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Research Article

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Strengthening postharvest technology development and improvement through feedback

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ABSTRACT
This inquiry is predicated on the datum or truism that all technologies have a gap and or become obsolete at some point, and the utilization of passé technologies and methods predisposes the agricultural sector to underdevelopment. It investigates technological paucities and fixes for NSPRI technologies (NSPRI Smoking Kiln (NSK), Parabolic-shaped Solar Dryer (PSSD), Ice Fish Box® (IFB®), Hermetic Steel Drum (HSD) and Ventilated Plastic Crate (VPC)) from the perspective of users of the technologies. The study adopted a cross-sectional research design using the in-person method as its feedback mechanism in 18 states across 6 geopolitical zones in Nigeria. Data were obtained through interview schedules supplemented with key informant interviews while a multi-stage sampling procedure was employed in the selection of respondents. Firstly, eighteen (18) States where NSPRI postharvest technologies have been disseminated and adopted were purposively selected. Secondly, users of improved NSPRI postharvest technologies were selected from diverse locations within the states earlier selected. Non-probabilistic techniques particularly snowballing were also employed at this stage. Frequencies, percentages, means and weighted averages were employed in the analysis of data components. Results showed that 70% of respondents have never provided feedback on NSPRI technologies. Executives of various associations were used by 45% of NSK users, 59% of IFB users, and 48% of VPC users to provide feedback while 43% of PSSD users and 40% of HSD users shared opinions through NSPRI extension staff. In general, there exists a strong (NSK: 94% PSSD: 95.2% IFB®: 91% HSD: 88.6% VPC: 74.5%) willingness to recommend technologies among respondents even as they provided positive feedback on use parameters and components of the technologies. However, respondents opined that the roller and chimney (NSK), durability of polypropylene cover (PSSD), draining of thawed ice (IFB®), and bolted ring (HSD) require improvement.

Keywords: Postharvest technology development, Solar Dryer, Ice Fish Box, datum

INTRODUCTION

Feedback, known in innovation management parlance as review is a crucial component of technological development and improvement. It is the information, perceptions, and inputs shared by stakeholders about their experiences with the utilization of technologies, products, protocols, or services; it provides insight into overall outcomes, characteristics and/or consequences of technologies, products, protocols, or services disseminated to clientele not leaving out their deficiencies and fixes. It is the process of relating information from end-users back to research after having received or used an innovation (Oyetoro and Akinbode, 2010).

Information gathered through feedback are reported to Research and Development (R&D) for making improvement to existing technologies or developing new ones from scratch. The improvements made to agricultural technologies based on feedback have led to significant enhancement in user satisfaction (Kimano, Mukandiwa, & Mario, 2010). Nonetheless, little or no consideration for feedback from end users has led to unrealistic, cost-ineffective and sometimes culturally incompatible technologies.

The importance of feedback is heightened by the cavernous information gap existing between Research and Development (R & D), extension, and users of research results impacting negatively on overall agricultural development, especially the development of agricultural technologies and practices (Omotayo, 2004). Add to the aforesaid, organizations at the frontlines of technological development in the agricultural sector especially in the Third World have had to stick with technologies long after their values have diminished because of huge financial investments that go into R & D which may not always give a tangible result. Even so, change is constant, and locking into technologies for unnecessarily long periods of time will not align with the ever-changing technology needed in modern agriculture.

Research by itself is not all-knowing; feedback creates a relationship between research and consumers of agricultural technologies by fostering conversations around and about agricultural technologies. Feedback motivates change, and as such creating avenues for feedback recognizes the fact that change is constant, and dynamic technology models are the bedrock of development in the agricultural sector. Feedback could be in the form of commendation (positive) for an innovation or commendation for some component of the innovation, it could also be disapproval (negative) for an innovation or disapproval for some of its components. Commendation gives credence while criticism offers ideas to improve the innovation.

Nigerian Stored Products Research Institute (NSPRI) among others is in the business of delivering improved postharvest technologies to stakeholders in Nigeria. Despite its contributions to combating food losses, large-scale empirical studies (studies with national spread) have not been conducted in recent times to improve on design, and production, as well as on increasing efficiency of these through feedback from clientele. Furthermore, all technologies have inadequacies and or become antediluvian at some time, therefore this investigation will seek to provide answers backed by scientific experimentation to the salient topical question: What are technological paucities and fixes for NSPRI technologies from the standpoint of users of such technologies? Consequently, the fact that the utilization of passé technologies and methods is rife in the research and development domain, the need to stem this anomaly calls for an investigation whose objectives are to ascertain the gaps in selected Nigerian Stored Products Research Institute (NSPRI) technologies through feedback from relevant stakeholders and generate data that will aid in improving deficient or obsolete NSPRI technologies based on feedback from users of such technologies. Furthermore, the findings would help make recommendations that would contribute to policy.

