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DETERMINANTS OF POST-HARVEST LOSSES OF ORANGE IN SELECTED LOCAL GOVERNMENT AREAS OF BENUE STATE

DETERMINANTY STRAT PO ZBIORACH POMARAŃCZY W WYBRANYCH OBSZARACH STANU BENUE

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Abstract

This study examined the determinant of postharvest losses of orange in two Local Government Areas of Benue State. The aim of the study is to identify the most important factor responsible for postharvest losses of oranges in the study area so that proactive steps should be taken in forestalling future losses. The research used primary data from a population of forty respondents (40). Eighteen farmers and twenty-two orange marketers were purposively selected from two Local Government Areas in Benue State using a structured questionnaire. The data were analyzed using the Statistical Package for Social Science (SPSS) Version 20.0. The data collected were analyzed using logit regression to establish the effect of each of the factors on post-harvest losses in the study areas. The result of the study indicates the following factors; Formal Education, Method of harvesting and Handling showed significant effect ($p<0.05$) on post-harvest losses. The method of harvesting was 4.698 times more likely to affect post-harvest losses than all the other variables of the study. Results from the second model indicate that factors such as; Packaging, Storage, Handling and Marketer's Experience showed a significant effect on postharvest losses in the study areas. The study showed that the method of storage was 5.767 times more likely to affect post-harvest losses than all the other variables of the study. The study recommends that scientific approaches like modern harvesting methods, improved storage, and handling facilities should be adopted to reduce post-harvest losses of orange.

Keywords: *Postharvest, Prevention, Losses, Harvesting, Marketing, Orange, Benue, Nigeria*

Streszczenie

W badaniu zbadano determinanty strat pomarańczy po zbiorach w dwóch obszarach samorządu terytorialnego stanu Benue. Celem badania było zidentyfikowanie najważniejszego czynnika odpowiedzialnego za straty po zbiorze pomarańczy na badanym obszarze, co pozwoliłoby na podjęcie kroków w zapobieganiu przyszłym stratom. W badaniu wykorzystano podstawowe dane z populacji czterdziestu respondentów (40). Osiemnastu rolników i dwudziestu dwóch sprzedawców pomarańczy zostało celowo wybranych z dwóch obszarów samorządu terytorialnego w stanie Benue przy użyciu ustrukturyzowanego kwestionariusza. Dane przeanalizowano przy użyciu pakietu statystycznego dla nauk społecznych (SPSS), wersja 20.0. Zebrane dane przeanalizowano za pomocą regresji logit, aby ustalić wpływ każdego z czynników na straty po zbiorach na badanych obszarach. Wynik badania wskazuje na następujące czynniki; Edukacja formalna, metoda zbioru i postępowania wykazały znaczący wpływ ($p <0,05$) na straty po zbiorach. Metoda zbioru miała 4,698 razy większy wpływ na straty po zbiorach niż wszystkie inne zmienne badania. Wyniki z drugiego modelu wskazują, że czynniki takie jak; pakowanie, przechowywanie, obsługa i doświadczenie handlowców wykazały znaczący wpływ na straty po zbiorach na badanych obszarach. Badanie wykazało, że metoda przechowywania miała 5,767 razy większy wpływ na straty po zbiorach niż wszystkie inne warianty. Zalecenia wynikające z przeprowadzonego badania mające na celu zmniejszenie strat pomarańczy po zbiorach to zastosowanie nowoczesnych metod zbioru, lepszego przechowywania oraz urządzeń do przeładunku.

Słowa kluczowe: *zapobieganie, straty, zbiór, marketing, pomarańcze, Benue, Nigeria.*

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Statement of the problem in general outlook and its connection with important scientific and practical tasks.

Due to huge losses of Orange fruit at the time of harvest, the overall output of the orange fruit is reduced which affects the product availability throughout the year. Several factors are responsible for this huge postharvest losses. In order to advise the government properly on the best policy option in the prevention of postharvest losses of orange. Various factors are responsible for spoilage of orange fruit. This study examines and identified the most significant factors responsible for orange spoilage so that the government can take significant policy in curtailing postharvest loses of orange in the study area. Food security is a major concern in a large part of the developing world. Food production must clearly increase significantly to meet the future demand for an increasing world population. Economically, food losses have a direct and negative impact on the income of both farmers and consumers (Foluke, 2011).

