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What Factors Explain Postharvest Losses of Orange Fruit (*Citrus sinensis*) from Farm to Fork in the Tropics?

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ABSTRACT

Demand for citrus fruit has increased over the years in Nigeria. However, post-harvest loss of tropical fruits is high in developing nations owing to poor handling and storage facilities along the supply chain. The study therefore assessed levels and correlates of postharvest losses of fresh oranges along the orange supply chain. Primary data collected from marketers and producers of orange were analysed using descriptive statistics and ordered logit. Orange farming was dominated by male (68.4%) while orange marketing was dominated by females. Most of the producers (63.16%) and wholesalers (65.38%) experienced postharvest loss of 6-10%, while 46.79% of the retailers experience a postharvest loss of less than 5%. Being a male farmer that harvested oranges in the afternoon increased the likelihood of postharvest losses among the farmers while having a large household size reduced it. However, education, smallholding marketing and use of storage facilities reduced the likelihood of postharvest loss among orange marketers. Postharvest training for farmers and marketers on fruit harvesting and storage methods will help to minimise postharvest loss from producers to retailers.

Key words: postharvest losses, producers, marketers, ordered probit

INTRODUCTION

Malnutrition is a major global public health and development concerns. Nigeria has the second highest burden of stunted children in the world, with a national prevalence rate of 32 percent of children under five and about 2 million children suffering from severe acute malnutrition in the country (UNICEF, 2021). About 5.1 million Nigerians were estimated to be in immediate need of food assistance in March-May 2020 (SWAC/OECD, 2020). Micronutrients are vital components of good nutrition, and their deficiency in the human diet is responsible for many health problems (Kuku-Shittu et al., 2016). Consumption of fruits and vegetables is a panacea for malnutrition. Orange fruit (*Citrus sinensis*) is known to be rich in calories and micronutrients such as vitamin C, thiamin, foliate, calcium, fibre and potassium (Cervoni, 2012). Of all the citrus fruits, orange is the most common and the most widely cultivated and consumed in Nigeria (Inienger and Udoh, 2020).

Global orange production for 2021/22 increased from 1.4 million tons in 2020/2021 to 48.8 million in 2021/2022 due to favorable weather (USDA, 2022). The production of oranges of Africa and Nigeria increased from 2.73 and 1.5 million tonnes, respectively in 1971 to 9.76 and 3.98 million tonnes, respectively in 2020 growing at average annual rates of 2.76% and 2.13%, respectively (Knoema, 2022). However, owing to their green color and small sizes, Nigerian oranges do not meet export standards (Dijkxhoorn et al., 2021). Although there has been an improvement in orange production in Nigeria over time, postharvest loss is still a major challenge (Adegbija, 2018).

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Orange fruits do change hands several times among the actors along the marketing chain. Farmers sell their fruits to the consumers through various intermediate marketers who keep the entire price share in the market (Arah, 2015). The amount of production that finally gets to the consumer is more important than the level of production as post-harvest losses of tropical fruits account for the reduction of produce that eventually gets to the consumer (Ezekiel et al., 2014). Postharvest loss, therefore, includes the food losses across the food supply chain from harvesting of crop to its consumption (Aulakh et al., 2013). These losses occur all along the supply chain, beginning from the time of harvest up to packing, storage, transportation, retailing and consumption (Saran et al., 2012). However, over 50% of the fruits produced in Nigeria are lost in transit between farms and major urban markets (Olife et al., 2015). Reduction in postharvest loss enhances inclusive economic growth, food and nutrition security by increasing food availability (AGRA, 2020; Mahmud, 2020).

Several factors are responsible for postharvest loss of orange in most developing countries are mainly due to the combination of poor infrastructures and logistics, poor farm practices, poor of postharvest technologies and handling knowledge, as well as a convoluted and ineffective marketing system (Parfitt et al., 2010; Doki et al., 2019). Mechanical damage occurs during transportation of fruits over untarred roads, which generates high temperatures that accelerate enzyme and microbial activities which contribute to the deterioration of fruit after harvests (Agona and Muyinza, 2008; Mashau et al., 2012). All these problems reduce the life span, quality and quantity of orange fruits that get to the consumer and hence increase postharvest losses of oranges.