MATERIALS AND METHODS

The research design was cross-sectional. In-person surveys and technology-based engagement platforms are common mechanisms employed in generating feedback. This study, however, employed the in-person feedback method. Fundamentally, this method is usually done orally and more often than not uses standardized interview schedules whose intent is to bring to the fore perceptions, experiences, requirements and suggestions of users of a technology, product or service towards its improvement. The study was carried out in 18 states (Kwara, Kogi, Niger, Nassarawa, Osun, Ekiti, Lagos, Ondo, Ogun, Oyo, Delta, Rivers, Akwa Ibom, Edo, Abia, Ebonyi, Kano, and Borno) across the 6 geopolitical zones of the country.

Sampling Procedure and Sample Size

A multi-stage sampling procedure was used for the study. At the first stage, eighteen (18) States where improved NSPRI postharvest technologies have been adequately disseminated and adopted in the past were purposively selected. The technologies of interest for this study were NSPRI Smoking Kiln (NSK), Parabolic-shaped Solar Dryer (PSSD), Ice Fish Box® (IFB®), Hermetic Steel Drum (HSD) and Ventilated Plastic Crate (VPC). Secondly, users of improved NSPRI postharvest technologies were selected from diverse locations within the eighteen (18) States earlier selected. Non-probabilistic techniques especially snowballing were also employed at this stage. Similarly, the Agricultural Development Project (ADP), local resource persons in selected seventeen (17) states, and the Agro Processing, Productivity Enhancement and Livelihood Improvement Support (APPEALS) project in Kano State assisted in survey mapping and enumeration. Essentially, past and present users of improved NSPRI postharvest technologies identified via previous NSPRI empowerment and popularization programmes were the focus of this investigation. Members of groups earlier empowered in Kwara, Kogi, Niger, Osun, Lagos, Ogun, Oyo, Delta, Rivers, Akwa Ibom, Edo, Abia, and Ebonyi States were interviewed on utilization and feedback for these technologies: Fish Smoking Kiln, Ice Fish Box®, Ventilated Plastic Crate, Hermetic Drum and Parabolic-shaped Solar Dryer. Ekiti, Ondo and Nassarawa States: Parabolic-shaped Solar Dryer. Kano State: Hermetic Drums and Parabolic-shaped Solar Dryer; Borno State: Fish Smoking Kiln, Ice Fish Box®, and Hermetic Drum. A total of 4,500 interview schedules were sent out (250 per State) across NSPRI technologies and along the women and youth divide based on the data sheets of users of improved NSPRI postharvest technologies obtained from NSPRI, ADPs and APPEALS, 3,017 were returned (67% return rate). For this investigation, the total number of valid responses retrieved was 2,202.

Pre-Testing of Survey Instrument

Face and content validity of the research instrument was carried out by an assortment of experts from the Department of Agricultural Extension and Rural Development, and the Department of Sociology, University of Ilorin, Nigeria. Using the Test-retest method, Pearson Product Moment Correlation was used to ascertain the reliability of the survey instrument. With this in perspective, the instrument was considered consistent as a reliability coefficient of 0.71 was obtained.

Data Collection and Analysis

Items on the research instrument were developed to provide answers to the objectives of the study. This was also augmented with a qualitative data tool viz.: key informant interview. The data obtained were in nominal, ordinal, and interval levels. Feedback from respondents on postharvest technologies was obtained through a Likert-type scale and analyzed using the weighted mean known in some circles as a weighted average. This incorporates multiplying each data point in a set by a value which is determined by some characteristics of its contribution to the data point (Clark-carter, 2010).

RESULTS AND DISCUSSION

Demographics of the Respondents

As shown in Table 1a, the distribution of stakeholders (users) along the sex divide reflects the focus of previous NSPRI empowerment programmes male 36.5, female 63.5 (disaggregated: NSK; male 37.1, female 62.9; PSSD; male 25.5, female 74.5; IFB®; male 31.7, female 68.3; HSD male; 44.7, female 55.3; VPC; male 43.6, female 56.4). Youths are persons between the ages of 15 and 35 years (African Union, 2006). Be that as it may, the mean age of users of these technologies is estimated at 44 years (disaggregated: NSK; 44; PSSD; 46; IFB®; 43; HSD; 45; VPC; 40), showing that respondents are relatively young. This might not be unconnected to the fact that major recipients of NSPRI empowerment programmes are women; womenfolk are not devoid of the aged. Across the technology divide, the majority of the respondents are married. Marriage exerts influence on stakeholders in the agricultural sector to embrace improved technologies (Ajala, Kolawole, Owolabi & Faseyi, 2017). Users (the crux of this investigation) of NSK, PSSD, IFB®, HSD and VPC have fish processing, grain processing and storage, fish retailing, grain processing and storage, and fruit & vegetable farming and processing as their major enterprises respectively.

Aggregated mean household size (Table 1b) is 6 (disaggregated household size for users of: NSK; 7, PSSD; 6, IFB®; 6, HSD; 7, VPC; 6). The majority of the respondents (i.e. users of PSSD, IFB®, HSD, and VPC) for this investigation are secondary school graduates. On the other hand, the majority (33.3%) of NSK users are recipients of primary school education. However, further scrutiny of the data presented in Table 1b suggests that across the board, respondents are educated; education is an important explanatory factor that positively influences the decision to utilize improved technologies (Namara, Weligamage and Barker, 2013). A large majority of respondents belong to a group, membership of this is however skewed towards a cooperative society. Membership in a group/association is known to provide opportunities for accessing information and knowledge, credit, input and improved technologies (Owojaiye, 2022).

