Available online at https://asric.africa/agricultural-sciences
ASRIC Journal on Agricultural Sciences Vol.5(1)(2024) 42-63

Constraints to Postharvest Handling among Sweet Orange Farmers in Benue State, Nigeria

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Received 30 March 2024; revised 06 May 2024; accepted 10 June 2024

Abstract
Beyond the threat to food security, constraints to postharvest handling adversely affect farmers' profitability, fruit market value, viability and availability. This study examined postharvest handling constraints of sweet orange farmers in Benue State, Nigeria. Orange farmers (235) were randomly sampled from orange-producing communities (eight) and LGAs (4) in Benue State. Orange farm size was 15.7±54.5 hectares, trees were mostly inherited (92.3%) and purely orchard (94.9%). The orange farming experience was 16.5±9.6 years. Major information sources were orange farmers ($\bar{x}$=1.71) and marketers ($\bar{x}$=1.58). Knowledge of postharvest handling was high (54.9%) and attitude was favourable (63.8%). Postharvest handling practices include use of shade trees ($\bar{x}$=1.99), sorting by bruises/disease ($\bar{x}$=1.98), selling at the farm gate ($\bar{x}$=2.00) and cleanliness of collection centres ($\bar{x}$=1.97). Postharvest constraints include lack of storage facilities ($\bar{x}$=3.00), premature fruit drop ($\bar{x}$=2.80), lack of training opportunities ($\bar{x}$=2.97), unpredictable change in climate (2.69), high temperature ($\bar{x}$=2.63), a glut in the market ($\bar{x}$=2.08). Knowledge (r=-0.175, p<0.01), attitude (r=-0.473, p<0.01), and postharvest handling practices utilisation (r=-0.287, p<0.01) significantly relate to postharvest constraints. Significant factors predicting utilisation were attitude (β=0.295), and postharvest constraints (β=-0.163). The study concluded that there is a need to help farmers with innovative solutions to overcome harvesting, storage, transportation and marketing-associated constraints.

Keywords: Postharvest, Utilisation, Constraints, Sweet orange, Knowledge, Attitude

Introduction
Farming is the main occupation of most rural dwellers in Nigeria and the rural areas represent the places where the bulk of agricultural produce usually comes from. Agriculture as an important sector of the Nigerian economy serves as a means of ensuring the nation's food security. This is made possible through significant contributions to food production. While ensuring food production is increasing, effective postharvest handling becomes imperative to ensure food availability. According to Rutten (2013), losses that occur during the entire food production and consumption process limit food availability. Food availability, particularly during the off-season, is an important indicator of the capacity of a nation to meet its food requirements. Effective postharvest handling is one of the most crucial and efficient ways to ensure

food security, and good nutrition, and improve farmers' income. Technologies for postharvest management can enhance food security primarily by lowering losses and waste (GrainPro, 2024). In this regard, effective postharvest handling will help ensure that sufficient food, both in quantity and quality is made available to prospective consumers at the point of purchase.

Postharvest handling is an important aspect of food production that has significant implications for food quality, storage life of produce, marketability, and economic viability. Rural farmers in Nigeria produce varieties of fruit crops such as citrus fruits. Citrus fruits are native to Southeast Asia (Rao, Zuo and Xu, 2021) and have typical fragrant flowers and edible juicy fruit. Citrus fruits include sweet oranges, grapes, lemons, lime, tangerines and tangelos. Sweet orange is the most important variety of citrus fruits and is cultivated in various States in Nigeria. Benue State is the leading producer of sweet orange in Nigeria (Daily Trust, 2022). Benue State grows sweet oranges in commercial quantities owing to its favourable agro-climatic conditions.

Sweet orange (*Citrus sinensis*) is one of the most valued citrus fruits in Nigeria. It is notable for its nutritional and medicinal properties (Richa *et al*., 2023). According to Liu *et al*. (2012), fresh citrus fruits are a good source of dietary fiber which is associated with gastrointestinal disease prevention and lowered circulating cholesterol. Sweet orange is an economic fruit crop that contributes to the economy and nutrition of the population. Despite the economic potential of the sweet orange enterprise, it faces numerous challenges, especially the postharvest handling processes, leading to inevitable losses that negatively impact farmers' profitability and the sustainability of the sweet orange enterprise. Acharya and Shrestha (2021) noted that poor orchard management, lack of irrigation, insect infestation, disease outbreaks, and lack of finance are part of the key constraints affecting sweet orange enterprise. The effort to improve farming practices and attain self-sufficiency in food production in Nigeria is continually plagued with numerous challenges which seriously impede the nation's capacity to produce food for its teeming population.

Beyond the threat to food security, constraints to postharvest handling adversely affect farmers. Postharvest handling entails all operations including harvesting, sorting, cleaning, packing, transporting, storage and marketing. Effective postharvest handling practices are crucial to ensuring sweet oranges are of good quality and safe for human consumption. Sweet oranges are perishable commodities that need to be properly handled if they are to get to consumers in good condition. According to Richa *et al*. (2023), the eating quality of oranges cannot be improved once harvested, therefore it is preferable to harvest them while they are at their peak maturity and quality. However, sweet orange farmers encounter challenges that limit their ability to handle postharvest processes effectively. These challenges range from technical to infrastructural, financial, and market-related constraints. Each constraint contributes to the overall inefficiency of the postharvest handling processes.

Technical efficiency is very crucial to sweet orange enterprise sustainability. Technical constraints such as lack of information access and training on best postharvest handling practices can lead to poor handling techniques that cause fruit damage and reduce fruit quality. Improper harvesting methods, packaging, loading/off-loading and transportation can result in bruising and microbial contamination which degrade fruit quality. Inappropriate harvesting methods and time can significantly affect sweet orange shelf life and quality. Quality fruits are obtained only when harvesting is done at the right maturity stage without damage to the fruits (Yadav, Goyal and Dhankar (2014). So, sweet orange farmers need extension services, training, workshops, and other knowledge dissemination platforms to equip them with the necessary skills that can improve their postharvest handling.

Infrastructural constraints affecting effective postharvest handling include inadequate storage facilities and the absence of cold storage facilities. According to Jarman *et al*. (2023), refrigerated storage, controlled environment storage, enhanced packaging, controlled ripening, pre-cooling, and other technologies are critical to ensuring year-round availability of fruits for consumers and minimising postharvest losses during marketing. In Benue State, Nigeria, sweet orange farmers rely on local preservation methods such as

keeping oranges under shaded trees which expose produce to adverse climatic conditions, pests, and diseases. Rutta (2022) discovered that most farmers relied on traditional postharvest storage methods that are ineffective in preventing storage losses because farmers lacked access to dependable and effective storage facilities. Also, small-scale farmers had to sell their fresh produce at lower profit margins due to a lack of adequate storage infrastructure, which had a detrimental impact on their livelihoods and incomes (Rutta, 2022; Ridolfi, Hoffmann, and Baral, 2018).

Financial constraints limit sweet orange farmers' ability to manage postharvest processes. Most rural farmers operate with limited financial resources, which restricts their ability to invest in appropriate postharvest infrastructure and technologies that can improve their farming enterprises. Transforming farmers from the use of crude methods in postharvest handling to using modern postharvest technologies requires sufficient financial support. Crude methods are not effective in enhancing the shelf life of fruits and preserving fruit quality.

