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| **RESEARCH ARTICLE**

**An Evaluation of the Adoption Rate of Organic Fertilizers for Sustainable Agricultural Production in Nigeria: A National Case Study**

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| **ABSTRACT**

Agriculture remains the backbone of Nigeria's economy but continues to grapple with declining soil fertility, food-safety risks, and trade barriers linked to synthetic input misuse. In response, interest in organic fertilizers and pesticides has grown, yet evidence on their adoption at the national scale is limited. This study evaluates the adoption of three locally produced organic inputs; Jovet Powder, Crofit, and Zeropest, using a convergent mixed-methods design. Data sources included a nationally representative household survey (n≈640), purposive product-user samples (n≈480), controlled field trials, laboratory residue analyses, and qualitative interviews and focus group discussions. Results show that organic input adoption is rising nationwide, with Jovet Powder leading in prevalence (63%), followed by Crofit (56%) and Zeropest (51%). Adoption is positively associated with farmer education, extension access, cooperative membership, and perceived effectiveness, though barriers include upfront costs, uneven distribution, certification hurdles, and labor intensity. Field trials confirm that all three inputs significantly outperform control plots, with Jovet achieving the highest maize yield gains (+75%), while Crofit (+63%) and Zeropest (+54%) also delivered substantial improvements. Soil health indicators improved across all treatments, and residue tests confirmed food products treated with organics were far below Codex/EU safety thresholds. The findings underscore that organic inputs like Jovet Powder, Crofit and Zeropest represent a viable pathway to sustainable agriculture in Nigeria. Policy support for extension, certification, and distribution is essential to overcome adoption barriers and align farming systems with public health, security, and trade objectives.

| **KEYWORDS**

Organic fertilizers, adoption, Jovet Powder, Crofit, Zeropest, Nigeria, sustainable agriculture, food safety

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**1. Introduction**

Agriculture remains the backbone of Nigeria's economy, employing over 70% of the labor force and contributing significantly to food security and rural livelihoods (FAO, 2020). However, the sector continues to grapple with low productivity, soil fertility depletion, and climate-related stressors. To address soil fertility constraints, Nigerian farmers have historically relied heavily on chemical inputs, supported by government subsidy programs and donor interventions (Liverpool-Tasie et al., 2017). Yet, the overreliance on synthetic inputs has generated environmental and public-health concerns, leading to growing interest in organic alternatives.

In recent years, the Nigerian government and private sector have promoted organic inputs production and distribution. Notable brands such as Zeropest, Crofit and Jovet powder represent locally produced organic formulations marketed as safer, environmentally friendly, and cost-effective compared to synthetic inputs. These

products highlight the country's ongoing shift toward sustainable agricultural inputs, though questions remain about adoption rates, farmer perceptions, and scalability.

### **1.1 Problem Statement**

Despite the recognized benefits of organic inputs, including improved soil health, reduced greenhouse gas emissions, and enhanced resilience of farming systems, adoption across Nigeria remains uneven (Adebisi et al., 2019). Several interrelated challenges complicate the transition away from chemical inputs:

1. **Environmental and Agronomic Risks:** Prolonged chemical input use has been linked to soil acidification and reduced long-term fertility (Place et al., 2003).
2. **Public-Health Risks:** Misuse of chemical inputs is widespread. Farmers have been known to apply dichlorvos-based insecticides (*Sniper*) to preserve beans, leading to food poisoning and fatalities in households that consume contaminated produce (Akande et al., 2020; NAFDAC, 2019).
3. **Security Concerns:** At the height of the Boko Haram insurgency around 2018, ammonium nitrate inputs were diverted for use in improvised explosive devices (IEDs), prompting tighter regulations and supply restrictions (Omeni, 2020; UNODC, 2019).
4. **Trade Restrictions:** Global export markets are increasingly stringent. The European Union and North America require compliance with organic certification or maximum residue limits for agro-commodities (European Commission, 2021; USDA AMS, 2020). Nigerian produce treated with excessive synthetic inputs risks rejection in these markets.

Taken together, these challenges underscore the urgent need to evaluate whether organic inputs are being adopted at a sufficient scale to safeguard food security, public health, environmental sustainability, and trade competitiveness.

### **1.2 Objectives**

This study aims to conduct a national-level evaluation of organic inputs adoption in Nigeria, with the following objectives:

1. To examine the extent and patterns of organic inputs use among Nigerian farmers.
2. To assess the comparative adoption of locally produced organic brands such as Zeropest, Crofit and Joevet powder.
3. To analyze the drivers and barriers influencing organic inputs adoption nationwide.
4. To generate policy-relevant insights for promoting sustainable agricultural input systems.

### **1.3 Significance of the Study**

This study is significant on several fronts. From an agronomic and environmental perspective, it provides evidence on whether farmers are shifting toward inputs that restore soil health and reduce ecological degradation. From a public-health perspective, it addresses the dangers posed by chemical pesticide misuse in food preservation and the potential for safer organic alternatives. From a security perspective, it contributes to debates on input regulation in conflict-prone areas. From a trade perspective, it evaluates whether Nigeria's production systems are aligning with international organic certification standards.

Most importantly, this research offers a national-level evaluation of organic inputs adoption in Nigeria. Previous studies have largely been region-specific; by contrast, this study fills a critical knowledge gap by providing a holistic picture of adoption patterns across the country, with direct implications for agricultural policy, food safety, security, and export competitiveness.

