



IMPACT OF REUSERBLE PLASTICS CRATE TECHNOLOGY ON THE POSTHARVEST LOSSES AND LIVELIHOOD STATUS OF FADAMA III TOMATO FARMERS IN KANO STATE, NIGERIA

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ABSTRACT

The study assessed the impact of RPCs technologies on post-harvest losses and livelihood status of *fadama* III Tomato Farmers in Kano State, Nigeria. Multi stage sampling procedure were used for the study and primary data were collected from a sample of three hundred and twelve (312) smallholder tomato farmers using structured questionnaire. The data were analyzed using descriptive statistics such as frequency and percentage, minimum, mean, maximum and standard and inferential statistics such as Propensity Score Matching (PSM). Result of the study showed that tomato production is dominated among young active (41 years), male (99.4%) people who were married (89.4%) and attended more of western formal education (74.7%). Findings of the study revealed that 63.78% of the smallholder tomato farmers were using TWBs to store their tomatoes. The remaining 36.22% were using RPCs to store their tomato fruit in the study area. Estimated average treatment effect indicated that the quantity of post-harvest tomato losses of RPCs technology users decreases with an average quantity of -3881.07 kg to -4141.83 kg depending on matching algorism. The result further revealed that adoption of RPCs technology affects the livelihood status of tomato farmers to increase with an average value of 0.047 to 0.057 depending on matching algorism when RPCs technology was used in the study area. The study recommended that rural development policies should be put in place to promote awareness about the impact of RPCs technology on the livelihood improvement among women using capacity building training.

Keyword: Impact, *Fadama* III, Technology, Postharvest, Losses.

INTRODUCTION

Postharvest losses (PHL) refer to the losses that occur along the food supply chain, from farm gate till it gets on the table of the final consumer. Losses are encountered along the chain in the handling, storage, transportation and processing, thereby resulting in a reduction of quantity, quality and market value of agricultural commodities. Post-harvest storage loss is one of the constraints that make tomato production unprofitable and improper handling constraint constitutes the major causes (Aghadi, 2019).

Empirical study in Sub-Saharan Africa shows that 40-50% of tomato produced in Nigeria is lost due to poor handling, storage, processing and preservation technologies (Sahel Research, 2015) and has significant effect to the livelihoods of smallholder tomato farmers in specific and the overall national food security in general.

Lipsey (2002) stated that technical change is nowadays largely accepted to be an engine of economic growth, researchers have tried to include it explicitly in the economic growth models, either as an exogenous or endogenous factor of influence. Endogenous or exogenous nature of the technological change refers to its source: endogenous change is internal to the



national economy, being created by domestic private or public enterprise, while exogenous change is external, originating from foreign sources.

Recognizing the challenges of post-harvest storage lost in tomato production, efforts were made by Governmental and Non-governmental organizations in promoting good post-harvest handling practices of tomato and other vegetables. Among the promoters is the World Packaging Organization (WPO) that promotes improved postharvest handling of tomato, emphasized that increased global demand for food in the near future does not necessarily require increased production, but better storage usage to ensure less food is wasted. Rapusas and Rolle (2009) also reported that increase in adoption of Reusable Plastic Crate (RPC) for the bulk packaging of fresh produce in developing countries is stimulated by their reusability, their contribution to post-harvest storage loss reduction and the alleviation of human drudgery, buyer preferences and government support.

Over the years, tomato production in Nigeria has been facing challenges that have contributed to reduced productivity and create a gap. between average quantity demand of 3 million metric tons and average quantity of tomato produced of 2.3 million metric tons. This of about 700,000 million metric tons which contributed to high importation (NIHORT, 2020). Based on the available data, Nigeria accounts for about 68.4% of West Africa, 10.8% of Africa's total output and 1.28% of world output (Babarinsa *et al.*, 2015). Unfortunately, the country still experiences deficiency in critical inputs, lack of improved technology, low yield and productivity, high post- harvest storage losses and lack of processing and marketing infrastructure, thereby affecting the livelihood of farmers negatively.

It was observed that farmers in Nigeria use Traditional Woven Baskets (TWBs) from Raffia to package their tomatoes for sale to customers (Idah *et al.*, 2007). These baskets usually cause injuries and quicker deterioration to the product due to their features, which lead to high level of tomato losses among actors along the value chain. These losses were observed to be detrimental to the welfare of the farmers and other actors bearing the loss. Subsequently, the situation for example necessitates empirical study to recommend the use of RPCs technology for tomato storage among farmers (Kitinoja, 2008).