Sweet orange farmers suffered market-related constraints which negatively influenced postharvest handling practices. Marketing constraints such as lack/inadequate market access and demand fluctuations hinder the sustainability of the sweet orange enterprise. A report by Daily Trust (2022) established that patronage for sweet oranges in Benue State, Nigeria had dropped compared to previous years. Farmers need access to reliable market information to guide against oversupply, shortages, and further economic losses. It is saddening that despite the commercial production of sweet oranges in Benue State, Nigeria, the government has not been able to establish a special market for sweet oranges to curb waste (Daily Trust, 2022). Sometimes, farmers are compelled to sell their produce at reduced prices to avoid spoilage. Also, constraints faced by orange marketers have a consequential effect on farmers. The lack of vehicles and its high cost coupled with long distances in the absence of proper packaging and stacking contribute to losses experienced by orange marketers (James *et al*., 2017).

Thus, understanding the postharvest handling constraints of sweet orange farmers is pertinent to designing effective interventions geared towards improving the efficiency of the sweet orange supply chain in Benue State, Nigeria. Research and development are crucial to achieving a viable and sustainable sweet orange industry. This is particularly crucial to developing innovative solutions tailored to the unique constraints faced by sweet orange farmers. Mitigating these constraints is critical to sweet orange profitability, viability, reduction of postharvest losses, and improved livelihoods for farmers. This study examined sweet orange farmers' enterprise characteristics, sources of information on postharvest handling, knowledge of postharvest handling, attitude towards postharvest handling and the utilisation of postharvest handling practices in Benue State, Nigeria. Also, factors influencing the utilisation of postharvest handling practices were determined.

2.0 Methodology

2.1 Description of the study area

Benue is a State located in the middle belt of Nigeria with its capital in Makurdi. Benue State is named after the Benue River in Nigeria. According to the 2006 census, Benue State has a population of about 4,253,641 persons. It has coordinates of 7.3369° N, 8.7404° E with an area of 34,059 km^2 (13,150 sq mi). Benue State is referred to as the 'food basket' of the nation. Major crops grown in Benue State include yam, fruits, and rice, among others.

2.2 Sampling procedure and sample size

The target population of this study were sweet orange farmers in Benue State, Nigeria. Four Local Government Areas (LGAs) were purposively selected because of their prominence in sweet orange production. The four LGAs were Konshisa, Vandeikya, Ushongo and Gboko (Daily Trust, 2022). Two sweet orange producing communities were purposively selected from each LGA to make a total of 8 communities. Mbatim and Mbakyou communities were selected in Konshisa LGA**,** Mbawa-Mbatia and Mbakase communities were selected in Vandeikya LGA, Mbayem and Mbakuha were selected in Ushongo

LGA, while Ipav and Mbayion communities were selected in Gboko LGA. Orange producing households in Mbatim, Mbakyou**,** Mbawa-Mbatia, Mbakase, Mbayem, Mbakuha, Ipav and Mbayion communities were 700, 700, 640, 640, 660, 640, 300 and 420, respectively. From each community, 5% of households were randomly sampled to give 235 households. Information was elicited from the household head or the person in charge of the sweet orange farm.

2.3 Data collection

Primary data for this study was collected using a well-structured interview schedule. The service of an interpreter was employed as most of the farmers were more convenient answering questions asked in their local dialect. During the administration of the interview schedule, farmers made worthwhile contributions beyond what was captured in the instrument.

Measurement of variables

Sources of information on postharvest handling were measured on a 3-point scale of Always, Sometimes and Never with scores of 2, 1 and 0 assigned, respectively. The mean for each item was computed and used to rank information sources. The knowledge of postharvest handling was measured using a 2-point scale of true and false with a score of 1 assigned to the correct response and 0 to the wrong response. The knowledge score for each farmer was summed, the mean score for the distribution was computed and used to categorise farmers as either having a high knowledge level of postharvest handling for those with scores equal to and above the mean or a low knowledge level of postharvest handling for those with scores below the mean. Attitude towards postharvest handling was measured using a 5-point Likert scale of Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree with scores of 5, 4, 3, 2 and 1 assigned respectively for positively worded statements and the reverse for negatively worded statements. The attitude score for each farmer was summed, the mean score for the distribution was computed and used to categorise farmers as either having a favourable attitude towards postharvest handling for those with scores equal to and above the mean or an unfavourable attitude towards postharvest handling for those with scores below the mean. The mean for each attitudinal item was also computed. The utilisation of postharvest handling practices was obtained by presenting farmers with a list of items on sweet orange postharvest handling. This was measured using a 3-point scale of always, sometimes and never with scores of 2, 1 and 0 assigned, respectively. Constraints to postharvest handling were measured on a 4-point scale of very severe, severe, mild and not a constraint with scores of 3, 2, 1 and 0 assigned respectively. The weighted mean score for each constraint item was computed and used to rank constraint items in other of severity.

Data Analysis

Descriptive and inferential statistics were used to analyse the data collected. Descriptive statistics used were frequency counts, tables, percentages, means and standard deviation while inferential statistics used were Pearson Product Moment Correlation and linear regression. Regression was used to determine predictors of postharvest handling practices utilization among sweet orange farmers.

The linear regression model for factors influencing farmers' utilisation of postharvest handling practices is expressed as:

$$Y = a+b_1X_1,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots+b_nX_n+e$$

Where Y = Utilisation of postharvest handling practices (score value)

a = Constant term

b_1, $b_2 \ldots b_n$ = Regression coefficient

e = error

X_1, $X_2 \ldots X_n$ = Regression parameters which are:

X_1 = Age (actual age in years)

X_2 = Household size (actual value)

X_3 = Years of experience in harvesting oranges for sale (actual years)

X_4 = Number of trees cultivated/possessed (actual number of years)

X_5 = Age of orange trees (actual age in years)

X_6 = Total farm size (actual value)
X_7 = Total farm size for orange (actual value)
X_8 = Sources of information (score value)
X_9 = Knowledge of postharvest handling (score value)
X_{10} = Attitude towards of postharvest handling (score value)
X_{11} = Constraints to postharvest handling (score value)

Results

Personal Characteristics of Farmers

Table 1 shows the distribution of sweet orange farmers based on their personal characteristics. The mean age of sweet orange farmers was 52.8±17.0 years. The majority of the farmers were males (94.5%), married (90.2%), and formally educated (90.6%) with the majority having secondary education (43.0%). The average household size was 14.6±9.8 persons. More farmers (40.4%) had household sizes between 6-10 persons. Farmers in the study area primarily engaged in farming (92.8%) as their occupation. Most farmers (58.3%) had no secondary occupation, but 23.0% of the farmers engaged in trading as a secondary occupation. The two prominent social groups among farmers were religious groups (52.3%) and cooperative societies (41.3%).

Table 1: Distribution of farmers based on their personal characteristics (n=235)

Variables	Categories	Freq	%
Age (in years)	< 31	18	7.7
	31 – 40	47	20.0
	41 – 50	56	23.7
	51 – 60	53	22.6
	> 60	61	26.0
	Mean±SD	52.8±17.0	
Sex	Male	222	94.5
	Female	13	5.5
Marital status	Single	10	4.3
	Married	212	90.2
	Widowed	13	5.5
Religion	Christianity	223	94.9
	Islam	0	0.0
	Traditional	12	5.1
Education	Non formal education	8	3.4
	No formal education	14	6.0
	Primary education	79	33.6
	Secondary education	101	43.0
	Tertiary education	33	14.0
Household size (persons)	1 – 5	20	8.5
	6 – 10	95	40.4
	11 – 15	44	18.7
	16 – 20	26	11.1
	> 20	50	21.3
	Mean±SD	14.6±9.8	
Primary occupation	Farming	218	92.8
	Civil service	2	0.9
	Teaching	6	2.6
	Trading	5	2.1
	Driving	2	0.9
	Traditional ruler	2	0.9

Secondary occupation	None	137	58.3
	Farming	17	7.2
	Civil service	11	4.7
	Teaching	9	3.8
	Trading	54	23.0
	Artisan	7	3.0
Social group membership	Cooperative society	97	41.3
	Informal savings and credit group (esusu)	33	14.0
	Occupational group	35	14.9
	Age grades	15	6.4
	Trade union	12	5.1
	Town development union	21	8.9
	Religious groups	123	52.3