Among users of these technologies (Table 1c), an estimated 65% do not have access to credit facilities while the majority of those rely chiefly on non-institutional sources. That said, access to credit is a key to rural development as it is essential for promoting Small and Medium Enterprise (Attah, Annan, and Ironbar, 2018), non-access however decreases income by inhibiting productive investments (Akinlo, 2014). Table 1c also shows the aggregated average years of experience in the enterprise to be 12 (disaggregated years of experience: NSK; 11, PSSD; 12, IFB®; 12, HSD; 13, VPC; 11) implying that respondents are relatively well-experienced. Long years of experience enhance respondents' understanding and aid the utilization of technologies of concern. Add to the aforementioned, experienced users would have a lower level of uncertainty about technology performance, have full information and better knowledge; and be able to evaluate the advantages of improved technologies (Adegbola, 2019). Also, Table 1c shows an overwhelming majority of respondents received technologies from the government (NSPRI empowerment and popularization projects).

As shown in Table 1d, the pre-eminent mode of technology utilization for IFB® and VPC (transportation and handling technologies) is personal. For the first the least mode of utilization is personal and group (i.e. both) while the group mode of utilization is the least for the other. The lowest mode of technology utilization for NSK and PSSD (processing technologies) is personal. For the former the most prominent mode of utilization is personal and group (i.e. both) while the group mode of utilization is foremost for the latter. For HSD, given its peculiarity as a low to medium-storage technology, the principal mode of utilization is personal. Apart from VPC which is principally used at a commercial level, respondents majorly utilized technologies for both subsistence and commercial purposes (i.e. both). The public extension system represents the most common source of information for stakeholders in Nigeria (Adegbola, 2019). Put in perspective, the majority of respondents have had contact(s) with extension agents in the past 12 months with an estimated average of 3 contacts. Most users of NSK and PSSD (processing technologies) live in rural areas, however majority of respondents who use the IFB®, HSD and VPC live in suburbs. Finally, all respondent categories except users of PSSD have their business in the suburbs.

Opinions/Feedback Channels

Limited feedback hinders the development, improvement, and advancement of technologies which have the potential to increase productivity and improve livelihood. According to Table 2, about 70% of respondents for this survey have never provided feedback(s) on NSPRI technologies. For those who have, these categories of respondents NSK users (45 %), IFB users (59%), and VPC users (48 %) have majorly shared their opinions through the executives of various associations they belong to. However, users of PSSD (43%) and HSD (40%) shared opinions through NSPRI extension staff. The high percentage of respondents who have never provided feedback mirrors the low premium placed on feedback in the sector. This phenomenon however is not untypical of the agricultural sector in developing countries Nigeria inclusive, where stakeholders' reliance on extension staff in transmitting and receiving information has been ineffective due to the low extension agent-to-farmer ratio. This dearth of feedback in the technology development space creates a chasm between subject matter specialists and end users of technology; it leaves the former in the dark as to required improvement while the latter are sometimes stuck with obsolete technologies or those not in sync with current needs and realities of the time.

Feedback on NSPRI Technologies

NSK is a technology for smoking/drying fish and meat. Its major components are the drying chamber with drying trays, a combustion chamber, and an oil collector. This kiln may be classified based on size and or heat source (charcoal, gas, and electricity). The charcoal variant was the focus of this investigation. Table 3a shows the opinion of respondents that the following components of the NSK; charcoal tray, door, oil extractor, fish tray, and metal sheet do not require improvement. In the same vein, this opine that drying time using the NSK is optimal (this may not be unconnected to the quality of the metal sheet (primary material) and lagging of the NSK) and needs no further improvement in this regard. They however hold that the roller and chimney components require improvements; the rollers are quick to get detached and the chimney needs a mesh and a cone-shaped covering.

PSSD is a form of confined solar dryer. It consists of transparent materials that provide a covering and transmit heat from the sun into the drying chamber. It also has an insulated black floor that stores heat from the sun to prevent its loss due to conduction. Table 3b shows the opinion of respondents that the following components of the PSSD: tray, frame, and aspirator do not require improvement. Similarly, respondents opine that drying time using the PSSD is ideal and products retain their natural colour (this may not be unrelated to the fact that the ultraviolet-treated polypropylene cover transmits heat and the insulated black floor forestalls heat loss). Nevertheless, they view the durability of polypropylene cover as suspect as it is quick to tear after a few months of use; it therefore requires improvement. A higher gauge of polypropylene cover would enhance its durability.

