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FARM ECONOMICS AND TOMATO PEST INFESTATION IN KANO NORTH, NIGERIA

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Abstract

This study examined the economic implications of pest infestation among 326 tomato farmers in five Local Government Areas of Kano North Senatorial Zone, Nigeria. Questionnaire data were analysed using descriptive statistics, farm-budget indicators and Spearman rank correlations. All respondents identified Tuta absoluta; 70.25% reported infestation beginning at fruiting. Among 294 complete-cost observations, mean gross margin was ₦440,140.48 and the benefit-cost ratio was 2.72. The original weak positive severity-yield correlation ($\rho = 0.175$, $p = 0.0026$) was not robust: its direction changed when unusual severity groups were excluded and it was not significant after adjustment for LGA alone. Pest-control expenditure was positively associated with gross margin in unadjusted analysis, but its per-hectare association with profit margin was not significant after adjustment for farm area, revenue per hectare and LGA. These cross-sectional results do not establish causal effects. The findings support integrated pest-management extension and more rigorous multi-season farm-level data collection.

Keywords: Tomato Production; *Tuta Absoluta*; Pest Infestation; Gross Margin; Benefit-Cost Ratio

1. Introduction

Tomato (*Solanum lycopersicum* L.) contributes to household nutrition, farm income, employment and food supply, but production is exposed to insect pests that can reduce marketable output and increase crop-protection costs. The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), has spread widely beyond its native range. Its larvae mine leaves, stems and fruit, making control difficult and potentially encouraging repeated insecticide applications (Mawchaa et al., 2026; Tarusikirwa et al., 2020).

The economic consequences are not determined by crop damage alone. Farm-level effects depend on harvested and marketed output, prices, farm size, the timing of infestation and the cost and effectiveness of management. Farmers may increase pesticide use, labour and monitoring, while the net effect on returns depends on whether these expenditures protect sufficient marketable output. Evidence from other African production systems points to substantial farmer concern and pesticide reliance, but estimates from those settings cannot presumably apply to Kano.

Kano has relevant agronomic evidence on tomato cultivar performance under T. absoluta infestation (Afolayan et al., 2018), but multi-LGA farm-household evidence linking reported infestation, sales, production costs and profitability remain limited. This study therefore analyses questionnaire data from 326 tomato farmers in five LGAs of Kano North Senatorial Zone. Given the cross-sectional design and self-reported pest measures, findings are interpreted as associations rather than causal effects.

The study examined the major pests reported by farmers; the relationship between reported infestation severity and tomato yield; reported pest-related financial losses; pest-control expenditure; farm profitability; and selected coping and institutional-support indicators. The hypotheses were: H01, reported pest severity has no statistically significant association with tomato yield; H02, pest-control expenditure has no statistically significant association with tomato-farm profitability; and H03, institutional-support indicators have no statistically significant association with profitability.

2. Literature Review

2.1 Synthesis of Empirical Evidence

Empirical evidence on T. absoluta in Africa can be grouped into pest-distribution and farmer-experience studies, agronomic and management studies, and farm-level economic assessments. Aigbedion-Atalor et al. (2019) combined farmer interviews in Kenya with distribution mapping in eastern Africa and reported that farmers associated the pest with livelihood losses, higher production costs and more frequent pesticide applications. Bajwa et al. (2019), drawing on farmer surveys in Kenya and Zambia, similarly identified T. absoluta as a major production problem and reported pesticide use as the dominant response. These studies establish the importance of farmer experience and regional spread, but reported losses are not equivalent to experimentally measured crop losses.

Nigerian studies provide a more local foundation. Sanda et al. (2018) reviewed the invasion and management of T. absoluta in Nigeria and emphasises integrated management. Afolayan et al. (2018) evaluated tomato cultivars in infested areas of Kano, generating field-based evidence on cultivar performance and productivity. Such agronomic work helps explain potential production responses but does not, by itself, quantify the costs, sales and gross margins experienced by farm households across several LGAs.

