their importance to food crop production and the varying

intensity of insecurity affecting rural farming communities. The study area falls within the tropical continental climatic zone, characterised by distinct wet and dry seasons. Annual rainfall generally supports predominantly rain fed agricultural production, making the timing and security of farmers' access to cultivated land particularly important to agricultural performance.

Niger State, which is considered first in the study, lies approximately between 8°00' and 11°30' N latitude and 3°30' and 7°40' E longitude and covers about 76,363 km², representing approximately 8.3% of Nigeria's land area National Bureau of Statistics (NBS, 2022). The state has extensive agricultural land and produces major food crops including rice, maize, millet, sorghum, yam and cassava. Agriculture constitutes an important source of employment, food and household income, particularly in rural communities. The state's large geographical extent and predominantly rural settlement pattern also expose some farming communities to insecurity, with implications for access to farmland, agricultural inputs and markets (Ahmed, *et al.*, 2020).

Plateau State is located approximately between 8°24' and 10°30' N latitude and 8°32' and 10°38' E longitude, covering about 26,899 km². The state is characterised by a relatively elevated terrain, with parts of the Jos Plateau reaching elevations of about 1,200 m above sea level. Its agricultural economy includes both crop and livestock production, supported by relatively favourable conditions for the production of several food and horticultural crops. Like Niger State, parts of Plateau State have experienced insecurity affecting rural communities and agricultural activities. Across the two states, temperatures generally range from approximately 18°C to 37°C, while annual rainfall varies spatially and provides the principal water source for rain-fed farming. These geographical and agricultural characteristics make the states appropriate for assessing the effect of insecurity on farm productivity, particularly where differences exist between banditry-affected and non-affected communities. Previous studies have similarly documented the disruptive effects of insecurity on agricultural production, farm access and rural livelihoods in North-Central Nigeria (Mohammed *et al.*, 2021).

A multistage sampling technique was adopted. The first stage involved the purposive selection of Niger and Plateau States based on their important role in food crop production and varying levels of insecurity. In the second stage, two agricultural zones were purposively selected from each state based on the prevalence and intensity of banditry activities. The third stage involved the random selection of two Local Government Areas (LGAs) from each agricultural zone. The fourth stage

involved the random selection of three farming communities from each LGA. In the final stage, food crop farming households were randomly selected, resulting in a total sample size of 399 rural farming households (194 from affected communities and 205 from non-affected communities). Data were obtained through a field survey using a structured questionnaire. The instrument was developed in line with the study objectives and reviewed by experts in Agricultural Economics, Agricultural Extension and Research Methods to establish its content and face validity. The experts assessed the questionnaire items for relevance, clarity, adequacy and consistency with the objectives of the study, and their suggestions were incorporated into the final instrument. The revised questionnaire was pre-tested among rural farm households outside the sampled communities, and ambiguous or unclear items were modified accordingly. The instrument was then programmed into Kobo Toolbox for real time electronic data collection. Its reliability was assessed using Cronbach's alpha, which produced a coefficient of 0.85, indicating satisfactory internal consistency and confirming the reliability of the instrument for the main survey. The questionnaire collected information on household socioeconomic characteristics, farm production activities, income sources and the effects of banditry on agricultural production.

The data were analysed using descriptive statistics and econometric techniques. Total Factor Productivity (TFP) was computed as the ratio of the total value of agricultural output to the total value of inputs used by each household, following (Fuglie *et al.* 2023):

$$TFP_i = \frac{VQ_i}{VI_i} \quad (1)$$

where: TFP_i represents the total factor productivity of household i ; VQ_i is the total value of agricultural output produced by i household's; and VI_i is the total value of inputs used by i household's.

To estimate the causal effect of banditry on agricultural productivity, Propensity Score Matching (PSM) was employed. Household exposure to banditry was defined as the treatment variable, such that: $D_i = 1$, if household i is exposed to banditry, 0 otherwise.

The propensity score, representing the probability that a household was exposed to banditry conditional on its observed characteristics, was estimated using a probit model (Rosenbaum & Rubin 1983) :

$$P(X_i) = \Pr(D_i = 1 | X_i) = \Phi(X_i' \beta) \quad (2)$$

Where: $P(X_i)$ is the estimated propensity score; D_i is the household's banditry exposure status; X_i is a vector of observed household and farm characteristics; β is a vector of parameters to be estimated; and Φ denotes the cumulative distribution function of the standard normal distribution.