Enterprise Characteristics of Farmers

Tables 2a and 2b present the distribution of farmers based on their enterprise characteristics. Table 2a shows that the average land size used for farming purposes was 40.4±142.9 hectares. However, the average farm size cultivated for sweet oranges was 15.7±54.5 hectares. Most of the farmers (92.3%) inherited the land used for farming while very few farmers purchased (4.3%) or used borrowed land (6.0%). The sweet oranges grown by the farmers were purely orchards (91.9%), but very few (6.8%) intercropped their oranges with arable crops such as cassava (3.4%), yam (5.1%), potatoes (4.3%), maize (3.8%), groundnut (5.1%), beans (4.3%) and soybean (3.8%). Farmers cultivate most orange trees themselves (85.5%), while 26.0% owned the trees by inheritance. The average years of farming experience was 27.8±13.7 years and farmers had been harvesting oranges for sales for an average of 16.5±9.6 years, with 40.0% having 11-20 years of experience.

From the results in Table 2b, all the farmers (100.0%) cultivated their orange trees using budded seedlings. The budded seedlings are mostly prepared by farmers personally (47.3%) or bought (46.4%). Farmers owned an average of 881.4±190.0 sweet orange trees aged 24.2±11.0 years. All the farmers (100.0%) used personal savings alone for their sweet orange production. Hired labour (39.1%), and a combination of hired and family labour (55.4%) were the major sources of labour. Besides sweet orange cultivation, few farmers grow tangelo (7.2%). Sweet oranges are harvested in the morning, afternoon and evening (95.3%). It was found that the majority of Benue farmers harvested their oranges at the mature green (93.6%), half-ripe (79.1%) and fully ripe (82.6%) stages. All the farmers (100.0%) temporarily store their oranges under tree shades after harvesting. All farmers (100.0.%) sell their oranges at the farm gate and majorly to wholesalers (100.0%).

Table 2a: Distribution of farmers based on their enterprise characteristics

Variables	**Categories**	**Freq**	**%**
Total farm size (ha)	1 - 5	39	16.6
	6 - 10	78	33.2
	11 - 15	33	14.0
	16 - 20	29	12.3
	>20	56	23.8
	Mean±SD	40.4±142.9	
Farm size for orange (ha)	1 - 5	121	51.5
	6 - 10	61	26.0
	11 - 15	25	10.6
	16 - 20	8	3.4
	>20	20	8.5
	Mean±SD	15.7±54.5	

Land acquisition*	Inherited	217	92.3
	Purchased	10	4.3
	Borrowed	14	6.0
	Leased	1	0.4
Cropping system *	Orchard	223	94.9
	Intercrop	16	6.8
	Both	6	2.6
If intercrop, which crops?*	Cassava	8	3.4
	Yam	12	5.1
	Potatoes	10	4.3
	Maize	9	3.8
	Groundnut	12	5.1
	Beans	10	4.3
	Soybean	9	3.8
	Bush mango	1	0.4
Ownership of orange trees*	Cultivated	201	85.5
	Inherited	61	26.0
Years of experience in harvesting orange for sales	< 11	81	34.5
	11 – 20	94	40.0
	21 – 30	38	16.2
	31 – 40	15	6.4
	41 – 50	7	3.0
	Mean±SD	16.5±9.6	
Farming experience	< 11	15	6.4
	11 – 20	74	31.5
	21 – 30	66	28.1
	31 – 40	40	17.0
	41 – 50	40	17.0
	Mean±SD	27.8±13.7	

***Multiple response**

Table 2b: Distribution of farmers based on other enterprise characteristics

Variables	**Categories**	**Freq**	**%**
Planted material	Budded seedlings	235	100.0
	Seeds	0	0.0
If budded, source	Ministry of Agriculture	2	0.9
	Self	111	47.3
	Bought	109	46.4
	Husband	13	5.5
Nunmber of trees owned	< 101	4	1.7
	101 – 400	123	52.3
	401 – 800	63	26.8
	801 – 1,200	22	9.4
	> 1,200	23	9.8
	Mean±SD	881.4±190.0	
Age of orange trees (years)	< 11	7	3.0
	11 – 20	111	47.2
	21 – 30	61	26.0
	31 – 40	30	12.8
	41 – 50	2	9.8

	> 50	3	1.3
	Mean±SD	24.2±11.0	
Sources of capital	Personal savings	235	100.0
Labour employed	Family	13	5.5
	Hired	92	39.1
	Hired/Family	130	55.4
Citrus types cultivated *	Orange	235	100.0
	Tangelo	17	7.2
Harvest time	Morning only	0	0.0
	Afternoon only	8	3.4
	Evening only	0	0.0
	Morning-Afternoon	3	1.3
	Morning-Evening	224	95.3
Harvest stage*	Mature green	220	93.6
	Fully ripe	194	82.6
	Half ripe	186	79.1
	Immature green	0	0.0
Storage after harvesting*	Under shade trees	235	100.0
Point of sale *	At the farm gate	235	100.0
Category of buyers*	Companies	0	0.0
	Wholesalers	235	100.0
	Retailers	5	2.1

Sources of information on postharvest handling

The distribution of farmers based on their sources of information on postharvest handling is presented in Table 3. The result shows that fellow orange farmers ($\bar{x}$=1.71) and orange marketers ($\bar{x}$=1.58) were the major sources of information on postharvest handling, and they ranked 1st and 2nd respectively. Information on postharvest handling was never gotten from radio (75.3%), associations (86.8%), government organisations (95.7%), television (97.9%) and NGOs (98.3%) by most of the farmers.

Table 3: Distribution of farmers based on their sources of information on postharvest handling

S/N	Information source	Always	Sometimes	Never	$\bar{X}$	R
1	Other orange farmers	70.6	29.4	0.0	1.71	1st
2	Orange marketers	58.7	40.4	0.9	1.58	2nd
3	Radio	0.0	24.7	75.3	0.25	3rd
4	Associations	7.7	5.5	86.8	0.21	4th
5	Government organisations	0.9	3.4	95.7	0.05	5th
6	Television	0.0	2.1	97.9	0.02	6th
7	NGOs	0.0	1.7	98.3	0.02	6th

Knowledge of farmers on postharvest handling

The study reveals in Table 4 that all farmers had knowledge that oranges while harvesting and transporting should be prevented from getting bruised ($\bar{x}$=1.00), deterioration increases during storage due to poor ventilation ($\bar{x}$=1.00), good oranges should not be packed with damaged ones ($\bar{x}$=1.00), sorting is good to separate diseased oranges from healthy fruits ($\bar{x}$=1.00), sweet oranges market value reduces due to poor appearance or decay ($\bar{x}$=1.00), sweet oranges deteriorate due to breakdown of vehicles on the road ($\bar{x}$=1.00) and that exposure to high temperature reduces the market value of sweet oranges ($\bar{x}$=1.00). The majority of the farmers had knowledge that mature and immature oranges should not be packed together ($\bar{x}$=0.99), exposing sweet oranges to heat makes them overripe or softened ($\bar{x}$=0.99), and that poor field sanitation promotes the spread of bacterial diseases ($\bar{x}$=0.99). Farmers had low knowledge of the statement 'sweet oranges should be prevented from falling directly on the ground when harvesting' ($\bar{X}$=0.49), with only 33.6% giving correct responses.

