

RISK ASSESSMENT AND MANAGEMENT STRATEGIES OF POST-HARVEST OPERATIONS IN TOMATOES PRODUCTION IN NIGER STATE, NIGERIA

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ABSTRACT

The study assessed the risk assessment and management strategies of post-harvest operations in tomatoes production in Niger state, Nigeria. A multi-stage sampling technique was used to select 119 registered vegetable farmers and data collected through a semi-structured questionnaire were analyzed using descriptive statistics (such as frequency count, percentages, mean) and Probit regression model. The results obtained shows that farmers in the study area were mostly males (54.6%) and formally educated (78.2%) with an average age of 34years. Also, majority of the farmers had perception for climatic variability, lack of storage facility and high cost of farm machineries for post-harvest management are recorded with high level of risk associated with post-harvest operation among the farmers in the study area. The results shows that use of modern method of processing (68.1%), processing into tomato paste (78.2), accessing agricultural loans (75.6%), storage in ventilated pit (70.6%) and use of modern storage facility (56.3%) were the top five post-harvest management strategies adopted by the tomato farmers in the study area. However, storage in barns ($\bar{X}=4.29$), storage in cold room ($\bar{X}=3.99$), storage in open dry shelf room ($\bar{X}=3.77$), storage in ventilated pit ($\bar{X}=3.65$) and insurance ($\bar{X}=3.61$) were top five most effective management strategies adopted by the tomato farmers against post-harvest losses in the study area. The result on Probit regression model shows that the (Prob $\chi^2=0.0002$) was statistically significant at 1% level of probability. From the model, the determinant of management strategies adopted by farmers against post-harvest operation was significantly influenced by socioeconomic factors like level of education, marital status, access to extension service, complexity, and relative advantage were the factors influencing post-harvest management strategies adopted by the farmers. Thus, the result concludes that climatic variability and lack of storage facility were the most prominent sources of risk associated with tomato post-harvest management. Hence, it was recommended that policy interventions on improving farmers' awareness about post-harvest technologies should be made in order to enhance their adaptive capacity in reducing the adverse impacts of post-harvest losses.

Key words: Risk, Assessment, Production, Strategies and Management practices

INTRODUCTION

Agriculture is considered the largest sector in Nigeria's economy. It employs 70 percent of the nation's labour force, contributes at least 40 percent of the gross domestic product and accounts for over three-quarters of the non-oil foreign exchange earnings (Matthew *et al.*, 2022). Nigeria's abundant land resources and wide variety of climate variations allows it to produce a variety of food and cash crops. These stable food crops include cassava, yam, cocoyam, maize, beans, sweet potato, millet, rice, sorghum and a variety of fruits and vegetables. The leading cash crops are cocoa, groundnut, palm oil and rubber (Matthew *et al.*, 2022). Fruits and vegetables provide different benefits and play a significant role in human nutrition, especially as sources of vitamins, minerals, and dietary fiber (Michael and Yingbo, (2016). Fruits and vegetables in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke, and other chronic diseases. Some components (phytochemicals) of fruits and vegetables are strong antioxidants and function to modify the metabolic activation and detoxification of carcinogens, or even influence processes that alter the course of the tumor cell (Michael and Yingbo, (2016). Particularly, diversification of traditional agricultural commodities into high value horticultural production and exports (fruits, vegetables and flowers) has

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been indicated as a sector that can provide real opportunities for enhancing export performance (Geburu and Belew, 2015).

Post-harvest loss (PHL) is the waste and spoilage of food product that occurs after harvest and before human consumption. Food loss occurs on-farm when grain is threshed, winnowed, and dried, and during storage, transportation, processing, wholesale, and retail distribution. The United Nations Sustainable Development Goals consider PHL a major contributor to food insecurity in developing countries, a threat to environmental sustainability, and a major current and future challenge. The problem is particularly acute in Sub-Saharan Africa, because of the region's high concentration of low-income developing countries. As population increases, there will be growing pressures on resources needed to satisfy basic human needs, particularly food, clothing, and shelter (Femi, 2022).

Production risk originates from adverse weather condition, insects, diseases, technology and any other events that directly affects production quantity and quality. Marketing risk emanates from uncertainty in the market for commodities such as fluctuations in output and input prices. Financial risk revolves round the method of acquiring and financing capital and farmer's ability to pay financial obligations. Institutional risk arises from changes in government and/or legal policies and standards that affect agriculture. Human risk emanates from man. The risk could be due to labour shortage, ill health, death, divorce, injury, fire outbreak, burglary or theft (Ndem and Osondu, 2018).

