RESEARCH ARTICLE

WELFARE IMPACT OF ADOPTION OF IMPROVED OIL PALM PROCESSING TECHNOLOGIES AMONG RURAL HOUSEHOLDS IN SOUTH-WESTERN, NIGERIA

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ABSTRACT

It has been observed that low adoption of agricultural technologies has crippled the productivity level and increased the poverty level of farmers/processors in Nigeria. The study specifically investigated the welfare impact of adoption of improved oil palm processing technologies in South Western Nigeria using poverty as an indicator. Data were collected through a multistage sampling technique from 360 sampled oil palm processors in the study area. Primary data were used for the study with the aid of a well-structured questionnaire. Descriptive statistics, Foster, Greer and Thorbecke (FGT) weighted poverty index and Cragg's (double-hurdle) model was used to analyze the data collected. The results of the study showed that based on the poverty line created, majority of the adopters of the improved oil palm processing technologies were above the poverty lines which mean they were non-poor. This showed that the adoption of improved oil palm processing technologies in the study area had impacted the welfare of the adopters in South Western Nigeria. Analysis of the determinants of the adoption and intensity of adoption of the improved oil palm processing technologies using cragg's double-hurdle model showed that in the first hurdle (probit model), variables such as access to credit, farm ownership status, volume of oil palm fruits processed and extension contacts were found to significantly influenced the decision to adopt the improved oil palm processing technologies while in the second hurdle (truncated regression), variables such as age, processor's perception and training was found to significantly influenced the intensity of use of the improved oil palm processing technologies. Implementation of policies that will increase the adoption of the improved oil palm processing technologies which will subsequently leads to improved welfare of the oil palm processors should be pursued by the government, agencies and stakeholders in Nigeria.

KEYWORDS

Oil palm processors, Improved technologies, Impact, Double-hurdle, Poverty and South Western Nigeria.

1. INTRODUCTION

Oil palm (*Elaeis guineensis*) originated in the tropical rain forest of West Africa and is one of the most vital economic oil tree crops in Nigeria. The major product of oil palm includes the fruit which undergoes further processing to obtain the three main commercial products including palm oil, palm kernel oil and palm kernel cake. The economic importance of palm oil is huge as it serves both food and non-food purposes. Presently, it is the most important vegetable oil in the world mainly because it is the cheapest vegetable oil and leads other vegetable oils in terms of yield per unit area, trade and consumption (Yusuf et al., 2014, Mba et al., 2015). In the time past, majority of the oil palm processors utilized traditional methods for processing which was considered primitive, labour intensive and highly inefficient, producing negligible quantities of low quality and unstable palm oil with a limited shelf life (Orewa, 2009; Wahid et al., 2010). Orewa further showed that traditional methods in Nigeria, on the average, yield about 4% crude palm oil of fresh fruit bunch (FFB) compared to 18% - 23% achieved by industrial and intermediate scale technologies (Orewa, 2009).

Efforts to raise agricultural production and farmer's standard of living require the introduction of improved farm equipment and technologies as well as increased availability and utilization of energy and power. This led to development of improved oil palm processing technologies which is more effective and more highly efficient. According to some study, with the use of improved oil palm processing technologies, Output increases by about 50% more as a result, 250 kg of palm fruit which yields about 30 litres of fresh palm oil now yields up to 45 litres of fresh palm oil (Nwajiuba and Akinsanmi, 2013). Nwajiuba and Akinsanmi further stated that there is an observed increase in the average income of the processors who utilized improved oil palm processing technologies, thus it's a significant source of rural liquidity with important consequences for rural livelihood and welfare (Nwajiuba and Akinsanmi, 2013). According to most studies, technological innovation and advancement including improved oil palm processing technologies is the most important factor in increasing agricultural productivity and also, reduction of poverty in the long-term (Solomon, 2010; Solomon et al., 2011).

The oil palm industry in Nigeria is dominated by farmers and processors

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who operate at a small scale and account for 80% of the Nigeria's palm oil production (Abdul-Qadir et al., 2016; Adejuwon et al., 2016). However, these processors are more involved in the use of traditional technologies (Taiwo et al., 2000). It has been observed that the use of traditional technology is challenging as it is characterized by intensive labour use and low processing capacity which results in low extraction rate and produce oil with high fatty acid (FFA) (Taiwo et al., 2000). Furthermore, a substantial portion of the annual fresh fruit bunches (FFB) yield is lost due to the inefficient traditional processing technologies (Taiwo et al., 2000). It is in response to these that efforts have been made for the provision of technologies to improve the processing of oil palm fruit in Nigeria (FAO, 2005). An increase in output, income and efficiency has been found to be associated with the use of these improved technologies (Gunn, 2014).