Table 4: Distribution of farmers based on their knowledge of postharvest handling

S/N	Knowledge statements	Correct response		
		F	%	Mean
1	Poor loading of sweet oranges affects their quality	229	97.4	0.88
2	Poor state of roads makes postharvest handling difficult	235	100.0	0.95
3	Deterioration increases during storage due to poor ventilation	235	100.0	1.00
4	Oranges, while harvesting and transporting should be prevented` from getting bruised	235	100.0	1.00
5	It is very good to use shade for sweet oranges	231	98.3	0.99
6	Harvesting of sweet orange should be done in the cool of the day	18	7.7	0.06
7	Sweet oranges should be prevetted from falling directly on the ground when harvesting	79	33.6	0.47
8	Exposing sweet orange to heat makes it overripe or softens	231	98.3	0.99
9	Water loss in sweet oranges increases due to injuries	231	98.3	0.99
10	Good oranges should not be packed with damaged ones	235	100.0	1.00
11	Mechanical damages are prevented when oranges are packed properly	65	27.7	0.22
12	Sorting is good to separate diseased oranges from healthy fruits	235	100.0	1.00
13	Sweet oranges market value reduces due to poor appearance or decay	235	100.0	1.00
14	Mature and immature oranges should not be packed together	228	97.0	0.98
15	Exposure to high temperature reduces the market value of sweet oranges	235	100.0	1.00
16	Sweet oranges deteriorate due to breakdown of vehicles on the road	235	100.0	1.00
17	Mechanical damages reduce the market value of sweet oranges	235	100.0	1.00
18	High cost of transportation affects effective postharvest handling	153	65.1	0.66
19	Poor field sanitation promotes spread of bacterial diseases	221	94.0	0.95
20	Oranges lose value due to weight loss or wilting	235	100.0	1.00
21	When packing, oranges should not be thrown	138	58.7	0.40
22	Sweet oranges should be protected from the sun after harvest	235	100.0	0.99

Level of knowledge of postharvest handling

The result in Table 5 reveals that most farmers (54.9%) had high knowledge level of postharvest handling, while 45.1% had a low knowledge level.

Table 5: Distribution of farmers based on their level of knowledge of postharvest handling

Knowledge	Freq.	%	Min. score	Max. score	Mean	S Dev.
Low (< mean)	106	45.1	16.00	20.00	18.59	1.03
High (≥ mean)	129	54.9				

Farmers' attitude towards postharvest handling

Table 6 presents the distribution of farmers based on their attitude towards postharvest handling. It was discovered that farmers show favourable attitude towards statements such as good state of vehicles to be used for orange transportation is highly important ($\bar{x}$=4.99), protecting sweet oranges from the sun ($\bar{x}$=4.99), high temperature is not good for oranges ($\bar{x}$=4.93), the postharvest loss is only caused by insect damage, it has nothing to do with bruising, puncturing or crushing of citrus ($\bar{x}$=4.86), cleanliness of collection centres is very important ($\bar{x}$=4.82), bruising of orange breeds diseases and pest infestation ($\bar{x}$=4.80), maintaining a good quality of the harvested orange for the market is very important ($\bar{x}$=4.78), harvesting of immature orange result in poor quality products ($\bar{x}$=4.70), cross-contamination occurs when decayed orange is packed together with good quality ones ($\bar{x}$=4.69), sorted orange get sold quickly and fetch better price for competition during marketing ($\bar{x}$=4.48) and that there is no need washing oranges ($\bar{x}$=3.83).

Table 6: Distribution of farmers based on their attitude towards postharvest handling

S/N	Attitudinal statements	Mean
1	Ensuring good state of vehicles to be used for orange transportation is not important	4.99
2	Protecting sweet oranges from the sun is simply not needed	4.99
3	High temperature is somewhat good for orange	4.93
4	Postharvest loss is only caused by insect damage, it has nothing to do with bruising, puncturing or crushing of sweet oranges	4.86
5	The cleanliness of collection centres is very important	4.82
6	Bruising of orange does not necessarily breed diseases and pest infestation	4.80
7	Packaging materials must be clean to prevent contamination and spoilage of the produce	4.80
8	Maintaining good quality of the harvested oranges for the market is very important	4.78
9	Poor loading and unloading of oranges do not contribute to postharvest loss	4.74
10	Bruised oranges are liable to attacks by decaying mechanism	4.71
11	Harvesting of immature oranges results in poor quality products	4.70
12	Cross-contamination cannot occur when decayed orange is packed together with good quality ones	4.69
13	Effective postharvest handling of oranges is not essential	4.68
14	Sorted oranges get sold quickly and fetch better prices for competition during marketing	4.48
15	Careful handling of oranges is necessary to prevent spoilage or contamination	4.43
16	Sweet oranges are best packaged in well-ventilated materials	4.36
17	Separating good oranges from damaged ones is a waste of time	4.28
18	Overfilling of packages could result in compression damage	4.19
19	It is good to package sweet oranges, it protects them against rough handling	3.92
20	There is no need to wash oranges	3.83
21	Large commercial quantities of oranges need better packaging to minimise losses over long transit	3.79
22	Crushing of fruits could result from packages being stacked too high	2.87

Level of attitude towards postharvest handling

The result in Table 7 reveals that most farmers (63.8%) had a favourable attitude towards postharvest handling, but 36.2% had an unfavourable attitude.

Table 7: Distribution of farmers based on their level of attitudinal disposition towards postharvest handling

Attitude	Freq.	%	Min. score	Max. score	Mean	S Dev.
Unfavourable (< mean)	85	36.2	83.00	108.00	99.41	3.64
Favourable (≥ mean)	150	63.8				

Utilisation of Postharvest Handling Practices by Sweet Orange Farmers

The different postharvest handling practices used by farmers are presented in Table 8. It was found that shaking trees while harvesting is a common practice among most farmers (89.8%). Harvesting only during the cool hours of the day is done occasionally by most farmers (94.5%). Most farmers always (63.8%) ensure that only mature oranges are harvested. It was discovered that containers used for packing oranges were always clean, smooth and free of rough edges as indicated by all farmers (100.0%). Gentle handling of oranges to avoid cuts and bruises is occasional among most farmers (88.5%). Oranges are always sorted by removal of bruised and diseased ones (98.3%), but never by stage of ripeness (90.6%) and sizes (86.0%). All farmers (100.0%) sell oranges right on the farm after harvesting. Sometimes, 92.3% of the farmers sell their oranges the same day it was harvested. But 59.1% always leave oranges for days before selling after harvesting and 63.8% do not sell their oranges if the price is not favourable.

Table 8: Distribution of Farmers Based on their Postharvest Handling Practices

SN	Harvesting handling practices	A	S	N	$\bar{x}$
1	Ensure containers used by field pickers are smooth and free of rough edges	100.0	0.0	0.0	2.00
2	Keep oranges in the shade after harvesting	98.7	1.3	0.0	1.99
3	Ensure containers used by field pickers are clean	98.7	1.3	0.0	1.99
4	Harvest only mature orange	63.8	36.2	0.0	1.63
5	Provide gentle handling to avoid cuts and bruising damage	11.5	88.5	0.0	1.11
6	Harvest only during the cool hour of the day	0.0	94.5	5.5	0.94
7	Ensure trees are not shaken when harvesting	0.0	10.2	89.8	0.10
	Sorting handling practices				
8	By bruises and diseases	98.3	1.7	0.0	1.98
9	By stage of ripeness	0.4	8.9	90.6	0.10
10	By sizes	1.3	12.8	86.0	0.15
	Marketing handling practices				
11	Sell orange at the farm gate	100.0	0.0	0.0	2.00
12	Protect oranges from the sun	99.1	0.9	0.0	1.99
13	Keep the collection centre clean always	96.6	3.4	0.0	1.97
14	Leaving oranges for days before selling after harvesting	59.1	40.0	0.9	1.58
15	Refuse to sell if price is not favourable	7.2	63.8	28.9	1.22
16	Selling oranges the same day they were harvested	6.0	92.3	1.7	1.04
17	Protect oranges from rain	0.0	12.8	87.2	0.13

A = Always, S = Sometimes, N = Never

Constraints faced by farmers in postharvest handling of sweet oranges

Table 9 conveys the various constraints militating against postharvest handling among farmers in the study area. Major harvesting constraints were premature fruit drop due to pests and diseases attacking orange farms ($\bar{x}$=2.80), unpredictable change in climate/weather ($\bar{x}$=2.69), premature ripening of oranges due to sudden/prolonged temperature, drought ($\bar{x}$=2.28), and poor harvesting/mechanical damage during harvest ($\bar{x}$=2.38). The sorting constraint found to be very severe among farmers was the high temperature ($\bar{x}$=2.63).