The federal government has been assisting farmers in mopping up excess farm produce and storing them at strategic reserves, which are sold to people at reduced prices during periods of need food scarcity. Farmers and stakeholders also argue that storage facilities alone cannot conquer the problems of post-harvest losses in Nigeria. Processing facilities are directly required across the country so as to add value to agricultural products for local consumption and export.

Orange fruits being non-climacteric have a relatively short post-harvest life in stark contrast to the climacteric fruits like mango, banana, and sapota. In a developing country, post-harvest losses of orange fruits are in the range of 25-30% as against 5-10% in developed orange growing countries like Brazil, USA, Australia, Spain, Italy, and Israel. This is mainly due to the unscientific practices of picking, handling, packaging, transportation, and storage. The main causes of food losses and waste in low-income countries are connected to financial management and technical limitation in harvesting, storage, and processing techniques.

Modern packaging containers involving use of corrugated fiberboard boxes in lieu of conventional wooden boxes, tray packing with linear low density polyethylene (LLDPE), low density polyethylene (LDPE) and high density polyethylene (HDPE) films have shown tremendous effects on preserving shelf-life as well as maintaining the quality of orange fruits during long term storage. Pre-harvest sprays of chemicals like plant growth regulators (PGR) and fungicides in various studies resulted in a better effect on reducing the color development and microbiological spoilage. Sesame oil, carbendazim, or ethephon treatment checked the decay losses due to Aspergillus niger, Alternaria citri, Penicillium digitatum and Penicillium italicum in orange fruits. The treatment with 2,4-D helped in maintaining color for longer duration during storage. The film wrapping in the modified atmosphere (MA) storage reduced the rate of respiration which resulted in prolonged shelf-life.

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Several other factors have been implicated in the post-harvest losses; crude method of harvesting, storage, packaging, and transportation are among several factors. The nature of the road such as the existence of potholes has also facilitated the occurrence of mechanical injury which reduces the shelf life of the orange fruit (Hartman, 2011).

According to Foluke (2011), major postharvest losses largely arose from pest, disease, natural disaster, careless human action, inadequate storage facilities, and processing. Postharvest losses occur in three stages; from the farm, storage, transportation, and marketing. This study examines the factors that lead to postharvest loses and the effect of each of the factors on postharvest losses of orange fruit in the study area.

Analysis of latest research where the solution of the problem was initiated.

Orange storage is a major factor in preventing post-harvest losses. As a result in Bangladesh, Bala et al. (1993 & 1994) evaluated the storage performances of different types of traditional storage systems and designed improved traditional storage systems for Bangladesh conditions for reducing postharvest loss in agricultural crops. Orange belongs to the family Rutacceae with about 150 genera (Opeke, 2005). More recent estimates put annual orange fruit production at 105 million metric tons and there has been a steady rise in the production globally due mainly to increase in hectarage, consumer preference for more health or convenience food and rising income (United Nations Conference on Trade and Development (UNCTAD, 2010). Orange is one of the most widely grown fruit trees in subtropical Africa which includes oranges, lemon, grapefruits and tangerines. It is believed to have been introduced into Africa by the colonial administrations and missionaries (Olife, Ibeagha & Onwualu, 2015). There are several thousand trees of the crop being grown almost all over Nigeria. FAOSTAT (2014) estimated that the production of orange in Nigeria in 2014 was about 3.4 million metric tons, making the country the world's 8th highest producer of the commodity and providing 2.7% of the world's total production. Major orange producing states in the country include Benue, Nasarawa, Osun, Anambra, Ekiti, Imo, Kogi, Ebonyi, Edo, Delta, Oyo, Kwara, Ogun, Taraba, and Kaduna (Olife, Ibeagha & Onwualu, 2015), with Benue State giving the highest annual production of orange fruits. Most orange production in Nigeria is accounted for by oranges but significant quantities of grapefruits, lemon and lime are also grown (Olife et al., 2015).

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Picture 1. Orange market in the studied area.

Source: https://bit.ly/2Nxv5NI.

