POST-HARVEST HANDLING PRACTICES AND LOSSES AMONG MANGO PRODUCERS IN BENUE STATE, NIGERIA

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ABSTRACT

The study examined post-harvest handling practices and estimate proportion of post-harvest harvest losses among mango producers in Benue State, Nigeria. A random sampling technique was used to select one hundred and fifty-four producers. Data were collected with the aid of well-structured questionnaire and analyzed using descriptive statistics and multiple linear regression. Result indicated that majority of mango producers were male (71.4%), had secondary school education (44.2%) with 11-20 years' experience in mango farming (53.3%). The average land size cultivated by the producer was 3.5 acres with an average of 223 mango trees comprising of various varieties. Findings also revealed that 48.1% of the producers harvested their mango when half ripe and the prevalent method of harvesting was hand plucking (96.1%) while also showing that 89.6% of the harvested mango were cooled after harvesting. Majority of the producers pack their mango in baskets (94.8%) and were stored for 1-5 days before transportation to the point of destination and transportation was mostly in the evening. Majority of the producers (85.7%) experienced post-harvest losses due to pest and disease infestation (75.3%); an average of 27.5% of total harvest was lost during the peak season. Household size and years of experience in mango production significantly affect the proportion of mango losses, while inadequate capital was the most important constraints to the use of post-harvest technologies. It is suggested that mango farmers should mobilize themselves into viable cooperative so that they can gain from the use of pooled resources and finances in cooperative.

Keywords: Mango, handling practices, post-harvest losses, constraints, Benue State

INTRODUCTION

Mango is an important fruit of great nutritional and economic importance (Elhadi et al, 2023). It is one of the most significant fruits worldwide due to its nutritional value and content of diverse phytochemicals, (Gupta et al., 2022). Ripe mango fruit are rich in sugars (glucose, fructose, sucrose), starch, pectins, cellulose and hemicellulose (Bello et al., 2007). Nigeria rank 11th position in Mango production in the world with 1.59% of total world production in 2022. Nigeria is Africa's largest producer of mango with about 800,000 metric tonnes of annual production. Mango is produced in Benue (the highest producing state in Nigeria), Jigawa, Plateau, Yobe, Kebbi, Kaduna, Kano, Bauchi, Sokoto, Adamawa, Taraba, and the Federal Capital Territory, Nasarawa, Katsina states (Ubwa et al, 2014).

Mango is a climacteric fruit, perishable after harvesting due to the ripening process, environmental conditions, and improper postharvest handling (Le et al, 2022). Handling processes such as transport, storage and processing affects mango fruit composition and quality likewise extent of losses (Elhadi et al, 2023). Minimizing postharvest losses of fruit and vegetable is a very effective way of ensuring food security and maintaining the quality of produce. Recent empirical work on Mango in Nigeria include those of Anda and Anda (2023), Johnson et al, (2017), Chiemela et al, (2020). Anda and Anda (2023) studied factors militating against post-harvest losses on Mango in Nassarawa state reported that efforts should be concentrated on developing high-yielding mango varieties that are resistant to attack by insects. Johnson et al, (2017) analyzed Innovation Strategy and Commercialization to Enhance Mango Value Chain in South-Western Nigeria, and found that income realized on past production, accessibility to information on better production practices, educational qualification of respondents and size of land cultivated are important factors that determined quantity of mango produced.

Chiemela et al (2020) analyzed mango fruit marketing in Makurdi Local Government Area of Benue State, Nigeria and found that mango marketing was profitable and stressed the need for the marketers to be educated on proper packaging, effective transportation, and handling techniques in order to increase their return on investment and marketing margin. Ojedokun and Oladejo (2019) analyzed mango marketing in Ogbomoso Agricultural Zone area Oyo State, Nigeria. They stated that mango marketing was profitable and that inadequate access to credit, seasonality in production, perishability, theft, long distance to the market and high cost of transportation were the problems encountered by the respondents respectively.

Although, Nigeria has comparative advantage in Mango production there are high post-harvest losses, the study therefore examined post-harvest handling practices, factors affecting proportion of post-harvest losses and constraints in mango post-harvest handling among producers in Benue State. This is essential to address the causes of the losses to improve contribution of the commodity to food security and economic empowerment.

