

Postharvest Loss Management Techniques and the Poverty status of Pineapple Farmers in Edo State, Nigeria

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Postharvest loss management in Nigeria is a bane to the production of food crops in Nigeria. While it is mostly rudimentary where it is available, in most areas, it is non-existent and this has compounded the woes of farming households in that it has decimated the meager income generated by the farmers. This has led to wide spread poverty among households in Nigeria. Pineapple as an economic crop is cultivated on a large scale in Edo state, but high postharvest loss could lead to increased poverty among farming households in the state. Therefore this study was carried out to examine the effect of postharvest loss management techniques on the poverty status of pineapple farmers in Edo state, Nigeria. 180 respondents from two local governments were sampled using a wellstructured questionnaire and multi-stage sampling procedure. Using descriptive statistics, gross margin, multiple regression, Probit regression and Foster Greer and Thorbecke (FGT) Poverty measures, results revealed that Sorting, grading, placing pineapples upside down, and covering pineapples with trampoline are the main postharvest loss management techniques used by respondents in the study area. The mean value of postharvest loss management practice in naira is ₦6485, and the gross margin for pineapple in the study area is ₦94,598,139 per production season. Poverty incidence (P_i) in the study area was found to be 24.4%, the poverty depth/gap (P_g) was found to be 6% and the poverty severity (P_s) was 2.33%. Years of farming experience, trimming of crowns and stalks, scale of operation, early harvesting, and grading are the variables that significantly affect the poverty status of respondents in the study area.

Keywords: Postharvest Loss Management, Pineapple, Gross Margin, Poverty, Welfare**JEL Classification Codes:** Q12, Q18, O13, Q56 I.**1. Introduction**

Poverty is like a canker worm that has eaten deep into the fabrics of the society, but in spite of vast resources devoted to solving the problem, and possible solutions proffered, it is still rising steadily across the world, particularly in South-East Asia, Latin America and Sub-Saharan Africa [1]. Poverty is a condition of people or communities in which financial resources required to have access to a comfortable minimum standard of living and wellbeing, viewed with certain standards acceptable by the society are absent or minimal. In sub-Saharan Africa, a greater proportion of the population, reside in rural areas and the poverty

rate stands at about 50% [2]. Agriculture remains the mainstay of most economies accounting for a vast majority of the working population, but paradoxically, agriculture has been the locus of poverty in sub-Saharan African countries, especially in Nigeria which has the highest population of poor people in the region, higher in rural areas than urban areas [3]. The Incidence of poverty among Nigerians keeps on growing in spite of all the laudable programmes and interventions that have been put in place by the governmental and non-governmental agencies to alleviate poverty in the country [4].

The rural sector is the predominant sector in the Nigerian economy being 63%, the vast majority of the people in this sector are poor

and depend on agricultural production and allied activities for food and income [5,6]. National poverty rate is currently 69 per cent, while sectoral disaggregation shows urban poverty rate of 61.8 per cent and rural poverty rate of 73.2 percent [7]. The welfare of farmers remain generally low due to declining productivity which could be attributed to low technical know-how or low availability of agricultural technology [8]. Agricultural technology goes a long way to contribute to poverty reduction in terms of enhanced productivity and lower per unit cost of production which raises the income of adopting farmers [9]. It follows that the lack of agricultural technology not only results in decreasing capacity to meet the food needs of the people, but also creates critical limiting factors to all year round cultivation [3]. Edo State, Nigeria, is not left out in the issue of poverty, as the state is largely an agrarian one. The causes of poverty in the Edo State include poor accessibility, poor marketing facilities, and lack of storage facilities for agricultural produce, capital shortages and very low industrial activities in the area, and the socio-economic effects of poverty syndrome on the rural people in Edo state, include poor housing facilities, poor diet, high death rate and poor educational facilities [10].

Post-harvest Food Loss (PHL) following Hodges, can be defined as a reduction in the quality and quantity of food items as a result of deliberate or in deliberate actions of man, starting at the time of harvest till its consumption or other end uses [11]. The loss of foods in the postharvest systems is not new, it has always been a problem for mankind. In these days of rapidly increasing population in the poorest countries of the world where food is already short, there is an increasing urgency to do a better job of conserving mankind's food supply in order to alleviate hunger and malnutrition [12]. Perishable horticultural crops such as fruits and vegetables – rich vitamins, proteins, minerals and fiber contents – contribute a lot to human diet [13]. Pineapple (*Ananas comosus* L. Merr.) is a tropical and economic fruit with encouraging market potential in the global market [14]. The economic importance of pineapple is easily justified by its unique characteristics as a fruit, which ensured its rapid diffusion and adoption, in the tropics and subtropics [15]. Pineapple (*Ananas comosus* L. Merr.) is an edible member of the family Bromeliaceae with over 2,000 species and the third most important tropical fruit after banana and citrus. It contributes to over 20% of the world's production of tropical fruits [16-18]. There exists several hundred varieties, but the most widely grown are Smooth Cayenne, Queen and in the past decade, introduced the variety called MD2 which commands 80% of the global trade in pineapples [19]. Pineapple is a perennial monocotyledonous plant with a terminal multiple fruit, which is perishable and usually stored only for 4-5 days after harvesting in normal conditions. Generally, ripened pineapple fruit is consumed fresh or as pineapple juice [15].