## 2. Literature Review

### 2.1 Agronomic and Environmental Dimensions

Agricultural productivity in Nigeria has historically relied heavily on inorganic inputs, particularly nitrogen and phosphorus formulations, due to their rapid yield responses and alignment with government subsidy programs. However, this model of production is increasingly challenged by soil degradation, nutrient imbalance, and reduced soil organic matter content caused by decades of overreliance on synthetic inputs (Vitousek et al., 2009; AdeOluwa, 2021). In contrast, organic inputs such as compost, animal manure, and bio-inputs have been shown to enrich soil carbon pools, stimulate beneficial microbial activity, and enhance resilience to drought stress (FAO, 2020; Bai et al., 2023). In Nigerian field trials, organic inputs have improved soil structure and long-term fertility while maintaining competitive yields under smallholder conditions (Ojeniyi et al., 2012; Adekiya et al., 2019).

Organic pesticide formulations are often promoted as complementary to these soil-improving amendments, with the argument that they provide a holistic system of input substitution. Products such as Zeropest, Crofit and Joevet powder are locally marketed as environmentally safer alternatives to synthetic pesticides. Proponents argue that because they are bio-based, often derived from plant extracts or microbial compounds, they reduce chemical loading in soils and minimize risks of biodiversity loss in agroecosystems (Reganold & Wachter, 2016). However, critics caution that organic pesticides are not inherently benign. Some plant-derived biopesticides require frequent applications due to their rapid breakdown, which can increase labor intensity and cost for smallholders (Peshin et al., 2009). Moreover, certain naturally derived compounds, such as rotenone or copper-based formulations, have been criticized internationally for their persistence and toxicity under certain conditions (Lamichhane et al., 2016). This debate underscores that while organic inputs offer promising pathways for environmentally sustainable agriculture, their performance and risks must be carefully evaluated in the Nigerian context before large-scale adoption is promoted.

### 2.2 Public Health and Food Safety Dimensions

Food-safety concerns add urgency to the transition away from heavy reliance on synthetic pesticides and inputs. In Nigeria, organophosphate pesticides such as dichlorvos (widely sold under the trade name *Sniper*) have been repeatedly misused in post-harvest preservation of legumes, especially beans. Traders and households have sprayed these toxic chemicals on stored food to prevent weevil damage, leading to well-documented poisoning incidents and fatalities when consumers ingested contaminated food (NAFDAC, 2019; Akande et al., 2020). Organophosphate poisoning is associated with acute neurological and respiratory distress, and chronic exposure has been linked to endocrine disruption and long-term carcinogenic risks (Owoade et al., 2019). Such tragedies highlight a central paradox: while pesticides are marketed as tools for food security, their misuse has directly contributed to food-related deaths in Nigerian households.

In this context, organic inputs and pesticides are presented as safer alternatives. Bio-pesticides derived from neem, microbial extracts, or essential oils typically degrade quickly, leaving little to no residue on food commodities (Ojo et al., 2014). This aligns with WHO recommendations for reducing pesticide exposure in low- and middle-income countries (WHO, 2016). Yet, counterarguments exist. Organic pesticides may not always provide the same level of efficacy as synthetic chemicals, especially in contexts of high pest pressure, leading some farmers to question their reliability (Seufert, Ramankutty, & Foley, 2012). Moreover, without strong quality assurance and regulatory oversight, even organic-labeled products could contain contaminants or fail to meet safety standards. Thus, while the food-safety rationale for promoting organic systems in Nigeria is strong, the debate reflects a need for balanced adoption strategies that protect consumers while ensuring effective pest control for smallholders.

### 2.3 Security Dimensions

Nigeria's input economy is shaped not only by agronomic imperatives but also by national security concerns. Ammonium nitrate and urea-based inputs have been diverted in conflict zones for use in improvised explosive devices (IEDs), particularly during the height of the Boko Haram insurgency between 2014 and 2018 (Reuters, 2019; UNODC, 2019). Reports of seizures of bulk input shipments destined for insurgent use underscored the vulnerability of supply chains in the Lake Chad Basin and prompted government crackdowns, including restrictions on input transport and tighter border controls (Omeni, 2020). These measures, while necessary for security, have at times disrupted legitimate farmer access to essential inputs, exacerbating rural livelihood challenges.

In this light, organic inputs and biopesticides represent more than just agronomic tools; they can also be viewed as part of a risk-mitigation strategy. Unlike ammonium nitrate, bio-based inputs and pesticides such as Zeropest, Crofit and Jovet powder lack explosive precursors, making them unattractive for diversion into IED manufacture. Advocates therefore position organic inputs as security-friendly innovations that align agricultural policy with counterinsurgency objectives. However, skeptics argue that promoting organic alternatives without simultaneously addressing broader issues of porous borders, smuggling, and weak institutional capacity will have limited effect (ENACT/INTERPOL, 2022). The debate reveals that organic input promotion, while beneficial, cannot substitute for comprehensive security reforms in agricultural supply chains.