The quality and nutritional value of fresh orange fruits are mostly affected by postharvest handling and storage condition (Sablani et al., 2006). The perishable nature of the citrus fruits implies that are inherently liable to deteriorate under different climatic and other circumstances due to their high moisture content (Kitinoja and Kader, 2002. Thus an efficient marketing strategy needs to be put in place to avoid damage to crops after they are harvested (Mbah et al., 2018).

Several studies have conducted studies on postharvest losses of oranges among farmers (Agada and Uga, 2017; Attah et al., 2018; Ikwuba et al., 2019) and marketers (Aminu et al., 2019; Girei et al., 2020) in Nigeria. Some studies also analysed the determinants of postharvest loss among farmers and marketers in Nigeria without disaggregating the marketers into wholesalers and retailers (Doki et al., 2019) or without identifying the determinants of postharvest losses (Adekalu et al., 2019). Owing to a paucity of empirical study on postharvest loss along orange supply chain in Nigeria, this study therefore identified the socio-economic and postharvest handling factors influencing postharvest losses along orange supply chain in the tropical southwest Nigeria.

MATERIAL AND METHODS

The study was conducted in tropical Oyo state, Nigeria, which is one of the major orange fruit producing states in Nigeria (Inienger and Udoh, 2020). A cross-sectional type of data was collected from three groups of actors along a short supply chain (orange farmers, orange wholesalers and orange retailers), using a multi-stage sampling procedure. A purposive sampling method was used to select four Local Governments Areas (Afijo, Ona Ara, Ogooluwa and Egbeda local governments) in Oyo state, where orange farming is predominant. A total number of 60 farmers were randomly selected, proportionate to the orange farming population of the area. Similarly, a multi-stage sampling procedure was used to select sample from both orange wholesalers and retailers for the study. The four major fruit markets (Odo-Oba, Oje, Elekara and Egbeda) in Oyo state were purposively selected for the study. A simple random sampling was used to select 10 orange wholesalers from each of these markets, making a total of 40 wholesalers. However, 80 orange retailers were randomly selected from the markets proportionate to the size of the orange retailers in the markets. Information obtained include socio-economic characteristics of the actors, percentage of postharvest loss, time of harvesting, materials for packaging, perceived causes of postharvest loss, among others.

Descriptive statistics were used to describe postharvest loss of the actors along the orange supply chain, while the ordered probit was used to identify determinants of postharvest loss at each of the supply nodes (production, wholesale and retailing) of the chain. An ordered categorical dependent variable (percentage postharvest losses) was estimated. The model is useful in determining a combination of the multiple factors contributing to the resultant percentage postharvest loss categories on a given crop. Unlike the Ordinary Least Squares method, the ordered probit model avoids specification of lead equation and recognizes unequal differences between ordinal categories in the dependent variable (Greene, 2003).

The postharvest loss per trip was estimated in percentage and categorized into three groups namely: low (1 – 5%) = 0; moderate (6 – 10%) = 1; high (> 10%) = 2. The respective category for quantity lost is unobserved and is denoted by the latent variable Y_i^*. The latent equation that shows how Y_i^* varies with explanatory variables is given as:

$$Y_i^* = X_i\beta + \varepsilon_i \quad (1)$$

where the latent variable Y_i^* measures postharvest loss by an actor *i* (0= low (1 – 5%); 1= moderate (6 – 10%); 2 = high (> 10%); Each actor *i* belongs to one of the three groups; X_i is a vector of exogenous variables; β is a conformable parameter vector; and the error term(ε_i) is independent and identically distributed as standard normal. The implied probabilities are obtained as:

$$\begin{aligned} \Pr\{Y_i = 0 | X_i\} &= \Phi(\mu_0 - X_i\beta) \\ \Pr\{Y_i = 1 | X_i\} &= \Phi(\mu_1 - X_i\beta) - \Phi(\mu_0 - X_i\beta) \\ \Pr\{Y_i = 2 | X_i\} &= \Phi(\mu_2 - X_i\beta) - \Phi(\mu_1 - X_i\beta) \end{aligned} \quad (2)$$

where μ is the unknown parameter that is estimated jointly with β; and $\Phi(\cdot)$ is the cumulative distribution function (cdf) of the standard normal (Verbeek, 2008). Estimation is based upon the maximum likelihood where the above probabilities enter the likelihood function. The interpretation of the β coefficients is in terms of the underlying latent variable model in equation (1).