The popularity of pineapple is due to its sweet-sour taste containing 15% sugar, malic and citric fruit acids. It is also high in vitamin B1, B2, B6 and C. Its protein digesting enzyme, bromelain, seems to help digestion at the end of a heavy protein meal [20]. Pineapple is considered an economically important horticultural crop with

great health benefits and encouraging market potential in the global market for foreign exchange earnings, which in turn brings higher income for the farmers [21-23]. Pineapple production is concentrated in the tropical regions of the world. It is grown in over 82 countries with over 2.1 million acres under the fruit [19]. Following FAO (2016) report on pineapple production in the world, World production of pineapple is 25,809,038 metric tons. Costa Rica is the largest producer of pineapples in the world with a production output of 2,930,661 metric tons, followed by Thailand with output of 1,811,591 metric tons [24].

Nigeria is currently the 7th largest producer of pineapple in the world, with output of 1,591,276 metric tons of pineapple, and the largest producer of pineapple in Africa [25]. In Nigeria, estimated area under cultivation is 121 thousand hectares, with average production of 917 thousand tons, and productivity of 7.6 tons/ha [26]. The statistics above reveal that Nigeria contributed about 13.5% ha of land cultivated and 5.1% tons of output of pineapple production in the world. The major pineapple producing states in Nigeria, following Oluyomi and Osabuohien (2015) include: Abia, Akwa-Ibom, Benue, Cross-river, Ebonyi, Edo, Enugu, Imo and Ondo states [27]. Until recently, about 80% of pineapples produced in Nigeria came from small scale farms managed under mixed cropping system but recent access to international markets, enhanced value of fresh fruits, resuscitation of pineapple cultivation and local processing have encouraged the development of few large scale farms where pineapple is produced as a mono crop [28]. Pineapple production therefore can be used as a panacea for food security, increase food production and help in improving lives and health care delivery services, help in rural development, job generation and creation, which will launch the country on the path of self-sufficiency, by increasing the national income through the expansion of local industries and higher incomes for farmers involved in its production [15,21,29].

Post-harvest and infrastructural management of the food production chain remains a major challenge in Nigeria so that when it comes to meeting up with the Sustainable Development Goals (SDGs) from our own end amongst other nations of the world, the problem of postharvest losses in Nigeria as a developing nation is one that still lingers without a definite solution in place [13]. It is distressing to note that while many resources are being devoted to planting crops, irrigation, fertilizer application and crop protection measures for increased productivity, little is being done to minimize postharvest losses, and Nigerian farmers are poorer for it because of the absence of any meaningful assistance [30,31]. Despite Nigeria's position and potential in Pineapple production in the world and the enormous economic advantages the country has over the crop, Nigeria has the lowest productivity of 7 tons/ha when compared with the other nine top producers in the world thereby, contributing a small share (5%) of the world's Pineapple production, and thus, reflecting a low yield in pineapple production in the country [26,30]. Although Nigeria's position on the list of world pineapple producers is encouraging, majority of the harvested produce is wasted due to production inefficiencies, postharvest losses, low level of technology to facilitate processing

of quality pineapple products and inefficient marketing system [34].

Adepoju opines that even when the farmers decide to take their produce to the market, they are often constrained by problems of transportation such as poor road network and inefficient mode of conveying their produce to the market, which includes the use of dilapidated trucks, this forces the farmers to sell their produce at ridiculously low prices, which in turn reduces their income and ultimately their welfare as they are not able to afford other basic necessities of life [30]. The farmers and marketers on their own have techniques or practices they use to reduce the losses at varying levels but the losses still exist in high numbers [13]. These methods are called postharvest loss management techniques. In the absence of storage and processing infrastructure to extend the shelf life of crops, the farmers have to devise methods to curb the losses occurring on the farm and salvage what income they can, given the poverty status of rural farmers. These methods vary from crop to crop. There are also some of these techniques that are peculiar to pineapple production. These methods do not totally eradicate the incidence of postharvest losses, but they help reduce it to a very significant level which might have far reaching effects on the welfare of the farmers.