Gaurav and Singh (2011) who carried out Economic Analysis of Post-harvest Losses in Marketing of Vegetables in Uttarakhand noted that post-harvest management techniques like packaging, storage, transport, and marketing have not been effective due to poor infrastructure, poor accessibility to technology, lack of irrigation infrastructure, incidence of small and fragmented land holdings and low investment capacity of farmers which makes policy in implementing government action plan difficult.

Postharvest losses in orange can occur in terms of economics, quantity, quality (aesthetic appeal), and nutrition (Sudheer and Indira, 2007). Postharvest losses can also occur at any stage in the supply value chain hence there is a need to consider the whole supply chain to determine the losses. For farmers, postharvest losses can be quantified in absolute terms for produce lost after harvest and then calculated as a percentage based on total harvested quantity (Weinberger, Genova, and Acedo, 2008). Postharvest management determines not only the quality and safety of food but competitiveness on the market. In developing countries, the horticultural supply chains lack sustainable postharvest management systems. Major constraints of postharvest management in these countries include inefficient handling and transportation, poor technologies for storage, processing, and packaging, the involvement of too many diverse actors and poor infrastructure (Ladaniya, 2008).

Agada and Uga (2017) examined the effects of farmers' attitudes towards post-harvest losses of orange in the Ushongo Local Government Area of Benue State, Nigeria. Primary data were collected from 90 orange farmers randomly selected using a structured questionnaire. Data were analyzed using descriptive and inferential statistics. Results showed that farmers experienced high post-harvest losses during harvesting (M=2.96), storage (M=2.48), gathering of fruits (M=2.38), transportation (M=2.34), packaging and bagging (M=2.31), wholesale market (M=2.24) and sorting (M=2.12). The losses were caused by improper harvesting (M=4.99), poor sanitation (M=4.98), pest and disease attacks

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(M=4.96), exposure of fruits to the sun (M=4.81), high rate of bruising (M=4.75), poor handling (M=4.62), among others. The effects of losses on orange included a reduction in output (M=2.00), reduction in farmers' income (M=2.00), poor taste (M=2.00) and so on. Farmers' suggested storage of fruits in cool places (M=2.00), removal of specks of dirt before packaging (M=2.00), among others as measures for reducing post-harvest losses in orange. The study revealed that household size (0.064; $p < 0.078$), level of education (-0.068; $p < 0.045$) and orange farming experience (0.001; $p < 0.084$) significantly influenced extent of losses of orange among farmers. The study further found that there exists a relationship (r=0.209) between farmers' attitudes towards orange production and the extent of post-harvest losses of orange. It was concluded that farmers experienced high post-harvest losses in orange with great effects on their production and income but possessed positive attitudes for reducing losses of the fruits.

The review of available literature advocated that most of the studies (Basappa, Deshmanya and Patil (2001); Srivastava (2002); Bari (2004); Basavaraja et al. (2007); Gangwar et al. (2007); Murthy et al.(2007); Ayandiji et al. (2009) only estimate post-harvest losses rather to estimate the determinants of post-harvest losses at aggregate level, this study carried out the various factors that affect postharvest losses and the relevant factors was regressed using logistic regression to determine the effect these factors on post-harvest losses in the studied areas.

Aims of paper. Methods

Description of the analysis of the research Sample

Population

The population for this study comprises all the orange farmers and the orange marketers in the study area. However, since the population of the study is large and scattered over a large area, it will be impossible to study all of them. Thus, a sample was purposively taken for the purpose of the study.

Number of samples

This study used a survey research design. It is a procedure in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population. Convenience sampling was used to sample available orange farmers and marketers in the study areas. This study was conducted in two locations; the Gboko Local Government Area and Makurdi Local Government Area of Benue State. Since the regions have vast potential for production, marketing of the orange fruit under study. These two Local Governments were purposively selected for the study. Respondents purposively selected in Gboko Local Government Area represents the grower of the orange crop while respondents in Makurdi Local Government represents the marketers of orange. Two markets were purposively selected, they are Rail Way Market High Level and Wadata Markets. These markets were purposively selected because of the volume of orange and other fruits and vegetables sold in the markets. Eighteen (18) orange farmers and twenty-two (22) orange marketers were purposively used for the study bringing the total population of the study to forty respondents. The study was based on the primary data collected from the selected

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farmers, and marketers using a structured questionnaire supplemented by the personal interview method.