IFB® is used to extend the shelf-life of fresh fish. It is a means of handling fish for transporting, distributing and marketing. The IFB® consists of a double-wall food-grade plastic with insulation between the walls. The box has a tight-fitting lid that is also insulated. The insulation reduces heat transfer from the surroundings and conserves the ice's cooling effect. The technology has a draining outlet for the water that could arise from the defrosting ice placed in it. As shown in Table 3c, respondents perceive that the size/capacity of the box, roller/wheel, and tightness of the lid/cover do not require improvement. Nonetheless, they opine that the draining of thawed ice requires improvement. The outlet for draining should be constructed to be at the same level as the floor of the box to allow for complete draining.

HSDs are rigid airtight structures used to store durable agricultural produce both at domestic and commercial levels. They provide moisture and insect control without pesticides. These have tight-fitting lids, creating a barrier between the produce and the outside atmosphere to prevent oxygen and water movement between the environment and the stored produce. Table 3e reveals the opinion of respondents to be that the following components of the HSD; capacity of drum lid/cover, and material (steel) do not require improvement. They however hold that the bolted ring requires improvement; its bolt and nuts are fitted too close to the drum and require other devices (spanner) to fasten and unfasten.

VPC are strong, rigid, easy to clean, stackable, nestable and reusable plastic crates for handling fruits and vegetables. These crates allow for cross ventilation of air to prevent heat build-up when loaded with fruits and vegetables. They have a maximum loading level to prevent mechanical damage when stacked. Utilization of this technology reduces overall transportation costs because they can be stacked and reused. As presented in Table 3d, respondents' feedback shows that the strength of the crate handle, holding capacity, ventilation of produce, the durability of crate, and strength of the base (all aspects of use/ components of the technology) function as desired and do not require improvement.

Advantages of using NSPRI Technologies

As shown in Tables 4a, b, c, d and e, the major advantages associated with the use of these technologies are as follows NSK: fast drying time, hygienic output, and extension shelf life; PSSD: fast drying time, dried products look better, saves stress; IFB®: durability of technology, extension of shelf life of commodity, portable; HSD: improved shelf-life, insect free products, prevents rodent attacks; VPC: protection of produce during transport, extension of shelf life, and easy to handle.

Challenges Associated with Usage of NSPRI Technologies.

As shown in Tables 5a, b, c, d and e, the major challenges associated with the use of these technologies are as follows NSK: roller, the capacity of fish tray, and quality of charcoal tray material; PSSD: Fastening bolts piercing the polypropylene cover, polypropylene cover susceptible to tear, and the structure as a whole lacks protective barrier against domestic animals; IFB®: Scarcity and cost of ice, and small holding capacity; HSD: It is expensive, scarce, and not compatible with dominant practices in the sector; VPC: does not allow flexible arrangement during transportation, not a unit of measurement, and small holding capacity.

Respondents' Willingness to Recommend Technology

Willingness to recommend is a strong research approach that captures interpersonal communication as one of the most powerful means to increase the adoption of technologies by both current and would-be users (Aksoy, Buoye, Cooil & Keiningham, 2011). Put in perspective, Table 6 revealed an overwhelming majority of users of these technologies (NSK: 94% PSSD: 95.2% IFB®: 91% HSD: 88.6% VPC: 74.5%) were willing to make a recommendation to potential users. This suggests that the advantages of the technologies far exceed the seeming challenges accompanying the use of these technologies.

Table 1a. Socio-economics information of respondents

	NSK			PSSD			IFB®			HSD			VPC		
	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean
Sex															
Male	179	37.1		111	25.5		145	31.7		344	44.7		24	43.6	
Female	304	62.9		325	74.5		313	68.3		426	55.3		31	56.4	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Age															
20 years Below	16	3.3		-	-		4	.9		25	3.2		2	3.6	
21- 30 years	39	8.1		18	4.1		51	11.2		56	7.2		5	9.1	
31- 40 years	123	25.5		118	27.1		142	30.7		242	31.5		16	29.1	
41- 50 years	181	37.5		160	36.7		166	36.4		249	32.4		23	41.8	
51- 60 years	103	21.3		100	22.9		70	15.4		160	20.8		8	14.5	
61 Years and above	21	4.3		40	9.2		25	5.5		38	4.9		1	1.8	
Total	483	100.0	44	436	100.0	46	458	100.0	43	770	100.0	45	55	100.0	40
Marital Status															
Single	22	4.6		75	17.2		23	5.1		27	3.5		7	13.0	
Married	415	86.1		328	75.2		390	84.9		665	86.4		40	74.1	
Widowed	28	5.8		13	3.0		30	6.7		47	6.1		3	5.6	
Divorced	6	1.2		5	1.1		11	2.4		12	1.6		-	-	
Separated	12	2.5		15	3.5		4	.9		19	2.5		4	7.4	
Total	483	100.0		436	100.0		458	100.0		770	100.0		54	100.0	
Major Enterprise															
Fish processing	457	94.6		21	4.8		105	23.1		4	.5		1	1.8	
fish retailing	26	5.4		-	-		345	75.2		2	.3		-	-	
grain processing/storage	-	-		159	36.5		7	1.5		725	94.2		-	-	
fruit & vegetable farmer/processor	-	-		79	18.1		1	.2		14	1.9		31	56.4	
fruit & vegetable marketer	-	-		-	-		-	-		-	-		22	40.0	
root & tuber farmer/processor	-	-		177	40.6		-	-		25	3.2		1	1.8	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	