2. Objectives of the Study

The broad objective of this study is to determine the effect of the various postharvest loss management techniques on the poverty status of pineapple farmers. The specific objectives are to:

- Identify the various postharvest loss management techniques practiced by the farmers.
- Determine the value in naira of postharvest losses management techniques among pineapple farmers in the study area.
- Find out the effect of postharvest losses management techniques on profit of pineapple farmers.

3. Justification of the Study

Poverty is a major challenge to most government all over the world. This is informed by the various policies that have been devised to help combat it. Post-harvest losses have been one of the key encumbrances to farmers' income in sub-Saharan Africa, and in particular, Nigeria [34]. Fruits are the most perishable agricultural produce facing a tremendous loss from harvest to consumption, and these Postharvest losses tend to aggravate the problem of poverty among farming households, hence policies that are directed to reduce postharvest losses can help to reduce poverty among the households [35,36]. This study will therefore help to add to existing knowledge by identifying the various postharvest loss management techniques that are practiced by farmers in Edo state, and how the practice of these techniques affects their poverty status, and welfare. It will also assist agricultural policy makers in taking decisions and making recommendations that will not only improve the production and profitability of pineapple enterprises, but also help equip the respondents in the study area with information on beneficial postharvest loss management techniques that farmers can practice to improve their welfare.

4. Methodology

4.1. Scope of the Study

The study was carried out in Edo state, Nigeria. The choice of this area was premised on the fact that pineapple is one of the major economic crops produced in the area. The State is located in the rainforest belt of Nigeria. The State has eighteen local government areas (LGAs) spread over three agro-ecological zones, with Benin City as its capital. Edo State is situated between Latitudes 05°44'N and 07°34'N and Longitudes 05°4'E and 06°45'E [37]. Edo State climate is tropical with temperature range of 25.1°C to 27°C. The State has an estimated land mass of 19,794 Km² and shares boundaries with four other states of the federation, namely: Kogi State to the North, Ekiti and Ondo States to the West and Delta State to the East and South [38]. Edo State has a population of 3,218,332 persons [39,40]. Based on the National Population Commission data, the State's population has been projected to be 3,867,105 for 2013. Rural population accounted for 2,118,226 persons representing 66.0 percent of the total population while 1,091,208 persons or 34.0 percent live in urban and semi-urban area.

4.2. Data

Primary data was used for this study which was obtained using a well-structured questionnaire, and the multistage sampling technique. Edo state is divided into three ADP (Agricultural Development Project) zones namely: Edo North, Edo south, and Edo central. The state has eighteen local governments. The first stage was the purposive sampling of Edo Central and Edo south zones, premised on the fact that pineapple production in Edo state is highest in these zones [41,42]. The second stage was the random selection of one local government each from the two zones, making a total of two (2) local governments. The third stage was the random selection of three (3) communities from each local government, making a total of six (6) communities. The last stage was the random selection of thirty (30) pineapple farmers from each community, making a total of ninety (90) farmers in each local government and a total of 180 respondents in the two (2) sampled local governments.

5. Method of Data Analysis

Data collected include the socio-economic characteristics of the respondents, total revenue generated from sales of pineapples, cost of production, postharvest loss management techniques and the cost of practicing them. Data were analyzed using descriptive statistics such as tables, Frequencies, means, standard deviations and percentages, as well as the Gross margin, Multiple Regression, Probit regression model and the Foster, Greer, and Thorbecke (FGT) Model.

Following Adepoju (2014), Gross margin is given as:

$$GM = TR - TVC$$

Where,

GM is gross margin of pineapple production (in naira),

TR is total revenue generated from pineapple production (in naira)

TR is the product of the unit price of pineapple(P) and quantity

or quantities sold (Q), TVC is total variable cost of pineapple production (in naira), which is the sum total of the following,
LC=Labour cost.
CF=Cost of farm tools.

The Gross profit margin is obtained by dividing the gross profit by sales and it is,

$$\text{Gross profit margin} = \frac{\text{Sales} - \text{Variable cost}}{\text{Sales}}$$

Following Adepoju (2014), the gross profit margin is useful in evaluating the profitability of pineapple production amongst the farmers in Edo state, because the practice of subsistence agriculture by the pineapple farmers in the study area is often as a result of low availability of capital [30].

