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Assessment of Sasakawa Africa Association Project in Northern Nigeria and Its Effects on Agricultural Productivity and Rural Livelihoods

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Abstract
This study assessed the implementation, effectiveness, and impact of Sasakawa Africa Association (SAA) agricultural interventions on smallholder farmers' productivity, post-harvest management, technology adoption, and livelihoods in Northern Nigeria. The study aimed to document major SAA interventions, examine adoption levels of improved seeds, agronomic practices, and post-harvest innovations, evaluate effects on crop productivity and post-harvest losses, analyze socio-economic outcomes, and identify challenges affecting adoption and sustainability. A mixed-methods cross-sectional design was employed in Kano, Jigawa, Kaduna, Nasarawa, Niger and Gombe States in 2025. Quantitative data were collected from 500 smallholder farmers using structured questionnaires, while qualitative insights were obtained through 12 Focus Group Discussion (FGDs) and 25 Key Informant Interviews (KIIs) with extension agents, Community-Based Facilitators (CBFs), and Farmers. Findings revealed high adoption rates for improved seeds (82%) and good agronomic practices (76%), moderate adoption of post-harvest technologies (71%), and lower uptake of mechanization and water management innovations (<45%). Adopters demonstrated significantly higher crop yields for maize (3.4 vs. 2.1 t/ha), rice (4.1 vs. 2.8 t/ha), sorghum (2.5 vs. 1.7 t/ha), and soybean (2.8 vs. 1.9 t/ha) compared to non-adopters ($p \leq 0.05$). Post-harvest losses were reduced substantially, particularly through metal silos (26%) and PICS bags (20%). Respondents reported improvements in household income (67%), food security (72%), and market access (59%), though challenges such as high technology costs, limited mechanization, and inadequate extension coverage persisted. The study demonstrates that integrated SAA interventions enhance smallholder productivity, post-harvest management, and livelihoods, highlighting the need for policy support, gender-inclusive programs, youth engagement, and expanded extension services to scale agricultural transformation in Northern Nigeria.

Keywords: Smallholder farmers, technology adoption, post-harvest loss, crop productivity, mechanization innovations.

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Introduction

Agriculture remains the cornerstone of rural livelihoods across Northern Nigeria, where over 70% of households depend on farming for income, food, and employment (Oni *et al.*, 2020). Despite its importance, productivity in the region remains significantly below potential due to persistent constraints such as limited access to improved inputs, weak extension delivery, land degradation, climate variability, and inefficient post-harvest systems (FAO, 2019; Akinbile and Adekunle, 2021). These challenges continue to undermine food security, household nutrition, and market competitiveness, especially among smallholder farmers who constitute the majority of producers.

Agriculture in Northern Nigeria continues to experience structural and systemic challenges that significantly constrain productivity, food security, and rural livelihoods. Despite being a major agricultural zone, the region still records low crop yields compared to global and regional benchmarks. Average cereal yields for maize, sorghum, and millet remain between 1.2–2.0 t/ha, far below the potential yields of 4–6 t/ha under improved management (Ibrahim *et al.,* 2021; FAO, 2020). This persistent low productivity is linked to limited access to improved seeds, fertilizers, mechanization, and irrigation facilities inputs that are critical for increasing output among smallholder farmers (Ahmed and Umar, 2019).

Access to improved seeds and fertilizers remains inadequate due to high market costs, supply inconsistencies, and weak input distribution networks, especially in rural areas (Olayemi and Adebayo, 2022). As a result, many farmers continue relying on low-yielding local varieties and sub-optimal soil fertility management practices. The agricultural extension system intended to bridge the gap between research and farmers faces severe manpower shortages, underfunding, poor logistics, and limited training. The farmer-to-extension-agent ratio in states such as Kano and Jigawa often exceeds 1:3,000, far above the FAO recommendation of 1:800 (FAO, 2021; Adamu *et al.,* 2020). This weak extension coverage undermines the dissemination of improved agricultural technologies.

Post-harvest losses constitute another major challenge, particularly for grains such as maize, cowpea, and sorghum. Smallholder farmers in Northern Nigeria lose between 25–35% of their harvest annually due to pest infestation, poor storage structures, and inefficient handling practices (Baributsa and Baoua, 2019; Yusuf *et al.,* 2020). These losses directly affect food availability, household income, and market supply stability.

Climate variability further compounds these challenges. Northern Nigeria is among the most climate-vulnerable regions in West Africa, experiencing frequent droughts, unpredictable rainfall patterns, rising temperatures, and declining soil fertility due to erosion and overuse (Ibrahim and Mustapha, 2021). These climatic stressors increase production risks and reduce farmers' willingness to adopt improved technologies. Coupled with this is limited market access caused by poor rural roads, weak aggregation systems, and lack of structured commodity markets factors that hinder commercialization and value-chain development (Nwafor and Okolo, 2022).