Source: Field survey 2022

Table 1b. Socio-economics information of respondents

	NSK			PSSD			IFB®			HSD			VPC		
	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean
Household Size															
5 and below	170	35.3		161	37.2		191	41.9		298	38.5		23	41.8	
6 -10	270	55.7		254	58.0		220	48.2		383	49.9		30	54.5	
11 -15	36	7.5		21	4.8		35	7.2		73	9.5		2	3.7	
16 -20	4	0.8		-	-		12	2.6		16	2.1		-	-	
20 and above	3	0.6		-	-		-	-		-	-		-	-	
Total	483	100.0	7	436	100.0	6	458	100.0	6	770	100.0	7	55	100.0	6
Level of Education															
No formal education	43	8.9		96	22.0		68	14.9		87	11.3		6	10.9	
Primary	161	33.3		84	19.2		48	10.1		115	14.9		5	9.1	
Secondary	48	9.9		98	22.5		136	29.8		218	28.3		22	40.0	
Vocational/technical	43	8.9		24	5.5		24	5.3		55	7.1		7	12.7	
OND/NCE	76	15.7		72	16.5		108	23.7		176	22.9		8	14.5	

HND/BSC	94	19.5		47	10.8		63	13.8		99	12.9		6	10.9	
MSC	17	3.5		15	3.4		11	2.4		17	2.2		-	-	
PhD	1	0.2		-	-		-	-		3	0.4		1	1.8	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Membership of Association															
No	137	28.4		117	26.9		106	23.1		158	20.5		6	10.9	
Yes	346	71.6		319	73.1		352	76.9		612	79.5		49	89.1	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Number of Association															
1	262	75.7		199	47.4		266	75.6		501	81.9		24	49.0	
2	69	19.9		136	32.4		78	22.2		100	16.3		22	44.9	
3	13	3.8		16	3.8		7	2.0		11	1.8		3	6.1	
4	2	0.6		69	16.4		1	0.2		-	-		-	-	
Total	346	100.0		420	100.0		352	100.0		612	100.0		49	100.0	
Types of Association															
Cooperative society	174	39.4		199	47.4		185	41.5		308	41.9		38	40.3	
Processors association	152	34.4		136	32.4		67	15.0		100	13.6		4	5.2	
Marketer's association	37	8.4		16	3.8		116	26.0		134	18.3		25	32.5	
Farmer's association	79	17.8		69	16.4		79	17.5		192	26.2		17	22.0	
Total	442	100.0		420	100.0		447	100.0		734	100.0		77	100.0	

Source: Field survey 2022

Table 1c. Socio-economics information of respondents

	NSK			PSSD			IFB®			HSD			VPC		
	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean
Access to Credit															
No	302	62.5		328	75.2		317	69.2		479	62.3		31	56.4	
Yes	181	37.5		108	24.8		141	30.8		291	37.7		24	43.6	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Source of Credit															
Institutional	53	29.3		38	35.2		31	22.0		66	22.8		16	66.7	
Non institutional	128	70.7		70	64.8		110	78.0		225	77.2		8	33.3	
Total	181	100.0		108	100.0		141	100.0		291	100.0		24	100.0	
Years of Experience in the Enterprise															
10 years Below	317	65.4		255	58.9		269	58.9		408	53.1		37	68.5	
11-20 years	92	19.2		115	25.9		99	21.7		214	27.6		13	24.1	
21-30 years	37	7.7		55	12.7		48	10.5		89	11.6		3	5.6	
31-40 years	30	6.3		6	1.4		33	7.0		48	6.3		1	1.9	
41-50 years	7	1.5		5	1.2		9	2.0		11	1.4		-	-	
Total	483	100.0	11	436	100.0	12	458	100.0	12	770	100.0	13	54	100.0	11
Mode of Technology Acquisition															
Given by government	429	88.8		398	91.3		401	87.5		656	85.3		42	76.4	
Gifted	3	0.6		15	3.4		-	-		-	-		2	3.6	
Purchased	18	3.7		-	-		8	1.8		12	1.6		7	12.7	
Hired/leased	3	.6		11	2.5		-	-		-	-		2	3.6	
NGO	30	6.2		12	2.8		49	10.7		102	13.1		2	3.6	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	