In order to increase agricultural productivity, technology must be adopted and the rate of adoption of a new technology was observed to be subject to its profitability, capital requirement, degree of risk associated with its use, agricultural policies and socio-economic characteristics of the adopters (Shideed and Mohammed, 2005). The significance of this study lies with the fact that the eradication of rural poverty through the adoption of improved technologies has been a cause of concern for both developing and underdeveloped countries in the time past. Intensification of advanced agricultural production system is one way of improving the welfare of farmers and this can be achieved if the processors take advantage of improved oil palm processing technologies. The direct impacts of improved technologies including changes in output and income are easy to measure quantitatively. It is however, difficult to establish the causal effect of processing technologies on welfare, but at the same time it is of paramount importance if we want to know the extent of agricultural enhancement of the poor.

It is important to state that many studies had been conducted on the adoption and factors influencing adoption of improved oil palm processing technologies in Nigeria (Taiwo et al., 2000; Owolarafe and Oni, 2011; Gunn, 2014; Adebo et al., 2015; Adejuwon et al., 2016; Akinwehinmi and Yesufu, 2019). However, none of these studies specifically measure the welfare impact of the adoption of these technologies on the adopters thus creating a dearth in knowledge. It is against this backdrop that this study intends to fill the knowledge gap. The general objectives of this study were to evaluate the impact of adoption of improved oil palm processing technologies on welfare of rural processors in South Western, Nigeria using poverty as an indicator. The specific objectives of the study were to:

- i. described the socio-economic characteristics of the adopters and non-adopters of improved oil palm processing technologies;
- ii. examined the different processing technologies being used for oil palm processing between the adopters and non-adopters;
- iii. analyzed the poverty level between adopters and non-adopters of improved oil palm processing technologies and
- iv. determine the factors influencing adoption and intensity of adoption of improved oil palm processing technologies.

The need for this research was borne out of the fact that assessing the impact of households technology adoption can assist with providing feedback to the research institutions and scientist, guiding government policy makers and also, those that are involved in technology transfer to have a better knowledge of how technological adoption had help improved the standard of living of the rural households. For the purpose of this study, processors who utilized improved technologies were classified as adopters while those using the traditional method of processing were referred to as the non-adopters

2. LITERATURE REVIEW

Technology is the application of knowledge for practical purpose, which is generally used to improve the condition of human and natural environment and carry out some other socio-economic activities (Tolagbonse et al., 2005). It is a complex blend of material processes and knowledge. Technology has made pertinent contributions to national

progress and its usefulness has attained universal recognition, both at national and international levels. In many developing countries including Nigeria, lack of appropriate technological and scientific knowledge application limits agricultural and economic progress (Odebode, 2008).

In Nigeria, improved agricultural technology has contributed significantly to agricultural development and the gap between developed and developing countries in the area of agricultural production can be attributed largely to differences in the level of technological development, adaptation and transfer process. In developed nations, there is an advanced level of technical know-how and widespread application of technological innovations resulting in high productive capability in agriculture as well as in industry. This is not so in Nigeria where these technologies are not often available to farmers. Where they are made available, few farmers usually have access to them (Adekanye, 1983). The relevance of the above discussions is to help in understanding the type of technologies being used in the study area and their adoption rates.

The operations of the traditional methods of processing palm oil necessitated the improved technique being promoted. The promotion and adoption of the mechanized operations is aimed at reducing drudgery, enhancing processing efficiency, avoiding the hazards associated with the traditional techniques and improving the welfare of the adopters thereby reducing the incidence of poverty among the processors. The success or failure of processing depends largely on the efficiency of the processing technology used. An efficient processing technique according to Ukpabi increases the quality and quantity of palm oil available for consumption and trade (Ukpabi, 2004). The objective of any palm oil processor as noted is to obtain the highest percentage of palm oil possible and palm oil processors from their individual stand points must be convinced and satisfied that their personal gains from palm oil processing should be more than their cost of processing for them to remain in the palm oil processing business (Oladipo, 2008).

Furthermore, Food and Agricultural Organization asserted that a matured oil palm can produce between 9,000-10,000 kg of fresh fruit bunches (FFB) per hectare (ha) when a plantation is well managed, and with good extraction technologies, these will yield approximately 2,000 liters of palm oil per year and per ha (FAO, 2005). However, the efficiency of processing techniques here in Nigeria is lower, when compared to the ones use by their Asian counterparts. As put by World Rainforest Movements, palm oil extraction rates in Nigeria ranges from 20% to 50% as compared to 90% in Malaysia (WRM's, 2001). Chavalparit for instance, reported that in Thailand the average yield is 15.6 tonnes of fresh fruit bunch (FFB) per hectare in a year, while efficiency of FFB production and oil yield per hectare of Thai oil palm plantations were put at 15% and 28% respectively (Chavalparit, 2006).