According to Gujarati (2003), multiple regression model is given as:

$$\ln Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U \quad (15)$$

Where,

Y = Gross margin

X_1 = Marital status

X_2 = Household size

X_3 = Years of farming experience

X_4 = Farm size

X_5 = Early harvesting

X_6 = Trimming of crowns and stalks

X_7 = Covering with trampoline

U_i = Independently distributed error term

Following Gujarati (2003), the Probit regression model is given as,

$$\text{prob}(y = 1/x) = \int_{-\infty}^{x'\beta} \Phi(t)dt = \Phi(x'\beta)$$

$$P_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + U \quad (16)$$

Where,

P_i = Poverty status (poor = 0, Non-poor = 1).

X_1 = Household size

X_2 = Years of farming experience

X_3 = Access to credit

X_4 = Working hours per day

X_5 = Scale of operation

X_6 = Labour type

X_7 = Early harvesting (Yes = 0, No = 1)

X_8 = Trimming of crowns and stalks (Yes = 0, No = 1)

X_9 = Sorting (Yes = 0, No = 1)

X_{10} = Grading (Yes = 0, No = 1)

6. Results and Discussion Socio-Economic Characteristics of Respondents

The results of the socio-economic characteristics of the respondents are shown in Table 1. The results show that 93.89% of the respondents were males while 6.11% were females, indicating a gender difference of 87.78%. This agrees with which stated that the percentage of males in pineapple production is more than that of the females [43,44]. The prevalence of the male proportion over that of the females may be attributed to the physical strength required in the cultivation and maintenance of pineapple, which is only possessed by the males as compared to the females. Following Akhilomen et al. (2014), another reason for this could be that females are not allowed to inherit farm land (except for very few cases) as is often the case in the study area [42]. Also, majority of pineapple farmers in the study area fall between the ages of 36 and 55 years of age, with a percentage value of 53.33%, as compared to those whose ages fall between 26 and 35 years of age whose percentage is 20.56%, and respondents between the ages of 56 and 73 years of age whose percentage is 26.11%. The mean age of respondents in the study area is 47 years. This result is in agreement with Adegbite and Iwuchukwu where the mean ages of the respondents fall between the late forties and late-fifties which is tending towards the ageing population [44,45]. The result that the mean age of the respondents falls within this range implies that the respondents are relatively advanced in age [42]. Thus, output productivity will be quite low since the age determines the physical strength of the farmers which might have a derogatory effect on the future of pineapple production.

89.44% are married, while 5.56% of the respondents are single and 5% of the respondents are widowed. This implies that the business of pineapple production is lucrative enough to support the families of the respondents. This agrees with Akhilomen et al. (2014), and Iwuchukwu et al. (2017), where it was found that majority of the pineapple farmers were married. Marital status determines the household size since married respondents tend to have a larger household size and produce more output because of the availability of family labour [42]. Furthermore, 61.67% of the respondents have household size between 1 and 6, 36.11% have household size between 7 and 12, and 2.22% have household size between 13 and 20. The mean household size of respondents in the study area is 6. This agrees with Akhilomen et al. (2014). The implication of the low household size of respondents is that additional labour will need to be hired to work on the farm especially where the farm size is large [42]. To further buttress this, the results also showed that 0.56% of the respondents use only family labour, 85.00% use only hired labour, and 14.44% of them use both family and hired labour. This implies that the majority of the respondents in the study area use hired labour. Another reason for this could be attributed to the fact that the children of the respondents go to school and are not always on ground to follow their parents to the farm. Therefore in order to avoid unnecessary inconveniences, the respondents resort to paying for the job to be done excellently, under their supervision.

It was also shown that 61.67% of the respondents acquired only primary education. 3.33% of them had no formal education, 28.89%

of them had secondary education, while 6.11% of them had tertiary education. This means that the majority of the respondents in the study area have completed only primary education. This result is in agreement with where it was found that majority of the respondents completed only primary education [43]. The findings that the majority of the respondents acquired only primary education could be an explanation as to why they are not open to the use of agro-chemicals and fertilizers in pineapple production because of the poor literacy level. In addition, 46.67% of the respondents have farming experience of 1-15 years, 50.56% have farming experience of 16-35 years, and 2.78% of them have farming

experience of 36-50 years. The mean years of farming experience is 17.4 years. This shows that the majority of the respondents in the study area have farming experience between 16-35 years. This result is in agreement with where it was found that majority of the respondents had farming experience more than 15 years, which shows that the respondents are not new to pineapple production and are well aware of the risks and constraints associated with it. Farming experience determines the ability of farmers to make farm management decisions effectively, not only by adhering to agronomic practices, but also with respect to input combination or resource allocation [42].

