ANALYSIS OF ADOPTION OF TOMATO POST-HARVEST TECHNOLOGIES AMONG SMALLHOLDER FARMERS IN KATSINA STATE, NIGERIA

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Abstract: The study analyzed the adoption of tomato postharvest technologies among smallholder farmers in Katsina State, Nigeria. Multistage sampling technique was used for the study and primary data was collected from a sample size of one hundred and sixty-two (162) smallholder tomato farmers. Both the Technology Acceptance Model and more traditional descriptive statistics (mean, frequency, percentage, and standard deviation) were used to examine the data. The survey found that most tomato growers were men (85%), that they had a mean age of 39, that their average household size was 10 people, and that their average farm was 0.7 hectares in size. The study also revealed that almost all the respondents accepted the tomato postharvest technologies promoted by Technoserve's Yieldwise project; the extent of adoption was estimated at 71%. The acceptance level of the tomato postharvest technologies was high and encouraging, and the technologies were adopted to a reasonable extent in the study area. The study recommended the need for more women participation in tomato production, smallholder farmers should form viable groups so that they can easily access credits from public and private financial institutions to raise the adoption level and tomato farmers using reusable plastic crates, tomato solar dryer and zero energy cooling chamber should be encouraged on saving of replacement cost to ensure sustainability.

Keywords: Adoption, Farmers, Post-harvest, Smallholder, Technologies, Tomato

Introduction

Tomato *(Lycopersicon esculentum)* is an important produce in Nigeria as it sustains a high demand with consumption rate of 12kg per capita annually (Erhie et al., 2018). Its nutritional value in terms of vitamins A, B and C has made the crop one of the most popular items on menus (Masunga, 2014). There are about 200,000 tomato farmers in Nigeria, and 90% of these farmers are small and medium scale farmers who utilize tomato farming as their major source of livelihood (Erhie et al., 2018). These farmers cultivate small landholdings, which are often less than one hectare in size and in fragmented plots. Nigeria produces an average of 2.2 million metric tonnes of tomato yearly and is ranked as the 13th largest tomato producing country in the world (FAO, 2018). Nigeria contributes about 1.3% of the global tomato output and 10.8% of Africa's total tomato output making it the second-largest producer in Africa after Egypt (FAO, 2018). About 70% of the tomato produced in the country originates from the Northern States (Ugonna et al., 2015).

In 2017, TechnoServe partnered with the Rockefeller Foundation, Syngenta Foundation for Sustainable Agriculture(SFSA) and Syngenta AG to implement the Yield Wise Nigerian project. The project goal was to reduce post-harvest loss (PHL) by 50 percent throughout the tomato supply chain and increase average tomato income for 45,000 participating farmers by 50 percent. Farmers from the "Tomato Triangle" region—Kano, Jigawa, Katsina, Kaduna, and Plateau States—participated in the initiative (TechnoServe, 2018). TechnoServe Yieldwise Project has piloted and supported the use of Reusable Plastic Crates (RPCs), Zero Energy Cooling Chamber (ZECC), Solar Dryer and Harvesting at mature green/turning stage as tomato post-harvest technologies in the five (5) States of the project. The objective of this research was to mitigate the extent of postharvest losses in tomatoes. The project was implemented using both direct delivery and market facilitation approaches with focused attention on optimizing tomato production and post-harvest loss reduction. The components of the project were integrated and designed to collectively address the key barriers to reducing post-harvest loss and increasing smallholder farmer incomes.

The Project was implemented in Katsina State between March 2018 and March 2021 in eighteen (18) Local Government Areas (LGAs). The beneficiaries of the project were smallholder tomato farmers across the selected tomato high producing LGAs from the 3 zones of Katsina State Agricultural and Rural Development Authority (KTARDA). Farmer Based Organisations (FBOs) were formed in each of the selected communities, each involving twenty-five (25) members. Subsequently, demonstration plots and Zero Energy Cooling Chambers (ZECC) were established in the communities while farmers received training on good agronomic practices and tomato post-harvest technologies by Local Community Trainers (LCTs) deployed to the communities by TechnoServe under the supervision of two (2) Business Advisers (BAs) and Desk Officer from the State Ministry of Agriculture.