A measure of goodness of fit can be obtained by calculating:

$$\rho^2 = 1 - [\ln L_b / \ln L_o] \quad (3)$$

where $\ln L_b$ is the log likelihood at convergence and $\ln L_o$ is the log likelihood computed at zero. This measure is bounded by zero and one. If all model coefficients are zero, then the measure is zero. Although ρ^2 cannot equal one, a value close to one indicates a very good fit. ρ^2 increases as the model fit improves (Greene, 2003).

RESULTS

A larger percentage of the orange farmers/producers were male (68.4%), married (89.5%) with mean and modal ages of 52.01 years and 41-50 years (38.5%), respectively; modal household size of six people (78.9%); and had primary education (35.1%) (Table 1). However, a larger part of the orange wholesalers (61.5%) and retailers (80.8%) were female, married (96.1%, 93.1% respectively), mean ages of 46.32 and 44.10 years, respectively; modal household size of 6 people (53.8% and 52.1%, respectively); and had secondary education (42.3%, 42.5%, respectively).

Most of the producers and marketers (retailer and wholesaler) had a high level of experience (more than 20 years) which constituted about 52.6%, 46.6% and 46.2%, respectively, with the mean values of marketing and farming experience being 20 and 24 years, respectively (Table 2). About a third of the producers (75.4%) belonged to a farmers' association while most of the marketers (retailers and wholesalers) which constituted 95.9% and 88.5%, respectively, belonged to a marketing group. Most of the wholesalers (61.5%) and retailers (91.8%) were primarily engaged in trading, while 73.7% of the producer were primarily engaged in farming. A high percentage of the farmers did not have access to credit which constituted about 73.7% while 79.5% and 69.2% of the retailers and wholesalers, respctively had access to credit. About 80.8% and 65.8% of the orange wholesalers and retailers got their source of finance from personal equity, while most the producer got theirs from cooperative society (47.4%).

A larger percentage of the producers (80.7%) harvested orange early in the morning (Table 3). Arrangements for the collection are done in advance so that the farmer can harvest accordingly. Further, a majority of the farmers (93.0%) transported their oranges in in open trucks without any protection; while only a few farmers (7.0%) packed their oranges in sacks. A larger percentage of producers (54.4%), wholesalers (80.8%) and retailers (52.1%) perceived perishability of the produce as the main cause of postharvest losses, while lack of storage facilities and bad road networks were next to it, respectively. The distribution of the post-harvest losses (in percentage) showed that most of the producers (63.16%) and wholesalers (65.38%) experienced a post-harvest loss of 6-10%, while 46.79% and 37.18% of the retailers experienced postharvest losses of less than 5% and 6-10%, respectively.

The ordered probit regression was used to identify the determinants of postharvest losses of orange fruits. The log likelihood (−32.7880) and chi-square of (34.03) of the ordered probit model for the producers were significant ($P<0.01$) and Pseudo-R2 of 0.3417 implying that all the variables jointly explained the variations in the level of post-harvest losses (Table 4). Five variables significantly explained the level of postharvest losses of orange among farmers at different levels. Those that significantly influence orange losses among farmers were gender, household size, primary occupation, time of harvest and packaging.

Data for both the wholesalers and marketers were pooled and analysed as marketers because none of the wholesalers had less than five percent post-harvest loss and none of the retailers had above 11% post-harvest loss. The log likelihood (−78.71568) and chi-square (40.52) with a cut1 of −1.6696 and cut2 of 0.0803 were significant implying that the model had a good fitness of the model (Table 5). Postharvest losses of orange among the marketers were influenced by quantity of orange purchased, education level and storage facilities.

DISCUSSION

Most of the orange producers in the study area were male (Table1). This shows that male farmers are more into orange production than females in the study area, which buttressed the findings of Attah et al. (2018) that orange farming was mostly practiced (80.0%) by the men in Benue State, Nigeria. However, female actors were prominent in marketing of oranges than their male counterparts. This is consistent with finding of Aminu et al. (2020) that most orange marketers in Lagos metropolitan markets were females. Most of the actors in the supply chain were married with fairly large household sizes. This confirms the findings of Attah et al. (2018) and Aminu et al. (2019) that the majority of orange farmers (95.0%) and marketers (81.4%) were married with mean household size of 14 and six people, respectively. Married and large households are expected to have an advantage with regards to labour availability for their production and post-harvest handling techniques (Obayelu et al., 2021). Most of the producers and marketers were also in their economic active age, buttressing the findings of Ikwuba et al. (2019) and Aminu et al. (2019) that orange farming and marketing activities were mostly practised by the middle-aged individuals in Nigeria.