Poor field sanitation ($\bar{x}$=0.41), insufficient number of workers ($\bar{x}$=0.30), and lack of the use of shade ($\bar{x}$=0.27) were not regarded as severe constraints. Transportation constraints found to be very severe among farmers include breakdown of vehicles on the road ($\bar{x}$=2.77), delay in getting vehicles ($\bar{x}$=2.66), poor road network ($\bar{x}$=2.56), high transportation cost ($\bar{x}$=2.46), and long distances to market ($\bar{x}$=2.30). Storage constraints severely militating against postharvest handling were lack of adequate storage facilities ($\bar{x}$=3.00), inadequate technological know-how ($\bar{x}$=3.00), inadequate knowledge of improved storage equipment ($\bar{x}$=3.00), non-affordability of storage facilities ($\bar{x}$=3.00), inadequate infrastructural facilities ($\bar{x}$=2.95) and high cost of maintenance ($\bar{x}$=2.92). Major marketing constraints to postharvest handling were a glut in the market ($\bar{x}$=2.08), poor market price ($\bar{x}$=2.06) and poor market information ($\bar{x}$=2.06). Other constraints militating against postharvest handling were a lack of training opportunities on postharvest handling ($\bar{x}$=2.91), hot/humid weather ($\bar{x}$=2.86) and lack of financial support ($\bar{x}$=2.65).

Table 9: Distribution of farmers based on constraints to postharvest handling

S/N	Constraints	VS	S	M	NC	$\bar{x}$	R
	Harvesting						
1	Premature fruit drop due to pests and diseases attacking orange farm	84.3	11.5	4.3	0.0-	2.80	1st
2	Unpredictable change in climate/weather	71.9	24.7	3.4	0.0	2.69	2nd
3	Premature ripening of oranges due to sudden/prolonged temperature, drought	58.7	30.2	11.1	0.0	2.48	3rd
4	Poor harvesting/mechanical damage during harvest	51.9	35.3	11.9	0.9	2.38	4th
5	Wrong time of harvest i.e hottest part of the day	0.0	2.1	25.1	72.8	0.29	5th
	Sorting						
6	High temperature	69.4	26.0	3.4	1.3	2.63	1st
7	Poor field sanitation	0.0	0.4	40.4	59.1	0.41	2nd
8	Insufficient number of workers	0.0	0.0	30.2	69.8	0.30	3rd
9	Lack of use of shade	2.1	3.4	13.6	80.9	0.27	4th
	Transportation						
10	Breakdown of vehicles on the road	67.2	29.5	3.3	0.0	2.77	1st
11	Delay in getting vehicles	74.0	17.4	8.5	0.0	2.66	2nd
12	Bad roads/poor road network	57.4	41.3	1.3	0.0	2.56	3rd
13	High cost of transportation	55.3	34.9	9.8	0.0	2.46	4th
14	Long distance to market	37.8	54.5	7.7	0.0	2.30	5th
15	Vibration of the vehicles itself and from rough road	23.0	68.9	8.1	0.0	2.15	6th
16	Non-availability of vehicles	25.5	53.6	20.9	0.0	2.05	7th
	Storage						
17	Lack of storage facilities	100.0	0.0	0.0	0.0	3.00	1st
18	Inadequate technological know-how	100.0	0.0	0.0	0.0	3.00	1st
19	Lack of knowledge of improved storage/processing equipment	100.0	0.0	0.0	0.0	3.00	1st
20	Non-affordability of storage facilities	100.0	0.0	0.0	0.0	3.00	1st
21	High cost of maintenance	95.3	4.7	0.0	0.0	2.95	2nd
22	Inadequate infrastructural facilities	92.3	7.7	0.0	0.0	2.92	3rd
	Marketing						
23	Glut in the market	16.6	74.9	8.5	0.0	2.08	1st
24	Poor market price	33.2	40.9	24.3	1.7	2.06	2nd
25	Poor market information	21.7	62.6	15.7	0.0	2.06	2nd
26	Poor sanitation of collection centres	0.0	0.9	39.6	59.6	0.41	3rd
	Others						
27	Lack of training opportunities	97.4	1.7	0.9	0.0	2.97	1st

28	Hot and humid weather	91.9	8.1	0.0	0.0	2.92	2nd
29	Lack of financial support	70.2	21.3	7.7	0.9	2.61	3rd

VS = Very Severe, S = Severe, M = Mild, NC = Not a constraint, R = Rank

Hypotheses Testing

Relationship between selected independent variables and constraints to postharvest handling

The result as presented in Table 10 reveals that a significant relationship exists between farmers' age (r=-0.132, p<0.05), knowledge of postharvest handling (r=-0.175, p<0.01), attitude towards of postharvest handling (r=-0.473, p<0.01), postharvest handling practices utilisation (r=-0.287, p<0.01), and the constraints to postharvest handling.

Table 10: PPMC relationship between selected independent variables and constraints to postharvest handling

Variables	r-value	p-value	decision
Age	-0.132*	0.043	Significant
Household size	0.117	0.072	Not Significant
Total farm size	0.006	0.927	Not Significant
Total farm size for orange	0.017	0.791	Not Significant
Years of eperience in harvesting orange for sale	0.008	0.897	Not Significant
Age of orange trees	-0.039	0.552	Not Significant
Number of trees cultivaed/possessed	0.028	0.672	Not Significant
Sources of information	-0.119	0.068	Not Significant
Knowledge of postharvest handling	-0.175**	0.007	Significant
Attitude towards postharvest handling	-0.473**	0.000	Significant
Postharvest handling practices utilisation	-0.287**	0.000	Significant

***Significant at 0.05, **Significant at 0.01**

Factors Influencing the Utilisation of Postharvest Handling Practices

Regression analysis was used to ascertain factors influencing the utilisation of postharvest handling practices among sweet orange farmers. Table 11 shows that the F value of 4.496 was significant at 1% level with an R^2 value of 0.182 depicting that 18.2% of the postharvest handling practices utilisation by sweet orange farmers can be explained by the independent variables in the regression model. The significant factors predicting postharvest handling practices utilisation were attitude towards postharvest handling (β=0.295), and the constraints to postharvest handling (β=-0.163).