METHODOLOGY

This study was conducted in Bosso, Gbako and Marigaa Local Government Areas of Niger State, Nigeria. Niger State was created out of the former North Western State and became a fully autonomous State on 3rd February, 1976, with headquarter at Minna. Niger State is in the North-central part of Nigeria and lies in between longitude $3^{\circ} 30^1$ and $7^{\circ} 20^1$ East of the Greenwich Meridian and latitude $8^{\circ} 20^1$ and $11^{\circ} 30^1$ North of the equator. The State presently comprises of 25 Local Government Areas (LGAs) and it is made up of three major ethnic groups which are the Nupe, Gbagyi and Hausa. However, the total inhabitants in the State are over 3,954,772 people during the 2006 population census. But, going by the annual population growth rate of 2.5% in Nigeria, the population of Niger State was projected to be 5,556,200 in the year 2016 (National Bureau of Statistics, 2018). Multistage sampling technique was used for this study. The first stage involved selection of one (1) LGA from each of the zones (I, II, III). In the second stage, three (3) villages was randomly selected (45% of the total villages) from each of the selected LGA. The third stage involved the use of Yamane formula to select sample size from the sample frame of each village as obtained from Niger State Agricultural and Mechanization Development Authority (NAMDA). Thus, a total of 119 registered vegetables farmers was randomly selected as respondents for this study.

Data were collected using semi-structured questionnaire and analysis was conducted using descriptive statistics (mean, frequency distribution, and percentage) and inferential statistics (Probit regression model) to the analyse the determinant of post-harvest management strategies adopted by the farmers in the study area was specified as follows:

Probit regression model analysis

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + e$$

Where

Y= probability of management strategies used (1= adopted; 0= not adopted)

X₁= Age (in years)

X₂= Gender (male=1, female=0)

X₃= Marital status (married=1, otherwise=0)

X₄= Level of education (number of years spent in school)

X₅= Land ownership (owned=1, otherwise=0)

X₆= Farm size (number of hectares)

- X₇= Farming experience (number of years)
- X₈= Household size (total number of people in the house)
- X₉= Extension visit (number of visit received)
- X₁₀= Cooperative membership (member=1, otherwise=0)
- X₁₁=Farm income (in naira)
- X₁₂=Credit (access=1, otherwise=0)
- X₁₃=Compatibility of the strategies
- X₁₄=Relative advantage
- X₁₅=Cost of management practices
- b₁-b₉= coefficients of independent variable
- b⁰= Constant term
- e= error term

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Farmers

Age of the respondents: The result in Table 1 shows that about 76.5% of the tomato farmers were between the age brackets of 31-40 years. The mean age of the farmers is 34 years, which implies that, the farmers were still in their active productive age. However, can practice tomato post-harvest management to improve yield efficiently. This result is in line with the result of Matthew *et al.* (2022) who reveals that majority (52.5%) of the farmers are between the ages of 31-40 years.

Marital status: Table 1 also reveals that majority (85.7%) of the tomato farmers were married thus, are likely to have larger family labour to support tomato production and post-harvest management in other to cater for their households needs. This result corroborates with the findings of Akinniran *et al.* (2017) who revealed that, majority of the vegetable farmers in the study area were married, and thus have adequate family labour supply to support vegetable production.

Household size: Furthermore, tomato farmers with household size ranging from 1-10 persons in the study area accounted for 79.9% while the mean household size of the sampled farmers was eight (8) persons. Implying a large household size among the tomato farmers in the study area as a result, that majority of the farmers are married and required family labour to carry out the farming activities. This finding agrees with the result of Ayandiji and Davies, (2016) who reported that majority (74.1%) of the respondents have a household size mean of 6 people which could be used as family labour in farming activities.

Formal education: Table 1 further reveals that majority (78.2%) of the tomato farmers had formal type of education involving attending primary, secondary and tertiary institutions with an average number of years spent in school to be 6 years while only very few had non-formal type of education. Given that there is high level of literacy, it is expected that the farmers will easily adopt tomato post-harvest management and processing technology practices. This finding agrees with Ibidapo *et al.* (2018) who reported that majority of the respondents (72.9%) had formal type of education with few of the respondents with non-formal education.

