

EASE OF UTILISATION OF MULTI-CROP DRYER IN THE PROCESSING OF PERISHABLE AND DURABLE CROPS IN LAGOS, NIGERIA

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ABSTRACT

Open sun drying pre-disposes agricultural produce to contaminants, with a consequent lower quality end-product. The multi-crop dryer (MCD) was developed by the Nigerian Stored Products Research Institute (NSPRI) to ensure the generation of hygienic and safe dried products. However, there is a dearth of existing study that analysed the ease of utilisation of this technology for the processing of agricultural produce. To narrow this gap in knowledge, primary data were collected, with the aid of a structured questionnaire schedule, from 181 trainees. A five-point Likert-type scale was employed to gauge trainee's expression regarding the effectiveness of training and Ease-of-Use of NSPRI-MCD. Kendall's Coefficient of Concordance (W) was used to test the degree of agreement in the expression of the trainees. Results revealed that participants gained relevant knowledge and skills from the training ($\bar{X}=4.49$); the knowledge gained would enhance performance in food processing ($\bar{X}=4.39$); quality attributes of the processed foods were generally acceptable ($\bar{X}=4.62$), among others. Furthermore, participants opined that drying time was not long and not discouraging ($\bar{X}=4.19$). However, they disagreed with the defining statement that changing of the drying trays at set time intervals was not cumbersome ($\bar{X}=2.28$), as well as the defining statement that operation of NSPRI/MCD was automated and did not require regular monitoring ($\bar{X}=1.40$). The Kendall's W^a of 0.84 and 0.61 shows a substantial agreement in the expression of the trainees regarding the effectiveness of training, and ease-of-use of NSPRI-MCD, respectively. The study concludes that the training was effective and the NSPRI-MCD was easy to use. It was recommended that the dryer be automated to enhance its ease-of-use.

Keywords: Agro-processing, Ease-of-Use, Multi-crop Dryer

INTRODUCTION

Drying is one of the earliest technologies employed by mankind to preserve various agricultural products. Of the several drying techniques, open sun drying is the most used method to preserve and process agricultural products across many parts of Nigeria. Classically, open sun drying simply entails spreading thin layers of agricultural produce under direct sunlight mostly on the ground, flat roof tops, tarps, trays, mats, baskets, paper or plastic sheets, drying tables, roads, stalls, or concrete floors, until it is bone-dry. The method is the simplest and most inexpensive technique of drying (Oshadumo *et al.*, 2025; Kazeem *et al.*, 2024), but the final product is usually of lower quality due to contamination by dust, dirt, debris, grit, insects, birds, animals, pests, dews and rain. Such contamination may cause the product to be of degraded market value. Losses of about 30 to 40% of total production of fruits and vegetables during drying have been reported, in developing countries (Dronachari and Shiramulu, 2019); resulting in a loss of millions of dollars' worth of gross national product (Yahia *et al.*, 2019).

The multi-crop dryer (MCD) is one of the technologies developed by the Nigerian Stored Products Research Institute (NSPRI) for the generation of hygienic and safe value-added agricultural products (Osegbo *et al.* 2022; Omodara, 2011). It is a more appropriate method of drying, which reduce heavy postharvest losses and generates superior quality products. The technology

has been used to dry and add-value to various durable and perishable agricultural crops.

Previous studies carried out on the multi-crop dryer mostly focused on the suitability of the technology for the generation of dried value-added products from durable crops, such as Instant pap from white maize, Beans flour from black-eyed white cowpea, wheat flour from wheat, and ground rice from white rice of the local variety (Osegbo *et al.*, 2022). In a similar vein, Fapounda *et al.*, (2022) utilised the technology for the development of dried value-added products from perishable crops which includes pineapple rings from pineapple, mango chips from mango, and dried leafy vegetable from various kinds of vegetables, dried tomatoes from Roma tomatoes, and dried pepper from the Bonnet spp. However, there is a dearth of existing studies that analysed the ease of utilisation of this technology for the processing of perishable and durable agricultural produce. This study attempts to narrow this gap in knowledge.

Ease-of-Use (EOU) is the degree to which a person believes that using a technology will be free from effort (Davis, 1989). In the context of this study, EOU refers to the extent to which users believe that the application of NSPRI-MCD is free of effort. If a technology is relatively easy to use, individuals will be more willing to learn about its features and finally intend to continue using it. The ease-of-use of this technology by farmers, agripreneurs, and agro-processors in value-added product development was examined with a view to

bring improvement to the technology. Specifically, the study seeks to:

1. gauge trainee's expression regarding the effectiveness of training on food processing, and
2. assess the expression of ease-of-use of NSPRI-Multi-crop dryer among trainees.