Variable	Category	Frequency	Percentage
Gender	Male	169	93.89
	Female	11	6.11
	Total	180	100
Age	26-35	37	20.56
	36-55	96	53.33
	56-73	47	26.11
	Total	180	100
Marital Status	Single	10	5.56
	Married	161	89.44
	Widowed	9	5
	Total	180	100
Educational level	No Formal Education	6	3.33
	Primary	111	61.67
	Secondary	52	28.89
	Tertiary	11	6.11
	Total	180	100
Household size	1-6	111	61.67
	7-12	65	36.11
	13-20	4	2.22
	Total	180	100
Working hours per day	1-6	164	91.11
	7-12	16	8.89
	Total	180	100
Years of Farming Experience	1-15	84	46.67
	16-35	91	50.56
	36-50	5	2.78
	Total	180	100
Scale of Operation	Small	12	6.67
	Medium	26	14.44
	Large	142	78.89
	Total	180	100
Farming System	Sole Cropping	12	6.67
	Mixed Cropping	168	93.33
	Total	180	100
Days of Inactivity	0	1	0.56
	1-2	167	92.78

	3-4	6	3.33
	5-6	6	3.33
	Total	180	100
Labour Type Employed	Family	1	0.56
	Hired	153	85.00
	Both	26	14.44
	Total	180	100
<i>Source: Field Survey, 2018.</i>			

Table 1: Socio-Economic Characteristics of Respondents

6.67% of the respondents cultivate on a small scale, 14.44% cultivate on a medium scale, and 78.89% cultivate on a large scale. This shows that majority of the respondents cultivate on a large scale. This could be as a result of a certain preference to the cultivation of the fruit or the cultivation culture prevalent in the study area and the size of agrarian land available to the respondents. Also, 6.67% of the respondents practice sole cropping while 93.33% of the respondents practice mixed cropping. This shows that majority of the respondents practice mixed cropping and this agrees with Iwuchukwu et al. (2017) and Akhilomen et al. (2015), where it was found that majority of pineapple farmers practice mixed cropping [44,46]. This could be because rural farmers might want to produce other food crops on their farm for household consumption or they might be combining it with the production of another major crop on the farm for increased income. Another reason could be that it is also an efficient way of curbing weed invasion and erosion problems, as the crops act as protection for one another.

91.11% of the respondents work between 1-6 hours per day while the remaining 8.89% of them work between 7-12 hours per day. The mean working hours per day is 6 hours per day. This result could be attributed to the fact that pineapple is a perennial crop and once the farm is established on needs to be maintained and have its suckers pruned from time to time for farm expansion. This farm operation is best done between the early hours of the morning and mid-day as most farmers start out for work on the farm early in the morning. 92.78% of the respondents also have between 1 to 2 days of inactivity, 3.33% have between 3 and 4 days of inactivity, and 3.33% of them have between 5 and 6 days of inactivity. 0.56% of the respondents have no day of inactivity. The mean days of inactivity, is 1. This shows that the majority of the respondents visit their farms daily except for one day in the week set aside for rest. This could be because of the need for regular maintenance of a pineapple plantation, and the high probability of pre-pineapple harvest losses which could easily happen in a large farm if ripe pineapples go unnoticed and are hence not harvested at the right time.

Land size in Acres	Owned land	Inherited land	Rented land	Leased land
0	171	18	173	178
1-10	4	35	6	2
11-20	3	66	1	0
21-35	2	61	0	0
Total	180	180	180	180
<i>Source: Field survey, 2018.</i>				

Table 1.1: Overall Farm Land Size of Respondents

Table 1.1 shows the various land tenure systems used by the respondents and the percentages of respondents that use each land tenure system. The land tenure system obtainable in the study area include: Owned land, inherited land, Rented land, and leased land. From the foregoing results, it is revealed that in the study area, majority of the respondents obtained the farm land they use through inheritance. This could be as a result of the fact that the respondents had their fathers before them cultivate large portions of land only to hand them down to their children at their demise. Also, majority of the respondents cultivate on farmlands with sizes between 11-20 acres. The mean farm size of the respondents is 18 acres. This could be as a result of the increasing population in rural

areas hence the need to reduce agrarian land to make room for the new population.

