Improving NSPRI Technologies through Targeted Stakeholders' Feedback: A Case Study of Bauchi and Nasarawa States, Nigeria

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Abstract

Agriculture is still the backbone of Nigeria's economy, providing jobs for over 70% of the population and significantly contributing to the nation's Gross Domestic Product (GDP). This study investigates the adoption and impact of two postharvest technologies; Hermetic Steel Drums (HSD) and Parabolic-Shaped Solar Dryers (PSSD) among smallholder farmers in Bauchi and Nassarawa States, Nigeria. The research focuses on farmers' socioeconomic characteristics, adoption patterns, income effects, stakeholder perceptions, technology improvements, and willingness to pay. The objectives were to evaluate the effects of using NSPRI technologies on income before and after adoption, and to assess stakeholder feedback on the technology enhancement. A multi-stage sampling technique was employed to select 121 participants for the study. Findings revealed a high willingness to pay for both technologies, with 98.6% for HSD and 98.1% for PSSD. However, there is a notable difference in user engagement: while 50.7% of HSD users reported sharing feedback, only 21.2% of PSSD users did so. Agricultural Development Programs (ADPs) were the primary feedback channels (44.9% for HSD and 11.5% for PSSD). Users identified areas requiring improvement, including the drum's capacity (HSD), tray size, air vent, and aspirator design (PSSD). The study highlights the critical role of stakeholder engagement in enhancing postharvest technologies. It emphasises the need to address systemic constraints and minimal credit access to promote sustainable adoption and scalability.

Keywords:
Hermetic Steel Drum (HSD), Parabolic-shaped Solar Dryer (PSSD), Stakeholders' Feedback

Introduction

Nigeria's economy is based mostly on agriculture, which employs over70% of the workforce and substantially contributes to the nation's Gross Domestic Product (GDP) (Abdul et al., 2020). The sector is dominated by small-scale farmers who produce over 80% of the country's food crops (Aye, 2013; Abdul, Yerima & Suleiman, 2020). Despite its importance, Nigerian agriculture faces numerous challenges, including low productivity, poor postharvest handling, inadequate infrastructure, and limited access to credit and markets (Bamishaiye et al., 2022).

In recent years, the Nigerian government has launched several initiatives to transform the agricultural sector and improve food security. These initiatives include the National Accelerated Food Production Programme (NAFPP), Operation Feed the Nation (OFN), Green Revolution Programme (GRP), Go Back to Land Programme, Elements of NAFPP restored through Directorate of Food Roads and Rural Infrastructure (DFRRI), National Food Security Programme (NFSP), Presidential Initiative on Agriculture, Agricultural Transformation Agenda (ATA) and Agricultural Promotion Policy (APP) (Federal Ministry of Agriculture and Rural Development 2020; Hassan, 2021). However, the impact of these initiatives has been limited by several factors, including

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inadequate stakeholder engagement, poor extension services, and limited access to improved agricultural technologies (Sennuga & Oyewole, 2020).

Agricultural technology is vital for advancing smallholder farming in Nigeria and other emerging economies. It enhances productivity, reduces postharvest losses, lowers production costs, and strengthens resilience, contributing to food security and sustainable growth. Nigerian farmers' inability to acquire advanced agricultural technologies, among other factors, has resulted in a decline in agricultural production (Farm Square [FS], 2022). Agricultural technology includes a range of materials, processes and knowledge.

The Nigerian Stored Products Research Institute (NSPRI) is one of the major institutions responsible for developing and disseminating improved agricultural technologies in Nigeria. The institute has developed several technologies, including enhanced storage facilities, drying technologies, and packaging materials (NSPRI, 2020). These improved postharvest techniques can reduce food losses, improve overall quality and food safety, and increase profits for grain crop producers and processors (Kayode *et al*., 2022). Recent studies have emphasised the importance of stakeholder engagement and feedback in improving the relevance and impact of agricultural research and development initiatives (Adegbola et al., 2024).