METHODOLOGY

The multi-crop dryer is a natural convection cabinet dryer fired with kerosene or charcoal. It comprises three functional components, namely: combustion chamber, heat exchanger and drying chamber (Figure 1). The combustion chamber houses a kerosene burner (stove), which is used to heat fresh ambient air flowing into the heat exchanger. The heat exchanger enables the transfer of heat from the burning flame to the cold ambient air without mixing the two. The heat exchanger is located above the kerosene stove. The drying chamber forms an enclosure inside which the commodity is held and dried by the heated air flowing out of the heat exchanger. The chamber carries the outlet vents for wet air exit at the roof (Babarinsa and Omodara, 2011). Commonly used materials for NSPRI-MCD include concrete (support base), wood and plywood (frame and cover), mesh wire, wire netting (tray), copper sheet (heat exchanger), charcoal using coal pot, kerosene using stove (power source).

All the participants of the 10 training workshops that were conducted for farmers, agripreneurs, and agro-processors on postharvest management and agro-processing between the year 2019-2023 were sampled for the study in line with the submission of Watson (2001), as shown in Table 1. A total of 181 trainees took part in the survey. However, upon screening for completeness only 104

questionnaires were found tenable for statistical analysis.

To assess trainees' expression of the effectiveness of training, a five-point Likert-type scale with expression indices from average of coded responses comprising; 5= Strongly agree, 4= Agree, 3= neutral, 2= Disagree and 1= Strongly disagree was presented to the participants to choose from, based on their agreement, or the lack thereof, with each defining statement on effectiveness of training. A total of 10 defining statements that underscore effectiveness of training (Table 3) were presented to the respondents. Similarly, to examine the ease-of-use of NSPRI-MCD, a five-point Likert-type scale with indices from average of coded responses comprising; 5= Strongly agree, 4= Agree, 3= Neutral, 2= Disagree and 1= Strongly disagree were presented to the respondents to choose from, based on their agreement, or the lack thereof, with each defining statement on ease-of-use of NSPRI-MCD. A total of 11 defining statements that underscore ease-of-use of NSPRI-MCD (Table 4) were presented to the respondents.

Kendall's coefficient of concordance (W) was used to test the degree of agreement in the expression of the trainees regarding the effectiveness of training on agro-processing, as well as the ease-of-use of NSPRI-MCD. The coefficient of concordance (W) has positive value ranging between zero (0) and one (1). It assumed a value of one in the situation where the scores assigned by each trainee are the same as those assigned by the other participants and zero when there is a maximum disagreement in the scoring of the expressed ease-of-use defining statements or the scoring of the defining statements that underscore effectiveness of training.



Figure 1: NSPRI-Multi Crop Dryer

Table 1: Selection of Respondents

SN	Theme of the Training Workshop	Month/Year	Number of Trainee
1	Processing and storage of agricultural produce in value addition	May, 2019	11
2	Upscaling and Sustenance	July, 2019	18
3	Scaling value added processing in Nigeria	Feb., 2020	19
4	Optimizing Postharvest Management: Scaling value addition in the Nigerian agricultural industry	Sept., 2020	17
5	Postharvest Management and Agro-processing in Nigeria: Current trends and approaches	April, 2021	22
6	Appropriate training for farmers and processors on knowledge and skill acquisition of some agricultural produce	Aug., 2021	16
7	Scaling postharvest management and value added processing in Nigeria: The NSPRI Perspective	Nov., 2021	21
8	Postharvest Management in Nigeria: A panacea to food and nutrition security	June, 2022	24
9	Postharvest Management in Nigeria: A tool for improving the livelihood of stakeholders	Oct., 2022	11
10	Postharvest Management in Nigeria: Scaling up your business in processing	Jan., 2023	22
Sample size			181

RESULTS AND DISCUSSION

Socioeconomic characteristics

Results in Table 2 indicates that 77.9% of the sampled trainees were females, while 22.1% were males. This may be because food processing is generally a female dominated enterprise in Nigeria. Most of the participants (34.6%) were of the age range between 51 and 60 years old. In addition, 33.7% of the respondents were between the ages of 41 and 50. Some 22.1% of the trainees fall within the age bracket of 41 to 50 years old. Of the remaining participants, 06.7% and 02.9% were of the age distributions <31, and >60 years, respectively. The average age of 46.31 years, in

addition to the age distribution indicates that most of the participants fall within an economically active and productive age group. Majority (91.3%) of the trainees had tertiary education, while 08.7% had secondary school education. Thus, most of the trainees had an appreciable level of educational attainment. The implication of this is that, most of them were able to process and understand relevant information during the training session.