To address these constraints, international and local development organizations have implemented targeted agricultural interventions. Among the most prominent is the Sasakawa Africa Association (SAA), established in 1986 through a partnership involving the Nippon Foundation and renowned agronomists including Norman Borlaug. SAA's mission is to promote agricultural transformation through technology dissemination, strengthening of national extension systems, and the promotion of regenerative and market-oriented agriculture (SAA, 2022). In Nigeria, SAA operates in collaboration with Federal and State Agricultural Development Programmes (ADPs), working across the entire agricultural value chain.

The Sasakawa Africa Association (SAA) represents one of the most prominent models of such interventions in Africa, particularly in Northern Nigeria. This literature review examines the theoretical and empirical foundations of SAA's approach, highlighting the Sasakawa Model, technology adoption, post-harvest technologies, and livelihood impacts. The Sasakawa Africa Association (SAA) promotes an extension-led agricultural transformation model, which emphasizes farmer-centered learning through field demonstrations, farmer training, and community-based innovations (SAA, 2020). The model, inspired by Norman Borlaug's small-plot adoption technique (SPAT), involves selecting small representative plots within farming communities where new technologies including improved seeds, fertilizers, and agronomic practices are demonstrated under real farming conditions. Farmers learn directly by observation and hands-on engagement, creating an effective platform for scaling innovations at the community level (Abdu and Haruna, 2023).

The SAA model also integrates market-oriented agriculture and nutrition-sensitive interventions, ensuring that improved productivity translates into higher income, better household nutrition, and adoption of value-added processing technologies (SAA, 2022). Its success hinges on close collaboration with government Agricultural Development Programs (ADPs), community facilitators, and extension agents, facilitating both top-down technical guidance and bottom-up farmer participation.

Recent reports illustrate the scale of SAA's activities in Northern Nigeria. In Kano State, under the Kano State Agro-Pastoral Development Project (KSADP), SAA has trained over 450,000 farmers on regenerative agriculture, market-oriented farming, and mechanization since 2021. Support has also included the distribution of parboilers, rice mills, onion storage facilities, solar dryers, threshers, and power tillers to strengthen value chains (SAA, 2025a). Similar interventions in Jigawa State have focused on biochar production, composting, vegetable preservation using ZECC, and capacity building for women and youth (SAA, 2025b). In 2024 SAA reported programmes in northern Nigeria which include Nasarawa, Niger Gombe and Jigawa State. According to as recent press items (October, 2025), a new target 100,000 small-scale farmers in Kaduna State to enhance the productivity and competitiveness of maize and soyabeans value chains with ambition to improved seed/supply access (Tribune Online, 2025; Peoples Gazette, 2025;News Agency of Nigeria, 2025; Business Day Nigeria, 2025).

Despite widespread implementation, systematic academic assessment of SAA's integrated agricultural interventions in Northern Nigeria remains limited. Most available documentation exists in project briefs, implementation reports, and media summaries, while scholarly literature examining program outcomes, adoption, and livelihood impacts is scant (Abdu and Haruna, 2023). This creates a knowledge gap concerning:

i. The actual influence of SAA interventions on agricultural productivity and post-harvest management.
ii. The extent to which capacity building translates into measurable livelihood improvements.
iii. The effectiveness and sustainability of climate-smart and market-oriented technologies promoted by SAA.

Moreover, this study contributes to the literature by providing a comprehensive assessment of SAA projects in Northern Nigeria. It evaluates the effects of SAA initiatives on smallholder farmers' productivity, technology adoption, income improvement, climate resilience, and overall livelihood outcomes. The findings are expected to inform policymakers, development organizations, and agricultural stakeholders on agricultural transformation strategies suitable for Northern Nigeria's socio-ecological context.

Over the past decades, the Sasakawa Africa Association (SAA) has implemented several interventions to address these constraints, including improved seeds, small-plot adoption techniques, post-harvest innovations, and extension strengthening. However, despite the scale and relevance of these interventions, there is limited empirical research assessing their outcomes, sustainability, adoption rates, or overall effectiveness in improving agricultural productivity and livelihoods in Northern Nigeria. Much of the available information is based on project reports and implementation briefs rather than rigorous scientific assessment (SAA, 2023).

This lack of peer-reviewed scientific documentation limits evidence-based policymaking, hinders effective scaling of successful interventions, and reduces donor confidence and investment in agricultural development programs. Without systematic evaluation, it remains difficult to determine the true impact of SAA projects on crop yields, technology uptake, post-harvest management, income improvement, or resilience to climate change among smallholder farmers. Therefore, there is a critical need for comprehensive academic assessment of SAA's interventions to generate reliable evidence that can guide policy, improve program design, and support long-term agricultural transformation in Northern Nigeria.