Table 11: Factors influencing the utilisation of postharvest handling practices

	Std. Error	Beta	t-value	p-value
(Constant)	7.286		3.006	0.003
Age	0.014	0.111	1.321	0.188
Household size	0.020	0.067	0.981	0.328
Years of experience in harvesting orange for sale	0.032	-0.071	-0.655	0.513
Number of trees cultivaed/possessed	0.000	0.013	0.100	0.920
Age of orange trees	0.024	0.006	0.067	0.947
Total farm size	0.003	-0.183	-1.147	0.253
Total farm size for orange	0.010	0.242	1.252	0.212
Sources of information	0.106	-0.040	-0.573	0.567
Knowledge of postharvest handling	0.183	-0.083	-1.229	0.220
Attitude towards postharvest handling	0.057	0.295	**4.048	0.000
Constraints to postharvest handling	0.033	-0.163	*-2.270	0.024
Parameters				
F	**4.496			

Sig.	0.000[b]
Sum of Squares	340.355
Df	11
Mean Square	30.941
R	0.426[a]
R Square	0.182
Adjusted R Square	0.141
Std. Error of the Estimate	2.623

*** = Significant at 0.05, ** = Significant at 0.01**

Discussion

Personal Characteristics of Farmers

The mean age obtained in this study (above 50 years) implied an ageing population of sweet orange farmers in the study area. This result was inconsistent with Ortese, Baiyeri, and Ugese (2012), that most Benue farmers are within the age bracket of 31-40 years. Most of the farmers in the study area are gradually outgrowing their productive ages. The age distribution shows that farmers are more adults than youth. This might be because orange is a tree crop that is mostly inherited and usually planted on permanent land. However, Abah (2017) reported that there are plans to revitalize citrus farming in Benue so that more young people would be attracted to the sector in the face of the dwindling oil economy and the imminent shift to an agriculture-based economy. The mean age of farmers obtained in this study is close to a report by Fagorusi (2016) that the average age of farmers in Nigeria is 55.0 years.

The result of a higher percentage of orange farmers who were males is in contrast with Musasa, Musundire, Mashingaidze and Makuza (2015) who found that citrus farmers were 48.0% female and 52.0% males in Chimanimani rural district, Zimbabwe. During the field survey, it was discovered that orange trees in Benue were owned mostly by men. If a father dies, the first son takes charge of the orange trees even if the wife is still alive. A few women farmers sampled were widows without male children who could take charge of the trees. It can therefore be deduced that orange farming in the study area is largely skewed towards males.

That the majority were married shows that sweet orange farmers are responsible adults who cherish marriage institutions. Oladoja *et al* (2008) asserted that marriage confers some responsibility and commitment on married individuals. Most farmers had either primary or secondary education. The result on education disagrees with Ortese, Baiyeri, and Ugese (2012) who found that most Benue farmers had tertiary education (60.2%). However, the result aligns with Adebisi-Adelani and Oyesola (2014) who found that most Benue farmers were secondary school (53.7%) certificate holders. According to Oduro-Ofori, Aboagye and Acquaye (2014), the level of educational attainment by a farmer would increase his farm productivity. Education enhances the ability to understand and evaluate new production technologies. The level of educational qualification is expected to increase respondents' knowledge of postharvest handling. Thus, education helps individuals to broaden their outlook and expand their mental horizons by helping them to develop proper attitudes and correct perceptions to decrease the knowledge gap about postharvest loss (Azad, 2013). Largely, farming is the primary occupation of the farmers surveyed. Corroborating the findings from this study, Muyengi *et al*. (2014) discovered that along the coast belt of Tanzania, agriculture is the mainstay of household income as farmers grow multiple crops. Some of the farmers complement their primary occupation with trading. The percentage of farmers who do not combine their primary occupation with other income-generating activities was high. Furthermore, farmers were members of social groups such as religious groups and cooperative societies. The household size of farmers was large and this aligns with Ortese, Baiyeri and Ugese (2012) who discovered that most farmers in Benue State had household sizes between 6-10 persons.

Enterprise Characteristics of Farmers

The average farm size was large, indicating that farmers have large expanses of land for farming activities. Also, sweet oranges occupy a large area of land in the study area. The large farm size can be attributed to

the fact that most orange farms in the study area are purely orchards and farmers cultivate/possess an increased number of sweet orange trees. Hence, sweet orange farmers in the study area are large-scale farmers. The lands cultivated for sweet oranges are mostly inherited. This agrees with Ortese, Baiyeri and Ugese (2012) that most farmers in Benue Stae, Nigeria got their lands by inheritance. This result depicts the permanency of land on which orange trees are grown in the study area. During interview schedule administration to farmers, it was garnered that oranges can only be grown by indigenes of a community and its cultivation must be on lands that belong to them. Where land is not enough, farmers sometimes can borrow land to grow arable crops like groundnut, soybean, rice, yam, among others in the study area. Few farmers who intercropped their oranges with arable crops were farmers that do not have sufficient land to grow arable crops. Also, some farmers with enough land cultivate arable crops on separate farmlands. Most of the sweet orange trees were cultivated by farmers, but some inherited the trees. Orange cultivation is a major source of income in the study area, coupled with the fact that trees start fruiting between 4-5 years after planting.

Farmers had been practising farming for close to 30 years. The average years of experience in harvesting sweet oranges for sale (16.5±9.6 years) implies that farmers were not novice in orange farming. In a similar study by Adebisi-Adelani and Oyesola (2014), farmers had between 10-20 years of experience in citrus production in Benue State, Nigeria. Furthermore, all the farmers planted their orange trees using budded seedlings. It is believed that planting oranges using budded seedlings yielded better and achieved the desired results, compared to seeds. The budded seedlings were either raised by the farmers themselves or bought. This result is supported by Ortese, Baiyeri, and Ugese (2012) who reported that in Benue, 62.2% of farmers got their seedlings from their personal nursery while 14.6% got theirs from other farmers' nursery. The study established that sweet orange farmers in Benue State, Nigeria possessed an increased number of orange trees and this is a reflection of the area of land cultivated for oranges. The average age of orange trees obtained in this study implies that the trees were not old. Farmers explained that they usually uproot older trees due to their low production and plant new ones.

Personal saving was the farmers' major source of finance. About 40.0% of the farmers use hired labour solely for their orange enterprise, while over 50.0% use a combination of hired and family labour. Thus, the use of hired labourers and a combination of hired and family labour is prominent among the farmers. Similarly, Ortese, Baiyeri, and Ugese (2012) found that Benue farmers used hired and family labour as their primary sources of labour. Farmers explained that they usually hire labourers to help in harvesting, assembling of oranges, putting oranges into bags and loading them into vehicles. The number of bags harvested/bagged/loaded determines the amount a hired worker will collect. All the farmers primarily grow sweet oranges. It is believed that sweet orange production gives more income than other citrus types and lands in the study area are well suited for its cultivation. The variety of sweet orange in very high demand in the study area was Ibadan sweet compared to Valencia and Washnigton DC varieties. Very few farmers grow other citrus species such as tangelo which are not in high demand.

It was discovered that harvesting of oranges is not restricted to a particular time of the day. Harvesting can be done in the morning, afternoon and evening. The result of this study is consistent with Muhammad *et al*. (2012) who found that fruit farmers harvest at no specific time of the day. However, the findings from this study negate the report by Kereth *et al*., (2013) who stated that majority of farmers (95.0%) harvest fruits early in the morning. Similar results have been reported by Genova, Weinberger, Hoang, Dang, Nguyen, Le and Nguyen (2006) that harvesting activities should be completed during the coolest time of the day, which is usually in the early morning and that produce should be kept shaded in the field and handled gently. In the same vein, Atanda, Pessu, Agoda, Isong and Ikotun (2011) advocated that harvesting should be carried out during the cool part of the day, which is early morning and late evening.

Sweet oranges can be harvested at the mature green, half ripe and fully ripe stages. Farmers attach much importance to the sweetness of oranges irrespective of the back colour. The back colour of oranges might be attributed to the weather conditions during the prevailing season. Oranges in Benue are usually green in

colour even when they are fully ripe during the rainy season but are yellow during the dry season when fully ripe. Atanda *et al*. (2011) advised that crops should be harvested at a matured green state as immature fruits may not ripen and fruits already ripe will have a short storage life. According to El-Ramady *et al*. (2015), the most important factor determining the postharvest life and final quality of fruits in terms of appearance, texture, flavour and nutritive value is maturity at harvest. Janghu, Kumar and Yadav (2024) believed that fruits should be harvested at a time when they may be consumed in the best possible shape and quality.