MATERIALS AND METHODS

Study Area

The study was carried out in Benue State, North central region of Nigeria. The state lies within the lower river Benue trough in the middle belt region of Nigeria. Its geographic coordinates are longitude 7° 47' and 10° 0' East. Latitude 6° 25' and 8° 8' North. Benue state has a tropical wet and dry or savannah climate. The city's yearly temperature is 29.38 °C (84.88 °F) and it is −0.08% lower than Nigeria's averages. The state receives about 135.2 millimeters (5.32

inches) of precipitation and has 160.01 rainy days (43.84% of the time) annually. Agriculture is the mainstay of the economy of Benue State, engaging over 75% of the state's workforce. Prominent crops include Mango, Yam, Rice, Beans, Cassava, sweet potato, soybean, sorghum, millet, sesame, cocoyam. Benue State consists of twenty-three Local Government Areas.

Sampling Technique
A two stages sampling procedure was employed; the first stage includes the purposive selection of two local government areas noted for mango production (Buruku and Gboko LGA respectively) in Benue state. This was followed by random sampling of mango producers in the local government areas. A total number of 154 mango producers were sampled in the study area.

Data Collection Instruments and Analysis
Data was collected using structured questionnaires on socio economics characteristics of the producers, handling practices, proportion of losses and constraints encountered in post-harvest handling of mango. Data collected was analyzed using descriptive statistics and while multiple linear regression was used to analyze the determinant of proportion of post-harvest losses experienced by the producers. The following formula was used:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \epsilon$$

Where Y= proportion of losses in percentage
X_1=gender of respondent (male =1, 0 otherwise)
X_2 = age of respondent (years)
X_3= marital status (1= married, 0 otherwise)
X_4= household size (number of household members)
X_5 = educational level (1= non-formal, 0 otherwise)
X_6= years of experience (years)
X_7= access to extension (1 = Yes, 0 otherwise)
X_8= access to credit (1 = Yes, 0 otherwise)
X_9=membership of cooperatives (1=membership, 0 otherwise)
β_0 = Intercept (constant term)
$\beta_1, \beta_2-\beta_9$ = Regression coefficients on each independent variable
ϵ = Error term

RESULTS AND DISCUSSION
Socioeconomic Characteristics of Farmers
Most of the farmers were male (71.4%) and within the age group of 31-40 years with the mean age of 41.58 years. Table 1 showed the socioeconomic characteristics of farmers in the study area. Majority of the producers were married and had mean household size of 10. This showed that the farmers had large household size. Most of the farmers had secondary level of education (44.2%) while 35.1% had tertiary level of education. Oni et al (2023) also found that most of okra producers in Igabi local government area of Kaduna had at least secondary level of education. More than 50% of the producers (53.3%) had 11-20 years of experience in mango production with mean years of experience of 13.5 and they had their major occupation as farming (88.3%). Majority of the farmers did not have access to extension services (96.1%) and credit facilities (94.8%) and were also not members of cooperative societies (90.9%). Most of the mango farmers had 1 to 5 acres of mango farmland (92.3%) with average farm size of 3.5 acres. This showed that the farmers are smallholders and this further emphasized the significance of smallholder farmers in agricultural/horticultural crop production. Findings further revealed that most of the farmers (44.2%) had between 201- 300 mango trees in their farmland with 223 mango trees as the average among the farmers in the study area. Most of the farmers cultivate different types of mangoes on their farmland but the commonest are the Apple mangoes, Broken, Peter, John and Bull varieties of mango (65%) and they sourced their seedlings from friends and open market (97.4%)

Table 1: Socioeconomic Characteristics of Farmers

Variable	Frequency	Percentage
Sex		
Male	110	71.4
Female	44	28.6
Age Group		
≤20	14	9.1
21 – 30	10	6.5
31 – 40	68	44.2
41– 50	42	27.3
51 – 60	16	10.4
>60	4	2.6
Mean	41.58±9.99	
Marital Status		
Single	24	15.6
Married	110	71.4
Divorced	14	9.1
Widow	6	2.9
Household Size		
< 10	112	72.8
11 – 20	38	24.7
21 – 30	-	-
31 – 40	-	-
41 -50	2	1.3
Mean	9.6 ±6.3	
Educational Level		