The strategy of the *Fadama* III additional financing project is based on the premier that collective action can help to overcome many problems that face tomato farmers in production and marketing, thereby, increasing yield and reduce poverty. It is therefore desirable to assess the impact of RPCs and Traditional Woven Baskets (TWBs) storage technologies as it has effect on the livelihoods of the smallholder tomato farmers under *Fadama* III project, which will be beneficial for reviewing or strengthening extension strategy for agricultural development.

Several studies have analyzed postharvest loss and its technological options to manage such losses particularly in the context of tomato traders (Kitinoja, 2013; Rapusas and Rolle, 2009). However, there is a remains of knowledge gap on the actual of the technology on postharvest losses and livelihood improvement of the tomato farmers.

MATERIALS AND METHODS

The Study Area

The study was conducted in Kano State, Nigeria and is divided into 44 Local Government Areas (LGAs). According to NPC (2006), the State had a population of 9.4 million out of which, 4,947,952 males and 4,453,336 females as at 2006 census. It has an annual growth rate of 2.9% which gives a projected figure of 12,985,526.74 populations in the year 2019. Kano State Agricultural and Rural Development Authority (KNARDA) is the technical and management unit responsible for Agricultural extension service of the state Government.



KNARDA is divided into three Agricultural zones namely, Zone I, Zone II and Zone III with their respective Local Governments Areas (LGAs) as follows: Zone I has 15 number of LGAs with Headquarter at Rano LGA. Similarly, Zone II has 14 has number LGAs with Headquarter at Danbatta LGA. Zone III has 16 number of LGAs with head quarter at Gaya LGA (KNARDA, 1998). *Fadama* III Project in Kano State covers all the three zones under KNARDA with a coordination office in KNARDA headquarters (National *Fadama* Development Project [NFDPP], 2017).

Agriculture is the primary source of livelihood for the smallholder farmers in the study area, which comprises of cultivation of crops such as tomato, sorghum, millet, maize, cowpea, soybean, rice and groundnut. cattle, sheep and goat, poultry and fish and artisanal fishing are the major form of livestock reared among the farmers in the study area. Fresh tomato drying and other form of fruit vegetable, marketing of agricultural product, farm labour supply to other farms, rice processing, maize flour processing, groundnut oil processing, groundnut cake production forms the major prevailing off-farm activities in the study area. Non-farm activities such as Blacksmithing, Carpentry, transportation of agricultural produce, Weaving, Rope making, Tricycle driving, Vulcanizing, bricks laying, non-farm business activities, remittance, western and Islamic school teaching supplement the livelihood of smallholder tomato farmers in the study area.

Sampling Procedure

Multi-stage sampling procedure was used in the study. As presented in Table 1, in the first stage, six (6) LGAs were purposively selected with two (2) each from the three Agricultural zones under Kano State Agricultural and Rural Development Authority (KNARDA). The LGAs were selected based on participation in *Fadama* III project. The selected LGAs were Garun Mallam, Kura, Bagwai, Makoda, Albasu and Warawa.

Stage two involved purposive selection of two villages each from the selected LGAs based on the concentration of the project beneficiaries. The selected villages (production clusters) are Dorawar sallau and Yadaqwari from Garun Mallam LGA; Butalawa and Kura from Kura LGA; Bagwai and Gurdo from Bagwai LGA; Satame, and Jigawa satame from Makoda LGA; Gagarama and Panda from Albasu LGA; Garun dau and Katarkawa from Warawa LGA. However, sample frame comprising 1,650 smallholder tomato producer's beneficiaries was collected from *Fadama* III project with the help of *Fadama* III Tomato value chain community facilitators. The third stage involved random selection of 312 (Table 1) tomato farmers using Raosoft sample size calculator at 5% margin error and 95% confidence level (Raosoft, 2019) based on proportionately distributed sample size according to the estimated number of tomato farmers in each of the selected production clusters.



Table1: Summary of Sampling Procedure for *Fadama* III Tomato Farmers

Agricultural Zones	Selected LGA's	Selected Villages (Production clusters)	Sampling frame	Sample size
Rano Zone	Garum Mallam	Dorawar Sallau	137	26
		Yadakwari	110	21
	Kura	Butalawa	123	23
		Kura	147	28
Danbatta Zone	Bagwai	Bagwai	134	25
		Gurdo	159	30
	Makoda	Satame	138	26
		Jigawa Satame	145	27
Gaya Zone	Albasu	Gagarama	139	26
		Panda	145	27
	Warawa	Garun dau	138	26
		Katarkawa	135	26
Total			1,650	312

Source: Field survey, 2019.