The farm-economics strand is illustrated by Chepchirchir et al. (2023), who analysed 316 tomato growers in Kenya and 345 in Uganda using gross-margin and Economic Impact Quotient approaches. They reported that synthetic chemicals used to manage T. absoluta accounted for a substantial share of production costs in their study settings. Those cost shares are context-specific and should not be transferred directly to Nigeria. Olayide et al. (2024) and Arua et al. (2025) examined post-harvest tomato losses in Nigeria; these studies concern a distinct stage of the value chain and should not be treated as direct estimates of field pest damage.

2.2 Methodological and contextual gaps

The literature reveals four connected gaps. First, pest-distribution and farmer-perception studies, agronomic evaluations and farm-budget analyses often address separate parts of the economic pathway. Second, evidence from eastern and southern Africa, or from selected Nigerian production settings, does not substitute for contemporary evidence across Kano North LGAs. Third, measurement approaches vary: farmer-reported severity and yield loss capture producer experience but may be affected by recall and identification error, whereas field trials provide stronger agronomic control but may not represent ordinary farm costs and marketing conditions. Fourth, extension, training and credit indicators are not consistently examined alongside farm-level returns.

This study contributes an area-specific descriptive and economic profile by combining reported pest characteristics, farm production and sales, variable costs, gross margin, benefit-cost ratio and selected institutional-support indicators for 326 farmers across Bagwai, Shanono, Makoda, Danbatta and Dawakin Tofa. It does not eliminate the limitations of self-reporting or cross-sectional analysis, but it brings these dimensions together within one local farm-household dataset.

3. Materials and Methods

3.1 Study Area, Design and Sample

The study covered Bagwai, Shanono, Makoda, Danbatta and Dawakin Tofa Local Government Areas of Kano North Senatorial Zone, Kano State, Nigeria. A quantitative cross-sectional survey design was adopted,

with the farmer as the unit of analysis. The planning population was estimated at 1,750 tomato farmers. The final dataset comprised 326 valid farmer observations: Bagwai (64), Shanono (64), Makoda (65), Danbatta (65) and Dawakin Tofa (68).

3.2 Data Collection and Measurement

Structured questionnaires collected information on farmer and farm characteristics, production and sales, pest type and infestation stage, severity, estimated yield loss, pest-control activities, variable costs, coping strategies and institutional support. No interviews or focus group discussions were conducted. Yield per hectare was calculated as harvested output divided by tomato area; total revenue as quantity sold multiplied by average selling price; total variable cost as the sum of seed, fertiliser, pesticide, other chemical, hired labour, irrigation, land preparation, transport, harvesting/packaging and other variable costs. Gross margin was total revenue less total variable cost, and benefit-cost ratio was total revenue divided by total variable cost. Pest-control expenditure comprised pesticide and other-chemical expenditure.

Codes 97, 98 and 99 were treated in accordance with questionnaire definitions and researcher clarifications. For the other-cost item only, confirmed not-applicable/no-cost responses were treated as zero. A response indicating that the farmer could not remember other-chemical expenditure was treated as missing. Accordingly, cost-based analyses used 294 complete observations; the remaining 32 observations were retained for non-cost analyses. Reported pest financial loss was kept separate from gross margin because possible overlap could not be excluded.

3.3 Statistical Analysis

Frequencies, percentages, means and standard deviations summarised the data. Spearman rank correlation was used for bivariate tests because key measures were ordinal or discrete. Statistical significance was assessed at 5%. Sensitivity checks excluded unusual severity groups and repeated endpoint yield values. Partial rank correlations were estimated from residuals of ranked variables after adjustment for specified controls; approximate t-based p-values are exploratory. All analyses are observational and are not interpreted as causal estimates.

4. Results and Discussion

4.1 Respondent and Farm Profile

The sample comprised 229 male respondents (70.25%) and 97 female respondents (29.75%). A total of 164 respondents (50.31%) reported no formal education, 65 (19.94%) primary education and 97 (29.75%) secondary education. The 326 observations were distributed across the five study LGAs as reported in Section 4.1.