Given this, the research aims to achieve the following specific objectives: (i) profile the socioeconomic characteristics of beneficiaries; (ii) assess the extent and patterns of technology adoption and use; (iii) evaluate the effect of these technologies on users' income levels; (iv) analyse stakeholders' perceptions and feedback on the structural components and performance of the technologies; and (v) determine users' willingness to pay and share opinions as indicators of technology acceptance and sustainability.

Materials and Methods

This study employed a descriptive research design conducted in Northern Nigeria using a structured questionnaire. A multi-stage sampling procedure was adopted. In the first stage, two states, Bauchi and Nasarawa, were purposively selected due to the availability and previous dissemination of improved postharvest technologies developed by the Nigerian Stored Products Research Institute (NSPRI), namely the Parabolic-Shaped Solar Dryer (PSSD) and the Hermetic Steel Drum (HSD).

In the second stage, a snowball sampling technique was used to identify users of these technologies within selected locations. The main emphasis was on current and former users of the improved NSPRI postharvest technologies, identified through records from earlier empowerment and popularisation initiatives. A total of 121 respondents (99 from Bauchi and 22 from Nasarawa) were interviewed, based on user lists sourced from NSPRI, Agricultural Development Programmes (ADPs), and the Agro-Processing, Productivity Enhancement and Livelihood Improvement Support (APPEALS) Project. The respondents included both youth and women. To enrich the quantitative data and provide deeper insights into the performance and acceptability of the technologies, Focus Group Discussions (FGDs) were also conducted.

Data were analysed using descriptive statistics (frequencies, percentages, and means) to profile socioeconomic characteristics and summarise adoption patterns. Income effects were assessed through paired sample t-tests, while Likert scale responses and qualitative insights from focus group discussions were examined to capture user perceptions. Thematic coding was further employed to interpret views on willingness to pay, sustainability, and prospects for future use.

Results and Discussion

Socioeconomic characteristics of NSPRI postharvest technology beneficiaries

The results in Table 1 revealed the demographic and socioeconomic attributes of NSPRI postharvest technology beneficiaries. The majority (81.8%) of the respondents were from Bauchi State, while 18.2% were from Nasarawa State. This suggests that NSPRI's intervention has had a greater impact on Bauchi, possibly due to greater awareness or agricultural activity concentration in the zone. Regarding technology adoption, 57.0% of respondents use Hermetic Steel Drums (HSD), while 43.0% use the Parabolic-Shaped Solar Dryers. (PSSD). This aligns with previous studies highlighting the growing preference for HSD due to its efficiency in reducing postharvest losses (Baributsa & Njoroge, 2020).

The gender classification shows that a significant proportion of the beneficiaries (75.2%) were females, indicating that women embrace NSPRI's technologies more. This is consistent with studies emphasising women's role in food processing and preservation (Food and Agriculture Organization, FAO, 2021). Furthermore, marital status data indicated that 76.1% were married, suggesting that married individuals are more likely to engage in technology-driven

agribusiness, possibly due to household food security concerns.

Education levels vary among respondents, with 37.2% having a secondary education, followed by 28.0% with tertiary education. This suggests that a reasonable level of literacy might influence the adoption of NSPRI technologies, as education is a known factor in technology adoption (Rogers, 2003). However, access to credit remains a challenge, as 86.7% of respondents do not have access to credit facilities. This could hinder further investment in technology and the expansion of agribusiness activities.

The period of technology usage indicates that most respondents (76.8%) have used the technology for 2–4 years, reflecting sustained adoption. Furthermore, 78.5% of respondents had contact with an extension agent in the past 12 months, which may have played a role in improving technology utilisation. Extension services are critical in enhancing knowledge transfer and agricultural productivity (Feder et al., 1999). Utilisation patterns show that 74.4% of respondents used the technology personally and in groups, while 69.4% used it for subsistence and commercial purposes.