Method of Data Collection

Primary data were used as source of information for this study. The data were collected from a sample of tomato farmers, extension workers, using questionnaire. The questionnaire-based interview was used to collect data related to socio- economic and institutional variables of smallholder tomato farmers such as age, sex, education level, marital status, farm size, the size of the household, income, access to credit and extension, post-harvest storage technologies in use among *Fadama* III projects smallholder tomato farmers.

Analytical Tools

The analytical tools used in the study include descriptive statistics and Propensity Score-Matching (PSM) Model were used to achieve the objective of the study. Descriptive statistics is a scientific method used for analyzing, summarizing and presenting collected data. Descriptive statistics such as frequency and percentage table were used for the present study.

Propensity Score-Matching (PSM) Model creates conditions of an experiment in which adopters and non-adopters are randomly assigned, providing an unbiased estimate of treatment effects. Rosenbaum and Rubin (1983) proposed propensity score matching as a method to reduce the bias in the estimation of treatment effects with observational data sets (Rosenbaum & Rubin, 1983). According to Rosenbaum & Rubin (1983), PSM was developed to overcome the unobserved counterfactual PSM constructs of a statistical comparison group by matching every individual observation of adopters with an observation having similar characteristics to the group of non-adopters. Pan (2014) specified the counterfactual frame work as follows:

$$\Delta_i = Y_i^1 - Y_i^0 \quad \dots(1)$$

where;

Y_i^1 = tomato farmer i who adopt the RPCs technology

Y_i^0 = tomato farmer i who does not adopt the technology, respectively

Thus, the normal outcome to be observed can be expressed as:

$$Y_i = D_i Y_i^1 + (1-D_i) Y_i^0 \quad \dots(2)$$

D = is a dummy variable that indicates adoption of technologies



RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Smallholder Tomato Farmers

The result (Table 2) revealed that 43% of the tomato farmers were between 18-29 year old followed by 30.1% of the tomato farmers which were between 42-53 years old, then 15.6% of the farmers interview were between 18-29 years old, another group of 8.9% of the farmers interview were between 54-65 years old and 1.2% of the farmers interview were between 56 and above years. The tomato farmers had a mean age of 41 years with minimum and maximum age of 18 and 70 years respectively and standard deviation of 11. This indicated that majority of tomato farmers were young within their active age group and are believed to be flexible in decision making towards using RPCs technology in the study area. The findings in respect to age of tomato farmers showed possibility of sustainable tomato production in the area. This agreed with Jabil and Abdu (2012) in North Central Zones of Plateau State, Nigeria who reported that young farmers are willing to adopt new technology like RBCs than the older ones and they are not aversive to risk

Table 2: Smallholders' tomato farmers base on quantitative socio-economic variables

Variable	Frequency	Percentage	Mean	Std. deviation	Min.	Max.
Age						
18-29	49	15.6	41	11	18	70
30-41	137	43.6				
42-53	94	30.1				
54-65	28	8.9				
66 ≥	4	1.2				
Gender						
Male	310	99.4				
Female	2	0.6				
Marital status						
Single	32	10.3				
Married	279	89.4				
Widow	1	0.3				
Highest educational qualification						
No formal education	79	25.3				
primary education	95	30.4				
Secondary education	93	29.8				
Tertiary education	45	14.5				

Source: Field survey, 2019

Table 2 findings further established dominance of male (99.4%) tomato producers in the study area. Only 0.6% of the farmers were female. 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, participation of female into tomato production could in many ways help in increasing production, technology development and post-harvest handling processes. This implied that cultural barriers could influence low participation of women into tomato production activities which could deprive many women from the use of the RPCs technology in the study area.

Result of Table 2 also shows that majority (89.4%) of tomato farmers were married, while 10.3% of these farmers were single. Only 0.3% of the respondents were widowed in the



study area. Married tomato farmers have social responsibilities to cater for the family which could facilitate farmers decision to adopt the use of RPCs technology reduces the level of their tomato losses there by improving their living condition in the study area.

Findings of this study revealed that 30.4% of the farmers had primary education, while 29.8% of the respondents received secondary education, 25.3% of the respondents acquired Islamic education, only 14.5% of the respondents were reported to have tertiary education. Formal education serves as valuable resource to tomato farmers and guide their attitudes and influence the use of RPCs technology in order to improve their level of productivity in the study area. Furthermore, Elemasho *et al.* (2017) in Rivers State, Nigeria reported that literacy could encourage effective use of post-harvest technologies such as RPCs technology.