Profile of respondent

The respondents are farmers and marketers. The farmers are stationary in the study area while the marketers come from all over the country to buy the products to be marketed to other areas where the products are needed. The respondents are not highly educated as most of them are itinerate traders and marketers.

Hypotheses

A) Farmer Level model

H_{01}: Formal Education has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{02}: Orchard size in Acres has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{03}: Method of harvesting has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{04}: Orange disease has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{05}: Weather condition has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{06}: Handling has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

B) Marketing level model

H_{01}: Transportation has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{02}: Packaging has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{03}: Storage has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{04}: Handling has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{05}: Education in years has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

H_{06}: Experience in years has no significant effect on postharvest of oranges in selected local government areas in Benue State, Nigeria

Research Problem

This study is necessitated by the need to understand the most significant factor that is responsible for post-harvest losses of orange in the study. The understanding of which will help the policymakers in Agriculture to make policies that will help in mitigating the huge losses experienced in the product during the time of harvesting.

Usage of Research Method

Logit regression was used to determine the effect of the various factors on postharvest losses of orange in the study area. Logit regression is appropriate and used for this study since the variables under study are categorical data that can fit in into the framework of logistic regression. The probability value of the logit estimates was used to test the stated hypotheses. The following decision rules were adopted for accepting or rejecting hypotheses: *If the probability value of* b_i [p (b_i) > critical value] we accept the null hypothesis, that is, we accept that the estimate b_i is not statistically significant at the 5% level of significance. *If the probability value of* b_i [p (b_i) < critical value] we reject the null hypothesis, in other words, that is, we accept that the estimate b_1 is statistically significant at the

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5% level of significance. The data were analyzed using the Statistical Package for Social Science (SPSS) Version 20.0

Model Specification

The model is specified in two forms; farmers factor, marketers factors. The implicit and explicit relationship between the variables of the study is specified as shown below:

A) Farmers level

The implicit relationship between the dependent and independent variables of the study is shown below:

Y = f (X1, X2, X3, X4, X5, X6)--------- (1)

Where,

X1 = Formal Education
X2 = Orchard size in Acres,
X3 = Method of harvesting
X4 = Orange disease
X5 = Weather condition
X6 = Handling
Y = Post-harvest losses of orange

In explicit form, the model can be represented in the form as shown below:

Y = α0 + α1X1 + α2X2 + α3X3 + α4X4 + α5X5 + α6X6 + Ut ---------- (2)

Where,

α0 = Regression Constant
α1, α2, α3, α4, α5, α6 = Coefficients of variables
Ut = Disturbance term

Measurement of Variables

X1 = Formal Education (education = 1, no education = 2)
X2 = Orchard size in Acres, (Large = 1, small = 2)
X3 = Method of harvesting (Hand picking = 1, Plucking with stick = 2)
X4 = Orange disease (High = 1, Low = 2)
X5 = Weather condition (Adverse = 1, Not adverse = 2)
X6 = Handling (Adequate = 1, Not adequate = 2)
Y = Post-harvest losses of orange (1 if there is loss, 2 otherwise).

B) Marketing level

Y = f (X, X1, X2, X3, X4, X5, X6, X7)- (3)

Where,

X1 = Transportation
X2 = Packaging
X3 = Storage
X4 = Handling
X5 = Education in years,
X6 = Experience in years,
Y = Post-harvest losses of orange in Kg

In explicit form, the model can be represented in the form as shown below:

Y = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + Et ---------- (2)

Where,

b0 = Variable Constant
b1, b2, b3, b4, b5, b6, b7 = Coefficients of variable
Et = Disturbance term

Measurement of Variables

X1 = Transportation (Tarred road = 1, Untarred road = 2)
X2 = Packaging (Suitable packaging =1, 2 otherwise)
X3 =Storage (Cold Storage = 1, Ordinary = 2)
X4 =Handling (Adequate = 1, inadequate = 2)
X5 = Education (Education = 1, no education = 2)
X6 = Experience (Adequate = 1, Not adequate = 2)
Y = Post-harvest losses of orange in Kg (1 if there is loss, 2 otherwise).