Despite the advantages offered by these technologies in tomato post-harvest loss reduction and promotion of its use in the study area, there is no study taken to analyse the adoption of the promoted tomato postharvest technologies by TechnoServe among smallholder farmers in the study area, therefore, the need to have such research information and hence the necessity of this study. The broad objective of the study was to analyse the adoption of tomato post-harvest technologies among smallholder tomato farmers in Katsina State. The specific objectives were to:

i. describe the socio-economic characteristics of smallholder tomato farmers in the study area;
ii. describe the level of acceptance of tomato post-harvest technologies among smallholder farmers, and
iii. determine the extent of adoption of tomato post-harvest technologies by smallholder farmers in the study area.

Materials and Methods

The Study Area

The study was carried out in Katsina State, located between latitudes 11°081N and 13°221N and longitudes 6°521E and 9°201E (GPS, 2018). The State consists of a total of 34 Local Government Areas, which are further divided into 3 ADP Zones, namely Ajiwa zone (Zone I), Funtua zone (Zone II) and Dutsinma zone (Zone III) and. It has a total land mass of 24,971 square kilometres with an estimated projected population of 7,831,300 million people (NPC, 2018). The State shares common boundaries with Niger Republic to the North, Sokoto and Zamfara States to the West, Kaduna State to the South and Kano and Jigawa States to the East (Ibrahim, 2017). The duration of the rainfall is between May and October with the mean annual rainfall of 257mm, the minimum and maximum temperatures of 15^0c and 39^0c respectively (NIMET, 2018).

Sampling Techniques

Purposive sampling technique was used to select 10 communities which is 50% of the project communities in 3 selected LGAs for the study based on the high concentration of the project beneficiaries. The selected communities were Ajiwa, Kurtufa and Yargamji in Batagarawa LGA; Dabai 'A', Dabai 'B', Danja 'A' and Kahutu in Danja LGA; Jobe, Masibil and Zucci in Ingawa LGA. Then, using sample size determination formula, a random selection of 162 respondents was made. The mathematical formula is given below;

$$n = \frac{Z^2\ P\ q\ N}{e^2\ (N-1) + Z^2\ P\ q} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$n = \frac{1.96^2\ (0.5 * 0.5 * 950)}{0.072^2(950-1) + 1.96^2 * 0.5 * 0.5} = \frac{912.38}{5.6105} = 162$$

Where;

n = Sample size

N = Population size

P = Population reliability (Frequency estimated for a sample size of n)

q = 0,5 considered for all developing countries population and P + q = (Where q = 1 – P = 0.5)

e = 0.07 error margin

$\frac{Z\,\alpha}{2}$ = normal reduced variable at 0.05 level of significance / confidence level and Z is 1.96

Data Collection Procedure

Data was collected using structured questionnaire with the help of trained enumerators. The questionnaire was designed in accordance with the objectives of the study.

Analytical Techniques

Descriptive statistical tools such as frequency, percentages, mean and standard deviation were used to analyse objectives i and ii, while, Adoption model was used to achieve objective

Results and Discussion

Socio-economic Characteristics of Smallholder Tomato Farmers

Age of the smallholder tomato farmers

The findings presented in Table 1 indicate that the average age of tomato producers was 39 years, with 44.4% falling within the age range of 32-42 years. This suggests that a significant proportion of tomato farmers are currently in their prime working years, which could potentially impact their inclination to adopt and utilise new technologies, as well as acquire additional knowledge and skills related to post-harvest management. These actions are likely to yield positive outcomes in terms of increased income and improved livelihoods. This is in agreement with the findings of Michael and Kolawole, (2020) in their study on Analysis of tomato production in some selected local government areas of Kano state, Nigeria, that majority of tomato farmers were within the age range of 30-49 years.

Household size of the smallholder tomato farmers

The study further revealed that 46.3% of tomato farmers had household size within the range of 8-13 peoples, the minimum household size was 1 while the maximum household size was 31 people and the average was 10 members. Large family size is an indicator for availability of labour, since the main source of labour in most African communities are from immediate family. This is in line with the findings of Shu'aib et al., (2017) in their study in Kano State which revealed that having large household size is a source of pride and a compelling force to produce more output by the household head in the farms.