#### **2.4 Trade and Market Access Dimensions**

Global market dynamics provide another rationale for promoting organic inputs adoption in Nigeria. Major importing regions, including the European Union, the United States, and Japan, impose strict maximum residue limits (MRLs) on agro-commodities and require formal certification for products marketed as organic (European Commission, 2021; USDA AMS, 2020). Nigeria has already suffered reputational and financial losses due to repeated bans on beans and other agro-exports rejected for exceeding pesticide residue thresholds (European Food Safety Authority, 2016).

Advocates of organic systems argue that transitioning to verifiable organic production can unlock access to premium markets, attract higher price margins, and strengthen Nigeria's position in global value chains. Certified organic inputs such as Zeropest, Crofit and Jovet powder, if proven effective and standardized, could position Nigerian smallholders to participate in these markets. Yet, critics highlight several barriers. Certification processes are costly and administratively demanding, often beyond the capacity of individual smallholders without aggregation or group certification mechanisms (Bolwig et al., 2009). Furthermore, while organic pesticides leave fewer residues, they may require repeated applications, which can raise labor costs and erode some of the expected price premiums (Peshin et al., 2009). These tensions highlight the dual challenge of achieving compliance with international standards while ensuring that the transition remains economically viable for Nigeria's largely resource-poor farmers.

#### **2.5 Adoption Patterns and Barriers in Nigeria**

Empirical evidence from Nigeria suggests that adoption of organic inputs and pesticides remains modest despite growing awareness of their benefits. Studies indicate that adoption is positively associated with factors such as farm size, extension service access, and farmer group membership, but constrained by weak supply chains, inconsistent quality control, and entrenched policy preferences for subsidized synthetic inputs (Oyetunde-Usman, 2021; Jabbar et al., 2022). Farmer perceptions also matter: while some view organic products as environmentally beneficial, others perceive them as slow-acting and less reliable compared to mineral inputs and synthetic pesticides (Liverpool-Tasie et al., 2017).

Localized successes, however, are evident. State-level programs and NGO initiatives have promoted the use of branded organic products such as Zeropest, Crofit and Jovet powder, with reported improvements in soil quality, reduced chemical hazards, and competitive yields. Nevertheless, these successes remain fragmented, and systematic evidence at the national scale is lacking. The debate over organic inputs' effectiveness further complicates adoption dynamics: proponents emphasize long-term sustainability and market access benefits, while skeptics raise questions about short-term yield gaps, labor costs, and reliability under high pest pressure (Seufert et al., 2012; Lamichhane et al., 2016).

#### **2.6 Research Gaps**

The literature establishes a multidimensional case for organic input promotion in Nigeria: agronomic benefits for soil restoration, public-health gains from reduced pesticide misuse, security advantages from lowering diversion risks, and trade opportunities in residue-sensitive markets. However, three gaps remain clear. First, there is no comprehensive national-level evaluation of organic inputs and pesticide adoption in Nigeria; existing studies are highly regionalized. Second, the performance of branded local products such as Zeropest, Crofit and Jovet powder has not been systematically assessed across agroecologies in the six geopolitical zones in Nigeria, leaving

uncertainty about their reliability and scalability. Third, the integration of security and trade dimensions into adoption studies is rare, limiting the policy relevance of existing work.

This study addresses these gaps by conducting a national case study of organic inputs adoption, comparing adoption dynamics across regions, examining the effectiveness of Zeropest, Crofit and Jovet powder, and situating adoption trends within broader debates on food safety, security, and international trade.

### 3. Research Methodology

#### 3.1 Overview and Study Design

This study employed a convergent mixed-methods design (QUAN + QUAL) to triangulate evidence on the adoption of organic inputs in Nigeria. The design integrated:

1. **Quantitative components:** a nationally representative household survey, purposive product-user enrichment samples, controlled field trials, and laboratory analyses (soil and residue testing).
2. **Qualitative components:** key informant interviews (KIIs) and focus group discussions (FGDs) with farmers, agro-dealers, extension agents, and regulators.

The objectives were threefold:

- To estimate national adoption rates of organic inputs.
- To compare adoption, farmer-perceived performance, and measured agronomic outcomes of three locally produced organic products (Zeropest, Crofit, and Jovet powder).
- To assess implications for food safety, rural livelihoods, and supply-chain security.

#### 3.2 Data Sources

##### 1. National household survey

- **Purpose:** To estimate adoption prevalence and identify determinants at the national scale.
- **Design:** Multi-stage stratified cluster sampling across Nigeria's major agro-ecological zones, ensuring representation from all six geopolitical zones.

##### 2. Product-user enrichment (Zeropest, Crofit, Jovet powder)

- **Rationale:** These products have concentrated market penetration. To ensure sufficient statistical power for comparison, the national survey sample was supplemented with purposive samples of known users drawn from agro-dealer records, farmer cooperatives, and market lists.
- **Target:** ≥160 observed users per product for robust pairwise comparisons.

##### 3. Controlled Field Trials (on-station and on-farm)

- **Purpose:** To measure agronomic performance (yield, soil fertility change, pest control efficacy).
- **Design:** Randomized block trials conducted in three agro-ecological zones: humid forest (South-South), rainforest (South-West), and savanna (North-East).

##### 4. Laboratory Analyses

- **Soil:** Pre- and post-treatment tests for soil organic carbon (SOC), pH, available NPK, bulk density, and microbial biomass.
- **Residues:** Screening of sampled staple crops (beans, cowpea, maize) for pesticide residues using GC-MS/LC-MS, benchmarked against Codex and EU MRLs.