Moreover, the level of education among the producers was low with majority of them having primary education, while the retailer and wholesaler were moderately educated. This is consistent with the finding of Ezekiel et al. (2014) that most orange farmers had primary education; and that of Aminu et al. (2019) that 38.1% of orange marketers had secondary education. This is expected because formal education is not requisite for non-skilled activities. Babalola et al. (2010) also found that the majority of farmers had low educational status and that only literate farmers could understand and use most of the available post-harvest technologies. Orange farmers and marketers were moderately experienced in their trades suggesting better knowledge and fair handling of postharvest techniques. This is in line with the findings of Babalola et al. (2010) that inexperienced farming community coupled with

Table 1: Distribution of the actors by their demographic characteristics

Demographic characteristics	Retailers (N = 73)	Wholesalers (N = 26)	Producers (N = 57)
Gender			
Male	14 (19.2)	10 (38.5)	39 (68.4)
Female	59(80.8)	16 (61.5)	18 (31.6)
Age of respondents			
≤ 30	11 (15.1)	3 (11.5)	0 (0.0)
30-40	20 (27.4)	6 (23.1)	8 (14.2)
41-50	17 (23.3)	5 (19.2)	22 (38.5)
>50	25 (34.2)	12 (46.2)	27 (47.3)
Mean	44.10	46.32	52.01
Household size			
≤ 5	35 (47.9)	12 (46.2)	11 (19.3)
6-10	38 (52.1)	14 (53.8)	45 (78.9)
>10	0 (0.0)	0 (0.0)	1 (1.8)
Educational status			
No formal education	0 (0.0)	1 (1.8)	1 (1.8)
Primary education	12 (16.4)	7 (26.9)	20 (35.1)
Secondary	31 (42.5)	11 (42.3)	13 (19.3)
Tertiary	30 (41.1)	7 (26.9)	22 (28.1)
Others	0 (0.0)	0 (0.0)	3 (5.3)
Marital status			
Single	3 (4.1)	0 (0.0)	2 (3.5)
Married	68 (93.1)	25 (96.1)	51 (89.5)
Separated	2 (2.7)	1 (3.8)	0 (0.0)
Widowed	0 (0.0)	0 (0.0)	4 (7.1)

Numbers in parentheses are percentages.

low formal education levels might be contributory to high postharvest losses. Household membership of association/ group increased access to information important to production and marketing decisions. The result is in line with Martey et al. (2012) that the majority of the farmers belong to a farmer association and have access to market information at all levels of supply chain in the study area. Most of the farmers diversified their livelihood activity to complement their earnings in order to manage their risks (Baiphethi and Jacobs, 2009). A larger percentage of the actors had access to credit with a larger percentage of producers obtained loans from informal sources, which is an indication that the formal sources of financing are difficult to access by actors in orange supply chain.

Furthermore, harvesting in the afternoon was reported to be a major cause of high postharvest losses because of high temperatures and evaporation which causes the vegetables to shrink, thus affecting the marketing quality. A majority of the producers harvested their oranges early in the morning which is known to reduce postharvest losses. Kasso and Bekele (2018) found that a larger proportion of farmers in Ethiopia preferred to harvest their horticultural crops during the coolest time of the day like in the early morning to transport to the market for sale. Similar results were also reported by Genova et al. (2006) and Kereth et al. (2013) that harvesting activities should be completed during the coolest time of the day, which is usually in the early morning. However, this was contrary to the findings of Muhammad et al. (2012) that a complete lack of proper postharvest knowledge was evident among farmers, as only 10% of the respondents in their study were found to harvest at an appropriate time of harvesting i.e. morning and evening.

In addition, a majority of the producers transported their oranges in open trucks from the farm to the first point of sale to buyers. This is consistent with the findings of Adekalu et al. (2019) and Aminu et al. (2019) that oranges are often transported on trucks/vans and are cushioned with grasses or paddy straw or moss or banana leaves, which easily expose the fruits to adverse weather conditions and losses. Ikwuba et al. (2019), however, found that a higher proportion of orange farmers in Benue State stored their oranges in bags.