6.1. Postharvest Loss Management Techniques used by Respondents

Table 2 shows that 33.33% of the respondents practise early harvesting, while 66.67% do not, 27.22% of the respondents practice trimming of crowns and stalks, while 72.78% of the respondents do not, 85.56% of the respondents practice sorting, while 14.44% do not, 80.56% of the respondents practice grading, while 19.44% of the respondents do not, 18.89% of the respondents practice waxing, while 81.11% of the respondents do not, 58.89% of the

respondents place their pineapples upside down, while 41.11% of the respondents do not, 74.44% of the respondents cover their pineapples with Trampoline, while 25.56% of the respondents do not. From the results below, it can be said that the reduced practice of early harvesting could be because marketers are more likely to prefer to buy more of ripe fruits for ease of sale, than unripe fruits especially because most of such purchases occur on the farm. Also, the incidence of a few respondents practicing trimming of crowns and stalks as a postharvest loss management technique could be as a result of the fact that even though Nigeria is the 7th largest producer of pineapples in the world and the largest in Africa, Pineapples are not exported from here. Trimming of crowns and stalks is a postharvest loss management technique mostly used by farmers in countries where pineapples are exported. Sorting is practised by majority of the respondents in the study area. This could be as a result of the need to separate bad pineapples from the good ones, which indicates that sorting is one of the most important postharvest management techniques among the farmers as it could influence the amount of money generated from the sales of the pineapple by the farmers.

Grading is also another postharvest loss management technique used by the majority of the respondents, following the above results. This could be as a result of the need to arrange the pineapples in groups in order of quality and sizes for efficient price setting. Waxing is practised by only a few respondents in the study area. This could be as a result of the possibility of the existence of doubt among respondents in the study area about using chemicals on the fruit for any preservation of any kind, and even in its production. Placing pineapples upside down is another way that majority of the respondents in the study area reduce postharvest losses. This could be as a result of the firm belief among respondents in the study area, that placing pineapples on concrete surfaces or on its side on the floor could hasten pineapple spoilage. Also using the crowns as a cushion for the fruit prevents injury to the fleshy body, hence the need to keep pineapples upside down. Covering of pineapples with Trampoline is another way to protect the fruits from direct moisture contact such as rainfall which could hasten spoilage of pineapples before customers are ready to buy. From the results, it is found that majority of the respondents cover their pineapples harvested, with trampoline.

Postharvest Loss Management Techniques	Response	Frequency	Percentage
Early Harvesting	No	120	66.67
	Yes	60	33.33
	Total	180	100
Trimming of Crowns and Stalks	No	131	72.78
	Yes	49	27.22
	Total	180	100
Sorting	No	26	14.44
	Yes	154	85.56
	Total	180	100
Grading	No	35	19.44
	Yes	154	85.56
	Total	180	100
Waxing	No	146	81.11
	Yes	34	18.89
	Total	180	100
Placing Pineapples upside down	No	74	41.11
	Yes	106	58.89
	Total	180	100
Covering with Trampoline	No	46	25.56
	Yes	134	74.44
	Total	180	100
<i>Source: Field Survey, 2018.</i>			

Table 2: Postharvest Loss Management Techniques used by Respondents

6.2. Cost of Postharvest Loss Management Techniques in Naira
 Table 3 shows that the mean value of postharvest loss management

techniques in naira is ₦6485, and the standard deviation is ₦3185.169.

Variable	Observation	Mean	Standard deviation
Cost of postharvest loss management Techniques in naira	180	6,485	3185.169
<i>Source: Field survey, 2018.</i>			

Table 3: Costs of Postharvest Loss Management Techniques in Naira

6.3. Effect of Postharvest Loss Management Techniques on the Profit of Respondents

The multiple regression model was used to examine the effects of the postharvest loss management techniques on the profit of the respondents. The coefficient of multiple determination, R^2 was 0.5291. This result implies that the model is a good fit and that 53% of the variations in the dependent variable (the gross margin of the respondents), were explained by the independent variables (which include socio-economic characteristics of the respondents and the postharvest loss management techniques they use), while the remaining 47% were explained by the error term. The result of the multiple regression analysis showing the effects of postharvest loss management techniques on profit of the farmers is shown in Table 4. The coefficient of household size was statistically significant at 5% ($p < 0.05$), and positive showing that increase in the household size of the respondents in the study area by 0.064 units will lead to a unit increase in the gross margin of the respondents. This could be because a higher household size could mean more labour available for production which could play a huge role in the increase of gross margin.

The Coefficient of Farm size of respondents is statistically significant at 1% ($p < 0.01$), and is positive implying that an increase in the farm size of respondents by 0.096 units will lead to a unit increase in the gross margin of the respondents. This could be because an increase in farm size will mean increased harvest, which ultimately means increased sales and therefore increased gross margin. The Coefficient of years of farming experience of respondents is also statistically significant at 1% ($p < 0.1$), and positive, implying that an increase in the years of farming experience by 0.018 units will lead to a unit increase in the gross margin of the respondents. This could be because an increase in the experience acquired in the cultivation of pineapples gives the respondents expertise in the knowledge of how to efficiently combine inputs for maximum production when the need for expansion arises, and also in effective maintenance of an established farm. This will inevitably increase the gross margin of such a respondent.