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Table 1 Socio-economic characteristics of respondents

Variable	Frequency	Percentage	Mean
Age			
30 years and below	4	3.4	34 years
31-40 years	91	76.5	
41-50 years	23	19.3	
Above 50 years	1	0.8	
Marital status			
Widow(er)	2	1.7	
Divorced	5	4.2	
Single	10	8.4	
Married	102	85.7	
Household size			
1-5 persons	41	34.5	8 members
6-10	54	45.4	
11-15	16	13.4	
Above 15	8	6.7	
Level of education			
Non-formal education	26	21.8	6 years
Primary education	8	6.7	
Secondary education	74	62.2	
Tertiary education	11	9.2	

Source: Field survey, 2023.

Level of risk associated with post-harvest operation on tomato production

Sources of risk are those means through which farmers are exposed to certain unforeseen negative circumstances, which hinder or inhibit their level of tomato production in the study area. A comprehensive list of the risk sources was made and farmers were asked to tick appropriately the level source of risk they encounter. The findings in Table 2 indicated that tomato farmers in the study area were more exposed to risks associated with climatic variability related factors. Which could be variation in seasonal rainfall and sunshine, high temperature and incidence of flood. This result is not surprising considering that most if not all crop farming operations are seasonal dependent and vegetables such as tomato are highly perishable and could be easily deteriorated with change in climate. Furthermore, lack of storage facility was second most severe source of risk to tomato production. This shows that without adequate storage facilities vegetable farmers may encounter significant loss in production of vegetables (tomatoes) as a result of perishable nature of the vegetable. High cost of machineries for post-harvest operation could also affect farmers as a source of risk as majority of the vegetable farmers produce crop at subsistence level of production and could not afford most of the post-harvest equipment to limit loss due to post-harvest damages.

Table 2 level of risk associated with post-harvest operation

Variables	Very high(%)	High(%)	Low (%)	Very low (%)	WM	Rank
Climatic variability	63(52.9)	25(21.0)	14(11.8)	17(14.3)	4.13	1 st
Lack of storage facilities	45(37.8)	27(22.7)	29(24.4)	18(15.1)	3.77	2 nd
High cost of machineries in PH management	58(48.7)	34(28.6)	19(16.0)	8(6.7)	3.71	3 rd
Limited technical/financial support	33(27.7)	37(31.1)	27(22.7)	22(18.5)	3.61	4 th
Poor local market/marketing information	45(37.8)	20(16.8)	20(16.8)	34(28.6)	3.60	5 th
Unsuitable credit facility	9(7.6)	64(53.8)	22(18.5)	24(20.2)	3.49	6 th
Poor transportation network	26(21.8)	43(36.1)	26(21.8)	24(20.2)	3.48	7 th
Absence of policy supporting farmers	39(32.8)	34(28.6)	25(21.0)	21(17.6)	3.40	8 th
Poor farmers network on PH operation	29(24.4)	24(20.2)	33(27.7)	33(27.7)	3.35	9 th
Inadequate skill labour on post-harvest operation	92(59.7)	17(11.0)	30(19.5)	15(9.7)	3.24	10 th

Source: Field survey, 2023

Management strategies to risk associated with post-harvest operation

Risk management strategies are those techniques employed by the farmers in order to mitigate the incidence of risks. A list of risk management strategies was made and farmers were asked to tick appropriately the risk management strategies they used. The findings in Table 4 shows the management strategies adopted by the farmers against risk source associated with tomato production in the study area. The results shows that use of modern method of processing (68.1%), processing into tomato paste (78.2), accessing agricultural loans (75.6%), storage in ventilated pit (70.6%) and use of modern storage facility (56.3%) were the top five post-harvest management strategies adopted by the tomato farmers in the study area. The results shows that the use of modern processing method enhances the shelf-life of the vegetable as it can be store for long period before usage without deteriorating in quality and shape this enables the farmers to adopt this management strategies against post-harvest losses. More so, the farmers also indicated high adoption of accessing agricultural loans at low interest rate to enable them purchase or manage the post-harvest machineries and reduction in amount/quantity of produce loss during post-harvest operations. Storage in ventilated pit was also adopted among the tomato farmers as ventilation will tend to slow bacterial inhibition which increase the deterioration of vegetable in store when the condition are favourable for their activities. In addition, farmers also adopt processing of tomato in to paste for easier sales and distribution. This is in line with the findings of Ndem and Osondu, (2018) that majority of the respondent adopted the use of improved seeds and varieties of rice, adopted mixed-cropping and non-farm businesses as a means of reducing risk.