Table 2: Distribution of actors by economic characteristics

Economic variables	Retailers (N = 73)	Wholesalers (N = 26)	Producers (N = 57)
Marketing/Farming experience			
≤ 5	3 (4.1)	1 (3.8)	2 (3.5)
6-10	17 (23.3)	2 (7.7)	6 (10.5)
11-15	14 (19.2)	5 (19.2)	12 (21.1)
16-20	5 (6.8)	6 (23.1)	7 (12.3)
>20	34 (46.6)	12 (46.2)	30 (52.6)
Mean Value	20.2 ± 10.49	19.5 ± 6.71	23.9 ± 11.35
Membership of Trade Association			
Yes	70 (95.9)	23 (88.5)	43 (75.4)
No	3 (4.1)	3 (11.5)	14 (24.8)
Primary Occupation			
Farming	6 (8.2)	10 (38.5)	42 (73.7)
Trading	67 (91.8)	16 (61.5)	15 (26.3)
Access to credit			
Yes	58 (79.5)	18 (69.2)	15 (26.3)
No	15 (20.5)	8 (30.8)	42 (73.7)
Sources of finance			
Personal equity	48(65.8)	21(80.8)	25(43.9)
Cooperative	11(15.1)	2(7.7)	27(47.4)
Money lender	6(8.2)	3(11.5)	5(8.8)
Friend and relatives	4(5.5)	0(0.0)	0(0.0)

Numbers in parentheses are percentages.

Table 3: Distribution of actors by postharvest variables

Postharvesting variables	Retailers (N = 73)	Wholesalers (N = 26)	Producers (N = 57)
Time of Harvesting			
Morning			46 (80.7)
Afternoon			1 (1.8)
Evening			10 (17.5)
Materials for packaging			
None	73 (100.0)	26 (100.0)	53 (93.0)
Sacks	-	-	4 (7.0)
Perceived causes of losses			
None	0 (0.0)	1 (3.8)	0 (0.0)
Perishability	38 (52.1)	21 (80.8)	31 (54.4)
Lack of adequate storage facilities	17 (23.3)	3 (11.5)	21 (36.8)
Bad roads	10 (13.7)	1 (3.8)	5 (8.8)
Mechanical damage	4 (5.5)	0 (0.0)	0 (0.0)
Lack of processing plant	4 (5.5)	0 (0.0)	0 (0.0)
Distribution of postharvest losses			
<5 %	5 (6.67)	0 (0)	68 (93.15)
6-10 %	36 (63.16)	17 (65.38)	5 (6.85)
11-15%	16 (28.07)	9 (34.62)	0

Numbers in parentheses are percentages.

The use of sacks does not protect fresh fruits from mechanical damage as they create high heat owing to physiological change by metabolic reaction, which in turn accelerates mechanical damage and microbial attack (Kader and Rolle, 2004; Kereth et al. 2013). However, all the wholesalers and retailers transported their oranges in open trucks, which may not protect fresh produce from mechanical damage as they cause postharvest losses by crushing (Kereth et al., 2013). The use of sacs as major packaging materials could be due to their accessibility and low cost (Yeshiwas and Tadele, 2021).

Postharvest losses were high among orange producers and wholesalers due to losses on the farm during harvesting and losses due to pest and diseases, duration of storage, poor transportation system without cold facility, distance of farm to the market, the number of days it takes to sell oranges and storage facilities available. The lack of good and cheap transportation poses a serious threat to orange supply from the point of production to the point of sale (Aminu et al., 2019). In addition, inexistence of cooling chain increased postharvest losses in Nigeria as the trucks do not have cooling facilities. Thus, unavailability of appropriate storage and transport facilities were major factors affecting trade efficiency and the quality of the oranges in its supply chain (Dijkxhoorn et al., 2021; Musasa et al., 2013). The retailers' lower losses can be due to the fact that they purchase only the quantity of oranges they can sell within a given period.

Gender had a negative relationship with the level of postharvest losses among orange farmers. This implies that the male farmers are more likely to experience postharvest loss than the female farmers. This may be attributed to the fact that females are more careful in handling of the fruit than their male counterparts (Garikai, 2014. Household size of the farmers also had a negative relationship with the level of post-harvest losses among orange farmers. The reason for this may be that larger households increase the numbers of labour that will assist both in the production and post-harvest activities (Adepoju, 2014; Obayelu et al., 2021).