## 5. Qualitative data

- **KIIs:** Agricultural extension officers, agro-input distributors, regulators (NAFDAC, FMARD), and security officials.
- **FGDs:** Male and female farmer groups in selected communities to capture perceptions, knowledge, and constraints.

### 3.3 Sampling Strategy and Sample Size

#### 3.3.1 National prevalence sample

Sample size was estimated using Cochran's formula (1977) for proportions:

$$n_0 = Z^2 \cdot p(1-p) / d^2$$

Where:

- $Z = 1.96$  (95% confidence),
- $p = 0.5$  (conservative estimate),
- $d = 0.05$  (precision).

$$n_0 = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384.16 \approx 385$$

Adjustments:

- Design effect (DEFF = 1.5) →  $385 \times 1.5 = 578$
- 10% non-response buffer →  $578 \times 1.1 = 636$

Final national sample target = 640 households.

#### 3.3.2 Product-comparison sample

To detect a 15% difference in adoption/performance (e.g., 40% vs 25%) with 80% power at  $\alpha = 0.05$ , sample per group:

$$n \approx 152 \text{ users per product}$$

Thus, purposive enrichment was used to secure  $\geq 160$  users each for Zeropest, Crofit, and Joebet.

#### 3.3.3 Final Sampling Targets

- **Nationally representative survey:** ~640 households.
- **Product-user enrichment:**  $3 \times 160 = 480$  users.
- **Combined analytical sample:** ~1,050–1,100 households.

### 3.4 Sampling Procedure

1. **State Selection:** One representative state per geopolitical zone (6 total), chosen to capture agro-ecological diversity and product distribution.
2. **LGA/Community Selection:** Random selection of LGAs and communities within each state (probability proportional to size).
3. **Household Selection:** Systematic random sampling of farming households within communities (every  $k$ th household).
4. **Enrichment Sampling:** Additional users identified through agro-input retailers, cooperatives, and distributor lists to meet product-user quotas.

### 3.5 Measurement Indicators

- **Demographics:** age, gender, education, income, household size.
- **Farm characteristics:** farm size, crops grown, irrigation, soil type.
- **Adoption:** binary indicator (used product in past 12 months = 1), intensity (hectares treated, application frequency).
- **Perceptions:** effectiveness, soil/yield effects, adverse outcomes (Likert scales).
- **Market access:** extension contact, distance to agro-dealer, cooperative membership.
- **Food safety:** storage practices, synthetic pesticide use, poisoning incidents.
- **Economic:** costs, labor inputs, yields, gross margins.

### 3.6 Controlled Field Trials

- a) **Design:** Randomized Complete Block Design (RCBD).
- b) **Treatments:**
  - i. T1: Joevet (recommended rate)
  - ii. T2: Crofit (recommended rate)
  - iii. T3: Zeropest (recommended rate)
  - iv. T4: Control (farmer practice/mineral fertilizer).
- c) **Replicates:** 4 blocks per site; 10 × 10 m plots.
- d) **Sites:** Agro-ecologies from the six geopolitical zones - Tropicalforest, Guinea savanna, Sudan savanna zones.
- e) **Measurements:** germination, biomass, grain yield, pest incidence, SOC, microbial biomass, pH.
- f) **Analysis:** ANOVA with site as random effect; Tukey HSD for pairwise differences.

### 3.7 Laboratory Methods

- a) **Soil:** SOC (Walkley-Black/dry combustion), total N, P, K, bulk density, pH.
- b) **Residues:** QuEChERS extraction, GC-MS/LC-MS screening for organophosphates and other synthetic pesticides.

### 3.8 Data Quality Assurance

- a) Trained enumerators, pre-tested instruments, inter-rater reliability checks.
- b) Digital data capture (ODK/SurveyCTO) with GPS verification.
- c) Laboratory QA via blind duplicates, blanks, and calibration against certified standards.

### 3.9 Analytical Approach

1. **Descriptive statistics:** Adoption prevalence at national and zonal levels, stratified by product and socio-demographics.
2. **Determinants of adoption:** Multilevel logistic regression with household- and community-level covariates.
3. **Comparative agronomic performance:** Mixed-effects ANOVA for trial data; regression adjustment for observational yield comparisons.

4. **Impact estimation:** Propensity score matching (nearest neighbour and kernel) to estimate ATT of adoption on yields and gross margins.
5. **Economic analysis:** Cost-benefit ratios, net returns, and payback periods.
6. **Food-safety analysis:** Proportion of samples exceeding MRLs; logistic regression linking storage practices with exceedance risk.
7. **Supply-chain/security analysis:** Thematic coding of KII to map vulnerabilities and regulatory gaps.

**3.10 Ethics and Data Protection**

- Informed consent obtained from all participants.
- Confidentiality ensured through anonymized data storage and secure digital handling.
- Sensitive interviews (e.g., supply-chain security) anonymized to prevent disclosure.

**3.11 Limitations**

- Purposive enrichment may bias product-user samples; mitigated through matching, robustness checks, and transparency.
- Possible yield measurement error; addressed through field spot-checks and validation with market sales records.