This extraction efficiency rate can be used as a yard stick in assessing the performance of a technology and how well a plantation is doing, because it is the quantity of oil realized per hectare that will determine if the venture is profitable or not. Technological efficiency can however, be achieved by employing improved processing technologies for the extraction of palm oil soon after the fruits are harvested by using some of these technologies including bunch receptor, thresher, sterilizer, digester, oil extractor and clarifier. Adoption of these improved oil palm processing technologies is expected to increase the output and income of the adopters which will subsequently help them improved their standard of living by reducing their level of poverty.

3. METHODOLOGY

3.1 Area of Study

The study was carried out in South-Western region of Nigeria. The South-West region of Nigeria represents a geographical area covering latitude 6° North and 4° South. The South-Western region of Nigeria comprises of six states including Osun, Ekiti, Oyo, Ondo, Lagos and Ogun State. The region is bounded in the north by Kogi and Kwara States, in the South by Atlantic Ocean, in the west by Republic of Benin and in the East by Edo and Delta State. The South Western region of Nigeria can boast of different varieties

of tree crops since the climatic conditions support the production of various tree crops including oil palm, cocoa, coconut etc. A large proportion of the oil palm fruits were being processed in South Western region of Nigeria and the use of improved oil palm processing technologies is also popular in the region, hence the choice of the study area.

Figure 1: Map of South Western, Nigeria

3.2 Sampling procedures and sample size

Multistage sampling procedures were employed for the study. The first stage involved purposive selection of three States including Oyo, Osun and Ondo State because of the presence of large numbers of oil palm processors in the States. The second stage involved purposive selection of two Local Government Areas (LGAs) because of the concentration of oil palm processors in the areas. At the third stage, three communities were randomly selected from each of the selected LGAs. At the fourth stage, twenty oil palm processors were randomly selected from each community to make a total of 360 (Three hundred and sixty) respondents. Primary data were used for the study. The primary data were sourced from cross-sectional survey of oil palm processors with the aid of well-structured questionnaire to cover information about the socioeconomic characteristics of respondent, types of technologies adopted, poverty status and adoption of improved oil palm processing technologies in the region.

3.3 Analytical techniques

The data were analyzed using descriptive, Foster, Greer and Thorbecke (FGT) weighted poverty index and Cragg's (double-hurdle) model

3.4 Descriptive statistics

Descriptive statistics was used to summarize the socio-economic characteristics of the respondents and types of technologies adopted.

3.5 Foster, Greer and Thorbecke (FGT) weighted poverty index

Foster, Greer and Thorbecke (FGT) weighted poverty index was employed in analyzing the poverty status (incidence, depth and severity) of the adopters and non-adopters of improved oil palm processing technologies. Poverty was proxied by per capital consumption expenditure and the poverty line was set at two-third of the mean per capital consumption expenditure per adult equivalent per day. The first three poverty measure of the FGT class namely; the poverty headcount, the poverty depth or gap, and the poverty severity or squared poverty gap was estimated. The choice of FGT index was due to, among other things, its additive decomposability into sub-groups. The respondent's per capital consumption was used in classifying them into two namely: poor and non-poor. The FGT class of poverty measure is written generally as:

$$P\alpha = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^\alpha$$

Where n is the total number of the people in the group, q is the number of poor, Z is the poverty line, Y_i is the value of the per capital consumption expenditure of the with person and α is the poverty aversion parameter. The classification of the poverty status was as follows;

Non-poor: These are respondents whose per capital consumption expenditure is above the poverty line. That is, $P > 2/3$ of the mean per capita consumption expenditure per day.

Poor: These are respondents whose per capita consumption expenditure is below the poverty line. That is, $P < 2/3$ of the mean per capita consumption expenditure per day.

- Poverty incidence or head count:** this is the share of the population which is poor, the proportion of the population for whom consumption is less than the poverty line. That is, the share of the population that cannot afford to buy a basic basket of goods.
- Poverty depth or gap:** this is the mean distance separating the population from the poverty line, with non-poor given a distance of zero. It provides information regarding how far households are from the poverty line. This measure captures the mean aggregate income or consumption shortfall relative to the poverty line across the whole population.

$$P\alpha = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^\alpha$$

y_i is the value of consumption expenditure of respondents, i th, α is the FGT parameter, which takes the values of 0, 1 or 2 representing the incidence, depth or severity respectively and Z is the poverty line. When there is no aversion to poverty, $\alpha = 0$, the incidence reduces to

$$P_0 = q/N$$

This is called head count ration or incidence of poverty. It is the proportion of the population for whom consumption expenditure Y is less than the poverty line.

Poverty gap is a useful statistic to assess how much resources would be needed or mobilized to eradicate poverty through cash transfers perfectly targeted at poor.

- Poverty severity or squared poverty gap:** this is often used to describe the measure of severity of poverty. While the poverty gap takes into account the distance separating the poor from the poverty line, the squared poverty gap takes square of that distance into account and it is sensitive to inequality among the poor, that is, a higher weight is placed on those households further away from the poverty line.