Therefore, the aim of this study is to assess the implementation, effectiveness, and impact of the Sasakawa Africa Association (SAA) agricultural interventions on smallholder farmers' productivity, post-harvest management, technology adoption, and livelihoods in Northern Nigeria, with the seeks to; identify and document the major SAA agricultural interventions implemented in Northern Nigeria, examine the level of adoption of SAA-promoted technologies, among smallholder farmers, assess the effect of SAA interventions on crop productivity and yield performance among beneficiary farmers, evaluate the impact of improved post-harvest and storage technologies promoted by SAA on grain quality preservation and reduction in post-harvest losses, analyze the socio-economic effects of SAA projects on farmers' income, food security, and livelihood outcomes in the study area, assess the challenges affecting the implementation, adoption, and sustainability of SAA agricultural interventions in North-western States and provide policy recommendations for strengthening and scaling SAA interventions to enhance agricultural transformation in Northern Nigeria.

Materials and Methods

Study Area: Northern Nigeria

Northern Nigeria constitutes a vast socio-cultural and agro-ecological region made up of nineteen states distributed across the North-West, North-East, and North-Central geopolitical zones. The region covers an estimated area of about 744,249 km², representing nearly half of the country's landmass (National Bureau of Statistics, 2022). Geographically, it stretches between latitudes 6°N and 14°N and longitudes 3°E and 14°E, and is characterized by a wide range of climatic conditions, ethnic diversity, and agricultural potentials. The region hosts a population of more than 90 million people, including major ethnic groups such as Hausa, Fulani, Kanuri, Tiv, Nupe, Gbagyi and several minority communities. Hausa language serves as the dominant lingua franca across rural and urban areas (National Population Commission, 2022).

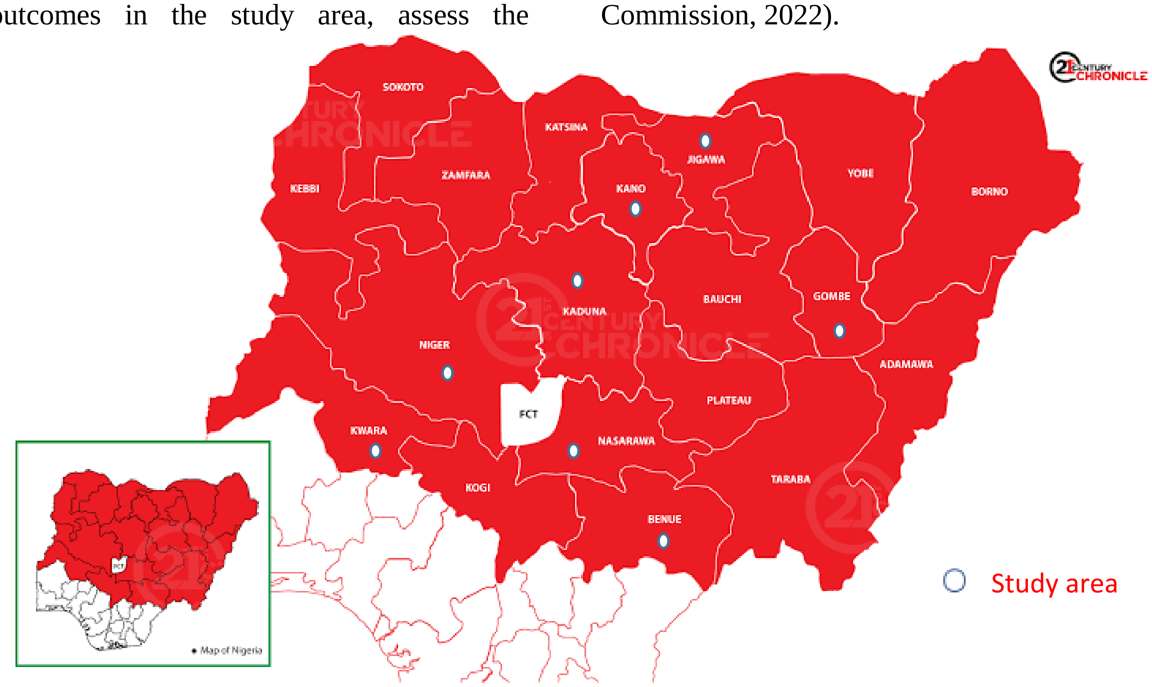

Figure 1: Map of Nigeria Showing Northern Nigeria.

Source: 21 Century Chronicle, 2025

Research Design

This study adopted a mixed-methods cross-sectional design, integrating both quantitative and qualitative approaches to provide a comprehensive assessment of the Sasakawa Africa Association (SAA) interventions in Northern Nigeria. The mixed-methods approach was chosen because it allows for the triangulation of data, combining numerical measurements of adoption, productivity, and post-harvest outcomes with in-depth insights from farmer experiences, extension agents, and project facilitators (Creswell and Plano Clark, 2018).

The quantitative component focused on structured measurement of: The extent and type of technology adoption, including improved seeds, composting and biochar practices, post-harvest storage facilities (AAOST, ZECC, PICS bags), and mechanization support. Impact on crop productivity, post-harvest losses, and household income.

The qualitative component employed Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) to explore: Farmers' perceptions of SAA interventions, challenges, and benefits. Implementation processes, training effectiveness, and sustainability of interventions from the perspective of extension agents and Community-Based Facilitators (CBFs). Contextual factors influencing adoption, including social, cultural, and economic constraints.