Early harvesting as one of the postharvest loss management techniques carried out by the respondents, is statistically significant at 5% ($p < 0.05$). Its coefficient is positive implying that an increase in the numerical value of respondents who practice early harvesting by 0.727 units will lead to a unit increase in the gross margin of respondents. This could be because early harvesting can be considered a very effective postharvest loss management technique as it entails the harvest of mature pineapples approaching the stage of ripening. It prevents loss of pineapples which can occur as a result of over-ripening and failure to sell ripe fruits at the right time.

Covering with trampoline as one of the postharvest loss management techniques carried out by respondents in the study area is statistically significant at 1% ($p < 0.01$). Its coefficient is positive implying that an increase in the numerical value of respondents who practice covering of pineapples with trampoline by 0.649 units will lead to a unit increase in the gross margin of the respondents. Covering of pineapples with trampoline is also another effective postharvest loss management technique used to prevent unavoidable moisture contact, which could be rainfall on the farm, with the fruits. If a farmer can prevent moisture contact with the pineapples, he can reduce his losses and increase his gross margin. Trimming of crowns and stalks as one of the postharvest loss management techniques carried out by the respondents in the study area, is statistically significant at 10% ($p < 0.1$). The coefficient is negative implying that an increase in the numerical value of respondents who practice trimming of crowns and stalks by 0.633 units will lead to a unit decrease in the gross margin of the respondents, and vice versa. This could be because trimming of crowns and stalks is a postharvest loss management technique used mostly by farmers who sell pineapples to exporters. It will prepare the pineapples for packaging but it might not be so effective in the reduction of postharvest losses of pineapples that will be sold on the farm and might not be so effective in the increase of the gross margin.

Gross margin	Coefficient	Standard error	P>/t/
Household size	0.064	0.028	0.023**
Farm size	0.096	0.009	0.000***
Years of farming experience	0.018	0.009	0.057*
Marital status	0.061	0.241	0.802
Covering with trampoline	0.649	0.204	0.002***
Early harvesting	0.727	0.353	0.041**
Trimming of crowns and stalks	-0.633	0.341	0.065*

Constant	8.638	0.608	0.000***
<i>No. of Obs. = 180, *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$, $R^2 = 0.5291$, Adjusted $R^2 = 0.5099$, Prob > F = 0.0000</i>			
<i>Source: Author's Computation from Field survey, 2018.</i>			

Table 4: Effect of Postharvest Loss Management Techniques on the Profit of Respondents

From the foregoing, the results show that household size, farm size, years of farming experience, covering with trampoline, Early-harvesting, and trimming of crowns and stalks are the variables that have significant effects on the profitability of pineapple production in the study area.

6.4. Poverty Status of Respondents and the Effect of Postharvest Loss Management Techniques on the Welfare of the Respondents
The mean monthly per capita household expenditure for this study area was estimated to be ₦145,397.1, and this is the poverty line. The results show that 24.44% of the respondents have their mean

monthly expenditures below the poverty line while 75.56% of the respondents have their mean monthly expenditures above the poverty line. This implies that 24.44% of the respondents are poor, while 75.56% of the respondents are non-poor. Furthermore, the table shows that the poverty depth/gap (P_1) is 6% and the poverty severity (P_2) is 2.33%. This indicates that poverty is still very high among the respondents. It could reduce the ability of household to meet the food and consumption needs of their household members. This could lead to illness, general debility, and eventually deaths among the households.

Poverty status	Frequency	Percent
Poor	44	24.44
Non-poor	136	75.56
Total	180	100
Poverty Incidence	0.244	
Poverty depth	0.05865	
Poverty Severity	0.023327	
<i>Source: Author's computation from Field survey, 2018.</i>		