Post-harvest Storage Technologies in Use among Small Holder Tomato Farmers

The study described the different types of post-harvest storage technologies in use among small holder tomato farmers using frequency and percentage table presented in Table 4. Findings of the study presented in Table 4 revealed that more than half (63.78%) of the respondents were found using Traditional Woven Baskets (TWBs) to store their tomato fruits. The remaining 36.22% were found using Returnable Plastic Crates (RPCs) to store their tomato fruits in the study area. Low percentage of RPCs technology could be attributed to the high cost of buying RPCs technology, insufficient knowledge on the use of the RPCs technology and unavailability of RPCs technology in the study area. However, the result disagreed with that of Adegbola *et al.* (2011) who reported that few respondents were then found using RPCs technology in Kano State, Nigeria. The findings are however in line with that of Nwabuogo *et al.* (2019) who reported low usage of RPCs technology among traders in Lagos State Nigeria.

Table 4: Respondents' post-harvest storage technologies in use

Tomato storage technology	Frequency	Percentage
TWBs	199	63.78
RPCs	113	36.22

Source: Field survey, 2019

Impact of RPCs Technology in Reducing Postharvest Storage Losses on Smallholder Tomato Farmers

Average treatment effect model was considered using four different matching algorithm such as Nearest neighbour, Kernel, Radius and Stratification method to examine the impact of RPC technology on post-harvest loss of tomato. The estimated impact result was presented in Table 5.

Table 5: Estimated average treatment effect of RPCs technology on post-harvest loss of tomato

Matching algorithm	RPCs users	TWB users	ATT	Std. Err.	t-values
Nearest neighbor	113	160	-3881.07***	399.65	-9.71
Kernel	113	182	-3988.17***	241.49	-16.52
Radius	113	182	-4366.95***	276.05	-15.82
Stratification	113	182	-4141.83***	360.21	-11.50

Note: RPCs = Reusable Plastic Crates; TWB = Traditional Weaving Basket; ATT = Average Treatment Effect on the Treated.

Source: Field survey, 2019



The results generally indicated that the choice of using RPCs technology exerts a negative impact on post-harvest loss of tomato. Table 5 revealed that the use of RPCs technology was found to negatively decrease post-harvest loss of tomato by -3881.07 kg to -4141.83 kg, when the control group is TWBs users. Specifically, findings of the study indicated that the quantity of post-harvest tomato losses of RPCs technology users decrease with an average quantity of -324.76 kg to -1411.96 kg depending on matching algorithm in the study area. This finding is in line with that of Babarinsa *et al.* (2018).

Impact of RPCs Technology in Reducing Postharvest Storage Losses on Smallholder Tomato Farmers

Average treatment effect model was considered using four different matching algorithm such as Nearest neighbour, Kernel, Radius and Stratification method to examine the impact of RPC technology on the livelihood of tomato farmers. The estimated impact result was presented in Table 6. The result revealed that the use of RPCs technology was found to exert positive effect on the livelihood status of the tomato farmers with an average value range between 0.047 to 0.057, when the control group is TWBs users. This implies that the livelihood status of tomato farmers increased with an average value of 0.047 to 0.057 depending on matching algorithm when RPCs technology was used in the study area.

Table 6: Estimated average treatment effect of RPCs technologies on livelihood status improvement of smallholder tomato farmers

Matching algorithm	RPCs users	TWB users	ATT	Std. Err.	t-values
Nearest neighbor	113	177	0.047***	0.010	4.638
Kernel	113	197	0.057***	0.007	8.155
Radius	113	197	0.057***	0.011	5.308
Stratification	113	182	0.057***	0.007	8.231

Note: RPCs = Reusable Plastic Crates; TWB = Traditional Weaving Basket; ATT = Average Treatment Effect on the Treated.

Source: Field survey, 2019

CONCLUSION AND RECOMMENDATIONS

The study assesses the impact of RPCs technology on the postharvest losses and livelihood status of *Fadama* III tomato farmers in Kano State, Nigeria. Result of the study shows that tomato production is dominated among young active, male people who were married and attended more of western formal education. Findings of the study further revealed that tomato farmers use more of TWBs technology compared to RPCs technology in the study area. Estimated average treatment effect analysis shows that adoption of RPCs technology significantly reduces post-harvest tomato losses and improved the livelihood status of *Fadama* III farmers. The following recommendations were suggested based on the findings of the study:

1. To enhance the usage of RPCs technologies among *Fadama* III tomato farmers in order to reduce post-harvest losses and improved livelihood rural development policies need to promote awareness on the impact RPCs technology through relatively young active married farmers that attended formal education.
2. To reduce the post-harvest losses among tomato farmers, development policies need to promote awareness among women about the impact RPCs technology on the livelihood improvement using capacity building training in the study area.



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