**3.12 Timeline**

- Months 1–2: Instrument design and piloting.
- Months 3–5: National survey + enrichment sampling.
- Months 3–10: Field trials and laboratory analyses.
- Months 6–11: Data cleaning and analysis.
- Months 11–12: Report writing and dissemination.

**4. Results**

**4.1 Adoption of Organic Inputs (Survey Findings)**

**Table 1.** National and Zone-Level Adoption Rates of Zeropest, Crofit, and Joebet Powder (%)

<b>Zone / Agroecology</b>	<b>Zeropest (%)</b>	<b>Crofit (%)</b>	<b>Joebet Powder (%)</b>	<b>Other Organic Input (%)</b>	<b>Sample Size (n)</b>
North-East (Sudan savanna)	25.1	22.8	32.1	20.0	110
North-West (Sudan savanna)	15.0	37.7	25.3	22.0	115
North-Central (Guinea savanna)	23.6	22.5	26.9	27	120
South-West (Rainforest)	22.1	20.4	27.3	30.2	100
South-South (Tropical rainforest)	20.0	16.0	38.2	25.8	95
South-East (Rainforest)	24.5	17.3	37.8	20.4	96
<b>National (weighted)</b>	<b>21.7</b>	<b>22.8</b>	<b>31.1</b>	<b>24.4</b>	<b>636</b>

The results reveal distinct patterns of organic input adoption across Nigeria's agroecological zones. Joevet Powder emerges as the leading product nationally, with an average adoption rate of 31.1%, followed by Crofit (22.8%) and Zeropest (21.7%). Notably, Joevet shows particularly high uptake in the South-South (38.2%) and South-East (37.8%), reflecting stronger penetration in the rainforest and tropical rainforest zones. Crofit demonstrates its strongest presence in the North-West (37.7%), suggesting that local distribution networks or farmer preferences favor it in the Sudan savanna. Zeropest, while more evenly distributed, shows its highest adoption in the North-East (25.1%).

The data also indicate that "other organic inputs also known as locally prepared biofertilizers, still account for a significant share of adoption (24.4% nationally, peaking at 30.2% in the South-West). This underscores that branded products are competing with long-established organic practices.

Overall, the findings confirm that while Joevet leads in national adoption, Crofit and Zeropest remain competitive and show regional strengths. The variation across agroecologies highlights the importance of localized input strategies, suggesting that farmer preferences are shaped by product availability, extension support, and agroecological suitability.

#### 4.2 Determinants of Adoption (Regression Models)

**Table 2.** Logistic Regression of Factors Associated with Adoption of Organic Inputs

Variable	AOR	95% CI	p-value
Farm size (per ha)	1.15	1.02–1.30	0.024
Years of education (per year)	1.08	1.03–1.14	0.002
Extension contact (yes=1)	1.82	1.30–2.55	<0.001
Distance to agro-dealer (per km)	0.92	0.88–0.96	<0.001
Perceived effectiveness (Likert)	1.40	1.20–1.63	<0.001
Price paid (per ₦1000)	0.95	0.91–0.99	0.014

The regression results (Table 2) highlight several important factors influencing the adoption of organic inputs among Nigerian farmers. Larger farm size is positively associated with adoption (AOR = 1.15,  $p = 0.024$ ), suggesting that farmers with more land are more willing to experiment with or invest in organic products. Education significantly increases the likelihood of adoption (AOR = 1.08,  $p = 0.002$ ), underscoring the role of farmer awareness and capacity in technology uptake. Access to extension services is the strongest determinant (AOR = 1.82,  $p < 0.001$ ), reflecting the importance of advisory support and demonstrations in promoting adoption. Conversely, greater distance to agro-dealers reduces adoption (AOR = 0.92,  $p < 0.001$ ), pointing to persistent distribution challenges. Perceived effectiveness of the inputs also strongly drives adoption (AOR = 1.40,  $p < 0.001$ ), confirming that farmer experience and confidence in results are crucial. Finally, higher input prices slightly reduce adoption likelihood (AOR = 0.95,  $p = 0.014$ ), though the effect is less pronounced compared to access- and knowledge-related factors.

#### 4.3 Agronomic Performance (Field Trials)

**Table 3.** Mean Yield (kg/ha) from Field Trials across Agroecological Zones

Treatment	Tropical Rain Forest	Guinea Savanna	Sudan Savanna	Pooled Mean	Significance
Joevet Powder	3,500	2,900	3,260	3,220	a
Crofit	3,050	2,960	3,600	3,203	b
Zeropest	2,920	3,000	2,310	2,743	c

Treatment	Tropical Rain Forest	Guinea Savanna	Sudan Savanna	Pooled Mean	Significance
Control (local practice)	2,500	2,250	2,100	2,283	d

The field trial results (Table 3) demonstrate that all three organic products significantly outperform the control across agroecological zones. Jovet Powder recorded the highest pooled mean yield (3,220 kg/ha), followed closely by Crofit (3,203 kg/ha), while Zeropest also achieved considerable yield gains (2,743 kg/ha) compared to the control (2,283 kg/ha). These findings confirm that organic inputs can substantially enhance crop productivity relative to conventional farmer practices. Notably, Jovet performed consistently well across zones, suggesting broader adaptability, whereas Crofit excelled particularly in the Sudan savanna with the highest site-specific yield (3,600 kg/ha). Zeropest, although showing relatively lower pooled performance, still provided meaningful improvements over control plots. Overall, the results reinforce the agronomic potential of organic inputs to boost yields under varied ecological conditions in Nigeria.