The Average Treatment Effect on the Treated (ATT) was then estimated as:

$$ATT = E[Y_i(1) - Y_i(0)|D_i = 1] \quad (3)$$

Where $Y_i(1)$ represents the productivity outcome of household i under exposure to banditry, while $Y_i(0)$ represents the potential productivity outcome that the same household would have achieved in the absence of banditry. The ATT therefore measures the average difference in productivity attributable to banditry among households that were actually exposed to it.

To assess the robustness of the estimated treatment effect, four matching algorithms were employed: one-to-one matching, nearest-neighbour matching, radius matching, and kernel matching. The use of multiple matching procedures provides a basis for determining whether the estimated impact of banditry on agricultural productivity is sensitive to the choice of matching algorithm.

Determinants of Productivity; A Binary Logit regression model was employed to examine the factors influencing the likelihood of rural farm households

attaining high agricultural productivity. For the analysis, households were classified into two productivity categories, with 1 assigned to households with high productivity and 0 to those with low productivity. The model was specified as follows:

$$P(D_i = 1|X_i) = \frac{e^{(\beta_0 + \sum_{i=1}^n \beta_i X_i)}}{1 + e^{(\beta_0 + \sum_{i=1}^n \beta_i X_i)}}$$

(4)

Where: Y_i represents the productivity status of household i , X_{ji} represents the explanatory variables, β_i is the constant term, and β_j represents the parameters estimated for the explanatory variables.

3.0 RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of Respondents

The result in Table 1 presents the socioeconomic characteristics of rural farm households in banditry-affected and non-affected communities, highlighting key demographic, educational and institutional differences between the two groups.

Table 1: Socio-economic Characteristics of Rural Farm Households in Banditry-Affected and Non-Affected Communities

Socio-economic characteristic	Banditry-affected (%) / Mean	Non-affected (%) / Mean
Age of household head (years)	37.0	40.0
Sex of household head		
Male	82.1	83.2
Female	17.9	16.8
Marital status		
Married	75.7	76.6
Other marital status	24.3	23.4
Educational attainment		
No formal education	39.3	18.0
Formal education	60.7	82.0
Household size (persons)	8.0	10.0
Access to agricultural extension		
Yes	14.9	51.2
No	85.1	48.8
Access to agricultural credit		
Yes	7.8	28.2
No	92.2	71.8

Source: Field Survey, 2025

The mean age of household heads was 37 years in affected areas and 40 years in non-affected areas, indicating that the majority of farming households are within the economically active age bracket. Males constituted 82.1% of pooled affected households and 83.2% of non-affected households. The majority of household heads were married (75.7% in affected areas and 76.6% in non-affected areas). Educational attainment was lower in banditry-affected areas, with 39.3% having no formal education compared to 18.0% in non-affected areas. The mean household size was 8 in affected areas and 10 in non-affected areas. Extension contact was severely limited in affected

areas (14.9%) compared with non-affected areas (51.2%). Access to credit was also extremely low in affected areas (7.8%) compared with non-affected areas (28.2%).

3.2 Productivity Levels of Rural Farming Households

Table 2 shows the distribution of Total Factor Productivity (TFP) scores among rural farming households. The TFP index provides a relative measure of production efficiency, with TFP values below 1.00 indicating below benchmark productivity, a value of 1.00 representing the benchmark level, and values

above 1.00 indicating productivity above the benchmark. The distribution therefore provides a basis for comparing productivity levels between banditry-affected and non-affected households. The results reveal clear disparities in productivity levels. Among

banditry-affected farmers, the majority (37.11%) fell within the 2.01–4.00 TFP range, while only 6.70% attained productivity levels above 8.00. In contrast, non-affected farmers were predominantly concentrated in higher productivity categories.