Primary occupation was negatively related to the quantity of orange lost by farmers, suggesting that respondents whose major occupation was trading tended to have low postharvest losses. This might be as a result of acquisition of marketing skills and information. The time of picking or harvesting is a very important factor in determining postharvest losses. Harvesting in the afternoon can be detrimental to fruits and vegetables due to high temperatures. It is therefore desirable that the fruits are harvested during the cooler parts of the day to reduce the risk of heat injury and sunburn (Bekele, 2018). Time of harvest had a positive relationship with the level of postharvest loss among orange farmers. This implies that farmers that harvested their oranges in the afternoon were more likely to have higher postharvest loss than farmers that harvested their produce in the morning. These results complement the findings by Kereth et al. (2013) that harvesting should preferably be done early in the morning.

Packaging materials used in postharvest handling play an important role in reducing postharvest loss. Produce should be immobilized by proper packaging and stacking during transportation to avoid excessive movement or vibration (Kitinoja et al., 2013). Packaging of oranges in open trucks had a positive relationship with the likelihood of postharvest losses. This implies a low likelihood of postharvest losses when oranges were packaged in sacks and baskets when transporting. This was in line with the findings of Garikai (2014) that use of packaging materials reduced post-harvest losses in cabbage and tomato. The coefficient of education level of the actor was negative implying that marketers with higher level of education experienced less postharvest losses than those with lesser years of formal education. Marketers with high educational level have the ability to understand and appreciate postharvest technologies better than those with low educational attainment (Mashau et al., 2012; Abera et al., 2020). The coefficient of quantity of orange purchased was positively related to postharvest losses among orange marketers. This fact is buttressed by the negative coefficient of improved storage facilities used. This suggests that use of storage facilities, that extend the shell-life of the oranges, minimizes storage losses among the marketers.

CONCLUSIONS

The major limitation of this study was the number of samples collected, which was due to funding challenges. In

Table 4: Determinants of postharvest losses among producers/farmers

Variables	Coefficient	Marginal effect Low loss (1-5%)	Marginal effect Moderate loss 6-10%	Marginal effect High loss 11-15%
Gender	-0.9917 (0.584) *	0.023(0.025)	0.276(0.182)	-0.298 (0.189)*
Age	-0.002 (0 .042)	-0.00004 (0.001)	0.0004 (0.010)	-0.0004 (0.011)
Household size	-0.241 (0.110)**	0.007 (0.007)	0.057 (0.028)**	-0.064 (0.029)**
Educational level	-0.016 (0.520)	-0.001 (0.015)	-0.004 (0.121)	0.004 (0.137)
Farming experience	-0.013 (0.044)	-0.0004 (0.001)	-0.003 (0.010)	0.003 (0.012)
Member of cooperative	0.035 (0.449)	-0.001 (0.013)	0.008 (0.108)	-0.009 (0.121)
Farm size	-0.087 (0.111)	0.003 (0.004)	0.020 (0.026)	-0.023 (0.029)
Primary occupation	1.517 (0.573)***	-0.118 (0.101)	-0.166 (0.093)*	0.284 (0.085)***
Access to credit	0.464 (0.474)	-0.011 (0.015)	-0.123 (0.141)	0.134 (0.150)
Time of harvesting	3.313 (0.773)***	-0.649 (0.16)***	0.255 (0.178)	0.394 (0.083)***
Packaging	-2.010 (0.980)**	0.331 (0.308)	-0.112 (0.304)	-0.219 (0.069)***
Number of observations	57			
LR chi2(11)	34.03			
Prob>chi2	0.0004			
Pseudo R2	0.3417			
Log likelihood	-32.788009			
/cut1	-0.8912(1.3147)			
/cut2	2.3027(1.3236)			

*, ** and *** represent 10%; 5% and 1% levels of significance, respectively.
Numbers in parentheses are standard errors.

Table 5: Determinants of postharvest loss at Market level

Variables	Coefficient	Marginal effect Low loss (1-5%)	Marginal effect Moderate loss 6-10%	Marginal effect High loss 11-15%
Age	-0.011 (0.014)	0.004 (0.0052)	-0.0022 (0.003)	-0.0017 (0.0023)
Quantity Purchased	0.00003 (8.61 e-06)***	-0.0001 (0.000)***	6.25e-06 (0.000)***	4.82e-06 (0.000)***
Educational level	-0.718 (0.342)**	0.234 (0.106)**	-0.083 (0.039)**	-0.151 (0.091)**
Marketing experience	0.027 (0.018)	-0.009 (0.007)	0.006 (0.004)	0.004 (0.003)
Household size	-0.034 (0.065)	0.013 (0.024)	-0.007 (0.014)	-0.005 (0.011)
Distance from farm to market	0.211 (0.022)	-0.008 (0.008)	0.004 (0.005)	0.003 (0.004)
Storage facilities	-0.782 (0.283)***	0.288 (0.106)***	-0.163 (0.076)**	-0.1253 (0.050)**
Access to credit	0.485 (0.341)	-0.185 (0.132)	0.120 (0.096)	0.066 (0.041)
Duration of storage	-0.210 (0.142)	0.078 (0.052)	-0.044 (0.032)	-0.034 (0.024)
Number of observations	99			
LR chi2(11)	40.52			
Prob>chi2	0.000			
Pseudo R^2	0.205			
Log likelihood	-78.716			
/Cut1	-1.669 (0.819)			
/Cut2	0.080 (0.806)			