After harvesting, oranges are temporarily kept under tree shades. This method is the most convenient and cost-effective for farmers at the moment. Similarly, in Rusitu valley, Zimbabawe orange farmers temporarily store their produce under tree shades waiting for buyers, but this method exposes the fruits to various adverse conditions such as fluctuations in temperature and humidity leading to deterioration in orange quality (Musasa *et al*., 2013). All the farmers sell their oranges at the farm gate, majorly to wholesalers. Farmers hire labourers to harvest the oranges and assemble them for the buyers, but the buyers are responsible for the cost of harvesting and assembling. It is believed that losses are avoidable when farmers sell their produce at the farm gate but some farmers prefer to sell at higher prices in the markets without considering the cost of wastage (Olife *et al.*, 2015).

Sources of information on postharvest handling

The prominent sources of information on postharvest handling were fellow orange farmers and orange marketers. This might be because the farmers and marketers are in the same line of business. Information on postharvest handling was sparingly received from radio, associations, government organisations, television and NGOs. The majority of the farmers in Benue State, Nigeria do not belong to occupational groups.

Knowledge of farmers on postharvest handling

Farmers knew that oranges lose value due to exposure to high temperature. Especially, if it cannot be sold right away. This aligns with Atanda *et al*. (2011) that an increase in temperature reduces the shelf life of horticultural crops as most factors that make the produce deteriorate or reduce its quality usually occur at a rate that is faster as the temperature increases. Farmers attest that deterioration increases during storage due to poor ventilation. According to Kereth *et al*. (2013), packaging materials for fruits must be made in such a way that it will allow for ventilation. Most farmers affirm that sweet oranges become overripe when exposed to heat and that packing mature and immature fruits together is not good. Farmers acknowledged that poor roads for orange transportation lead to postharvest loss. The role of heat in quickening ripeness and softness of oranges is known by most farmers. It was obvious that the coolness of the weather was not given much prominence in the orange enterprise by farmers. It was found that most of the farmers disagreed that during harvesting oranges should be avoided from falling directly on the ground. This result might not be disassociated from the method of harvesting employed in the study area. Harvesting of oranges in Benue State, Nigeria is mostly done by shaking the trees, which makes falling of oranges on the ground inevitable. Moreso, sweet orange trees in Benue State, Nigeria are not tall enough to warrant climbing for harvesting.

Level of knowledge of postharvest handling and loss

The high level of knowledge observed among farmers is at variance with Muhammad *et al* (2012) who found that farmers had poor knowledge of proper postharvest handling practices despite several years of farming experience, hence the huge losses incurred at harvest. Additionally, orange production is a major source of income for the farmers in Benue and it is usually throughout the year. The high level of knowledge is expected coupled with the fact that they are relatively educated and have been cultivating orange for close to 20 years.

Farmers' Attitude Towards Postharvest Handling

Generally, farmers show favourable attitudinal dispositions to almost all the attitude items assessed in this study. The study established that the good condition of vehicles to be used for orange transportation is very paramount. This is because the breakdown of vehicles while moving oranges to the market increases their

deterioration. Farmers are positively inclined to the protection of sweet oranges from the sun. The storing of oranges under shade is considered important by the majority of farmers as high temperatures are not good for oranges.

Farmers believed that there was no need to wash oranges. This is because water will increase the rate of spoilage, hence farmers do not harvest while raining. Also, the touch of water makes sand to rub on the oranges, hence resulting in spoilage. The touch of water on oranges leaves a mark on the orange, resulting in poor appearance, reduction in market value and loss of income. Whenever it rains after harvesting, oranges are left on the farm until they are properly dried before packing them into sacks for buyers. More so, farmers' customers were wholesalers and so did not attach importance to washing oranges as they deal with large volumes of oranges. However, this scenario might not be the same with sweet orange retailers. Furthermore, the cleanliness of the environment for postharvest handling is crucial to loss reduction as contamination of healthy fruits results in more loss. The points where farmers gathered their oranges are mostly under shaded trees which are well cleaned and most times these points were layered with leaves or grasses. According to Kereth *et al.* (2013), fruit contamination occurs when they are handled in a dirty environment, thereby resulting in loss of fruit quality by microbes, pests or insects which are responsible for the spread of fruit diseases.

Sorting is a stage in postharvest handling that requires carefulness, if profit is to be maximised, particularly when with removal of oranges with diseases. Farmers agreed that sorted oranges get sold quickly and fetch better prices. Muhammad *et al.* (2012) reported that sorting fruits is crucial so that damaged fruits can be removed to prevent the contamination of good ones. However, because of the volume of oranges handled by the farmers, optimum attention might not be given to sorting. Farmers claimed during the field survey that loaders sometimes pack mature and immature oranges together. Harvested fruits that are immature or over-ripe, will have uneven ripening, a short shelf life, increased deterioration, and a higher potential for loss (Guan, Zeng and Chen, 2023). Also, lack of supervision made paid loaders pack unwholesome oranges into sacks with good ones; this is done in a bid to bag them before the arrival of vehicles.

Level of Attitude Towards Postharvest Handling

The attitudinal disposition of farmers towards postharvest handling was favourable. This result might have been influenced by the high level of knowledge recorded among farmers. A favourable attitude is expected to positively influence the utilisation of postharvest handling practices According to Barua *et al.* (2017), attitude plays a prominent role in the adoption of new technologies such as postharvest handling practices and it is usually required for any action whether positive or negative. Also, a favourable attitude is fundamental to the utilisation of postharvest handling practices. Corroborating this, Allison, Saugto and Dana (2016) asserted that the use of good management practices and technologies requires a change in an individual's behavioural disposition which is usually the last-mile challenge standing in the way of significant loss reduction.

Utilisation of Postharvest Handling Practices

The major harvesting method employed was shaking trees for oranges to fall independently. The shaking of trees could indicate the large farm size cultivated for oranges, and the higher number of trees possessed by farmers. Inappropriate harvesting methods affect orange marketers if oranges are not properly sorted before packaging or loading. According to Janghu, Kumar and Yadav (2024), the amount of loss from mechanical damages - cuts, bruises, and other injuries is significantly impacted by harvesting done by hand, with pluckers, or with machinery. The shaking of the trees results into harvesting both mature and immature oranges, leading to poor quality products. Furthermore, oranges got injured/pierced as they fell from the tree to the ground. Singh and Sharma (2018) advised that harvesting should be done carefully to prevent bruising damage, cuts, abrasions, and other injuries that could harbour germs that cause deterioration. Most times, the activities of paid labourers put farmers and marketers at a disadvantage, as they are after money to be paid. Also, the lack of effective monitoring of paid labourers during harvesting, packaging and loading

of oranges into vehicles contributed to poor postharvest handling practices that decreased effort to reduce postharvest loss.

Farmers are not so particular about harvesting oranges at the cool part of the day. There is no time of the day that farmers cannot harvest oranges. The most important thing is that in the morning, farmers ensure that the morning dew is completely gone as oranges are better harvested when the trees are dried. About 60.0% of the farmers often ensure that only mature oranges are harvested. This result is an indication of the method employed for harvesting which does not guarantee that only mature oranges will be harvested when shaking the trees. This is supported by the comment made by a farmer during the field survey that 'during harvesting when trees are shaken by paid labourers, both mature and immature oranges normally fall'. Also, when trees are shaken, oranges get bruised by some sharp thorns, or dead branches as they fell from the trees. According to El-Ramady, Domokos-Szabolcsy, Abdalla, Taha and Fári (2015), the poor appearance of fruits results from mechanical damages such as bruises which also serve as entry points for microbes, insects and pests.