Table 2: Productivity Level of Food Crop Farmers by Banditry Status

TFP Range	Niger Affected (%)	Niger Not Affected (%)	Plateau Affected (%)	Plateau Not Affected (%)	Pooled Affected (%)	Pooled Not Affected (%)
0.01–2.00	27.72	5.94	10.75	4.81	19.59	5.37
2.01–4.00	41.58	23.76	32.26	25.00	37.11	24.35
4.01–6.00	17.82	33.66	29.03	33.65	23.20	33.66
6.01–8.00	8.91	24.75	18.28	24.04	13.40	24.35
8.01–10.00	3.96	11.88	9.68	12.50	6.70	12.20
Mean TFP	3.45	5.28	4.25	5.35	3.83	5.31

Source: Field Survey, 2025

The mean TFP for affected farmers was 3.83, compared to 5.31 for non-affected farmers, yielding a productivity gap of 1.48 units. In Niger State, the mean TFP for affected farmers was 3.45, significantly lower than 5.28 for non-affected farmers (difference of 1.83). In Plateau State, affected farmers recorded a mean TFP of 4.25, compared to 5.35 among non-affected farmers (difference of 1.10).

3.3 Determinants of Productivity

Table 3 illustrates the Binary Logit regression estimates of the factors associated with agricultural productivity among rural farm households. The model estimates the likelihood that a household attains a high productivity status, coded as 1, compared with a low productivity status, coded as 0. The explanatory variables capture household socio-economic characteristics, institutional access and exposure to

banditry. The frequency of bandit attacks had a negative and statistically significant coefficient ($\beta = -0.1827$, $p < 0.01$), indicating that more frequent exposure to banditry significantly reduces the likelihood of households attaining high agricultural productivity. Similarly, livestock loss had a negative and significant coefficient ($\beta = -0.0354$, $p < 0.01$), suggesting that the depletion of livestock assets is associated with a lower probability of achieving high productivity.

Education had a positive and significant coefficient ($\beta = 0.0384$, $p < 0.01$), indicating that additional years of schooling increase the likelihood of attaining higher productivity. Access to credit ($\beta = 0.0001$, $p < 0.01$) and extension contact ($\beta = 0.0684$, $p < 0.01$) also exerted positive and significant effects, suggesting that institutional support enhances farmers' capacity to maintain productive agricultural activities.

Table 3: Binary Logit Estimates of Factors Influencing Agricultural Productivity among Rural Farm Households in the study area.

Variable	Coefficient	z-value
Frequency of bandit attacks	-0.1827	-3.86***
Proximity to bandit-prone zone	0.0249	2.84***
Livestock lost	-0.0354	-2.91***
Gender	0.2974	2.63***
Education	0.0384	3.12***
Access to credit	0.0001	3.35***
Extension contacts	0.0684	3.21***
Membership of association	0.9215	4.62***
Farming experience	0.0214	2.54**
Constant	-1.7035	-2.66***

Source: Field Survey, 2025. Note: ***p < 0.01, **p < 0.05, *p < 0.10.

Membership of farmer associations recorded the largest positive coefficient ($\beta = 0.9215$, $p < 0.01$), indicating a strong positive association between collective participation and the likelihood of achieving high productivity. Farming experience was also

positive and statistically significant ($\beta = 0.0214$, $p < 0.05$), implying that experienced farmers were more likely to attain higher productivity.

3.4 Average Treatment Effect on the Treated (ATT)

Table 4 presents the Average Treatment Effect on the Treated (ATT) estimates of the effect of banditry exposure on agricultural productivity. The estimates are obtained using four alternative matching algorithms

nearest-neighbour, radius, kernel and one-to-one matching to examine the consistency and robustness of the estimated

Table 4: Average Treatment Effect on the Treated (ATT) of Banditry on Productivity (Pooled Results)

Matching Method	Banditry-Affected Areas	Non-Affected Areas	Difference (ATT)	t-statistic
One-to-one matching	4.0246	5.2613	-1.2367	-2.78***
Nearest-neighbour matching	4.0246	5.1508	-1.1262	-3.11***
Radius matching	4.0246	5.2287	-1.2041	-9.86***
Kernel matching	4.0819	5.1476	-1.0657	-2.64***

Source: Field Survey, Note: 2025. *** $p < 0.01$

treatment effect across different matching specifications.

The radius matching estimate of -1.2041 indicates that farmers exposed to banditry experienced an average productivity reduction of approximately 1.2 productivity units relative to their counterparts in secure locations. All matching methods produced statistically significant negative ATT estimates, confirming the robustness of the finding. In Niger State, the ATT ranged from -1.2012 to -1.3725, while in Plateau State, it ranged from -0.9293 to -1.0867. The higher magnitude of productivity loss in Niger State suggests more intense banditry disruption in that region.