Source: Field survey 2022

Table 1d. Socio-economics information of respondents

	NSK			PSSD			IFB®			HSD			VPC		
	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean	Freq	%	Mean
Mode of Technology Utilization															
Personal	112	23.2		37	8.5		172	37.4		273	35.5		27	49.1	
Group	169	35.1		275	63.1		149	32.6		230	29.9		12	21.8	
Both	202	41.7		124	28.4		137	30.0		267	34.6		16	29.1	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Level of Technology Utilization															
Subsistence	30	6.2		32	7.4		36	7.9		92	12.0		8	14.5	
Commercial	180	37.3		179	40.9		199	43.4		295	38.4		24	43.6	
Both	273	56.5		225	51.7		223	48.7		383	49.7		23	41.8	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Contacts with Extension Agents in the Past 12 Months															
No	88	18.0		65	15.1		97	21.2		145	18.9		12	21.8	
Yes	395	82.0		371	84.9		361	78.8		625	81.1		43	78.2	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Number of Contacts with Extension Agents in the Past 12 Months															
5 times and below	326	82.5		328	88.4		283	78.4		525	84.1		40	93.0	
6-10 times	46	11.6		29	7.8		67	18.5		73	11.7		3	7.0	
11-15 times	16	4.1		14	3.8		9	2.5		18	2.9		-	-	
16-20 times	6	1.5		-	-		2	.6		7	1.0		-	-	
21 times and above	1	0.3		-	-		-	-		2	.3		-	-	
Total	395	100.0	4	371	100.0	3	361	100.0	4	625	100.0	4	43	100.0	1
Region of Residence															
Rural	185	38.2		214	49.1		154	33.6		242	31.5		7	12.7	
Urban	129	26.8		79	18.1		122	26.7		262	34.1		14	25.5	
Sub-urban	169	35.1		143	32.8		182	39.7		266	34.5		34	61.8	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	
Region of Business Operation															
Rural	158	32.8		162	37.2		125	27.3		233	30.3		8	14.5	
Urban	146	30.1		115	26.4		153	33.4		234	30.4		15	27.3	
Sub-urban	179	37.1		159	36.5		180	39.3		303	39.3		32	58.2	
Total	483	100.0		436	100.0		458	100.0		770	100.0		55	100.0	

Source: Field survey 2022

Table 2. Distribution of respondents according to feedback channels

	NSK		PSSD		IFB®		HSD		VPC	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Sharing opinions about NSPRI technologies in the past										
No	340	70.7	307	70.4	366	79.9	465	60.5	34	61.8
Yes	143	29.3	129	29.6	92	20.1	305	39.5	21	38.2
Total	483	100.0	436	100.0	458	100.0	770	100.0	55	100.0
Channels of sharing about opinions on NSPRI technologies										
ADPs	32	22.4	40	31.0	13	14.1	56	18.3	3	14.1
NGO	-	-	7	5.4	2	2.2	16	5.3	1	4.7
Association Executives	64	44.8	26	20.2	54	58.7	111	36.4	10	47.7
NSPRI extension staff	47	32.8	56	43.4	23	25.0	122	40.0	7	33.5
Total	143	100.0	129	100.0	92	100.0	305	100.0	21	100.0

Source: Field survey 2022

Table 3a. Respondents' perceptions of NSK

	Very Good (5) Frequency (%)	Good (4) Frequency (%)	Average (3) Frequency (%)	Poor (2) Frequency (%)	Very Poor (1) Frequency (%)	WS/N	Weighted Mean Score (WMS)	Decision
Door Air Tightness	130 (26.9) 130x5=650	225 (46.6) 225x4=900	81 (16.8) 81x3=243	32 (6.6) 32x2=64	15 (3.1) 15x1=15	1872/483	3.88	DNRI
Roller	15 (3.1) 15x1=15	28 (5.8) 28x4=112	70 (14.5) 70x3=210	238 (49.3) 238x2=476	132 (27.3) 132x1=132	945/483	1.96	RI
Chimney	39 (8.1) 39x5=195	96 (19.9) 96x4=384	131 (27.1) 131x3=393	142 (29.4) 142x2=284	75 (15.5) 75x1=75	1331/483	2.75	RI
Holding Capacity (Charcoal Tray)	79 (16.4) 79x5=395	249 (51.4) 249x4=996	124 (25.8) 124x3=372	21 (4.4) 21x2=42	10 (2.1) 10x1=10	1815/483	3.76	DNRI
Steel Strength of Kiln	183 (38.0) 183x5=915	261 (53.4) 261x4=1044	32 (6.7) 32x3=96	3 (0.6) 3x2=6	4 (0.8) 4x1=4	2065/483	4.28	DNRI
Oil Extraction	171 (35.6) 171x5=855	257 (53.0) 257x4=1028	49 (10.2) 49x3=147	2 (0.4) 2x2=4	4 (0.8) 4x1=4	2038/483	4.22	DNRI
Drying of Fish Smoking Kiln	257 (53.3) 257x5=1375	188 (38.9) 188x4=752	29 (6.0) 29x3=87	7 (1.4) 7x2=14	2 (0.4) 2x1=2	2230/483	4.62	DNRI
Fish Tray	176 (36.4) 176x5=880	258 (53.4) 258x4=1032	33 (6.9) 33x3=99	11 (2.3) 11x2=22	5 (1.0) 5x1=5	2038/483	4.22	DNRI