*, ** and *** represent 10%; 5% and 1% levels of significance, respectively.
Numbers in parentheses are standard errors.

addition, owing to a lack of local or nationally representative data on magnitude of losses, socio-economic characteristics of actors and associated factors explaining postharvest loss along the supply chain of orange, the study, therefore, made use of a sample of the actors along the value chain in one of the major orange producing states of Nigeria. This study concluded that the larger the quantity purchased, the less the postharvest loss incurred. The study also concluded that harvesting of oranges should be completed during the coolest time of the day, which is usually in the early morning, in order to minimize postharvest loss by the farmers. There were neither cooling transportation nor adequate storage facilities for oranges from the point of production to the point of sale to consumers. Being a male farmer increased the likelihood of postharvest loss among the farmers, while large farming household size and harvesting of orange in the morning would reduce it. However, education, smallholding marketing and use of improved storage facilities reduced the likelihood of postharvest loss among the marketers. Owing to inadequate storage facilities and non-existence of a cold chain in the orange supply, marketers who bought large quantity of oranges than they could sell within a few days were likely to incur more losses than those who bought less. Thus, both the public and the private agricultural financial sectors should review the existing credit system in the country and introduce innovative credit schemes that would promote credit access to smallholder actors along the orange supply chain. Moreover, solving the problem of postharvest loss along orange supply chain in a developing economy requires the implementation of a blend of policies that focus on gender equity, as well as provision of storage and logistic infrastructure. In addition, governmental and non-governmental organisations should emphasize on trainings and awareness programmes on harvesting and postharvest handling of oranges for all actors at each node of orange supply chain.

CONFLICT OF INTERESTS

The authors declare no conflict of interest for this manuscript.

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Dejavniki, ki pojasnjujejo izgube pridelka pomaranč (*Citrus sinensis*) po obiranju v tropskih območjih v verigi od proizvajalca do potrošnika

IZVLEČEK

Povpraševanje po citrusih se je v Nigeriji v zadnjih letih povečevalo, vendar pa je za države v razvoju značilna precejšnja izguba tropskega sadja po obiranju zaradi slabih pogojev pri obiranju in skladiščenju sadja tekom dobavne verige. Cilj raziskave je bil oceniti stopnje in korelacije izgub svežih pomaranč po obiranju v celotni dobavni verigi. Podatki, zbrani pri proizvajalcih in prodajalcih pomaranč, so bili analizirani z uporabo deskriptivne statistike in ordinalne regresijske analize. Rezultati so pokazali, da so bili pridelovalci pomaranč v glavnem moški (68,4 %), pri trženju/prodaji pomaranč pa so prevladovale ženske. Pri večini proizvajalcev (63,2 %) in veletrgovcev (65,4 %) so izgube pridelka pomaranč po obiranju znašale 6-10 %, pri 46,8 % trgovcev na drobno pa pod 5 %. Pri proizvajalcih je bila verjetnost izgub pomaranč po obiranju večja, če so pomaranče obirali moški v popoldanskem času, medtem ko je imela velikost gospodinjstva oziroma število družinskih članov obraten učinek (zmanjšane izgube). Pri prodajalcih se je izkazalo, da izobraževanje, trženje na malih posestih in uporaba skladišč zmanjšujejo verjetnost izgub pridelka pomaranč. Usposabljanje za pridelovalce in prodajalce pomaranč o metodah obiranja in skladiščenja sadja bo v prihodnje pripomoglo k zmanjšanju izgub po spravilu v celotni verigi proizvajalcev in trgovcev na drobno.

Ključne besede: izgube po obiranju, proizvajalci, prodajalci, regresijska analiza