3.6 The Cragg's model two-step estimation procedure

The Cragg's model was chosen for this study because it relaxes the restrictive assumption of the Tobit model that the factors influencing the discrete decision (adoption decision) and the continuous decision (intensity of use) as well as their effects are the same. Hence, in the Cragg's model, the coefficients of the dependent variables of the first and second hurdle are different. The first step analyses the factors influencing the decision of farmers to adopt improved oil palm processing technologies, while the second step deals with the intensity of use of the adopted improved oil palm processing technology.

Step 1: Probit model for the discrete adoption decision

For the Probit model, we assume that the decision of the i 'th processor to adopt a technology or not depends on an unobservable utility index Y_i^* , that is determined by the explanatory variables, and that the higher the value of this utility index the higher the probability that the processor will adopt the technology. The adoption probability (dependent variable) Y_i is limited between the values of 1 and 0.

$$Y_i = \begin{cases} Y_i^* & \text{if } Y_i^* > 0 \\ 0 & \text{if } Y_i^* \leq 0 \end{cases}$$

The Probit model is expressed as:

$$\text{Prob}(Y^* > 0) = F(X'\beta) = \Phi(X'\beta) = \int_{-\infty}^{X'\beta} \phi(Z) dZ$$

Where; $F(X'\beta)$ = cumulative degree of freedom of the standard normal distribution.

$$Y_i^* = X_i'\beta + \varepsilon_i$$

$$X_i'\beta = \beta_0 + \beta_1\text{AGE} + \beta_2\text{EXP} + \beta_3\text{EDUYRS} + \beta_4\text{ACCCRE} + \beta_5\text{FINCOME} + \beta_6\text{HHSIZE} + \beta_7\text{FARMWNSHP} + \beta_8\text{ASSN} + \beta_9\text{PERCEPTN} + \beta_{10}\text{COMP} + \beta_{11}\text{VOLPROCE} + \beta_{12}\text{AWARE} + \beta_{13}\text{TRAINIING} + \beta_{14}\text{EXTN}$$

Where; AGE = Age (years); EXP = Experience (years); EDUYRS = Years of Education (years); ACCCRE = Access to credit (1=access; 0=no access); FINCOME = Farm income (N); HHSIZE = Household size (#); FARMWNSHP = Farm ownership (3=purchased; 2=leased; 1=borrowed; 0=inherited); ASSN = Association membership (1=member; 0=non-member); PERCEPTN = Perception (1=good; 0=otherwise); COMP = Complexity (1=complex; 0=otherwise); VOLPROCE = Volume processed (1=large, 0=otherwise); AWARE = Awareness (1=aware; 0=not aware); TRAINIING = Training (1=yes; 0=no); EXTN = Extension contacts (#).

Step 2: Model for the continuous decision (intensity of use using uncensored observations)

$$E(Y|Y^* > 0) = X'\gamma + \sigma\lambda\left(\frac{X'\gamma}{\sigma}\right)$$

Here the Cragg's model makes use of uncensored observations i.e. the observations with zero adoption level were not cut out of the observation, thus giving a better representation of the population.

$$X'\gamma = \gamma_0 + \gamma_1\text{AGE} + \gamma_2\text{EXP} + \gamma_3\text{EDUYRS} + \gamma_4\text{ACCCRE} + \gamma_5\text{FINCOME} + \gamma_6\text{HHSIZE} + \gamma_7\text{FARMWNSHP} + \gamma_8\text{ASSN} + \gamma_9\text{PERCEPTN} + \gamma_{10}\text{COMP} + \gamma_{11}\text{VOLPROCE} + \gamma_{12}\text{AWARE} + \gamma_{13}\text{TRAINIING} + \gamma_{14}\text{EXTN}$$

Where; Y = Intensity of Adoption

Where; AGE = Age (years); EXP = Experience (years); EDUYRS = Years of Education (years); ACCCRE = Access to credit (1=access; 0=no access); FINCOME = Farm income (N); HHSIZE = Household size (#); FARMWNSHP = Farm ownership (3=purchased; 2=leased; 1=borrowed; 0=inherited); ASSN = Association membership (1=member; 0=non-member); PERCEPTN = Perception (1=good; 0=otherwise); COMP = Complexity (1=complex; 0=otherwise); VOLPROCE = Volume processed (1=large, 0=otherwise); AWARE = Awareness (1=aware; 0=not aware); TRAINIING = Training (1=yes; 0=no); EXTN = Extension contacts (#)

4. RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of the adopters and non-adopters of Improved oil palm processing technologies in South Western, Nigeria

Presented in Table 1 is the socio-economic characteristics of the adopters and non-adopters of improved oil palm processing technologies in South Western Nigeria. The mean age of the adopters and non-adopters of the improved oil palm processing technologies were 49.32 (± 16.73) and 47.18 (± 12.42) respectively with the pooled mean age of 47.36 (± 14.92). This implies that processors of oil palm in South Western, Nigeria were in their active age and are thus expected to be productive (Akinwehinmi and Yesufu, 2019; Olapade-Ogunwole et al., 2019). The mean years of formal education were 12.21 (± 6.45) and 12.04 (± 5.15) for the adopters and non-adopters respectively. This shows that oil palm processors in the region were literate, thus, they can read and write. This agrees with that processors of oil palm in Nigeria had a form of education (Olapade-Ogunwole et al., 2019). About 43.39% of the adopters were female while majority of the non-adopters were female.