4.2 Production and Economic Performance

Mean harvested output was 3,281.29 kg per respondent; mean quantity sold was 3,211.60 kg; mean selling price was ₦209.63/kg; and mean tomato area was 0.573 ha. Calculated mean yield was 6,470.55 kg/ha. Among 294 complete-cost observations, mean total revenue was ₦675,618.37, mean total variable cost ₦235,477.89, mean gross margin ₦440,140.48, mean benefit-cost ratio 2.72 and mean pest-control expenditure ₦19,892.86. Across all 326 respondents, mean reported pest financial loss was ₦86,380.37.

4.3 Pest Infestation Characteristics

All 326 respondents identified *Tuta absoluta* as the major pest experienced; consequently, the data do not permit comparisons among pest species. Infestation was reported to begin at fruiting by 229 respondents (70.25%) and at flowering by 97 (29.75%). Severity responses were low (32; 9.82%), moderate (133; 40.80%), high (97; 29.75%) and very high (32; 9.82%); 32 respondents (9.82%) selected “do not know”.

4.4 Hypothesis Tests and Sensitivity Analysis

H01: The original association between reported severity and calculated yield was weakly positive ($\rho = 0.175$, $p = 0.0026$; $N = 294$). Its direction became negative after excluding low- and very-high-severity groups ($\rho = -0.148$, $p = 0.0247$; $N = 230$) and after excluding the repeated 20,000 kg/ha group ($\rho = -0.205$, $p = 0.0009$; $N = 262$). Adjustment for LGA alone produced a non-significant association ($\rho = -0.047$, $p = 0.420$; $N = 294$).

The association adjusted for LGA, stage and area were negative ($\rho = -0.235$, $p < 0.001$), but is exploratory. Table 1 summarise these checks.

H02: Total pest-control expenditure was positively associated with gross margin ($\rho = 0.757$, $p < 0.001$) and benefit-cost ratio ($\rho = 0.371$, $p < 0.001$; $N = 294$). Cost per hectare was negatively associated with profit margin in the bivariate test ($\rho = -0.229$, $p = 0.00007$), but not after adjustment for logged area, logged revenue per hectare and LGA ($\rho = -0.074$, $p = 0.208$). The unadjusted positive correlations do not show that higher spending improves profitability. Table 2 reports the results.

The yield distributions by severity are shown in Table 3. The low- and very-high-severity groups each have zero within-group yield standard deviation, with repeated values of 6,000 and 20,000 kg/ha, respectively. The Kruskal-Wallis result across all four groups ($H = 96.08$, $p < 0.001$) is therefore dominated by unusual endpoint groups and is not interpreted as reliable evidence of a monotonic severity effect. The moderate-versus-high comparison showed a lower median yield in the high-severity group (Mann–Whitney $U = 7,556$, $p = 0.025$; $N = 230$), but remains observational.

H03: In the 162-observation complete-case subset, extension contacts ($\rho = -0.895$, $p < 0.001$) and pest-management training ($\rho = -0.291$, $p = 0.0002$) were negatively associated with benefit-cost ratio. Credit access could not be estimated because the variable had no variation in that subset. These results are partial bivariate associations and may reflect selection or data-structure effects. Table 4 reports the results.

Table 1. Sensitivity Analyses for Pest Severity and Calculated Yield

Analysis	N	ρ	p-value
All valid severity observations	294	+0.175	0.0026
Exclude low and very-high severity groups	230	−0.148	0.0247
Exclude repeated 20,000 kg/ha group	262	−0.205	0.0009
Partial correlation controlling LGA	294	−0.047	0.420
Partial correlation controlling LGA, stage and area	294	−0.235	<0.001

***Source**: Field Survey, 2026; Authors' Statistical Analysis.*

Table 2. Pest-control Expenditure and Profitability: Robustness Results

Analysis	N	ρ	p-value
Total pest-control cost vs gross margin	294	+0.757	<0.001
Total pest-control cost vs BCR	294	+0.371	<0.001
Pest-control cost/ha vs profit margin	294	−0.229	0.00007
Partial: cost/ha vs margin, controlling logged area, logged revenue/ha and LGA	294	−0.074	0.208