Source: Field survey 2022

Table 3b. Respondent perceptions of PSSD

	Very Good (5) Frequency (%)	Good (4) Frequency (%)	Average (3) Frequency (%)	Poor (2) Frequency (%)	Very Poor (1) Frequency (%)	WS/N	Weighted Mean Score (WMS)	Decision
Capacity of Tray	165 (37.8) 165x5=825	160 (36.7) 160x4=640	89 (20.4) 89x3=267	9 (2.1) 9x2=18	13 (3.0) 13x1=13	1763/436	4.04	DNRI
Durability of Polypropylene Cover	18 (4.1) 18x5=90	78 (17.9) 78x4=312	207 (47.5) 207x3=621	108 (24.8) 108x2=216	25 (5.7) 25x1=25	1264/436	2.90	RI
Strength of the Frame	151 (34.6) 151x5=755	206 (47.2) 206x4=824	64 (14.8) 64x3=192	15 (3.4) 15x2=30	-	1801/436	4.13	DNRI
Drying Time	223 (51.1) 223x5=1115	163 (37.4) 163x4=652	31 (7.1) 31x3=93	16 (3.7) 16x2=32	3 (0.7) 3x1=3	1895/436	4.35	DNRI
Aspirator	128 (29.4) 128x5=640	197 (45.1) 197x4=788	87 (20.0) 87x3+261	19 (4.4) 19x2=38	5 (1.1) 5x1=5	1732/436	3.97	DNRI

Source Survey: Field Survey 2022. *DNRI= Does not require improvement, *RI= Requires improvement, *WS= Weighted score, *N= Number of respondents.

Table 3c. Respondent perceptions of IFB®

	Very Good (5) Frequency (%)	Good (4) Frequency (%)	Average (3) Frequency (%)	Poor (2) Frequency (%)	Very Poor (1) Frequency (%)	WS/N	Weighted Mean Score (WMS)	Decision
Draining of Thawed Ice	29 (6.3) 29x5=145	76 (16.6) 76x4=304	83(18.2) 83x3=249	231 (50.4) 231x2=462	39 (8.5) 39x1=39	1199/458	2.62	RI
Size/Capacity of Box	55 (12.1) 55x5=275	155 (33.8) 155x4=620	86 (18.8) 86x3=258	95 (20.7) 95x2=190	87 (14.6) 87x1=87	1430/458	3.12	DNRI
Roller/Wheel	34 (7.4) 34x5=170	190 (41.5) 190x4=760	232 (50.7) 232x3=696	2 (0.4) 2x2=4	-	1630/458	3.56	DNRI
Tightness of Lid/Cover	238 (52.0) 238x5=1190	192 (41.9) 192x4=768	15 (3.3) 15x3=45	13 (2.8) 13x2=26	-	2029/458	4.43	DNRI

Source Survey: Field Survey 2022. *DNRI= Does not require improvement, *RI= Requires improvement, *WS= Weighted score, *N= Number of respondents.

Table 3d. Respondent perceptions of VPC

	Very Good (5) Frequency (%)	Good (4) Frequency (%)	Average (3) Frequency (%)	Poor (2) Frequency (%)	Very Poor (1) Frequency (%)	WS/N	Weighted Mean Score (WMS)	Decision
Strength of Crate Handle	28 (50.9) 28x5=140	21 (38.2) 21x4=84	6 (10.9) 6x3=18	-	-	242/55	4.40	DNRI
Holding Capacity	29 (52.7) 29x5=145	22 (44.0) 22x4=88	3 (5.5) 3x3=9	1 (1.8) 1x2=2	-	244/55	4.44	DNRI
Ventilation of Produce	33 (60.0) 33x5=165	18 (32.7) 18x4=72	4 (7.3) 4x3=12	-	-	249/55	4.53	DNRI
Durability of Crate	21 (38.2) 21x5=105	31 (56.4) 31x4=124	3 (5.5) 3x3=9	-	-	238/55	4.33	DNRI
Strength of the Base	34 (61.8) 34x5=170	20 (36.4) 20x4=80	1 (1.8) 1x3=3	-	-	253/55	4.6	DNRI

Source Survey: Field Survey 2022. *DNRI= Does not require improvement, *RI= Requires improvement, *WS= Weighted score, *N= Number of respondents.

Table 3e. Respondent perceptions of HSD

	Very Good (5) Frequency (%)	Good (4) Frequency (%)	Average (3) Frequency (%)	Poor (2) Frequency (%)	Very Poor (1) Frequency (%)	WS/N	Weighted Mean Score (WMS)	Decision
Size/Capacity of Drum	207 (27.0) 207x5=1035	368 (47.9) 368x4=1472	181 (23.3) 181x3=543	6 (0.8) 6x2=12	8 (1.0) 8x1=8	3070/770	3.99	DNRI
Bolted Ring	59 (7.7) 59X5=295	101 (13.1) 101x4=404	192 (24.9) 192x3=576	345 (448) 345x2=690	73 (9.5) 73x1=73	2038/770	2.65	RI
Lid/Cover	259 (33.6) 259X5=1295	394 (51.3) 394x4=1576	83 (10.8) 83x3=249	23 (2.9) 23x2=46	11 (1.4) 11x1=11	3177/770	4.13	DNRI
Material (Steel)	430 (55.9) 430x5=2150	261 (33.9) 261x4=1044	61 (7.9) 61x3=183	11 (1.4) 11x2=22	7 (0.9) 7x1=7	3406/770	4.42	DNRI

Source Survey: Field Survey 2022. *DNRI= Does not require improvement, *RI= Requires improvement, *WS= Weighted score, *N= Number of respondents.