Variable	Frequency	Percentage
Non-formal	30	19.5
Primary	2	1.3
Secondary	68	44.2
Tertiary	54	35.1
Years of experience in Mango production		
<10	64	41.6
11- 20	82	53.3
21-30	6	3.9
31-40	2	1.3
Mean	13.5±5.7	
Major Occupation		
Farming	136	88.3
Civil Servant	10	6.5
Trader	8	5.2
Access Extension Service		
Yes	6	3.9
No	148	96.1
Access to Credit		
Yes	8	5.2
No	146	94.8
Member Cooperatives		
Yes	14	9.1
No	140	90.9
Mango Farm Size (in acres)		
<1	2	1.3
1 to 5	142	92.3
6 to 10	4	2.6
>10	4	2.6
Nill	2	1.3
Mean	3.5	
Number of Mango Stands		
<100	32	20.8
100 – 200	28	18.2
201 -300	68	44.2
301 – 400	18	11.7
401 – 500	2	1.3
>500	6	3.9
Mean	223	
Varieties		
Apple mangoes, broken, peter, john bull	100	65
common mangoes, Saigon	20	13
broken john, bull Julie	30	19.5
Nill	4	2.6
Sources of seedlings		
Research institute	4	2.6
Open market and friends	150	97.4

Postharvest Handling Practices Among Mango Producers

Most of the producers (Table 2) harvested mango when half ripe (48.1%) followed by when the mangoes are fully matured but unripe (40.3%) while 3.9% harvested mango when fully ripe (3.9%). According to Medina and Garcia (2002), harvesting mango when fully matured but unripe optimized the shelf life and reduces post-harvest losses due to improper ripeness. Thus, harvesting mango when fully ripe may increase the extent of post-harvest losses in the commodity. The prevalent method of harvesting was hand plucking and packing (96.1%). The recommended method of harvest is harvesting mango by using clippers and placed the harvested fruit in a harvesting bag carried by the harvester. In the case of large trees, it is recommended that fruits be harvested using picking poles with attached clippers. Findings revealed that most of the farmers cool mango after harvest (89.6%), sort (94.8%), grade (96.1%), store mango in open air shed (83.1%). The common packaging method use by the farmers is the basket (94.8%) while 5.2% utilized jute bags. Only 11.7% of the farmers are using plastic crates in the study area. Plastic crates, which are stackable, stable, easy to clean and reuse has been shown to reduce damage of perishable crops (Kitnoja, 2013). Most of the producers stored mango for 1-5 days before being transported to the consumption areas (83.2%). Mango is transported in the evening by most of the farmers (48.1%) using trailer, lorry and bus (80.6%).

Table 2: Post-Harvest Handling Practices Among Mango Producers

Variable	Frequency	Percentage
Stage of Harvest		
Matured Green	62	40.3
Half ripe	74	48.1
Fully ripe	6	3.9
Others	12	7.8
Method of Harvest		
Hand cropping and packaging	4	2.6
Hand plucking	148	96.1
Stick with hooks	2	1.3
Nill	12	7.8
Cool Harvest		
Yes	138	89.6
No	16	10.4
Sort Mango		
Yes	146	94.8
No	8	5.2
Do you Grade		
Yes	148	96.1
No	4	2.6
Nill	2	1.3
Variable	**Frequency**	**Percentage (%)**
If yes basis grading		
Yes	24	15.6
No	2	1.3
Others	128	83.1
Store Mango		
Farm shed	16	10.4
Open air shed	128	83.1
Others	10	6.5
Packaging Method		
Basket	146	94.8
Jute bag	8	5.2
Use of Plastic Crates		
Yes	18	11.7
No	136	88.3
Store Mango Before sold		
1 – 5 days	128	83.2
6 – 10 days	10	6.5
Above 10days	4	2.6
Choose not to say	12	7.8
Time of Transport		
Morning	48	31.2
Afternoon	24	15.6
Evening	74	48.1
Others	8	5.2
Type of Vehicle		
Trailer, Lorry, bus	124	80.6
Car	4	2.6
Pick –up	10	6.5
Wheelbarrow	2	1.3
Nill	14	9.1

Proportion and Factors Affecting Post-Harvest Losses Among Producers

Findings from table (Table 3) revealed that majority of the producers experienced post-harvest losses (85.7%) and the major causes of the losses are pest and disease (75.3%), poor transportation (3.9%) and weak market linkages (1.3%).