Target Population

The study population consisted of smallholder farmers, extension agents, and community-based facilitators (CBFs) actively involved in SAA interventions in North-western Nigeria. These groups represent the primary actors engaged in the implementation and adoption of SAA-promoted technologies and practices.

The inclusion of these three population groups ensured a holistic assessment of SAA interventions, capturing both quantitative outcomes (yields, income, post-harvest losses) and qualitative insights (perceptions, experiences, challenges). By targeting both beneficiaries and implementers, the study could evaluate not only the extent of adoption but also the effectiveness, sustainability, and socio-economic impact of the interventions.

Sample Size and Sampling Technique

A multi-stage sampling technique was employed to ensure representative coverage of SAA interventions across North-western State of Nigeria, while capturing diverse farmer experiences and perspectives from extension personnel and Community-Based Facilitators (CBFs). Multi-stage sampling is appropriate for geographically dispersed populations and allows systematic selection of participants at multiple levels (Cochran, 1977; Bryman, 2016).

Stage 1: Selection of Intervention States

Kano, Jigawa, Kaduna, Katsina, Niger, Kwara, Benue and Zanfara States were purposively selected due to their high intensity of SAA interventions, including KSADP mechanization support, post-harvest storage technologies, biochar and compost-making training, and climate-smart agriculture demonstrations (SAA, 2023). These states represent major rice, maize, Soyabean and vegetable-producing areas in North-western Nigeria, where smallholder farming is dominant.

Stage 2: Selection of Local Government Areas (LGAs)

Within the eight states, LGAs were purposively selected based on the presence of active SAA project sites, key producers or recipients of state Agricultural inputs and documented intervention activities:

- Kano State: Takai, Bagwai, Kadawa, and Garum Mallam LGAs.
- Jigawa State: Dutse, Hadejia, Babura and Gumel LGAs.
- Kaduna State: Chikun, Lere, Giwa and Kauru LGAs
- Niger State: Bosso, Minna, Bida and Kontagora LGAs
- Nasarawa: Assakio, Lafia, Obi, and Doma LGAs
- Gombe: Balanga, Shongom, Billiri and Akko LGAs
- Benue: Makurdi, Guma, and Gwer East
- Kwara: Ilorin, Asa, Moro, Edu, Patigi, Kaiama, and Baruten.

These LGAs were chosen to capture both mechanization and post-harvest technology interventions, as well as variations in farm size, crop types, and local socio-economic conditions.

Stage 3: Selection of Farmer Households

Within each selected LGA, farmer households were randomly sampled from SAA beneficiary lists provided by extension offices and Community-Based Facilitators (CBFs). The use of random sampling at this level minimized selection bias and enhanced the generalizability of the findings to the wider population of SAA beneficiaries.

Stage 4: Selection of Extension Agents and Community-Based Facilitators

A purposive sampling approach was applied to select 25 key informants (extension agents and CBFs) for in-depth interviews. These participants were chosen based on their active involvement in project implementation, training facilitation, and farmer support activities.

2.4.1 Sample Size Determination

The sample size for farmer households was determined using Cochran's (1977) formula for large populations, which is widely applied in agricultural and social science research:

$$n_0 = \frac{Z^2\, pq}{d^2}$$

Where:

- n_0 = initial sample size
- Z = standard normal deviate corresponding to the desired confidence level (1.96 for 95% confidence)
- p = estimated proportion of the population possessing the attribute of interest (0.5, used to maximize sample size where true proportion is unknown)
- q = 1 – p
- e = margin of error (0.05)

Substituting into the formula:

$$n_0 = \frac{(1.96)^2 (0.5)\,(0.5)}{(0.05)^2}$$

$$n_0 = \frac{3.8416 \text{ X } 0.25}{0.0025}$$

$$n_0 = 384$$

The minimum statistically required sample size was therefore 384 respondents. However, to account for potential non-response, incomplete questionnaires, and to enhance analytical robustness across multiple LGAs and states, the sample size was increased by approximately 30%, resulting in a final sample of 500 smallholder farmers. This adjustment aligns with best practices in large-scale field surveys and improves the reliability of subgroup analyses (Israel, 2013).

Justification of Sampling Technique

The combination of multi-stage sampling, proportional allocation, and mixed quantitative qualitative approaches ensured comprehensive coverage of SAA intervention areas while capturing heterogeneity in farmer characteristics, adoption behavior, and contextual challenges. This methodological approach strengthens the internal validity and external relevance of the study findings.

Data Analysis

Quantitative Analysis

Quantitative data collected from structured questionnaires were entered and analyzed using SPSS version 26. The analysis followed a two-stage approach: descriptive and inferential statistics.

Descriptive statistics:

Frequencies, percentages, means, and standard deviations were computed to summarize farmers' socio-economic characteristics (age, gender, education, and farm size), levels of technology adoption, crop yields, post-harvest losses, and income changes.