Table 3 Management strategies to risk associated with post-harvest losses

Variables	Adopted (%)	Not adopted (%)
Storage in ventilated pit	84(70.6)	35(29.4)
Training on post-harvest operation and processing	57(47.9)	62(52.1)
Use of modern method of tomato processing	81(68.1)	38(31.9)
Using modern storage facility	67(56.3)	52(43.7)
Storage in thatched roof pit	73(61.3)	46(38.7)
Processing into tomato paste	93(78.2)	26(21.8)
Processing into sun-dry tomato chips	72(60.5)	47(39.5)
Accessing timely information on tomato marketing	59(49.6)	60(50.4)
Government intervention on tomato production	41(34.5)	78(65.5)
Accessing agricultural loans for tomato production	90(75.6)	29(24.4)
Storage in barns	56(47.1)	63(52.9)
Curing method	55(46.2)	64(53.8)
Storage in mud hut	70(58.8)	49(41.2)

Source: Field survey, 2023

Tomato farmers’ perception on the effectiveness of risk management strategies

The findings in Table 5 shows that storage in barns (\bar{X} =4.29), storage in cold room (\bar{X} =3.99), storage in open dry shelf room (\bar{X} =3.77), storage in ventilated pit (\bar{X} =3.65) and insurance (\bar{X} =3.61) were top five most effective management strategies adopted by the tomato farmers against post-harvest losses in the study area. The results shows that storage in barns was rank first with a mean of (\bar{X} =4.29) among management strategies of post-harvest losses as the most effective method of managing post-harvest operation in the study area. Also, storage in cold room (\bar{X} =3.99) was rank second most effective management strategies used by the vegetable farmers in the study area. However, storage in ventilated pit (\bar{X} =3.65) proves to be very effective in management of post-harvest losses among the tomato farmers in the study area. The findings of Okere, (2019) indicated that farmers in the study area fund that diversification into non-farm business (WM=4.06), crop rotation (WM=3.62) and use of improved seeds (WM=3.58) to be very effective risk management strategies in rice production. Other effective management strategies indicated by the respondents includes the use of agrochemicals and cooperative

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marketing of their farm products. Irrigation system is also adopted to augment water availability in dry periods of production.

Table 4 Farmers perception on the effectiveness of risk management strategies

Variables	VE(%)	E(%)	LE(%)	NS(%)	NE (%)	WM	Rank
Storage in barns	67(56.3)	25(21.0)	23(19.3)	3(2.5)	1(0.8)	4.29	1 st
Storage in cold room	65(54.6)	20(16.8)	6(5.0)	24(20.2)	4(3.4)	3.99	2 nd
Storage in open sided shelf roof	44(37.0)	26(21.8)	30(25.2)	16(13.4)	3(2.5)	3.77	3 rd
Storage in ventilated pit	39(32.8)	33(27.7)	12(10.1)	27(22.7)	8(6.7)	3.65	4 th
Insurance	22(18.5)	55(46.2)	19(16.0)	20(16.8)	3(2.5)	3.61	5 th
Using modern storage facility	32(26.9)	35(29.4)	21(17.6)	21(17.6)	10(8.4)	3.49	6 th
Storage in mud hut	22(18.5)	24(20.2)	47(39.5)	26(21.8)	0(0)	3.35	7 th
Modern processing method	22(18.5)	33(27.7)	31(26.1)	23(19.3)	10(8.4)	3.29	8 th
Storage in elevated store shed	18(15.1)	39(32.8)	28(23.5)	20(16.8)	14(11.8)	3.23	9 th
Training of processing of tomato	20(16.8)	31(26.1)	25(21.0)	22(18.5)	21(17.6)	3.06	10 th

Source: Field survey, 2023. Note: **VE**=very effective, **E**=effective, **LE**=less effective, **NS**=not sure and **NE**=not effective.