Farm size of the smallholder tomato farmers

The result of the study in Table 1 also indicated that more than half (54.9%) of the tomato farmers had 0.1- 0.6 hectares, the minimum farm size was 0.1 hectare and the maximum was 2.5 hectares with an average of 0.71 hectares. This finding contradicts the research work by Pelemo *et al.,* (2020) in their study on "Farmers' knowledge on post-harvest management of Tomatoes in Kogi and Niger States, Nigeria who reported that majority of their respondents had an average farm size of 2.8 hectares. This implies that tomato farmers in the study area are small scale farmers subsistent farmers producing tomato purposely for consumption and the surplus for sales.

Farming experience of the smallholder tomato farmers

Table 3 provides additional evidence that a majority (56.1%) of the tomato farmers possessed a range of experience in tomato production spanning from 13 to 22 years, with a mean of 15 years. The least and maximum years of experience reported were 3 and 47 years, respectively. This suggests that tomato growers in the research area possessed a substantial amount of experience in the cultivation of tomatoes. This intervention has the potential to enhance the performance of experienced tomato farmers by enabling them to make informed decisions regarding the adoption of post-harvest technology, thereby enhancing their overall livelihoods. This finding aligns with the research conducted by Elemasho et al. (2017), which suggests that farmers with extensive experience are more likely to engage in comparative evaluations of traditional and modern technological practises. Such assessments can play a crucial role in promoting the adoption of new post-harvest practises, ultimately leading to increased earnings for farmers.

Sex of the smallholder tomato farmers

Table 2 presents the qualitative socio-economic characteristics of the tomato farmers, majority (85.19%) of the were males while females constitute 14.81%. Low involvement of female in tomato farming could be attributed to the fact that in those areas some agricultural activities including tomato farming are male specific. However, due to social changes that occur in our societies and involvement of interventions like Yieldwise project of TechnoServe in the study area, female start realizing the importance of the tomato production and tend to venture into it. This observation aligns with the research

conducted by Tafida and Ayuba (2019) in Kano state, Nigeria, whereby it was documented that a significant majority (80.7%) of tomato producers in the region are of the male gender. The involvement of women in tomato production has the potential to contribute significantly to the enhancement of production, technological advancements, and post-harvest management procedures. This observation aligns with the research conducted by Tafida and Ayuba (2019) in Kano state, Nigeria, whereby it was revealed that a significant proportion (80.7%) of tomato producers are of the male gender. The involvement of women in tomato production has the potential to contribute significantly to the enhancement of production, technological advancements, and post-harvest management procedures.

Marital status of the smallholder tomato farmers

Table 2 indicated that majority (86.4%) of the tomato farmers were married. This result implies that tomato production was dominated by married people in the study area and this served as income generating activity in the area. This agrees with the findings of Abolusoro et al., (2014) who reported that majority of tomato farmers in Nigeria were married in Kogi and Adamawa states respectively.

Table 1: Quantitative Socio-economic Characteristics of the Respondents (n = 162)

Variables	Frequency	Percentage	Minimum	Maximum	Mean	Std. Deviation
Age						
21-31	31	19.1	21	69	39	10
32-42	72	44.4				
43-53	43	26.5				
54-64	12	7.5				
65-69	4	2.5				
Household Size						
1-7	48	29.6	1	31	11	6
8-13	75	46.3				
14-19	24	14.8				
20-25	9	5.6				
26-31	6	3.7				
Farm Size (Ha)						
0.1-0.6	89	54.9	0.1	2.5	0.71	0.53
0.7-1.2	43	26.5				
1.3-1.8	16	9.9				
1.9-2.4	11	6.8				
2.5-2.9	3	1.9				
Farming experience						
3-12	51	31.5	3	47	15.46	8.33
13-22	91	56.1				
23-32	13	8.0				
33-42	4	2.5				
43-47	3	1.9				

Source: Field Survey, 2023

Access to credit by the smallholder tomato farmers

The result in Table 2 also revealed that 72.8% had no access to credit for their farming activities. This is in line with the findings of Hamidan (2019) who reported only about one third of his respondents has access to credit while most of the farmers had no access to credit in Gwarzo Local Government Area of Kano State, Nigeria.