Inferential statistics:

i. Independent t-tests were conducted to compare mean crop yields, post-harvest loss reduction, and household income between adopters and non-adopters of SAA-promoted technologies, assessing the statistical significance of intervention impact.
ii. Chi-square tests were used to evaluate associations between socio-economic factors (e.g., gender, education level, farm size) and adoption of specific technologies, identifying potential determinants of adoption behavior (Agresti & Finlay, 2019).
iii. Where appropriate, correlation and regression analyses were employed to examine relationships between levels of adoption and outcome measures, such as crop productivity and income improvement.

All statistical tests were conducted at a 95% confidence level ($p \leq 0.05$) to determine significance.

Qualitative Analysis

Qualitative data from Key Informant Interviews (KIIs) and Focus Group Discussion (FGDs) were analyzed using thematic analysis, following Braun and Clarke's (2006).

This approach allowed for the identification of patterns, narratives, and contextual factors that influence adoption and effectiveness of SAA interventions.

Data Integration (Triangulation)

To enhance the rigor and validity of findings, quantitative and qualitative results were triangulated:

- Quantitative outcomes (e.g., yield improvement, income changes, post-harvest loss reduction) were compared with qualitative insights from farmer narratives and implementer feedback.
- Discrepancies or convergences between data types were analyzed to provide a comprehensive understanding of SAA interventions' effectiveness.
- Integration ensured that statistical trends were contextualized, and farmer experiences, challenges, and success stories were adequately represented (Creswell and Plano Clark, 2018).

Results and Discussion

Socio-Economic Characteristics of Respondents

The socio-economic characteristics of the respondents are presented in Table 1. The findings show that agricultural participation in the study area is predominantly male (76%), while females constitute 24% of the respondents a gender distribution consistent with broader evidence that men dominate production and control of farm resources in northern Nigeria. Gendered access to land, credit and extension services has been shown to limit women's participation in commercial agriculture and technology uptake. (Ogunlela and Yusuf, 2022; Kehinde and Adebayo, 2021).

The majority of respondents (56%) fall within the economically active age range of 31–50 years, while 21.3% are 30 years or below, and 22.7% are above 50 years, indicating active engagement of both young and middle-aged farmers in SAA activities. This age structure mirrors recent demographic analyses of semi-arid Nigerian farming communities, which emphasise the predominance of middle-aged farmers as the core agricultural workforce and the challenges of engaging youth in farming without targeted incentives. (Azeez *et al*., 2023; Adamu *et al*., 2024).

In terms of educational attainment, a considerable proportion (34%) reported no formal education, suggesting limited literacy levels among farmers which may impede comprehension of extension messages and complicate adoption of technical innovations. The mix of primary and secondary education among the remainder indicates a base level of literacy that can be built on through practical, demonstration-based training. Multiple studies have documented the strong positive relationship between education and adoption of agricultural technologies in West Africa. (Abubakar *et al*., 2022; Ajetomobi and Saka, 2021).

Table 1: Socio-Economic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	380	76.0
	Female	120	24.0
Age	≤30 years	107	21.3
	31–50 years	280	56.0
	>50 years	113	22.7
Education	No formal education	170	34.0
	Primary	132	26.3
	Secondary	140	28.0
	Tertiary	58	11.7
Farm size	<1 ha	119	23.7

Variable	Category	Frequency	Percentage (%)
	1–3 ha	279	55.7
	>3 ha	103	20.6
SAA participation	Yes	500	100

Source: Field Survey, 2025

Regarding landholding, most respondents (55.7%) operated on 1–3 hectares, typical of smallholder agricultural systems in Northwest Nigeria. Small farm sizes constrain economies of scale and capital investment capacity, limiting the uptake of higher-cost technologies (e.g., metal silos, mechanisation) while making low-cost, scalable innovations more attractive. This farm-size profile aligns with regional analyses of landholding and production systems in semi-arid Nigeria. (Olayemi *et al*., 2019; Musa and Adebayo, 2021).

Notably, all respondents (100%) reported participation in SAA interventions, confirming complete programme exposure among the sampled farmers. SAA's documented outreach and programme design incorporating farmer training, demonstration plots, seed distribution and post-harvest support explain the high reported level of participation in study communities and provides a valid basis for evaluating programme effects. (Sasakawa Africa Association [SAA], 2023).

Major SAA agricultural interventions implemented in Kano and Jigawa States

Results (Table 2) indicate that the Sasakawa Africa Association (SAA) implements a broad range of interventions covering the agricultural value chain in North-western Nigeria. These interventions emphasize technology dissemination, farmer capacity building, and market-driven productivity enhancement (Field Survey, 2025; SAA, 2023). Core activities identified include improved seed systems, particularly community-based seed multiplication (CBSM) and farmer seed enterprise linkage, which enhance farmer access to quality seeds and expedite varietal diffusion (Baoua *et al.*, 2014; De Groote *et al.,* 2020).