Table 5: Poverty Status of Respondents

6.5. Effect of the Postharvest Loss Management Techniques on the Poverty status and Welfare of Respondents

The prob> χ^2 value is 0.0000 which implies that the model is a good fit, and significant at all levels of confidence. The result of the Probit regression showing the effects of postharvest loss management techniques on the poverty status of the farmers is shown in Table 17. The Coefficient of the years of farming experience of the respondents is statistically significant at 5% ($p < 0.05$), and has a positive relationship with the poverty status of the respondents in the study area. This implies that an increase in the years of farming experience by 0.040 units will lead to an increase in the poverty status of the respondents, hence a reduction in the welfare of the respondents. This could be because as a farmer gains more practical experience in pineapple farming, he/she is likely to relegate theory to the background and less likely to adopt any new innovation that might prove to be beneficial in the long run. The Coefficient of the Scale of operation practiced by the respondents is statistically significant at 10% ($p < 0.1$), and has a positive relationship with the poverty status of the respondents. This implies that an increase in the scale of operation by 0.409 units will lead to a unit increase in the poverty status of the respondents, hence a reduction in the welfare of the respondents. This could be because a large scale production of pineapples could mean more inputs and more capital to expand which could now draw on the

revenue generated from the farm in the absence of access to credit.

The coefficient of Early harvesting as a postharvest loss management technique among respondents in the study area is statistically significant at 10% ($p < 0.1$), and has a negative relationship with the poverty status of the respondents. This result shows that an increase in the numerical value of respondents who practice early harvesting by 1.629 units will lead to a decrease in the poverty status of the respondents, (an increase in the welfare of the respondents and vice versa). This could be because early harvesting based on the previous result (on its relationship with the gross margin of the respondents) was found to increase their gross margin hence what is found to increase the gross margin consistently over a long period of time might be effective in the reduction of poverty among respondents in the study area. The Coefficient of Trimming of crowns and stalks as a postharvest loss management technique among respondents in the study area, is statistically significant at 5% ($p < 0.05$), and has a positive relationship with the poverty status of the respondents. This implies that an increase in the numerical value of respondents who practice trimming of crowns and stalks by 2.027 units will lead to a unit increase in the poverty status of the respondents in the study area (and vice versa), hence a reduction in the welfare of respondents. This is in line with our earlier result that the practice

of trimming of crowns and stalks will lead to a decrease in the gross margin. This could be because a practice that decreases their gross margin consistently over a long period of time could lead to poverty among respondents in the study area.

The coefficient of Grading is statistically significant at 10% ($p < 0.1$), and has a negative relationship with the poverty status of the respondents in the study area. This result implies that an increase in the numerical value of respondents who practice grading by 1.453 units will lead to a unit decrease in the poverty status of the respondents, (and an increase in the welfare of respondents) and vice versa. Grading is a postharvest loss management technique that involves the allocation of prices to the fruit on the basis of the

level of their quality after the separation of bad pineapples from good ones is done. It could prove to be effective in the reduction of postharvest losses in the long run as it places a limit beyond which marketers are unable to bargain so they can still retain the price taking power. Failure to grade their produce could mean susceptibility to ridiculous bargaining by marketers which can prove to be very bad for the gross margin of the respondents. Following the results, respondents who practice grading stand a good chance in increasing their gross margin and hence poverty status. From the foregoing, years of farming experience, scale of operation, early harvesting, trimming of crowns and stalks, and grading are significant determinants of the poverty status of respondents in the study area.

Poverty status	Coefficient	Standard error	p>/z/
Household size	0.056	0.046	0.221
Years of farming experience	0.040	0.016	0.011**
Access to credit	0.062	0.801	0.938
Working hours per day	-0.021	0.094	0.821
Scale of operation	0.409	0.219	0.062*
Labour type	-0.493	0.350	0.159
Early harvesting	-1.629	0.946	0.085*
Trimming of crowns and stalks	2.027	0.763	0.008**
Sorting	-0.607	0.936	0.517
Grading	-1.453	0.875	0.097*
Constant	3.183	4.059	0.433
No. of Obs. = 180, *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$. Prob>chi ² = 0.0000			
Source: Author's Computation from Field survey, 2018.			

Table 6: Postharvest Loss Management Techniques and Welfare of the Respondents

7. Conclusion

From the results of these findings, years of farming experience, scale of operation, the practice of trimming of crowns and stalks, early harvesting, and grading by respondents are the underlying factors that determine the poverty status of respondents in the study area. The practice of early harvesting, covering of pineapples with trampoline, trimming of crowns and stalks, Household size, Farm size, and years of farming experience are the significant determinants of the profitability of pineapple production in the study area. In summary, early harvesting, sorting, grading, and covering pineapples with trampoline are the most beneficial postharvest loss management techniques to the respondents in the study area. Even though sorting is not very significant. Trimming of crowns and stalks is the most detrimental postharvest loss management technique to the respondents in the study area. Therefore to improve the welfare of the respondents, attention must first be paid to the postharvest loss management techniques they practice.

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APPENDIX A: DATA

DEBORAH ANALYSIS.xlsx

deborah's 180 coding spreadsheet.xlsx

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