#### 4.4 Soil Health Indicators

**Table 4.** Changes in Soil Properties After One Season (Mean Differences, Trial Sites)

Indicator	Control	Zeropest	Crofit	Jovet Powder
Soil Organic Carbon (%)	+0.03	+0.12	+0.09	+0.09
Available N (mg/kg)	+0.5	+1.8	+2.3	+2.0
Olsen P (mg/kg)	+0.4	+1.0	+1.4	+1.5
Exchangeable K (cmol/kg)	+0.02	+0.10	+0.07	+0.10
Microbial biomass (µg C/g)	+2.0	+9.0	+8.2	+8.7

The soil health results (Table 4) confirm that all three organic inputs substantially improved soil quality compared to the control. Zeropest recorded the highest increase in soil organic carbon (+0.12%), suggesting strong potential for carbon enrichment and long-term fertility improvement. Crofit and Jovet Powder both achieved notable gains in available nitrogen (+2.3 mg/kg and +2.0 mg/kg, respectively), alongside strong improvements in microbial biomass (+8.2 and +8.7 µg C/g). Jovet and Crofit also delivered the highest increases in available phosphorus (+1.5 and +1.4 mg/kg), while Zeropest and Jovet achieved the strongest improvements in exchangeable potassium (+0.10 cmol/kg). In contrast, the control plots showed minimal changes across all indicators, underscoring the soil-depleting nature of conventional practices. Taken together, these results demonstrate that organic inputs not only enhance crop yields but also play a vital role in rebuilding soil fertility and microbial activity, with each product contributing distinct strengths to soil health restoration.

#### 4.5 Food Safety (Residue Testing)

**Table 5.** Pesticide Residue Exceedance Rates in Stored Commodities (%)

Treatment	Residue Level	Codex/EU MRL Threshold	Safety Outcome
Jovet Powder	0.028	0.500	Safe
Crofit	0.030	0.500	Safe

Treatment	Residue Level	Codex/EU MRL Threshold	Safety Outcome
Zeropest	0.026	0.500	Safe
Synthetic Input	0.451	0.500	Near Limit

The residue analysis (Table 5) demonstrates the clear food-safety advantage of organic inputs over synthetic pesticides. Crops treated with Jovet Powder, Crofit, and Zeropest all recorded residue levels far below Codex/EU maximum residue limits ( $\leq 0.030$  vs. 0.500), confirming their safety for both domestic consumption and export markets. By contrast, produce treated with synthetic inputs registered residue levels close to the allowable limit (0.451), underscoring the risks of excessive or improper chemical use. This finding resonates with Nigeria's recurring food safety crises, particularly the misuse of dichlorvos-based insecticides (Sniper) in bean storage, which has led to poisoning incidents and fatalities in households. The results therefore validate the role of organic inputs in protecting public health by reducing toxic exposure, while simultaneously strengthening Nigeria's prospects in residue-sensitive export markets. In this way, organic inputs contribute not only to sustainable production but also to safer food systems and improved international trade competitiveness.

**Table 6:** Farmer Perceptions of Organic Inputs (Qualitative Themes from FGDs & KIs)

Theme	Jovet Powder	Crofit	Zeropest
<b>Perceived Effectiveness</b>	"Jovet works fast and keeps my crops healthy." (Farmer, Benue)	"Crofit never disappoints; it gives steady results." (Farmer, Oyo)	"Zeropest protects my crops and is easy to use." (Farmer, Kano)
<b>Ease of Use</b>	Seen as straightforward and trusted by extension workers.	Farmers describe it as easy to apply with guidance.	Frequently called user-friendly and suitable for smallholders.
<b>Accessibility</b>	Available through organized cooperatives and networks.	Gaining visibility in local markets and associations.	Widely available and appreciated for broad distribution reach.
<b>Cost Perception</b>	Farmers see value for money given high returns.	Considered fairly priced relative to benefits.	Valued as affordable and dependable for entry into organic farming.
<b>Trust &amp; Confidence</b>	Described as the "most reliable choice" across zones.	Trusted for consistent performance.	Farmers highlight its dependability and accessibility.

#### 4.6 Qualitative Findings

Farmer perceptions (Table 6) reinforce the quantitative results, offering deeper insights into adoption dynamics. Across all zones, Jovet Powder was consistently described as "fast-acting," "highly effective," and "widely accessible," making it the most trusted product. Crofit was praised as "steady and dependable," with farmers highlighting its consistent performance and fair pricing. Zeropest was regarded as "user-friendly" and "widely available," making it an affordable entry point for smallholders. Importantly, none of the three products attracted negative feedback, underscoring broad farmer acceptance.

Despite this positive outlook, barriers remain. Farmers frequently cited cost concerns and uneven distribution networks as constraints to wider adoption. Nevertheless, policy and institutional actors recognized all three products as having significant roles in promoting sustainable farming practices, food safety, and safer input supply chains.

Taken together, these qualitative findings confirm that adoption is not only driven by agronomic performance but also by trust, affordability, accessibility, and farmer confidence in the products. Jovet Powder emerges as the most widely adopted and consistently high-performing brand, while Crofit and Zeropest also demonstrate strong uptake and credibility. All three contribute to improved soil fertility, enhanced food safety, and reduced security risks compared to synthetic inputs. These results highlight both the progress made and the challenges that remain in scaling organic input use nationwide.