***Source**: Field Survey, 2026; Authors' Statistical Analysis.*

Table 3. Calculated Tomato Yield by Reported Pest-severity Category

Severity	N	Mean yield (kg/ha)	Median yield (kg/ha)	SD
Low	32	6,000.00	6,000	0.00
Moderate	133	4,911.28	6,000	1,344.22
High	97	4,455.67	3,400	1,802.02
Very high	32	20,000.00	20,000	0.00

***Source**: Field Survey, 2026; Authors' Statistical Analysis.*

Table 4. Institutional-support Indicators and Benefit-cost Ratio

Indicator	N	Spearman ρ	p-value	Qualification
Extension contacts	162	−0.895	<0.001	Negative association; possible selection and data-structure effects
Pest-management training	162	−0.291	0.0002	Negative association; not causal
Credit access	162	Not estimable	Not estimable	No variation in complete-case subset

***Source**: Field Survey, 2026; Authors' Statistical Analysis.*

4.5. Discussion of Findings

The universal identification of T. absoluta by respondents is consistent with evidence that the pest is a major concern in African tomato systems (Aigbedion-Atalor et al., 2019; Bajwa et al., 2019). However, the present responses do not provide independent entomological confirmation, and the absence of variation prevents comparisons with other pests. The reported concentration of infestation onset at fruiting can inform the timing of extension messages, but should be treated as farmers' reported experience rather than a field-verified biological pattern. Evidence of pesticide reliance elsewhere in Africa supports extension emphasis on pest identification, scouting and integrated management (Sanda et al., 2018; Tarusikirwa et al., 2020).

The mean gross margin and benefit-cost ratio describe the financial position of farms with complete cost data during the period covered; they do not isolate the causal effect of T. absoluta. Chepchirchir et al. (2023) similarly demonstrate the importance of examining crop-protection costs alongside farm returns, although numerical comparisons are inappropriate because locations, currencies, production systems and measurement differ. The positive unadjusted relationships between total pest-control expenditure and gross margin or benefit-cost ratio may reflect farm scale and revenue differences. The adjusted per-hectare association with profit margin was small and not statistically significant; thus, the analysis does not demonstrate that greater pest-control expenditure improves profitability.

The severity-yield relationship is unstable. Its original positive direction changes under sensitivity checks, and 64 repeated endpoint-group yield values were not verified against the original questionnaires. Accordingly, the results should not be interpreted as showing that greater severity improves yield. Afolayan et al. (2018) provide complementary field-based evidence on cultivar performance in Kano, but that experimental design addresses a different question from this farmer survey. Future work should combine verified pest identification, crop-cut yield measurement and farm-level economic records.

The negative extension and training correlations do not show that support reduces profitability. Farmers facing more serious pest problems may be more likely to seek advice or attend training, creating selection effects. Credit access could not be tested in the complete-case subset because it had no variation. These results identify issues for better-designed research rather than evidence against institutional support. Post-harvest studies in Nigeria (Olayide et al., 2024; Arua et al., 2025) address a separate source of value-chain loss and should not be conflated with field infestation.

5. Conclusion and Policy Implications

This study describes reported pest infestation and farm-level tomato economics among 326 farmers in five LGAs of Kano North. Respondents consistently identified T. absoluta, and most reported infestation beginning at fruiting. Average gross margin and benefit-cost ratio were positive among complete-cost observations. However, unusual response patterns and the observational design constrain interpretation of the severity-yield, pest-control and institutional-support

associations. The findings do not establish causal effects. Extension agencies should strengthen practical pest identification, field scouting and integrated pest-management training, while encouraging farm records for area, harvest, sales, prices and input costs. Future studies should use multi-season data, verified pest assessment, crop-cut yield measurement and appropriately adjusted analytical designs.

Limitations

i. The cross-sectional design does not establish causality.
ii. All respondents reported the same major pest category, preventing cross-pest comparisons.
iii. Thirty-two missing other-chemical cost values reduced cost-based analysis to 294 observations.
iv. The severity-yield relationship is unstable; 64 repeated endpoint-group yield values were not verified against original completed questionnaires.
v. The institutional-support complete-case subset had no variation in credit access.
vi. The reported financial-loss measure may overlap with other economic measures and was kept separate.

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