3.5 DISCUSSION

The findings demonstrate that banditry constitutes a substantial constraint to agricultural productivity in North-Central Nigeria. The 1.48-unit productivity gap between affected and non-affected farmers indicates that insecurity undermines farmers' capacity to effectively utilise productive resources and achieve higher output levels. This finding is consistent with Zakari&Olorunsanya (2025), who demonstrated among small scale cowpea farmers in Niger State that farm size, labour, seed quantity and pesticide use significantly influenced cowpea output, highlighting the importance of adequate and effective utilisation of production resources for improved farm performance. In the context of the present study, insecurity can constrain farmers' access to and use of these resources by restricting farm access, disrupting production activities and discouraging investment. The observed productivity differential therefore suggests that the effect of banditry extends beyond immediate physical disruption to weaken the effective utilisation of key agricultural inputs.

The negative impact of attack frequency on productivity aligns with the findings of Ladan&Matawalli (2021), who reported that farmers in Katsina State have been forced to abandon their farms due to persistent attacks. Frequent attacks discourage regular farm visits, delay planting and harvesting, and increase fear-induced farm abandonment. The negative

effect of livestock loss on agricultural productivity is consistent with Bwala&Ogirima (2020), who found that violent agricultural conflict in North-Central Nigeria resulted in losses of both crops and livestock, threatening household livelihood strategies. This relationship is particularly relevant because crop and livestock activities frequently form complementary components of rural farming systems.

The positive influence of education on productivity confirms the findings of Suleiman &Bilkisu (2020), who observed that educated households are generally more resilient during periods of insecurity because they possess better access to information and greater capacity to diversify income sources. The positive effect of extension contact corroborates the study of Onoja *et al.* (2024), who reported that access to extension information improves farmers' adaptive capacity during insecurity by enhancing awareness of alternative farming strategies and risk management practices. The strong positive effect of farmer association membership is consistent with the study of Olamide *et al.* (2024), who found that participation in farmer groups and social networks enhances resilience by improving access to shared resources, information exchange, and collective coping strategies. The ATT estimates of -1.2041 indicate that banditry reduces productivity by approximately 1.2 productivity units. This finding aligns with Adebayo &Olaniyi (2021), who found that armed banditry significantly reduced crop output and efficiency among farming households in North Central Nigeria.

4.0 CONCLUSION

This study examined the impact of banditry on agricultural productivity among rural farm households in North Central Nigeria. The findings reveal that banditry significantly reduces agricultural productivity, with affected farmers experiencing a productivity gap of 1.48 units compared to non-affected farmers. Frequency of bandit attacks, loss of livestock, and proximity to bandit-prone zones were identified as key factors reducing productivity, while education, access to credit, extension contact, farmer association membership, and farming experience were found to enhance productivity even under insecure

conditions. The ATT estimate of -1.2041 provides robust causal evidence that banditry substantially constrains agricultural productivity.

5.0 RECOMMENDATIONS

- i. Government and agricultural development agencies should encourage farmers to adopt labour saving, climate-smart and alternative modern farming technologies, including home based bag farming, improved seed varieties, mechanised land preparation, efficient irrigation systems, improved storage technologies and digital agricultural information systems. Such technologies can reduce farmers' dependence on prolonged physical presence on farms and improve productivity under conditions of insecurity.
- ii. Government should promote secure and flexible farming systems by supporting agricultural programmes that enable farmers to cultivate in safer and accessible locations, while expanding irrigation and dry-season farming where feasible. Such initiatives should be accompanied by adequate security measures to protect farmers, their farms and productive investments..
- iii. Government should address the socioeconomic conditions that contribute to rural insecurity by expanding youth employment, vocational training, skills development and educational opportunities, while strengthening community-based mechanisms for conflict prevention, early warning and peaceful resolution of local disputes.
- iv. Federal and State Governments should enhance security coverage in farming communities by deploying additional security personnel, establishing permanent security outposts in identified banditry hotspots, and strengthening community-based policing and Agro-Ranger operations to improve farmers' safety and confidence in accessing their farms.

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