Anda and Anda (2023) also found that insects and diseases (30%) are the major factors causing post-harvest losses in Mango production in Nasarawa state. An average of 27.5% of mango was lost during the peak season of mango harvesting in the study area. Sambe (2020) also reported that post-harvest

losses in Mango in developing country such as Nigeria can be about 30 percent.

Table 3: Proportion of Post-Harvest Losses

Variable	Frequency	Percentage
Experience Post Harvest		
Yes	132	85.7
No	22	14.3
Causes of losses		
Pest and disease	116	75.3
Poor Transportation	6	3.9
Weak market linkages	2	1.3
Others	30	19.5
Mean Percentage losses	**27.5%**	
Trained on Mango post-harvest handling		
Yes	8	5.2
No	146	94.8

The results (Table 4) revealed that household size and years of experience in mango production significantly affects the proportion of mango losses experienced by the respondents. An increase in the number of household members increases the proportion of mango losses experienced by the mango farmers while increasing years of experience in mango production reduces the proportion of mango losses.

Specifically, the coefficient of household size was positive and significant ($p<0.01$) to proportion of mango losses experienced in the study area. This implies that increasing number of household members increases the proportion of mango losses experienced because presence of additional younger household members may not permit some older household members to be fully engaged in harvesting and other farm-related activities.

The coefficient of years of experience in mango production was negative and significant ($p<0.01$) to the proportion of mango losses experienced in the study area. This implies that with increasing the years of experience, the farmers are expected to have accumulated knowledge on postharvest management that can aid in reducing proportion of mango losses on their farms.

Table 4: Factors Affecting Proportion of Mango Post-Harvest Losses

Variable	Coefficient	Standard error	p-value
Gender	1.953	3.317	0.557
Age	-0.102	0.125	0.415
Marital status	1.852	2.310	0.424
Household size	0.945	0.221	0.000
Educational level	-1.267	1.007	0.210
Years of experience	-0.623	0.224	0.006
Access to extension	-4.878	7.672	0.526
Access to credit	-11.101	6.723	0.101
Membership of cooperative	-5.221	5.102	0.308
Constant	29.630	7.688	14.433
No. of observations	154		
F (9, 144)	5.00		
Prob >F	0.0000		
R-squared	0.2382		
Adjusted R-squared	0.1906		
Root MSE	16.659		

Constraints to the Use of Post-Harvest Technologies

The most important constraints (table 5) to the use of post-harvest technologies among the mango producers is inadequate capital (100%). Most of the farmers are of the opinion that improved packaging materials such as the plastic crates are capital intensive and may not be able to remove such fund from their business activities. Another important constraint is inadequate extension services (97.4%), technical know-how (97.4%), lack of knowledge and information on the technology (96.1%) and low level of awareness about the technology (97.4%).

Table 5: Constraints to the Use of Post-Harvest Technologies

Constraints	Frequency	Percentage
Lack of Capital		
Yes	154	100
No		
Poor extension services1		
Yes	150	97.4
No	4	2.6

Constraints	Frequency	Percentage
Lack of technical know how		
Yes	150	97.4
No	4	2.6
Lack of knowledge and information on the technology		
Yes	148	96.1
No	6	3.9
Low level of awareness about the technology		
Yes	150	97.4
No	4	

CONCLUSION

Most of the producers were smallholders and cultivate different types of mangoes ranging from Apple mango, Broken, Peter etc. Producers harvest half ripe mango and the prevalent method of harvesting was hand plucking and packing, while baskets were the major packaging materials. Majority of producers experienced post-harvest losses due to insect and disease attack. Coefficient of household size and years of experience in mango production significantly affect the proportion of mango losses. Inadequate capital was the most important constraint to the use of post-harvest technologies amongst mango producers. It is therefore suggested that mango producers should mobilize themselves into viable cooperatives so that they can gain from the use of pooled resources and finances in cooperatives. Awareness should be created as regards measures to the control of post-harvest losses through intensive extension activities.