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Exposition of main material of research with complete substantiation of obtained scientific results. Discussion.

This section presents the results of the logistic regression and its interpretation and discussion or the two models of the study. Various factors that affect post-harvest of orange at farming and marketing levels were regressed to determine the effect of each of the factors on post-harvest losses of orange fruit in the studied area.

Analysis At Farmer's Level

Table 1. Classification Table.

Classification Table[a]

Observed			Predicted		
			Y		Percentage Correct
			1.00	2.00	
Step 1	Y	1.00	11	5	68.8
		2.00	5	19	79.2
	Overall Percentage				75.0

The cut value is .500

Source: Author's computation, 2019

This Table presents the descriptive classification of the variables used for this study. As shown above, 75.0% of the cases were correctly classified.

Table 2. Model Summary.

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	42.773[a]	.242	.327

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001

Source: Author's computation, 2019

Table 2 contains the Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. Therefore, the explained variation in the dependent variable based on our model ranges from 24.2% to 32.7%. Since Nagelkerke *R2* is a modification of Cox & Snell *R2*, we are using the Nagelkerke *R2* value of 32.7% as the explained variation

Variables in the Equation

The "**Variables in the Equation**" table shows the contribution of each independent variable to the model and its statistical significance. This table is shown below:

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Table 3. Variables in the Equation.

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	X1	1.182	.824	2.059	1	.015	.307	.061	1.541
	X2	.559	.791	.500	1	.480	1.749	.371	8.240
	X3 (1)	-1.547	.868	3.175	1	.048	4.698	.857	25.767
	X4	.462	.809	.326	1	.568	.630	.129	3.075
	X5	-1.639	.879	3.478	1	.062	.194	.035	1.087
	X6	.204	.856	.057	1	.011	1.227	.229	6.567
	Constant	1.863	2.893	.415	1	.519	6.446		

a. Variable(s) entered on step 1: X1, X2, X3, X4, X5, X6.
Source: Author's computation, 2019

From these results (X_1) Formal Education (p = .015), (X_3) Method of harvesting (p = 0.048) and (X_6) Handling (p = 0.011) added significantly to the model/prediction. (X_2) Orchard size in Acres (p = 0.480), X_4 = Orange disease p = *0.586) and* (X_5) Weather condition (p = 0.062) did not add significantly to the model. Increasing Orchard size in Acres was associated with an increased likelihood of post-harvest losses in orange, but increasing the Method of harvesting was associated with a reduction in the likelihood of post-harvest losses.

Logistic regression was performed to ascertain the effects of Formal Education, Orchard size in Acres, Method of harvesting, Orange disease, Weather condition and Handling on the likelihood that there are post-harvest losses of the orange. The logistic regression model was statistically significant, $\chi 2(6) = 11.067$, $p <$ .05 using values from the Omnibus Test of Model Coefficient Table. The model explained 62.20% (Nagelkerke R^2) of the variance in post-harvest losses of orange in the studied areas and correctly classified 75.0% of cases. The method of harvesting was 4.698 times more likely to cause post-harvest losses than all the other variables of the study.

Analysis At Marketing Level

Table 4. Classification Table.

Classification Table[a]

	Observed		Predicted		
			Y		Percentage Correct
			1.00	2.00	
Step 1	Y	1.00	11	5	68.8
		2.00	7	17	70.8
	Overall Percentage				70.0

a. The cut value is .500

Source: Author's computation, 2019

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This Table presents the classification of the variables used for this study. As shown above, 70.0% of the cases were correctly classified.

Table 5. Model Summary.

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	46.858[a]	.502	.622

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Source: Author's computation, 2019.

Table 5 contains the Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. Therefore, the explained variation in the dependent variable based on our model ranges from 50.2% to 62.2%.

The "Variables in the Equation" table shows the contribution of each independent variable to the model and its statistical significance.
This table is shown below:

Table 6. Variables in the Equation.