Table 4a. Advantages of NSK

	Frequency	Percent
Fast drying time	110	39.1
Hygienic output	88	31.3
Less stressful	14	4.9
Increased patronage	30	10.7
Extension of shelf-life	32	11.4
Removable tray	7	2.6
Total	281	100.0

Table 4b: Advantages of PSSD

	Frequency	Percent
It saves cost	8	2.9
Products dry faster	84	30.9
It protects products against animal incursion and contamination	11	4.1
Dried products are neater and hygienic	48	17.6
Dried products look better	63	23.2
Saves stress	58	21.3
Total	272	100.0

Table 4c: Advantages of IFB®

	Frequency	Percent
Keep ice from defrosting for a longer period	7	2.3
Durability of technology	40	13.4
Simple to operate	6	2.0
Extension of shelf life of commodity	190	64.2
Easy to move from one point to another	17	5.6
Portable	36	12.5
Total	296	100.0

Table 4d: Advantages of HSD

	Frequency	Percent
Durable	100	15.1
Easy to use	33	5.0
Increases patronage	3	0.5
More hygienic products	4	0.6
Improved shelf-life	199	30.1
Insect free products	130	19.7
It can store variety of grains	4	0.6
It is chemical free	51	7.7
It prevents rodent attacks	112	16.9
It reduces storage treatment cost	13	2.0
It stores more quantity	5	0.8
Mobile	5	0.8
Not stressful	2	0.2
Total	661	100.0

Table 4e: Advantages of VPC

	Frequency	Percent
Durability of crates	6	10.9
Protection of produce during transport	20	36.5
Extension of shelf life	9	16.3
Easy to handle	20	36.3
Total	55	100.0

Table 5a: Major challenges with the use of NSK

	Frequency	Percent
Heat regulation	10	4.4
Roller	88	39.1
Quality of steel	14	6.2
Oil collector	2	0.9
Capacity of fish tray	68	30.2
Quality of charcoal tray material	43	19.2
Total	225	100.0

Table 5b: Major challenges with the use of PSSD

	Frequency	Percent
Aspirator not functioning optimally	26	6.8
Fastening bolts piercing the polypropylene cover	61	15.9
High cost of technology	42	11.0
Polypropylene cover susceptible to tear	105	27.4
Rusting of tray mesh	18	4.7
Difficulty in replacing worn out/damaged part	30	7.8
It lacks protective barrier against domestic animals	53	13.8
Mesh removing from tray	12	3.1
Small capacity	15	3.9
Not readily availability for group members due to rotational usage	21	5.6
Total	383	100.0

Table 5c: Major challenges with the use of IFB®

	Frequency	Percent
Scarcity and cost of ice	17	8.3
Incomplete drain of thaw ice	7	3.4
Small holding capacity	181	88.3
Total	205	100.0

Table 5d: Major challenges with the use of HSD

	Frequency	Percent
It is expensive	60	12.9
Inner part of the drum and cover prone to rust	5	1.1
Difficulty in tightening and loosening bolted ring	47	10.1
Airtight rubber seal not stable	27	5.8
Scarce	110	23.6
Small capacity	4	0.9
Not compatible with dominant practices in the sector	213	45.6
Total	466	100

Table 5e: Major challenges with the use of VPC

	Frequency	Percent
Does not allow flexible arrangement during transportation	14	25.5
Scarce	8	14.5
Not a unit of measurement	19	34.5
Small holding capacity	14	25.5
Total	55	100.0

Table 6: Distribution of respondents according to their willingness to recommend Technology

	NSK		PSSD		IFB®		HSD		VPC	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Will not recommend	4	0.8	-	-	5	1.1	24	3.1	5	9.1
Indifferent	25	5.2	21	4.8	36	7.9	64	8.3	9	16.4
Will recommend	454	94.0	415	95.2	417	91.0	682	88.6	41	74.5
Total	483	100.0	436	100.0	458	100.0	770	100.0	55	100.0

CONCLUSIONS

Little or no consideration for feedback from end users has led to impracticable, incompatible, and cost-ineffective technologies in the agricultural sector. This investigation revealed that most users of postharvest technologies have never provided feedback that could aid the improvement of technologies or the development of new ones from scratch. The executives of various associations these users belong to, NSPRI Extension Staff and ADPs represent the most popular channels of providing feedback among respondents. Feedback garnered showed that four of the five technologies of interest had at least one component requiring improvement. Despite the desire for these improvements, respondents' satisfaction with technology components and use parameters is reflected in their strong willingness to recommend these technologies. The positive feedback on most components of these technologies gives credence while negative feedback from the perspective of end-users on a few components calls for further research to improve these technologies.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

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