Sometimes, farmers delayed the harvesting of their oranges till when better prices were offered since they sell at the farm gate, hence the oranges remained on the trees. Most times, farmers were unable to sell their oranges the same day it was harvested. But, during dry season, selling immediately after harvesting is possible provided buyers have vehicles on the ground to convey the oranges to market. However, buyers may be delayed by unforeseen circumstances that are inevitable or beyond their control at times.

Constraints Faced by Farmers in Postharvest Handling of Sweet Oranges

The dropping of premature fruits due to pests and disease attacks on farms was very severe. A similar study on postharvest loss conducted by Seid, Hassen and Yitbarek (2013) in South Wollo, Ethiopia found pests and diseases as being severe causes of loss among horticultural crop farmers sampled. Similarly, Musasa *et al*. (2015) also reported pest infestation and diseases as a major constraint to postharvest handling. Fruit drop in citrus trees caused by fruit-piercing insects is a limiting factor to citrus production, and the aborted fruits have no market value and amount to a waste of resources expended on the maintenance of the citrus trees (Oyedele and Yahaya, 2015).

It was found that high temperature was among the severe constraints experienced by farmers. Exposure of fruits to high temperatures can result in physiological disorders and other associated internal and external symptoms (El-Ramady *et al*. 2015). The sorting of oranges was not severely constrained by poor field sanitation, insufficient number of workers, and lack of the use of shade. Sanitation is of great concern to produce handlers, not only to protect produce against postharvest diseases, but to protect consumers from food-borne illnesses (El-Ramady *et al*. 2015).

Though farmers do not transport oranges in Benue State, Nigeria to markets, they suffer from the aftermath effects of transportation-associated constraints faced by marketers. Poor road network makes orange farms inaccessible, which makes evacuation of oranges stressful thereby increasing losses incurred by farmers when they cannot get buyers. Buyers most times will prefer going to accessible farms which will cost less particularly when it comes to transportation cost. When transportation costs are high, farmers find it difficult to get buyers for their produce at the right time, hence oranges become wasted. Poor road networks result from factors such as government neglect, poor governance, poor political leadership, poor maintenance culture and poor funding (Oni, 2013). Long distance to market was a severe constraint for farmers. Owing to long distances, buyers who had earlier made contact might fail to arrive at the agreed date due to unforeseen circumstances. Meanwhile, farmers might have harvested their oranges, waiting for buyers. Most times, these harvested oranges got spoilt before the eventual arrival of buyers. In some cases, the buyer may not even come, thereby increasig in loss incurred by farmers.

Storage constraints were very severe in the study area. Farmers desired the possibility of preserving their oranges, thereby avoiding loss whenever there was a glut in the market and also delaying the sale of their

oranges till when price was favourable. Unfortunately, this is not possible owing to an array of storage constraints. In Benue State, sweet oranges are produced all year round, and it is saddening for farmers to see their oranges waste away. This represents a waste of human effort, time and resources invested into the sweet orange business. Farmers lack storage facilities and lack knowledge of improved storage equipment. Oni (2013) noted that in the rural areas where majority of the smallholders operate, inadequate infrastructure constitutes a major constraint to agricultural investment, production and trade. Inadequate and lack of knowledge of improved processing technologies contribute to postharvest losses incurred by farmers. Olife *et al.* (2015) reported that there is little investment in citrus processing in Nigeria, even though investment in the processing of citrus has good economic returns. Investment in the processing of orange fruits into juice concentrates and other products will greatly reduce the waste experienced, especially during peak seasons as oranges can be processed into various value-added products (Olife *et al.*, 2015).

Foremost marketing constraints were poor market information, poor market prices, and a glut in the market. Most times oranges are wasted when there are no buyers to buy them. Especially when there is a surplus, and storage is not possible. This aligns with the report of Daily Trust (2022) that orange farmers in Benue State lament that their oranges are wasting away on the trees without buyers coming to price or purchase the oranges. When there is a surplus, farmers sometimes sell at ridiculous prices. Farmers will have to take whatever price the buyer gives if they do not have postharvest storage on their farms (Yeshiwas and Tadele, 2021). Most times, farmers have no other option than to sell instead of incurring losses. The rotting away of oranges on the trees made farmers sell at extremely cheap prices (Daily Trust, 2022). During the field survey, a farmer laments that '*we are compelled to sell at times when we are financially constrained and we need money to meet some basic need*'. Abah (2017) noted that there is so much produce coming out of the farms, yet processing and a huge market are lacking. In Benue State, Nigeria, sweet oranges are produced in commercial quantity, but the government has not been able to establish a special market for them to curb wastage (Daily Trust, 2022).

Hypotheses Testing

Relationship between selected independent variables and constraints to postharvest handling

There was a significant and inverse relationship between the age of farmers and the constraints to postharvest handling. The result implies that younger farmers were more constrained when handling oranges than older farmers. There was a significant and inverse relationship between knowledge of postharvest handling and the constraints to postharvest handling. This connotes that farmers with low knowledge of postharvest handling were more constrained compared to farmers with high knowledge. There was a significant and inverse relationship between attitude towards postharvest handling and the constraints to postharvest handling. This implies that farmers with favourable attitudes are less constrained compared to farmers with unfavourable attitudes. Similarly, there was a significant and inverse relationship between the utilisation of postharvest handling practices and the constraints to postharvest handling. This implies that farmers who utilise postharvest handling practices face fewer constraints.

Factors Influencing the Utilisation of Postharvest Handling Practices

The significant factors influencing the utilisation of postharvest handling practices were attitude towards postharvest handling, and the constraints to postharvest handling. The beta value of 0.295 obtained for attitude connotes that attitude towards postharvest handling contributed 29.5% to sweet orange farmers' utilisation of postharvest handling practices. Hence, a favourable attitude towards postharvest handling aided sweet orange farmers' utilisation of postharvest handling practices. The beta value of -0.163 obtained for constraints indicates a negative contribution. Constraints to postharvest handling inversely contributed 16.3% to sweet orange farmers' utilisation of postharvest handling practices. This implies that postharvest constraints limit farmers' utilisation of postharvest handling practices,

Conclusion and Recommendations

The demography of sweet orange farmers is changing. The average age obtained in this study indicates farmers are tending towards old age. Males dominate sweet orange farming in the study area and are formally educated. Farmers possess quite a large number of orange trees that are relatively above 20 years of age. The quantum of orange produced by these trees needs effective postharvest handling to ensure profit maximisation. Over half of the farmers primarily engaged in orange farming and had no secondary occupation. Oranges are grown in pure orchards cultivated on inherited land. Orange trees are grown from budded seedlings. Sweet orange farmers had knowledge of postharvest handling and are favourably disposed to various postharvest handling practices. The harvesting method employed by sweet orange farmers in the study area does not guarantee the wholesomeness of the oranges. Additionally, farmers severely suffered storage constraints which made large quantities of oranges waste in the absence of buyers. Most times, a glut in the market is inevitable. Transportation-associated constraints also have a consequential effect on farmers. The breakdown of vehicles and high transportation costs can dissuade marketers from buying oranges from farmers. Also, sweet orange farmers lack training opportunities on postharvest handling. These arrays of constraints significantly influence farmers' utilisation of postharvest handling practices. The study recommends training farmers on the best harvesting method and value-addition techniques through capacity building workshops coordinated by organisations such as the National Institute for Horticultural Research (NIHORT). Extension services tailored toward educating sweet orange farmers on fruit preservation are pertinent. There is a need for farmers to ensure effective supervision of paid labourers who harvest, assemble, package, and load oranges into vehicles. To curtail losses, provision of storage/processing facilities that can elongate the shelf life of oranges so that farmers can get value for their produce is necessary.

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