This result shows that adoption of the improved oil palm processing technologies was common among the male gender while majority of the female gender do not adopt the technologies, thus sticking to the traditional method of processing. This might be due to the fact that male gender were more prone to the adoption of new innovation in Nigeria than

the female gender, hence the result (Adejuwon et al., 2016; Gunn, 2014). The mean years of processing experience for the adopters and non-adopters were 17.72 (± 11.23) and 16.24 (± 10.62) respectively. This shows that processors of oil palm in South Western Nigeria had been into the enterprise for a long period of time. They are thus expected to use their experience and improve their production (Gunn, 2014; Adesiji et al., 2014). This agrees with. Majority (69.28% and 78.84%) of the adopters and non-adopters were members of association. This implies that they might experience group dynamism and access to quality information which might help them improve their processing activities in the study area.

This is in agreement with that majority of the oil palm processors in Nigeria were into one form of association or the other (Akinwehinmi and Yesufu, 2019; Olapade-Ogunwole et al., 2019). Majority (68.92%) of the adopters had access to extension agents in the time past while about 54.41% of the non-adopters had access to extension agents. This reveals that more of the adopters had access to extension agents than the non-adopters and this might have influenced their decision in adopting the improved oil palm processing technologies in South Western Nigeria. This agrees with (Akinwehinmi and Yesufu, 2019). The mean household size of the adopters and non-adopters of improved oil palm processing technologies were 6.3 (± 2.4) and 7.2 (± 3.3) respectively. This implies that they have a relatively large household size and they can thus utilize family labor for their processing activities (Adebo et al., 2015). The mean annual income annual income of the adopters and non-adopters of improved oil palm processing technologies were 417472 (± 212826) and 321368 (± 287391) respectively. This shows that there is a significant difference in the annual income of the two sets of respondents and this might be due to the influence of the use of improved technologies among the adopters in South Western Nigeria.

Table 1: Socio-economic characteristics of the respondents

Variables	Adopters	Non-adopters	Pooled
Age	49.32 (± 16.73)	47.18 (± 12.42)	47.36 (± 14.92)
Years of formal education	12.21 (± 6.45)	12.04 (± 5.15)	12.11 (± 5.26)
Female (%)	43.39	77.26	
Years of processing experience	17.72 (± 11.23)	16.24 (± 10.62)	18.35 (± 10.51)
Association membership (%)	69.28	78.84	74.82
Extension contact (%)	68.92	54.41	57.16
Household size (#)	6.3 (± 2.4)	7.2 (± 3.3)	5.8 (± 2.9)
Farm income	417472 (± 212826)	321368 (± 287391)	391537 (± 293892)

Figures in parenthesis are standard deviation

4.2 Processing Technologies Used for Oil Palm Processing by the Adopters and Non-adopters

The result of the types of technologies used for oil palm fruit processing by the adopters and non-adopters were presented in Table 2. It was shown that 18.1% of the respondents used improved oil palm processing technologies such as thresher, sterilizer, oil extraction and clarifier while 81.9% of the non-adopters still used the traditional method for oil palm operations such as threshing, sterilizing, oil extraction and clarification. However, all the respondents (100.0%) utilized digester technology for digestion of oil palm fruits in the study area although most of the respondents do not own a digester, they rather take their steamed fruits to the machine operators. When this occurs, they either pay in cash or pay with palm oil for the services rendered to them. The traditional method of threshing oil palm fruits includes the use of cutlass for the separation of the fruits from the bunches and the use of hand-picking to remove the fruit from the spikelet. For the sterilization operation, the traditional method (non-adopters) include the use of local drums for steaming the fruits. For the oil extraction, the traditional method involves the use of cemented

troughs where the digested fruits are separated using large quantities of water. However, the improved technology users (adopters) either use screw press or the hydraulic press for oil extraction (Adejuwon et al., 2016; Gunn, 2014; Adebo et al., 2015; Akinwehinmi and Yesufu, 2019).