Level of education of the smallholder tomato farmers

The result in Table 2 further established that more than one third (38.3%) of the tomato farmers had Qur'anic education. The high proportion of those with primary, secondary and tertiary levels among the tomato farmers, implies that most of them are in a better position to be aware of, understand and adopt tomato post-harvest technologies with ease. In their research on the factors influencing the adoption of post-harvest technologies for selected food crops in Rivers State, Nigeria, Elemasho et al. (2017) found that literacy has a significant role in promoting the efficient use of these technologies.

Participation in training by the smallholder tomato farmers

The findings presented in Table 2 indicate that a significant majority of tomato growers (96.9%) actively engaged in the training provided by the Yield wise project. The availability of opportunities to engage in training and demonstrations serves as a foundation for obtaining the necessary knowledge that facilitates the adoption of technology (Melesse, 2018).

Table 2: Qualitative Socio-economic Characteristics of the Respondents (n = 162)

Variable	Frequency	Percentage
Sex		
Male	138	85.2
Female	24	14.8
Marital status		
Single	26	16.0
Married	132	81.5
Widow	4	2.5
Educational level		
Qur'anic education	62	38.3
Primary certificate	57	35.2
S.S. C. E./NECO	29	17.9
ND/NCE/Degree	14	8.6
Access to credit		
No access	118	72.8
Have access	44	27.2
Participation in training		
No	5	3.1
Yes	157	96.9

Source: Field Survey, 2023

Level of Acceptance of Tomato Post-harvest Technologies

Technology acceptance model was used to determine the level of acceptance of Yieldwise project tomato post-harvest technologies. The decision to accept or reject the tomato post-harvest technologies was measured using the four (4) constructs of the model viz: Perceived Ease of Use (PE), Perceived Usefulness (PU), Attitude (AT) and Behavioural Intention (BI). A five-point Likert scale was used to compare the means.

The results in Table 3 revealed that majority of the respondents perceived that the tomato post-harvest technologies have ease of use, they also strongly agreed that the technologies were useful, they indicated a positive attitude towards using the technologies and eventually indicated their interest to continue using the technologies and even recommend other farmers to use the technologies in the future. Based on this result, it is obvious that the acceptance level of tomato post-harvest technologies was high and encouraging.

Table 3: Acceptance Level of Tomato Post-harvest Technologies

Construct	Measurement Instrument	Mean	SD
Perceived Ease of Use (PE)	Learning how to make use the technologies is easy E_1	4.77	0.42
	The technologies are easy to apply E_2	4.38	0.71
	It is easy to become skilful in the use of the technologies E_3	4.78	0.47
Perceived Usefulness (PU)	The technologies may increase access to good quality tomato produce U_1	4.94	0.24
	The use of technologies may increase productivity U_2	4.52	0.50
	The use of technologies may enhance our effectiveness on tomato production U_3	4.60	0.53
	The use of technologies may increase profit U_4	4.64	0.48
	The use of technologies may increase amount of tomato produce in Katsina State U_5	4.62	0.49
Attitude (AT)	Introducing tomato post-harvest technologies may fail as past interventions A_1	2.22	1.06
	High productivity could be achieved if the use of the technologies is sustained A_2	4.74	0.48
	Reduced post-harvest losses in tomato production A_3	4.83	0.38
	Access and use of the technologies are beneficial to all and sundry not just selected/influential members of the community A_4	4.02	0.86
	Tomato post-harvest technologies are beneficial to all actors along the value chain	3.73	1.23
Behavioural Intention to Use (BI)	I intend to use tomato post-harvest technologies in future B_1	4.93	0.26
	I will recommend others to use the technologies B_2	4.88	0.33

Source: Field survey, 2023

Code for the Likert scale: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree and 5 = strongly agree.