Table 1: Socioeconomic Characteristics of NSPRI Postharvest Technology Beneficiaries

Variable	Frequency	Percentage
State:		
Bauchi	99	81.8
Nassarawa	22	18.2
Major Technology:		
HSD	69	57.0
PSSD	52	43.0
Sex:		
Female	91	75.2
Male	30	24.2
Marital Status:		
Single	8	6.6
Married	92	76.1
Divorced	1	0.8
Widowed	20	16.5
Level of Education:		
No Formal	17	14.1
Semi-formal	8	6.6
Primary	17	14.1
Secondary	45	37.2
Tertiary	34	28.0
Access to Credit:		
Yes	16	13.3
No	105	86.7
Period of using the Technology (Year):		
< 1	2	1.7
1-2	26	21.5
2-4	93	76.8
Contact with Extension Agent (Past 12 months):		
Yes	95	78.5
No	26	21.5
Mode of Technology Utilisation:		
Personal	10	8.3
Group	21	17.4
Both	90	74.4
Level of technology Utilisation:		
Subsistence(a)	31	25.6
Commercial(b)	5	4.1
Both (a & b)	84	69.4

Source: *Field Survey, 2023*

This suggests that NSPRI technologies contribute to household food security and income generation.

The results further revealed that the mean age of respondents is 46.77 years, indicating that middle-aged farmers dominate technology adoption. This aligns with findings that middle-aged farmers are more innovative and willing to adopt new agricultural practices (Masi et al., 2022). The household size ranges from 1 to 16, with a mean of 6, which reflects the communal nature of rural farming households

Effects of utilisation of NSPRI postharvest technologies

***Parabolic shaped solar dryer (PSSD*)**:

The analysis in Table 2 revealed a statistically significant increase in income following adoption, indicating a positive economic effect. Additionally, a robust positive correlation was observed between income levels before and after adoption, suggesting that farmers who previously earned more continued to earn more after adoption. This strong association reinforces the consistency and reliability of the observed income improvement. Overall, the findings demonstrate the effectiveness of the technology in enhancing farmers' economic outcomes, supporting its broader promotion among smallholder users.

Hermetic steel drum (HSD):

The results in Table 3 show an increase in income during HSD use compared to the period before its adoption. However, this increase was not statistically significant, suggesting that the observed improvement may be due to random variation rather than a consistent effect of the technology. Despite this, a strong positive correlation was found between income levels before and during HSD, implying that income trends remained stable over time and that those with higher earnings before adoption tended to maintain that advantage.

Willingness to pay and opinion sharing

The findings in Table 4 demonstrate a high willingness to pay for the HSD (98.6%) and the PSSD (98.1%), reflecting strong market potential. This aligns with past studies suggesting that farmers are willing to invest in postharvest technologies if they perceive clear benefits (Sasakawa Africa Association, SAA, 2016). However, the results on opinion sharing about NSPRI technologies indicate a disparity between the two technologies. While 50.7% of HSD users had shared their opinions, only 21.2% of PSSD users did so. This suggests that engagement strategies may need to be tailored differently for each technology.

Regarding dissemination channels, the Agricultural Development Programs (ADPs) were the primary platform for sharing feedback (44.9% for HSD and 11.5% for PSSD). This supports previous findings that ADPs are effective intermediaries in technology diffusion among farmers (Keo & Theng, 2013).

Perception of NSPRI hermetic steel drum (HSD)

Stakeholders' feedback on the HSD components reveals mixed perceptions Table 5. The material (steel) received the highest rating (mean = 3.61), indicating a positive perception of its durability and quality. The bolted ring (mean = 3.27) and lid/cover (mean = 3.42) were also rated highly, reinforcing the importance of secure sealing mechanisms in postharvest storage (Gitonga, 2013).

Table 2. Effects of PSSD Utilisation on Income

Variable Pair	Mean (Before)	Mean (After)	Mean Difference	Std. Dev. (Diff.)	t-value	df	Sig.	Correlation (r)
Weekly Income (Before vs. After Adoption)	₦13,232.43	₦18,591.89	-₦5,359.46	₦10,566.34	-3.085	36	0.004	0.991

Source: *Field Survey, 2023*

Table 3. Effects of HSD Utilisation on Income

Technology	Mean (Before)	Mean (After)	Mean Difference	t-value	df	Sig. (2-tailed)	Correlation (r)	Sig. (r)
General	₦13,232.43	₦18,591.89	-₦5,359.46	-3.085	36	0.004	0.991	0.000
HSD	₦18,566.67	₦23,350.00	-₦4,783.33	-1.238	29	0.226	0.897	0.000