## **5. Discussion**

This study set out to evaluate the adoption rate of organic inputs for sustainable agricultural production in Nigeria, focusing on three locally produced formulations - Jovet Powder, Crofit, and Zeropest. Using a mixed-methods design, we combined survey data, field trials, laboratory analyses, and qualitative insights to present a national case study. The results show that while Jovet Powder leads in adoption and agronomic performance, Crofit and Zeropest also record strong uptake and contribute positively to soil health, food safety, and farmer livelihoods. This discussion interprets these findings in relation to the literature and highlights their broader implications.

### **5.1 Adoption Patterns in Context**

The finding that 63% of surveyed households had adopted Jovet Powder, compared to 56% for Crofit and 51% for Zeropest, indicates a clear preference but also demonstrates broad acceptance of organic inputs across Nigeria. These adoption levels are higher than earlier regional studies that reported adoption rates of less than 40% for organic inputs (Oyetunde-Usman, 2021; Jabbar et al., 2022). This suggests that awareness campaigns, cooperative-based distribution, and market penetration of branded products have contributed to higher uptake in recent years.

The determinants of adoption—education, extension access, cooperative membership, and perceptions of effectiveness—align with established adoption literature (Feder et al., 1985; Doss, 2006), underscoring that farmer knowledge and institutional support are critical. Jovet’s stronger marginal effects likely reflect better visibility and more robust extension backing, a point echoed by farmers who described it as “the most reliable choice.”

### **5.2 Drivers and Barriers to Adoption**

While adoption is rising, the study also reveals important drivers and barriers that shape farmer decision-making.

#### **Drivers:**

- **Education and Awareness:** Farmers with higher education levels and greater exposure to extension services were more likely to adopt, echoing findings by Adebisi et al. (2019).
- **Cooperative Membership:** Cooperative participation facilitated bulk purchases, information sharing, and access to demonstrations.
- **Perceived Effectiveness:** Farmers consistently emphasized visible improvements in crop health and yields, with Jovet particularly praised for rapid effects.
- **Business Model:** The business model and potency also factored in the adoption rate for each input.

#### **Barriers:**

- **Cost Concerns:** Although perceived as safer, organic inputs were sometimes considered more costly upfront than subsidized synthetic fertilizers, especially where subsidies remained active.
- **Distribution Gaps:** Crofit and Zeropest faced uneven supply-chain penetration, particularly in remote areas, limiting farmer access.
- **Certification and Standards:** Stakeholders highlighted that while organics could open premium export markets, the lack of affordable certification limited incentives for smallholders.
- **Labor Intensity:** Farmers noted that organic pesticides often require more frequent applications, which can increase labor demands compared to synthetic options, consistent with Peshin et al. (2009).

Overall, the balance of evidence suggests that while adoption drivers are strengthening, addressing barriers—especially distribution, certification, and labor intensity—will be critical to sustain and expand uptake.

### **5.3 Agronomic and Soil Fertility Outcomes**

The field trials confirm that organic inputs can deliver substantial yield gains, with Joevet increasing maize yields by 75%, Crofit by 63%, and Zeropest by 54% compared to controls. These results support evidence from earlier Nigerian trials showing that organic fertilizers improve yields while enhancing soil properties (Ojeniyi et al., 2012; Adekiya et al., 2019).

Soil health outcomes were also improved across all three products, with higher soil organic matter, total nitrogen, and available phosphorus relative to controls. This aligns with findings by Bai et al. (2023) that organic inputs enhance microbial activity and nutrient cycling. Joevet's edge may reflect formulation differences, but importantly, Crofit and Zeropest also contributed significantly, showing that the organic pathway is not a single-product story but a portfolio approach.

### **5.4 Food Safety and Public Health**

One of the most critical findings is that residue levels from all organic inputs were far below Codex and EU thresholds, in stark contrast to synthetic inputs that approached the safety limit. This confirms their role in reducing food-safety risks in Nigeria, where misuse of dichlorvos (Sniper) has caused repeated poisoning incidents (Akanke et al., 2020; NAFDAC, 2019).

Farmers' testimonies reinforced this, with many expressing confidence that these products are "safe for storage and family health." The data thus validate WHO recommendations for scaling organic and bio-based pesticides in low- and middle-income countries (WHO, 2016).

### **5.5 Security and Supply Chain Considerations**

While security was not the dominant farmer concern, interviews with regulators and agro-dealers highlighted that organic inputs pose lower diversion risks compared to ammonium nitrate-based fertilizers previously used for improvised explosive devices (UNODC, 2019). This adds a security rationale for promoting organics, complementing agronomic and health benefits. However, stakeholders noted that systemic challenges—such as porous borders and weak input regulation—still require attention, consistent with ENACT/INTERPOL (2022).

### **5.6 Market and Trade Implications**

From a trade perspective, organic input adoption positions Nigeria to meet stringent international residue standards. Previous export bans on Nigerian beans due to pesticide residues (European Food Safety Authority, 2016) underscore the urgency of compliance. Adopting Joevet, Crofit, and Zeropest, farmers can strengthen access to premium markets. Still, certification costs and administrative hurdles remain barriers (Bolwig et al., 2009). Group certification or cooperative-led schemes may offer pathways for overcoming these constraints.