REFERENCES

Anda, D. A & Anda, S.A.D (2023). Factors Militating Against Post-Harvest Losses on Mango Varieties in Lafia Local Government Area, Nasarawa State, Nigeria. *Journal of Agricultural Economics, Extension and Rural Development*, 11(10): 23-29. ISSN-2360-798X

Bello, P.L.A., Garcia, S.F.J. &Agama, A.E. (2007). Mango carbohydrates. *J. Food Agric*. 1(1), 36–40. http://www.globalsciencebooks.info/Online/GSBOnline/images/0706/FOOD_1(1)/FOOD_1(1)36-40o.pdf

Chiemela, C.J, Onyia, C.C & Joseph D.D (2020). Mango Fruit Marketing in Makurdi Local Government Area of Benue State, Nigeria, *Journal of Agricultural Economics, Extension and Rural Development,* 3 (2): 8 – 15. https://aksujaeerd.com/viewpdf/articles/publications/d/49.pdf

Elhadi, M. Y, Jose´ D. O, Jeffrey K. B., Pablo G., Maria E. M. (2023). The contribution of mango fruit (Mangifera indica L.) to human nutrition and health, *Arabian Journal of Chemistry*, 16: 1-27 DOI:10.1016/j.arabjc.2023.104860

Gupta, A.K., Gurjar, P.S., Beer, K., Pongener, A., Ravi, S.C., Singh, S., Verma, A., Singh, A., Thakur, M., Tripathy, S. &Verma, D.K., (2022). A review on valorization of different byproducts of mango (Mangifera indica L.) for functional food and human health. *Food Bioscience*, 48(4):101783, doi.org/10.1016/j.fbio.2022.101783 101783.

Johnson, O.B., Adeyemo A.O & Sodiq A.R (2017). Assessment of Innovation Strategy and Commercialization to Enhance Mango Value Chain: A Case Study of South-Western Nigeria *Journal of Economics and Sustainable* 8(5): 82-86. https://www.iiste.org/Journals/index.php/JEDS/article/viewFile/36090/37083

Kitinoja, L (2013). Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. PEF White Paper No. 13-01, The Postharvest Education Foundation (PEF). https://postharvest.org/wp-content/uploads/2023/12/Kitinoja-2013-PEF-2013-01-RPCs-White-paper.pdf

Le, T.D., Viet N. T., Muoi N.V., Toan H.T., Lan N.M. & Pham T.N (2022). Supply Chain Management of Mango (Mangifera indica L.) Fruit: A Review with a Focus on Product Quality During Postharvest. Front. Sustain. *Food Syst*. 5:1-16 doi: https://doi.org/10.3389/fsufs.2021.799431

Medina, J.D, & García H.S. (2002). MANGO: Post-harvest Operations, Food and Agriculture Organizations of the United Nationshttps://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendium_-_Mango.pdf

Ojedokun, I.K. & Oladejo, J.A (2019). Economic Status of Mango Marketing in Ogbomoso Agricultural Zone Area of Oyo State, Nigeria, *International Journal of Research and Scientific Innovation (IJRSI)* 6(9): 62-66. https://rsisinternational.org/journals/ijrsi/digital-library/volume-6-issue-11/62-66.pdf

Oni, B. O., Akure, C. O., Adamu, S., Agbomaka, F. I. & Balogun O. S. (2023)**:** Socio-Economic Factors affecting the Production of Okra among rural farmers in Igabi Local Government Area of Kaduna State, Nigeria, *FUDMA Journal of Sciences (FJS)*, 7(6): 206-210. DOI: https://doi.org/10.33003/fjs-2023-0706-2186

Sambe, N. (2020): Mango varieties and causes of postharvest losses Kwande LGA, Benue State. NSUK *Journal of Science and Technology*. 16 (1):104- 112. ISSN: 0794-5213; S

Ubwa, S. T., Ishu M. O., Offem J. O., Tyohemba R. L. & Igbum G. O., (2014): Proximate composition and some physical attributes of three mango (Mangifera indica L.) fruit varieties, *International Journal of Applied Agricultural Research*. **4** (2): 21–29.