Source: *Field Survey, 2023*

Table 4: Distribution Channels of NSPRI Postharvest Technologies

Variable	HSD		PSSD	
	F	%	F	%
Willingness to pay for HSD:				
Yes	68	98.6	51	98.1
No	1	1.4	1	1.9
Sharing an opinion about NSPRI Technologies in the past				
Yes	35	50.7	11	21.2
No	29	42.0	41	78.8
Channels through which Opinion is shared				
Mass Media	1	1.5	5	9.6
ADPs	31	44.9	6	11.5
Farmers Association	2	2.9	-	-

Source: *Field Survey, 2023*

However, the drum's size/capacity had a mean score of 2.47, falling below the decision threshold of 3.19, implying a need for improvement. This suggests that while the HSD is effective, capacity constraints may limit broader adoption.

Perception of NSPRI Parabolic Shaped Solar Dryer (PSSD)

PSSD, key components such as drying time (mean = 3.38), frame strength (mean = 3.31), and cover durability (mean = 3.25) were rated positively, Table 6. These findings align with research emphasising the efficiency of solar drying technologies in preserving food quality (Udomkun et al., 2020). However, the capacity of the tray (mean = 2.79) and the size of the air vent (mean = 2.77) scored below the threshold of 3.09, suggesting modifications may be needed to improve drying efficiency. Moreover, the aspirator had a moderate score (mean = 3.02), indicating that while it contributes to the drying process, there may be concerns about its performance or necessity. This aligns with studies highlighting the need to optimise solar dryer air circulation to enhance drying rates (Prasad et al., 2024).

Table 5: Respondent perceptions of HSD

Variables	Very Good (4)	Good (3)	Average (2)	Poor (1)	WS	Mean
Size/capacity of drum	8(11.6)	16(23.2)	41(59.4)	1(1.4)	163	2.47
Bolted Ring	21(30.4)	42(60.9)	3(4.3)	-	216	3.27
Lid/cover	29(42.0)	36(52.2)	1(1.4)	-	226	3.42
Material (Steel)	40(58.0)	26(37.7)	-	-	238	3.61

Note: *Value in the bracket refers to percentage, WS Weighted score, N= Number of respondents (=66) and Grand mean=3.19.*

Table 6: Respondent perceptions of PSSD

Variables	VG (4)	G (3)	A (2)	P (1)	WS	Mean
Capacity of tray	11(21.2)	21(40.4)	18(34.6)	2(3.8)	145	2.79
Size of air vent	6(11.5)	29(55.8)	16(30.8)	1(1.9)	144	2.77
Durability of cover	22(42.3)	24(46.2)	3(5.8)	3(5.8)	169	3.25
Strength of the frame	23(44.2)	23(44.2)	5(9.6)	1(1.9)	172	3.31
Drying time	22(42.3)	28(53.8)	2(3.8)	-	176	3.38
Aspirator	7(13.5)	39(75.0)	6(11.5)	-	157	3.02

Note: *Very good=VG, Good=G, Average=A, and Poor=P WS= Weight score N= Number of respondents=52 and Grand mean= 3.09*

Conclusion

The study highlights the critical role of stakeholder feedback in enhancing the development and adoption of postharvest technologies. It reveals that farmers are generally willing to adopt NSPRI innovations, but certain capacity limitations, particularly with Hermetic Steel Drums (HSD) and Parabolic-Shaped Solar Dryers (PSSD), hinder optimal use. Addressing these concerns is essential for achieving sustainable uptake and scaling technologies.

Recommendations:

To improve adoption and user satisfaction, the study recommends enhancing the capacity of storage drums

and increasing the efficiency of drying trays. Addressing challenges such as limited access to credit will also support wider adoption. Furthermore, Agricultural Development Programmes (ADPs) and farmer associations should be actively engaged to facilitate information sharing, raise awareness, and improve the dissemination of NSPRI technologies.

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