Determinant of management strategies adopted by farmers against post-harvest operation

Probit regression model was used to examine the determinant of management strategies adopted by farmers against post-harvest operation in the study area. Thus, the result from Table 5 shows the Pseudo R^2 of (0.3068), implying that about (31%) of variations that occur in the tomato farmers' adoption of post-harvest management strategies were explained by the independent variables included in the models. while the remaining (69%) were due to error in measurement of some variables. The Prob chi-square is significant at 1% level of probability. This implies the model is fit for the objectives. The finding reveals that the coefficient of level of education of the tomato farmers is positive and significant at 5% level of probability. This implies that as the respondent's educational attainment increases the level of adoption of post-harvest strategies also increases. This might be as a result that education is a function of exposure of the respondents, which also enable the farmers easily understand the use and benefit of post-harvest technologies. This agrees with Okere, (2019) which showed that level of education influences farmers decision to adopt a given technology or innovations.

The coefficient of marital status was negatively significant at 10% level of probability. This implies that married vegetables farmers have higher tendency of adoption of post-harvest management operations than any other form of marital institutions. As there is need to provide food for household consumption which makes the adoption to be high among married vegetables farmers. This disagrees with the result of Ndem and Osondu, (2018) who showed that marital status is not significant in adoption of management strategies to post-harvest losses. Furthermore, the coefficient of access to extension service was positively significant at 5% level of probability. This implies that the higher the farmers access to extension service the higher their adoption of post-harvest management strategies. As extension, service would provide the farmers with the information needed about the benefit of using post-harvest technologies in the study area. This substantiate with the work of Nmadu and Dankyang, (2015) with showed that the higher the farmers had access to extension service will lead to an increase in the adoption of innovation.

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Table 5: Probit regression on determinant of management strategies adopted by farmers

Variables	Coefficient	Standard error	Z-value	p> T
Age	1.1962	0.7604	1.57	0.118
Household size	0.3579	10.9365	0.03	0.974
Level of education	0.0980	0.0497	1.97**	0.049
Marital status	-0.3545	0.1991	-1.78*	0.075
Farm size	0.2428	0.4918	0.49	0.662
Access to extension service	0.5313	0.2468	2.15**	0.031
Farming experience	-0.0211	0.0278	-0.76	0.448
Cooperative society	-0.0510	6.4165	-0.01	0.994
Complexibility	-0.5889	0.3134	-1.88*	0.060
Annual income	0.2428	0.4918	0.49	0.662
Goal of farming	0.1604	0.0997	1.61	0.108
Access to credit	-0.00016	0.0002	-0.80	0.422
Relative advantage	1.9228	0.9305	2.07**	0.039
Constant	-53.6236	36.3838	-1.47	0.143
Number	119			
LR chi2(13)	38.68			
Prob > chi ²	0.0002***			
Pseudo R ²	0.3068			

Source: field survey, 2023

However, the coefficient of complexibility and relative advantage of the management strategies was negative and positively significant at 10% and 5% level of probability respectively. Which implies that the higher the difficulty in using some of the post-harvest management strategies the lower the rate of adoption of such practices while the relative advantage of the management strategies to the existing practices the higher the rate of it adoption vice versa. This agrees with the findings of Okere, (2019) who showed that relative advantage of a practice increase the level of its adoption among the farmers.

Conclusion and Recommendations

The result concludes that climatic variability and lack of storage facility were the most prominent sources of risk associated with tomato post-harvest management. The results also, conclude that the use of modern method of processing, processing into tomato paste and storage in ventilated pit are the most adopted management strategies among the tomato farmers. In addition, farmers indicates storage in barns and storage in cold room to be the most effective management operation in tomato production. While level of education, marital status, access to extension service, complexibility and relative advantage were the significant factors, influencing adoption of post-harvest management practices by the farmers in the study area. It was therefore recommended that;

- i. Policy interventions on improving farmers' awareness about post-harvest technologies should be made in order to enhance their adaptive capacity in reducing the adverse impacts of post-harvest loses. This could be through organizing the farmers into cooperatives and targeting them for programs aimed at improving their literacy level regarding the key post-harvest technologies usage and techniques.
- ii. Financial institutions, either government or private should be encouraged to collaborate with tomato farmer groups to provide support by ensuring access to agricultural credit facilities. This will afford them the opportunity to adopt the use of post-harvest technologies that they otherwise would not have been able to, thereby indirectly insuring them against produce loses in storage.
- iii. Farmers' awareness of the source of information regarding post-harvest technologies and new farm practices/innovation should be provided through extension services that are easily accessible to the farmers.

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