Table 2: Distribution of respondents by types of processing technologies used

Operations	Adopters		Non-adopters	
	Freq	(%)	Freq	(%)
Threshing	65	18.1	295	81.9
Sterilization	65	18.1	295	81.9
Digestion	360	100.00	0	0.0
Oil extraction	65	18.1	295	81.9
Clarification	65	18.1	295	81.9

4.3 Impact of adoption of improved oil palm processing technologies on poverty status of sampled households

The result of the poverty status of the sampled households based on computed poverty lines were presented in Table 3. The sampled households were separated by the poverty line in to poor or non-poor. A non-poor poverty line was drawn from above 2/3rd of the mean per capita expenditure per adult equivalent per day while a poor poverty line was drawn from below 2/3rd of the mean per capita expenditure per adult equivalent per day. Based on this arrangement, few (18.5%) of the adopters of improved oil palm processing technologies were poor while that of non-adopters who were poor were 83.4%. Majority (81.5%) of the adopters of improved oil palm processing technologies were non-poor while just 16.6% of the non-adopters were non-poor. This result showed that non-adopters were poorer than the adopters of improved oil palm processing technologies in South West Nigeria. Thus, adoption of the improved oil palm processing technologies had contributed to the welfare status of the adopters as regarding consumption expenditure of the respondents.

Table 3: Poverty Status of sampled households based on poverty lines

	Poor		Non-poor		Total
	Freq	(%)	Freq	(%)	
Adopters	12	18.5	53	81.5	65
Non-adopters	246	83.4	49	16.6	295

4.4 Impact of adoption of improved oil palm processing technologies on Incidence, Depth and Severity of Poverty (FGT measures) among the sampled households

Table 4 presents the values for Foster-Greer-Thorbecke's measure of poverty, incidence of headcount, poverty gap and poverty severity. The poverty line computed for the adopters, non-adopters and the pooled sampled were ₦241.56, ₦233.46 and ₦236.17 per adult equivalent per day respectively. The headcount index estimated for the adopters and non-adopters of the improved oil palm processing technologies and the total sampled households were 0.185, 0.834 and 0.672 respectively. The results implied that the proportion of rural households whose per capita expenditure fell below poverty line among the adopters were 18.5% and it was 83.4% among the non-adopters and 78.6% among the pooled households. The poverty gap index (poverty depth) which is the distance of the per capital expenditure of poor households from poverty line for the adopters and non-adopters were 4.6% and 9.3% respectively while it was 7.6% for the pooled households.

This implies that the poor households among the adopters and non-adopters would need to mobilize additional 4.6% and 9.3% of their poverty lines respectively to completely move out of poverty. Also, the squared poverty gap index for the adopters and non-adopters of improved oil palm processing technologies had a value of 0.018 and 0.041 respectively with 0.032 for the pooled households. This implies that the severity of poverty was 1.8 and 4.1 for the adopters and non-adopters with 3.2 for the pooled households. The results further proof the big role of improved oil palm processing technologies in contributing to poverty reduction in South Western Nigeria. The results of analysis of poverty status (incidence, depth and severity) by adoption status shown in Table 4 was an indication that the incidence of poverty, depth and severity were lower among the adopters of improved oil palm processing technologies

than non-adopters. Thus, the adoption of improved oil palm processing technologies had the potential to gradually improve their consumption to the level required to escaped from poverty among the respondents especially the non-adopters of the improved oil palm processing technologies in South Western Nigeria.

Table 4: Poverty analysis of sampled households by adoption status

	Poverty Indices		
	Headcount	Depth	Severity
Pooled	0.786	0.076	0.032
Adopters	0.185	0.046	0.018
Non-adopters	0.834	0.093	0.041

4.5 Households' Asset Endowments by Adoption Status

Apart from measuring the poverty status of the adopters and non-adopters of oil palm processing technologies as an indicator of welfarism, households' asset endowments are another means of ascertaining the welfare impact of the adoption of the technologies on adopters (Awotide et al., 2012). The households' asset endowment by adoption status of the adopters and non-adopters of oil palm processing technologies were presented in Table 5. Households' asset endowment are the assets purchased by the adopters and non-adopters from the proceedings they realized from processing of oil palm fruits using either improved or traditional method of processing. From Table 5, majority (95.4%) of the adopters of improved oil palm processing technologies possessed their own cemented house while only 45.1% of the non-adopters had a cemented house.

Although considerable proportion (54.2%) of the pooled respondents lived in their own house, the adopters seems to be better-off as larger percentage (95.4%) of them live in cemented plastered house walls and floors. The use of basic assets such as cell-phone, motor-cycle, bicycle, car, radio, television and generator could improve the standard of living of the rural household members and might encourage the adoption of improved oil palm fruits processing technologies. It could be observed from Table 5 that adopters of improved oil palm processing technologies possesses more of these assets than the non-adopters. For example, all (100.0%) the adopters of the oil palm processing technologies possessed cell phone while 62.4% of the non-adopters possessed cell phone. Also, 55.4%, 96.9%, 78.5% and 72.3% of the adopters possessed Motor bike, radio, television and generator respectively compared with 24.1%, 32.5%, 23.4% and 10.9% of the non-adopters of oil palm processing technologies who possessed motor bike, radio, television and generator respectively.