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	X1	.174	.803	.047	1	.828	.840	.174	0.056
	X2	-.110	.831	.017	1	.048	.896	.176	4.571
	X3	1.752	.906	3.737	1	.053	5.767	.976	34.076
	X4	-.177	.890	.040	1	.042	.838	.147	4.791
	X5	-.201	.839	.057	1	.810	.818	.158	4.237
	X6	.577	.825	.489	1	.048	.561	.111	2.831
	Constant	-.407	3.195	.016	1	.899	.666		

a. Variable(s) entered on step 1: X1, X2, X3, X4, X5, X6.

Source: Author's computation, 2019

From these results (X_2) Packaging (p = .049), (X_3) Storage (p = 0.053) and (X_4) Handling (p = 0.042), (X_6) Experience (0.048) added significantly to the model/prediction. In other words, we reject the null hypothesis. This means for the farmers model, packaging, storage, handling, and experience had a significant effect on postharvest losses that (X_1) Transportation (p = 0.828), (X_5) Education (p = 0.810) which did not add significantly to the model. Thus the null hypothesis for the effect of transportation and education was accepted against the alternative. Increasing the variables X_2, X_3, X_4 , X_6

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(Packaging, Storage, Handling and Experience) was associated with the likelihood of reduced post-harvest losses in orange. This finding is in line with that of Bari (2004), Srivastave (2002) and Lum (2001) who stated that post-harvest losses in fruits and vegetables highest due to picking (19.6%), packing (3.5%), carrying (2.2%) and during loading and transportation (7.1%).

The logistic regression model was statistically significant, $\chi 2(6) = 6.983$, $p < .05$. The model explained 62.20% (Nagelkerke R^2) of the variance in post-harvest losses of orange in the studied areas and correctly classified 70.0% of cases. The method of storage was 5.767 times more likely to cause post-harvest losses than all the other variables of the study.

Conclusions.

This study has analyzed the factors responsible for post-harvest losses of orange fruit at both the farmer and marketing level. The study revealed that three factors have been implicated to be responsible for post-harvest losses of orange in the study areas. The factors are formal education, method of harvesting and handling. The education of the farmer was shown to be an important factor in preventing post-harvest losses. This is because illiterate farmers do not have the requisite knowledge needed to prevent losses of their crops that occurs as a result of several factors. Also, the method of harvesting was identified as a major factor contributing to post-harvest losses in the orange plant.

Wrong methods of harvesting constitute a high percentage of orange losses resulting from the physical damages to the oranges (scarring and bruising of the orange peels and crushing of the oranges) during harvesting. The result of the study indicated that the farmers in the study area experienced serious postharvest losses particularly due to poor post-harvest handling measures. Improvement of these age-old practices and the development of new technologies through organized research efforts have become necessary to prevent huge post-harvest losses of orange. However, there is an immediate and pressing need for more and improved storage and handling facilities. From the analysis, there is no sufficient evidence from the results that orchard size in acres, orange disease, and weather conditions leads to post-harvest losses.

Based on the result of the study, packaging, storage, handling and experience are factors that significantly affect post-harvest losses of orange during marketing. While Transportation and Education level of marketers of the orange did not add significantly to the model. The type of packaging material affects orange as wrong packaging materials lead to bruises and mechanical damage. Cold storage of produce extends the shelf life and prevents deterioration of the produce during storage and marketing. Handling and experience of the marketer are also factors implicated in spoilage and losses and can be reduced if appropriate handling measures are taken in the handling of the orange during transportation and marketing.

Recommendations

Several factors have been implicated in post-harvest losses from farmers and marketing levels mainly due to improper and poor harvesting and handling techniques, marketing inefficiencies, lack of infrastruc-

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ture. This study recommends that by adopting some scientific approaches like modern harvesting methods, improved storage, and handling facilities, post-harvest losses of oranges would be greatly reduced.

The government should provide storage facilities to minimize post-harvest losses and make food available all year round.

Suggestions for further study

One of the limitations of this study is that the sample size for the study was not large enough. It is suggested that the larger sample size of the respondents should be increased for future study to increase the external validity of the study. Also, factor analysis should be used to extract the most significant factors and those factors should be regressed in a logistic regression to determine the effect they have on the postharvest losses of orange in the future study.

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