Table 2: Major SAA Agricultural Interventions in Northern Nigeria

Intervention Category	Specific Activities	States Implemented
Improved Seed Systems	Seed production training, community-based seed multiplication (CBSM), linkages with seed companies	Gombe, Kaduna, Kwara, Niger, Kano, Jigawa
Good Agronomic Practices (GAP)	Plant spacing, fertilizer micro-dosing, row planting, weed management	Gombe, Kwara, Nasarawa, Niger, Kano, Jigawa
Soil Fertility Management	Composting, biochar production, manure management	Nasarawa, Jigawa, Kano
Post-Harvest Technologies	PICS bags, AAOST, zero-energy cool chambers (ZECC), metal silos	Kano, Jigawa, Kwara
Mechanization Support	Multi-crop threshers, rice reapers, planters	Nasarawa, Kano, Kwara
Extension Capacity Building	Training of extension agents, community-based facilitators (CBFs)	Kwara, Benue, Kano, Jigawa

Source: Field Survey, 202

Promotion of Good Agronomic Practices (GAP) such as row planting, recommended spacing, weed control, and fertilizer micro-dosing was also widespread, improving yield responsiveness and resource-use efficiency. This aligns with evidence that GAP adoption enhances productivity among smallholders in semi-arid farming systems (Ajetomobi & Saka, 2021). Both states also benefited from soil fertility improvement initiatives, including composting, biochar production, and manure management, consistent with climate-smart strategies reported to enhance soil organic matter and reduce reliance on inorganic fertilizers (Tefera, 2023).

In addition, post-harvest innovations such as hermetic storage (PICS bags), zero-energy cool chambers (ZECC), Airtight African On-Farm Storage Technology (AAOST), and metal silos were promoted in both states, contributing to grain quality preservation and reduction of storage losses (Amle *et al.,* 2022; Hussaini, 2023). Mechanization support, however, was more pronounced in Kano, driven by KSADP collaborations that supplied multi-crop threshers, rice reapers, and planters to farmer clusters, reflecting a growing trend toward smallholder mechanization in northern Nigeria (Mondo *et al.*, 2021).

Finally, extension capacity building through training of governmental extension agents and community-based facilitators (CBFs) was observed across both states. Strengthening extension systems remains critical to accelerating technology adoption and scaling sustainable agricultural innovations in West Africa (Aliyu & Saadu, 2023; Musa *et al.*, 2022). These findings reinforce that SAA interventions in Northwestern Nigeria are holistic, farmer-centered, and strongly aligned with value-chain development and technology-based agricultural transformation.

Plate 1: Biochar prouction in jigawa state
Source: SAA, 2025

Plate 2: Mega field domestratin in Gombe state
Source: SAA, 2024

Plate 3: Distrubuting of 210 hermstic storage Drums in 44 LGAs in Kano State state
Source: SAA/KSADP, 2025

Plate 4: Mechanization Support (Single row hand push planters) to smallholder farmers
Source: SAA/KSADP, 2025

Adoption of SAA-Promoted Technologies

The findings show that the level of adoption of Sasakawa Africa Association (SAA) technologies among farmers in the study area varies across practices and technologies. The adoption of improved crop seeds (82%)

recorded the highest uptake. This suggests a strong farmer preference for high-yielding and climate-resilient seed varieties, consistent with Sasakawa's seed system model that promotes community-based seed multiplication and linkages with seed companies. Similar outcomes were reported by Abdoulaye and Sanders (2021), who noted that availability and accessibility of improved seeds facilitate rapid adoption among smallholders.

Table 3: Adoption Rates of SAA Interventions

Technology/Practice	Adopters (%)	Non-Adopters (%)
Improved crop seeds	82	18
Good Agronomic Practices (GAP)	76	24
Biochar/compost training	54	46
Hermetic storage (PICS bags, AAOST, metal silos)	71	29
Drip irrigation & water management	38	62
Post-harvest threshers & shellers	44	56

Source: Field Survey, 2025

Adoption of Good Agronomic Practices (GAP), such as fertilizer micro-dosing, row planting, and timely weeding, was also substantial at 76%. This aligns with previous studies highlighting that GAP interventions are cost-effective and improve yield efficiency, making them more attractive to resource-poor farmers (FAO, 2022). The strong uptake reflects the effectiveness of SAA's training and demonstration approaches implemented through extension support and community-based facilitators.

On the other hand, biochar and compost technologies showed moderate adoption (54%). Although beneficial for long-term soil fertility, their comparatively lower adoption may be associated with labour intensiveness and lack of immediate financial return. These findings corroborate the work of Ajayi *et al.* (2020), who observed that organic practices are less readily adopted when labour demands are high.

Adoption of hermetic storage technologies such as PICS bags, metal silos, and the AAOST model stood at 71%, indicating a rising interest in post-harvest loss reduction technologies. This is consistent with the widespread promotion of storage solutions under SAA post-harvest interventions. Increased awareness of losses due to pests, particularly weevils, may have contributed to the high uptake, aligning with FAO (2022), which recognized storage innovations as a key driver for reducing grain spoilage.