This shows that adopters of the oil palm processing technologies will have more access to quality information that can help them improve their processing activities as majority of them had assets that can help them access information. The implication of this result is that more of the adopters of the oil palm processing technologies possessed more households' endowment assets than the non-adopters which shows that the adopters might have fared well than the non-adopters of the oil palm processing technologies. Furthermore, all (100.0%) and 66.1% of the adopters and non-adopters of the improved oil palm processing technologies were owners of their farm. This revealed that access to farmland is not a constraint to adoption of improved oil palm processing technologies.

Table 5: Households' asset endowment by adoption status

Asset endowments	Adopters (n=65)	Non-adopters (n=295)	Pooled (n=360)
Possess cemented house	62 (95.4)	133 (45.1)	195 (54.2)
Cell phone	65 (100.0)	184 (62.4)	249 (69.2)
Motor-cycle	36 (55.4)	71 (24.1)	107 (36.3)
Bicycle	7 (10.8)	45 (15.3)	52 (14.4)
Car	48 (73.9)	14 (4.8)	62 (17.2)
Radio	63 (96.9)	96 (32.5)	159 (44.2)
Television	51 (78.5)	69 (23.4)	120 (33.3)
Generator	47 (72.3)	32 (10.9)	79 (21.9)
Possess farm land	65 (100.0)	195 (66.1)	260 (72.2)

Figures in parentheses were percentages

4.6 Determinants of the adoption and intensity of adoption of improved oil palm processing technologies in South Western, Nigeria

The determinants of the adoption and intensity of adoption of improved oil palm processing technologies were examined using the Cragg's double-hurdle model. A two steps estimation procedure comprising of Probit regression (decision to adopt) and Truncated regression (intensity of adoption) of the improved oil palm fruit processing technologies. Processors that have used the improved technologies in the past and are still using it were classified as adopters while those that used the traditional methods of processing as at the time of survey were classified as non-adopters. The result of the probit model (first hurdle) used in examining the factors that influenced the decision to adopt improved oil palm processing technologies were obtained using maximum likelihood estimation technique and were presented in Table 6. The likelihood estimates of the probit regression indicated that the Chi-square statistics of 81.495 was highly significant ($p < 0.0001$) which suggested that the model has a strong explanatory power (Akinwehinmi and Yesufu, 2019).

The decision to adopt the improved oil palm processing technologies was significantly influenced by some socio-economic factors (farm ownership and volume processed) and some institutional factors (access to credit and extension contacts). The farm ownership status of the respondents had a positive coefficient which was significant at 1% probability level as regarding the decision to adopt the improved oil palm processing technologies in the area. This implies that processors who have their own farm land were likely to adopt the improved technologies in the study area. Thus, farm ownership status will increase the likelihood of adoption of improved oil palm processing technologies in the study area by 8.4%. Another socio-economic variable that affect the decision to adopt the improved oil palm processing technologies in the study area was volume of oil palm fruits processed. Volume of oil palm fruits processed was positive and significant at 5% level of probability.

This implies that processors who processed a large volume of oil palm fruits are likely to adopt the improved oil palm processing technologies in the study area because processing with traditional technologies will make the processing operations less effective and more drudgery. Also, the required palm oil that is expected to be obtained from the processing activities will not be actualized using the traditional technologies, hence the decision to adopt the improved technologies in order to obtain maximum palm oil output. Thus, volume of palm fruits processed increased the decision to adopt the improved oil palm processing technologies in the study area by 84.5% (Akinwehinmi and Yesufu, 2019). Furthermore, institutional factors such as access to credit was positive and significant at 10% level of probability on the decision to adopt the improved oil palm processing technologies in the study area. This implies that access to credit will increase the likelihood of adoption of the improved oil palm processing technologies in the study area by 75.2%. This is true because in order for the processors to adopt the technologies, they will require capital and since they might have been short of capital, it might affect their decision to adopt the improved technologies.

However, having access to credit might facilitates them adopting the improved oil palm processing technologies (Adesiji et al., 2014). In addition, extension contacts were another institutional factor that significantly affect the decision to adopt the improved oil palm processing technologies in South Western Nigeria. Extension contacts was positive and significant at 5% probability level. This implies that processors who had access to extension services were likely to adopt the improved oil palm processing technologies in the region. This is true because access to quality information might help them gain knowledge about the economic gain they might obtained if they adopt the improved processing technologies. The fact that majority of the adopters of the improved oil palm processing technologies in the study area had endowment assets such as radio, television etc that can help them obtain information might have influenced their decision to adopt the improved oil palm processing technologies in the study area. Thus, access to extension services increases the likelihood of adopting the improved oil palm processing technologies in the study area by 96.6% (Gunn, 2014).