Furthermore, the results show that, with a mean household size of 05.5, above 73% of the respondents were married. Roughly 16% of the respondents identified as single as at the time of the training. In addition to 3.9% that were divorced,

about 7% of the participants reported being widowed. The average household size, as well as the fact that majority of the respondents were married indicates that agro-processing could be a viable source of income that enables households to meet their physiological needs and other obligations.

However, most (65.4%) of the trainees indicated that agro-processing is not their major source of income. Nevertheless, it is, perhaps, a viable means of income diversification.

Table 2: Socio-economic Characteristics of Trainees (n=104)

Variables	Frequency	Percentage
Sex (Categorical)		
Male	23	22.1
Female	81	77.9
AGE (Years)		
<31	07	06.7
31-40	23	22.1
41-50	35	33.7
51-60	36	34.6
>60	03	02.9
Mean	46.31	
Standard Deviation	09.41	
Marital status (Categorical)		
Single	17	16.3
Married	76	73.1
Divorced/Seperated	4	03.9
Widowed	7	06.7
Level of education (Categorical)		
Secondary	09	08.7
Tertiary	95	91.3
Household size (Ratio)		
<4	20	19.2
4 – 6	60	57.7
>6	24	23.1
Mean	05.05	
Standard Deviation	02.01	
Occupation (Categorical)		
Major	36	34.6
Minor	68	65.4
Experience (Years)		
<6	48	46.2
6-10	46	44.2
11-15	07	06.7
>15	03	02.9
Mean	6.05	
Standard Deviation	03.32	
Annual revenue (₦)		
<500,000	61	58.7
500,000-1,000,000	29	27.9
1,000,001-2,000,000	12	11.5
>2,000,000	02	01.9
Mean	656,250	
Standard Deviation	530,251	
Membership of cooperative (Categorical)		
Yes	44	42.3
No	60	57.7
Membership of professional association (Categorical)		
Yes	36	34.6
No	68	65.4

Source: Survey Result, (2024).

Results in Table 2 further depicts that about 46% of the participants had been actively involved in agro-processing for less than six years. Further, 44.2% of the respondents have been engaged in agro-processing for a time duration of 6-10 years. Approximately 7% of the trainees have between 11 and 15 years of experience in processing of agro-products. For the remaining 2.9% of the respondents, they specified that they have been involved in agro-processing for more than 15 years. The distribution of the participants experiences in agro-processing, as well as the mean experience of 6.05 years shows that most of the trainees have been actively involved in agro-processing for an ample period. The annual income from agro-processing, as well as from other sources for most (58.7%) of the participants is less than ₦500,000. Whereas above 27% of the trainees indicated earning between ₦500,001-₦1,000,000 annually, 11.5% revealed that they earned between ₦1,000,001-₦2,000,000. A few (1.9%) of the participants earned more than ₦2,000,000 in a typical year. Results also showed that, 42.3% of the trainees indicated membership of cooperative society. By the same token, 34.6% of the participants indicated that they are members of at least one professional association.

Trainees’ expression of the effectiveness of training on agro-processing

Results in Table 3 shows that the participants found the training to be most effective in aspects that pertains to acceptable quality attributes of processed foods (\bar{X} =4.62), beneficial hands-on nature of the training (\bar{X} =4.61), enhanced safe food practice (\bar{X} =4.51), and gaining of relevant knowledge and skills (\bar{X} =4.49). The Kendall’s W^a of 0.84 shows a strong agreement in the expression of the trainees regarding the effectiveness of training on agro-processing.

These findings suggest that the training received was generally seen as effective by the respondents. This highlights the significance of training as a veritable tool for information dissemination in order to harness the full benefits of agricultural processing technologies. The key idea behind virtually any form of Postharvest Training Information (PhTI), that is training tailored towards reduction in food loss/waste, is to serve as a medium to impart knowledge, and to foster capacity development among players in the agricultural value chain (farmers, processors, marketers, inter alia), which usually exerts a significant influence on adoption and subsequent utilisation of agricultural innovation/technologies.

Table 3: Effectiveness of training on food processing

Defining Statement	SD	D	Percentages			Mean	Standard Deviation
			UD	A	SA		
I gained relevant knowledge and skills from the training	0.0	0.0	0.0	51.0	49.0	4.49	0.50
Knowledge and skill gained will enhance my safe food practice	0.0	0.0	0.0	49.0	51.0	4.51	0.50
The hands-on practical session of the training was more beneficial	3.8	19.2	25.0	33.7	18.3	4.61	0.49
What I have learnt will improve my performance in food processing	0.0	0.0	0.0	60.6	39.4	4.39	0.49
The training has improved my food safety awareness	0.0	0.0	0.0	58.7	41.3	4.41	0.49
Quality attributes of processed foods were generally acceptable	0.0	0.0	0.0	38.5	61.5	4.62	0.48
The facilitators of the training were competent	0.0	0.0	0.0	57.7	42.3	4.42	0.49
The questions and answers session were highly impactful	0.0	0.0	0.0	56.7	43.3	4.43	0.47
The environment was conducive for learning	0.0	0.0	1.9	67.3	30.8	4.29	0.49
Other trainees kept to training ground rules and were well behaved throughout the training	0.0	2.9	17.3	56.7	23.1	4.00	0.72
Diagnostic Test							
Kendall’s W^a						0.84	
Chi-Square						52.44	
Df						6	
Asymp. Sig						000	