Conversely, drip irrigation and water management technologies recorded relatively low adoption (38%). Access barriers such as cost, technicality, and water availability likely hindered uptake. This echoes observations from the Kano State Agro-Pastoral Development Project (KSADP, 2024), which reported limited adoption of irrigation tools among smallholders due to affordability constraints.

Similarly, the adoption of post-harvest threshers and shellers (44%) was lower than expected. Despite their efficiency in reducing drudgery and labour cost, limited ownership and dependence on shared or hired machines may restrict use. Mechanization adoption among smallholders often depends on collective service provision models, as highlighted in FAO (2022).

Overall, the results indicate that technologies requiring low investment and offering quick benefits (e.g., seeds, GAP, hermetic storage) achieve higher adoption rates than those requiring higher capital, labour, or technical skills (e.g., drip irrigation, mechanization, composting).

Farmers repeatedly attributed adoption to SAA's extension support:

"Before SAA training, we planted anyhow. Now we follow spacing, fertilizer timing, and yields increased." — FGD participant, Patigi (Kwara)

"We adopted improved seeds because they perform better on our farms and SAA gives training." — Farmer, Takai (Kano)

Extension agents also emphasized challenges:

"Some farmers want to adopt, but affordability of equipment like threshers slows them down." — KII, Jigawa SAA field officer

"Mechanization is good, but only few can access the machines." — Extension worker, Chikum (Kaduna)

Effect of SAA Interventions on Crop Productivity

The impact of SAA interventions on crop productivity was assessed by comparing the mean yields of adopters of SAA-promoted storage and agronomic technologies versus non-adopters. Table 3 presents the results for maize, rice, sorghum, and soyabean.

Table 4: Mean Crop Yields of Adopters vs. Non-Adopters

Crop	Adopters (t/ha)	Non-Adopters (t/ha)	t-value	p-value
Maize	3.4	2.1	4.87	0.001*
Rice	4.1	2.8	5.23	0.000*
Sorghum	2.5	1.7	3.94	0.002*
Soybean	2.8	1.9	4.12	0.001*

*Significant at $p \leq 0.05$

Source: Field Survey, 2025

The analysis of crop yields indicates that adoption of SAA-supported technologies significantly improves productivity among smallholder farmers. Maize adopters produced an average of 3.4 t/ha, compared to 2.1 t/ha for non-adopters, while rice adopters recorded 4.1 t/ha versus 2.8 t/ha for non-adopters. Sorghum and soybean also exhibited higher yields among adopters, with 2.5 t/ha and 2.8 t/ha, compared to 1.7 t/ha and 1.9 t/ha for non-adopters, respectively. Statistical tests confirmed that these differences were significant at $p \leq 0.05$, demonstrating the positive impact of SAA interventions on crop productivity.

These findings highlight the effectiveness of improved seeds, good agronomic practices, and post-harvest technologies in increasing output. Enhanced yields not only contribute to food security but also strengthen farmers' income and resilience, corroborating previous studies that link adoption of improved agricultural technologies to higher productivity in West Africa (Ibrahim & Umar, 2020; Musa, Adediran, & Salihu, 2022; Kaminski *et al.,* 2023). These results underscore the value of scaling up SAA interventions to maximize their socioeconomic and agronomic benefits across smallholder farming systems.

"Using improved rice seed from SAA, I harvested almost double compared to last year." — Farmer, Akko (Gombe)

"Before the training, my maize yield was low. With row planting and the new seed, production increased." — Farmer, Obi (Nasarawa)

Impact on Post-Harvest Loss Reduction

The adoption of SAA-promoted storage technologies significantly reduced post-harvest losses among smallholder farmers. Losses in maize, rice, sorghum, and soybean were considerably lower after intervention. Specifically, PICS bags reduced losses from 28% to 8% (20% reduction), metal silos from 32% to 6% (26% reduction), and AAOST/ZECC storage from 25% to 10% (15% reduction).

Table 5: Reduction in Post-Harvest Losses by Storage Technology

Storage Technology	Before SAA (%)	After SAA (%)	Reduction (%)
PICS Bags	28	8	20
Metal Silos	32	6	26
AAOST/ZECC storage	25	10	15

Source: Field Survey, 2025

These reductions demonstrate the effectiveness of hermetic and improved storage systems in protecting grains against pests, moisture, and mycotoxin contamination. The results align with prior studies highlighting that hermetic storage can reduce losses by 65–92% without chemical fumigation (Chigoverah and Mvumi, 2021; Zulu *et al.*, 2022; De Groote *et al.*, 2020). Improved storage not only preserves grain quality but also enhances food security, increases household income, and strengthens resilience against seasonal shortages.

"We used to lose maize to weevils, but with PICS bags we now store till the next season without fear." — Farmer, Bagwai (Kano)

"Weevils used to destroy our maize, but with PICS bags the grains remain clean for months." — Farmer, Dutse (Jigawa)

"ZECC helps us keep tomatoes and peppers fresh for longer." — FGD, Bida (Niger)

Extension agents noted improved market timing:
"Farmers now store longer and sell when prices rise income has improved."