The result of the second hurdle (truncated regression) which is the intensity of adoption of the improved oil palm processing technologies in South Western Nigeria was presented in Table 6. Age, processor's perception and training significantly affect the intensity of the adoption of the improved oil palm processing technologies in the region. Age was positive and significant at 5% level of probability. This implies that as processors grow older, they tend to gain more knowledge and experience about the use of the improved oil palm processing technologies which might influence their decision to intensify its use. Thus, age increase the intensity of use of the improved technologies by 6.6% in South western Nigeria. Also, processor's perception about the improved oil palm processing technologies was positive and significant at 1% probability level.

This implies that the adopters had a positive perception about the improved oil palm processing technologies and might have influenced their decision to intensify the use of the technologies in the region. Thus, processors perception about the usefulness and economic returns of the improved oil palm processing technologies will increase the intensity of use of the improved oil palm processing technologies in the study area by 15.8%. Furthermore, training was positive and significant at 5% probability level. This implies that the more the training the adopters received about the usage and operation of the improved processing technologies, the more they tend to intensify the use of the improved oil palm processing technologies. Thus, training increases the intensity of use of the improved oil palm processing technologies in South Western Nigeria by 6.7%.

Table 6: Determinants of the adoption and intensity of adoption of improved oil palm processing technologies

Variables	First hurdle (Probit regression)		Second hurdle (truncated regression)	
	Coefficients	Std. Err.	Coefficients	Std. Err.
Age	-0.0183 (-0.31)	0.0122	0.0462** (2.39)	0.0748
Processing Experience	0.0300 (1.40)	0.0214	0.0063 (0.24)	0.0261
Years of education	0.0608 (1.63)	0.0374	-0.0352 (-0.69)	0.0514
Access to credit	0.7528* (1.73)	0.4055	0.6025 (1.39)	0.4326
Farm income	-0.1518 (-0.34)	0.4517	-0.3338 (-0.8)	0.4181
Household size	1.01e-06 (1.22)	8.29e-07	-0.00559 (-0.61)	9.14e-07
Farm ownership	0.0840*** (-2.70)	0.0311	-0.0039 (-0.16)	0.0252
Association membership	0.6517 (1.55)	0.4209	0.0567 (0.12)	0.4910
Perception	-0.5341 (-1.04)	0.5139	1.5836*** (2.71)	0.5849
Complexity	-0.0041 (-0.12)	0.0346	-0.0389 (-0.71)	0.0549
Awareness	0.0241 (0.06)	0.4053	-0.3313 (-0.64)	0.5147
Volume processed	0.8452** (2.11)	0.4246	1.0502 (1.05)	0.5670
Training	0.5949 (1.33)	0.4461	0.0677** (2.02)	0.0336
Extension	0.9669** (1.97)	0.4919	0.6378 (1.08)	0.5904
Constant	-0.7005 (-0.62)	1.1355	3.7001* (1.75)	2.1137
Number of observations = 360 LR Chi2 (26) = 81.495 Prob > chi2 = 0.0001 Log likelihood = -71.75930				

Figures in parentheses are t-values; ***= significant at 1%, **= significant at 5%, *= significant at 10%.

5. CONCLUSIONS

This study examined the impact of adoption of improved oil palm processing technologies on the welfare of the oil palm fruits processing households in South Western, Nigeria using poverty as an indicator. The following conclusions were made: firstly, while all the adopters adopted the improved oil palm processing technologies, digester was the only technology that seemed to be heterogeneous among the adopters and non-adopters in South Western Nigeria. Secondly, many of the adopters of the improved oil palm processing technologies were above the poverty lines which mean they were non-poor. This showed that the adoption of improved oil palm processing technologies had impacted the welfare of the adopters in South Western Nigeria. In the first hurdle, variables such as access to credit, farm ownership status, volume of oil palm fruits processed and extension contacts were found to significantly influenced the decision to adopt the improved oil palm processing technologies in the South Western Nigeria while in the second hurdle, variables such as age, processor's perception about the technologies and training was found to significantly influenced the intensity of use of the improved oil palm processing technologies in South Western Nigeria.

POLICY RECOMMENDATIONS

In order to increase the adoption of the improved oil palm processing technologies so as to improve the welfare of the oil palm processors in South Western Nigeria, Government, stakeholders and private agencies need to put in place and implement a number of policies which include:

- i. Credit facility should be made available and accessible for the rural oil palm processors which will help them acquire the recommended improved oil palm processing technologies which will subsequently help to improve their welfare status.
- ii. Since adoption leads to a reduced poverty status among the adopters, it is important that extension services should be made available to the rural oil palm processors which will help them assess first hand quality information that can help them improve their processing activities and adopt the recommended technologies which will help them increase their palm oil outputs. This will no doubt leads to improved welfare of the rural oil palm processors.
- iii. Also, there is need to intensify training of rural oil palm processors. The training in form of educating the processors on best management practices on adoption of the recommended improved oil palm processing technologies which will help them increase their outputs and subsequently improve their well-being.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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