Source: Survey Result, (2024)

Note: SD, D, UD, A, SA represents Strongly Disagree (1), Disagree (2), Undecided (3), Agree (4), and Strongly Agree (5), respectively.

In their analysis of the effectiveness of postharvest training information on improved maize crib utilisation by maize farmers, Benson *et al.* (2022) surmised that the consistency with which training information is passed down to farmers could be instrumental in curtailing postharvest loss in maize stored in cribs. By the same token, Sennuga and Oyewole (2020) found a strong positive association between adoption of Good Agricultural Practices (GAPs) and training on agricultural technologies.

Trainees’ expression of Ease-of-Use of NSPRI-MCD

Results in Table 4 reveals that the top defining statements, regarding the ease-of-use of NSPRI-MCD that the trainees generally agreed with

include; I do not have to consult fellow trainees when using NSPRI/MCD (\bar{X} =4.39), use of charcoal as the heat source minimizes cost of drying (\bar{X} =4.34), and drying time is not long and not discouraging (\bar{X} =4.19). In a similar vein, the trainees revealed their disagreement with the following defining statements; Use of domestic cooking gas as the heat source minimizes cost of drying (\bar{X} =2.21), Operation of NSPRI/MCD is automated and doesn’t require regular monitoring (\bar{X} =1.40), NSPRI/MCD requires regular maintenance (\bar{X} =2.68), NSPRI/MCD can dry large quantity of produce at a particular time (\bar{X} =2.50). The Kendall’s W^a of 0.61 shows a moderate agreement in the expression of the trainees regarding the ease-of-use of NSPRI-MCD.

Table 4: Expression of Ease-of-Use of NSPRI-MCD

Defining statements	Percentages					Mean	Standard Deviation
	SD	D	UD	A	SA		
I do not have to consult fellow trainees when using NSPRI-MCD	1.0	0.0	0.0	57.7	41.3	4.39	0.59
Drying time is not long and not discouraging	2.9	0.0	7.7	53.8	35.6	4.19	0.81
The arrangement of the drying trays enhances efficient drying	0.0	4.8	23.1	57.7	14.4	3.82	0.73
Changing of the drying trays at set time intervals is not cumbersome	13.5	54.8	24.0	5.8	1.9	2.28	0.84
NSPRI/MCD operating principle is neither rigid nor complex	0.0	1.0	0.0	77.9	21.2	4.19	0.46
Use of charcoal as the heat source minimizes cost of drying	0.0	0.0	1.0	64.4	34.6	4.34	0.49
Use of domestic cooking gas as the heat source minimises cost of drying	33.7	26.0	26.9	12.5	1.0	2.21	1.07
Operation of NSPRI/MCD is automated and does not require regular monitoring	61.5	36.5	1.9	0.0	0.0	1.40	0.53
NSPRI/MCD requires expertise to build	1.0	1.0	0.0	37.5	60.6	4.56	0.65
NSPRI/MCD requires regular maintenance	1.9	32.7	61.5	2.9	1.0	2.68	0.61
NSPRI/MCD could dry large quantity of produce at a particular time	4.8	45.2	46.2	2.9	1.0	2.50	0.68
Diagnostic Test							
Kendall’s W^a						0.61	
Chi-Square						446.21	
Df						7	
Asymp. Sig						0.000	

Source: Survey Result, 2024.

Note: SD, D, UD, A, SA represents Strongly Disagree (1), Disagree (2), Undecided (3), Agree (4), and Strongly Agree (5), respectively.

CONCLUSION

Participants generally gained knowledge and skills from the training, which has improved their food safety awareness, enhanced their safe food practice, and improved their performance in food processing. As well, the quality attributes of the processed foods were generally acceptable to the trainees. Furthermore, although the trainees were of the notion that NSPRI-MCD operating principle was neither rigid nor complex, they found the changing

of drying trays at set time intervals to be cumbersome. Subsequent versions of the NSPRI-MCD should be automated so as to reduce the drudgery involved in the manual changing of the drying trays at set time intervals.

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