Livelihood Effects of SAA Interventions

The implementation of SAA interventions contributed to noticeable improvements in household livelihoods. Respondents reported that household income improved for 67% of farmers, while food security improved for 72%, indicating that increased productivity and reduced post-harvest losses translated directly into better household welfare. Additionally, 59% of respondents reported improved access to markets, facilitating better commercialization of produce. Women's participation in agriculture showed positive changes, with 48% reporting increased involvement, reflecting efforts to include women in SAA extension activities, though challenges remain as 14% reported a decline.

Table 6: Perceived Livelihood Improvements among Respondents

Livelihood Indicator	Improved (%)	No Change (%)	Declined (%)
Household income	67	29	4
Food security	72	24	4
Access to markets	59	31	10
Women's participation	48	38	14

Source: Field Survey, 2025

These findings align with previous research demonstrating that integrated agricultural interventions combining improved seeds, GAP, mechanization, and post-harvest technologies enhance income, food security, and empowerment in rural West African contexts (Aliyu and Saadu, 2023; Musa *et al*., 2022; Ajetomobi and Saka, 2021).

"My wife joined the compost training. Now she sells organic manure and supports the household." — Farmer, Dutse

"Women want to join more activities but domestic work reduces their time." — CBF, Kaduna

"Income increased because we now produce more maize and store until the price goes up." — Farmer, Giwa (Kaduna)

"Women joined compost groups and now earn small income from manure sales." — CBF, Dutse (Jigawa)

To assess challenges affecting implementation and sustainability

Respondents identified several challenges limiting the adoption and effectiveness of SAA interventions. The high cost of technologies emerged as the most significant barrier, reported by 66% of respondents. Limited access to mechanization (55%) and inadequate extension coverage (46.7%) were also notable constraints, highlighting the need for improved service delivery and resource provision. Additionally, low literacy among farmers (40.7%) and gender barriers (33.7%) affected participation, especially in adopting modern agronomic practices. Limited water access for irrigation was reported by 37.7% of farmers, constraining the uptake of water-dependent interventions such as drip irrigation.

Table 7: Major Challenges Identified by Respondents

Challenge	Frequency	Percentage (%)
High cost of technologies	198	66.0
Limited access to mechanization	165	55.0
Inadequate extension coverage	140	46.7
Low literacy among farmers	122	40.7
Gender barriers to participation	101	33.7
Limited water access for irrigation	113	37.7

Source: Field Survey, 2025

These findings corroborate prior studies indicating that financial, institutional, and socio-cultural factors strongly influence technology adoption in Northern Nigeria (Kuku & Adeoye, 2023; Onyango *et al.,* 2022; Abubakar, Abdu, & Sadiq, 2022). Addressing these barriers through targeted subsidies, inclusive extension programs, and community-based support mechanisms is essential to enhance the effectiveness and reach of SAA interventions.

"The training is good, but the equipment is expensive for many farmers." — KII, Benue

"Women want to join more trainings, but household duties limit them." — FGD, Makurdi (Benue)

These challenges mirror constraints commonly found in rural agricultural systems input affordability, extension gaps, and gender inequality (Ahmed and Umar, 2019). Addressing these barriers is crucial for sustainability.

Conclusion and Recommendations

This study assessed the implementation and impacts of Sasakawa Africa Association (SAA) agricultural interventions in Northern Nigeria, focusing on technology adoption, crop productivity, post-harvest management, and livelihood outcomes. The findings demonstrate that integrated, extension-led interventions significantly enhance smallholder farmers' agricultural performance and welfare in resource-constrained settings. High adoption of improved seeds and good agronomic practices resulted in substantial yield increases for major staple crops, while improved storage technologies effectively reduced post-harvest losses. These gains translated into improved household income, food security, and market participation among beneficiary farmers. The results further highlight the value of SAA's holistic approach, which combines farmer training, strengthened extension services, post-harvest innovations, and market-oriented support across the agricultural value chain.

Despite these positive outcomes, the study identifies persistent challenges, including high technology costs, limited mechanization access, weak extension coverage, low literacy levels, and gender-related barriers, which constrain wider and more sustainable adoption. These limitations indicate the need for stronger policy integration, inclusive extension systems, and supportive financing mechanisms. Addressing these challenges requires affordable technology delivery models, strengthened and digitized extension systems, gender-sensitive programming, youth engagement strategies, and improved water management support. Stronger institutional partnerships and community-based monitoring systems are also essential for sustaining adoption and guiding adaptive implementation. The study provides empirical evidence that SAA interventions contribute meaningfully to agricultural productivity growth and livelihood improvement in Northern Nigeria. With sustained investment, targeted policy support, and inclusive implementation strategies, such interventions have strong potential to support long-term, resilient, and inclusive agricultural transformation in the region.

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