The Extent of Adoption of Tomato Postharvest Technologies

The extent to which the farmers adopt the tomato post-harvest technologies was measured using five steps of adoption viz: Awareness, Interest, Evaluation, T rial and Adoption. The percentage of farmers at each step for each technology was worked out, mean adoption score and grand mean adoption score were also evaluated in Table 4. The result shows the distribution of farmers according to their adoption of four Yieldwise project tomato post-harvest technologies promoted by TechnoServe in the study area. The highest adoption score was 0.91 for harvesting at turning stage and the least adoption score was 0.52 for solar drier. The least adoption score for Solar drier is attributed to its high initial cost and inability to contain large quantity of tomato as reported by most of the farmers. The grand mean adoption score was 0.71. That is, about 71% of the entire Yieldwise project tomato post-harvest technologies were adopted by the smallholder tomato farmers in the study area.

Table 4: Tomato farmer's Extent of Adoption of Postharvest Technologies

Stages	Tomato Postharvest Technologies			
	Harvesting stage	RPC	Solar Dryer	ZECC
Awareness	100	100	82.7	97.5
Interest	96.3	98.1	79.0	75.9
Evaluation	88.3	98.1	77.2	74.7
Trial	84.6	35.2	11.7	61.7
Adoption	83.3	42.6	8.0	14.8
Total	452.5	374	258.6	324.6
Mean adoption score	0.91	0.75	0.52	0.65
Grand mean adoption score	0.71			

Source: Field survey, 2023

Postharvest Technologies in Use Among Smallholder Farmers

The study described the different types of tomato post-harvest technologies adopted among small holder farmers in the study area as presented in figure 1. Findings of the study established that 83.3% of the respondents were found using Harvesting at turning stage technology, 42.6% were found using RPCs, 8.0% and 14.8% were found using Solar Dryer and Zero Energy Cooling Chamber respectively. Low adoption of RPC technology could be attributed to the high initial cost and unavailability of RPCs in the study area. The low adoption rate of Solar dryer is attributed to its high initial cost and low capacity, that is why most of the farmers prefer to use their conventional sun drying method despite the differences in quality of outputs between the two methods.

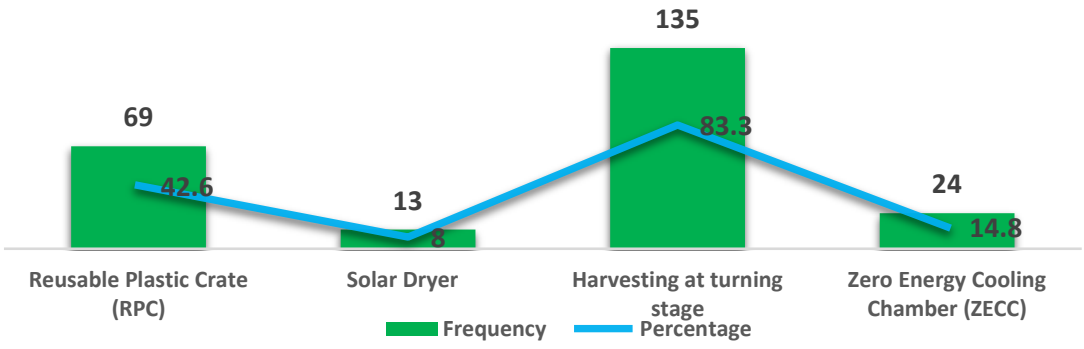

Figure 1: Adoption of tomato postharvest technologies

Conclusion and Recommendations

Based on the findings of the study, it was concluded that, the acceptance level of Technoserve's Yieldwise project tomato postharvest technologies were high and encouraging, the technologies were implemented to a satisfactory degree within the designated study region. The study's findings informed the formulation of the following suggestions.

1. Smallholder tomato farmers should form viable groups so that they can easily access credits from public and private financial institutions to raise the adoption level.
2. It is imperative to ensure the availability and accessibility of tomato postharvest technology, such as Returnable Plastic Crates (RPCs) and Solar dryers, to smallholder farmers.
3. There should be more women participation in tomato production in the study area.

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