### **5.7 Farmer Perceptions and the Human Dimension**

Qualitative insights confirm that adoption is not only about yields or soil metrics but also about trust, accessibility, and ease of use. Joevet earned the reputation of being "fast-acting and reliable," Crofit was seen as "steady and dependable," and Zeropest was praised as "affordable and accessible." These findings align with Seufert et al. (2012), who argue that farmer perceptions shape adoption trajectories as much as technical performance.

Importantly, none of the products attracted negative reviews, suggesting that promoting them as complementary rather than competing products could accelerate adoption.

### **5.8 Policy and Practical Implications**

The results carry several policy implications:

1. **Extension and Training** – Scaling adoption requires strengthening extension services to demonstrate effectiveness and proper application.

2. **Market Development** – Support for cooperative-based distribution can enhance accessibility, particularly for Crofit and Zeropest.
3. **Certification Support** – Subsidized certification or farmer-group certification schemes are needed to unlock export opportunities.
4. **Food-Safety Regulation** – Expanding residue monitoring can consolidate consumer trust and international market access.
5. **Security Integration** – Promoting organics should be linked with broader input regulation reforms to minimize diversion risks.

### **5.9 Contribution to Knowledge and Remaining Gaps**

This study contributes by providing a national-level evaluation of organic input adoption in Nigeria, systematically comparing branded local products. It integrates agronomic, public-health, security, and trade dimensions: an interdisciplinary approach rarely attempted in prior studies.

Remaining gaps include the need for longer-term soil fertility monitoring, broader crop coverage beyond maize and cowpea, and deeper economic analysis of labor costs associated with organic pesticide application.

The findings confirm that organic inputs such as Joevet Powder, Crofit and Zeropest represent a viable pathway for sustainable agriculture in Nigeria. They improve yields, restore soil fertility, safeguard food safety, and align with both security and trade imperatives. Scaling adoption, however, requires coordinated action across policy, extension, markets, and certification systems.

## **6. Conclusion and Recommendations**

This study provides a national-level evaluation of the adoption of organic inputs in Nigeria, focusing on three locally produced brands: Joevet Powder, Crofit, and Zeropest. The findings show that adoption of organic inputs is steadily rising, with Joevet leading in adoption, while Crofit and Zeropest also demonstrate strong uptake and significant contributions to soil health, food safety, and farmer livelihoods.

The study confirms that:

- Adoption is driven by education, extension access, cooperative membership, and perceptions of effectiveness, while barriers include cost concerns, distribution gaps, certification hurdles, and labor demands.
- Agronomic results demonstrate that organic inputs significantly outperform control plots, with Joevet recording the highest yield gains, closely followed by Crofit and Zeropest.
- All three inputs improve soil fertility indicators and contribute to sustainable farming practices.
- Residue analysis confirms that organic inputs are safer for consumers, with residue levels well below international thresholds.
- Organic inputs offer security advantages, as they are less prone to diversion into harmful uses compared to synthetic fertilizers.
- Widespread adoption positions Nigeria to compete in export markets that demand compliance with residue and organic certification standards.

By combining quantitative and qualitative evidence, this study highlights that organic inputs are not only agronomic tools but also instruments of public health protection, food security, environmental sustainability, and trade competitiveness.

## 6.1 Recommendations

### For Farmers

1. Adopt organic inputs as part of integrated soil fertility management to improve yields and long-term soil health.
2. Participate in cooperatives and farmer groups to reduce costs, access bulk purchases, and qualify for certification programs.
3. Adopt safe storage practices by replacing chemical misuse with organic preservation alternatives to protect household health.

### For Policymakers

1. Strengthen agricultural extension services to provide demonstrations, training, and awareness campaigns on organic input use.
2. Support certification programs, particularly group or cooperative-led schemes, to enable smallholders to access export markets.
3. Expand subsidy frameworks beyond synthetic fertilizers to include approved organic inputs such as Jovet, Crofit, and Zeropest.
4. Enhance regulation and monitoring to ensure product quality, reduce counterfeit risks, and protect farmers and consumers.
5. Integrate organic input promotion with national food safety and security strategies, linking agricultural productivity with public health and trade competitiveness.

### For Agro-Dealers and Input Distributors

1. Expand distribution networks, especially in underserved rural and northern areas, to improve accessibility.
2. Bundle organic inputs with training and extension services to build farmer confidence and improve correct usage.
3. Collaborate with cooperatives to strengthen market penetration and increase trust among smallholder farmers.

### For Development Partners and NGOs

1. Support pilot and demonstration projects showcasing yield, soil, and food-safety benefits of organic inputs.
2. Invest in research and innovation to improve the formulation, stability, and scalability of local products.
3. Facilitate farmer-to-farmer learning platforms to accelerate peer-driven adoption.

## 6.2 Conclusion

Locally produced organic inputs with nationwide impact like Jovet Powder, Crofit and Zeropest represent a credible pathway to sustainable agricultural production in Nigeria. To achieve nationwide impact, adoption efforts must go beyond product promotion to address barriers of cost, certification, and distribution. By aligning agronomic practice with public health, security, and trade objectives, Nigeria can build a farming system that is productive, resilient, and globally competitive.

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