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An Assessment of the use of Postharvest loss Prevention Technologies for Cassava in Nigeria.

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Abstract
Food Security remains a major issue in the world today especially in developing countries. Availability and access to food are negatively affected by many factors, prominent of which is post-harvest loss. Minimizing post-harvest losses is thus a critical agricultural problem. Cassava, an important staple food and income earner in Nigeria and other parts of West Africa, is a perishable crop. Improved harvesting, better postharvest handling and optimized processing technologies are crucial for improving supply of cassava-based foods and income to smallholder processors. This study was carried out to examine the factors influencing the choice of post-harvest technologies used by cassava processors in the study area and assess the impact of improved technology on the processors income. Data were collected from 150 cassava processors in Kwara State, Nigeria using structured questionnaire and analyzed with multinomial logit model. Factors such as years of education, post-harvest technology capacity, processing experience, motives for processing, amongst others were found to influence the choice of post-harvest technologies used in the study area. Furthermore, the impact assessment revealed that cassava processors using improved post-harvest technologies had increased income and output compared to those using traditional technologies. The study concludes that policy should be directed towards investment in improved post-harvest technologies by both private and public sector.
Key words: food security, cassava, post-harvest losses, improved technologies, income

Introduction
Cassava *(Manihot esculenta)* is one of the most important root crops cultivated in tropical and sub-tropical regions of Africa, Asia, Latin America and the Caribbean. It is the third major source of carbohydrate food item in the tropics after rice and maize (FAO, 2004). Cassava is produced globally on about 16.2 million hectares of land in 99 countries (FAO, 2001) with total production estimated at over 250 million tonnes. Nigeria is the largest cassava producer in the World with an estimated production of about 45 million tonnes, almost 19% of the World total production (IITA, 2014).

In Africa, particularly in Nigeria, cassava is important as it serves as a food crop, an economic rural crop and also as an industrial raw material. However, the high perishability of cassava roots has limited its uses and also cripples its potential. Cassava roots are known to deteriorate within three to four days of harvest, thus leading to substantial quantitative and qualitative post-harvest losses. Over 50% of the harvested cassava produce is lost due to production and post-harvest inefficiencies (Ezedinma *et al*., 2007). These high post- harvest losses have been further exacerbated with the utilization of traditional technologies for processing cassava roots. The use of indigenous technologies are fraught with several setbacks such as labor intensity, uneconomical operations, low efficiency, time consuming nature of the processes, and lack of quality assurance (Ajao *et al*., 2009; Zu *et a*l, 2012), thereby crippling its cassava export potentials. Processing using appropriate post-harvest technologies is therefore important for extending the versatility and economic viability of the crop. Processing adds value to the crop and also reduces rapid post-harvest deterioration (Westby, 2002). The use of improved processing technology is expected to minimize losses during production and processing in the cassava system.

Materials and Methods

The study was carried out in Kwara State, Nigeria. Kwara State which is located in the North-central part of the country is characterized with a high cassava production and hence a high level of cassava processing. A Multi-stage sampling technique was used in selecting a sample size of 150 cassava processors. Primary data were collected using structured questionnaire. Descriptive statistics and multinomial logit model were used to analyze the data. Also, the average causal impact of using improved post-harvest technology was measured by average treatment effect.

Multinomial logit model

The Multinomial Logit model (MNL) has response probabilities given as:

$$P_{ij} = p(y_i = j) = \frac{\exp(x_i b_j)}{1 + \sum_{j=1}^{m} \exp(x_i b_j)}$$

Where, j = 1, 2…... m; xi is the vector of the independent variables associated to the individual i and bj is the vector of parameters associated with the alternative j.

Average Treatment Effect (ATE)

As defined by Rosenbaum and Rubin (1983), the average treatment effect (ATE) is the expected difference between the income of the processor that adopts the improved processing technologies and what their income would have been had they not adopted. ATE is thus defined as:

$$\alpha = E(Y_i^1 - Y_i^0)$$

Results and discussion

Socio-economic characteristics of cassava processors.

The various existing post-harvest processing technologies for cassava processing in the study area were classified into traditional, semi-improved and improved technologies based on characteristics of the technologies such as mode of operation, capacity level and turn-over rate. Findings of the study revealed that 50.0% of the processors used semi-improved post-harvest technologies, 30.7% used traditional technology while 19.3% used improved technologies. Cassava processors are mostly female. Furthermore, 32.67% of the cassava processors had primary school education, 28.0% had secondary school education, 18.67% had tertiary school education, 15.33%% had no formal education and 5.33% had Arabic school education. Gari (49.33%) and starch (26.00%) are the products that are mostly processed in the study area. A high percentage of the processors (51.33%) processed for market purpose alone, 29.33% processed for both market and family use while 19.3% processed solely for family use.

Determinants of the factors influencing the use of post-harvest technologies among cassava processors

To determine how processors choose between the various post-harvest technologies category for cassava processing, multinomial logit estimates were derived and are presented in table 1. In the estimation, the use of traditional technology was taken as the base for comparison. The likelihood ratio chi-square test is 101.84 at degree of freedom 28**.** The significance level (the probability of obtaining the chi-square statistic (101.84) if there is no effect of the predictor variable) is 0.000.

The result shows that the capacity of post-harvest technology significantly increases the probability of using semi-improved post-harvest technology by 0.0002% and improved technology by 0.0003%. Also, processing for market purpose alone significantly increases the probability of using both semi-improved and improved technology by 2.6768% and 3.0456% respectively. Furthermore, total income from the sale of output (0.00002%), total number of years spent in school (0.5066%) and membership in social group (2.4254%) are positively significant in the use of improved post-harvest technology while processing experience between 11 to 20 years (1.9326%) and secondary school educational group (7.4547%) reduce the probability of using improved technology.

Table 1: Determinants of use of post-harvest technology

	Improved technology		Advanced technology	
Independent Variables	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-1.72	-1.19	-3.54	2.62
PHT CAPACITY	0.0002(0.02)***	2.28	0.0003(0.01)***	2.56
YEARS OF EXPERIENCE: 11to 20 years	-0.7948	-1.45	-1.9326(0.03)**	-2.15
YEARS OF EXPERIENCE:21 to 30 years	-0.0349	-0.05	-0.4527	-0.44
YEARS OF EXPERIENCE: 31to 40 years	-0.7796	-0.52	-0.7834	-0.40
PROCESSING FOR FAMILY USE &MKT PURPOSES	0.6247	0.95	0.8166	0.63
PROCESSING FOR MARKET ALONE	2.6768(0.00)***	3.23	3.0456(0.03)**	2.14
TOTAL INCOME	-0.0000	0.80	0.00002(0.02)**	2.27
AGE	-0.0017	-0.07	-0.0368	-1.00
PRIMARY SCHOOL EDUCATION	0.5660	0.39	1.0491	0.60
ADULT LITERACY EDUCATION	0.5017	0.45	-2.3979	-1.18
SECONDARY SCHOOL EDUCATION	0.6413	0.36	-7.4547(0.06)**	-1.92
TERTIARY EDUCATION	0.0055	0.00	-7.2909	-1.53
TOTAL YEARS SPENT IN SCHOOL	-0.0096	-0.07	0.5066(0.08)*	1.73
MEMBERSHIP IN SOCIAL GROUP	0.7759	1.39	2.4254(0.07)*	1.84
Log likelihood	-103.09			
Chi-square	101.8***			

***= significant at 1%, **= significant at 5%. *= significant at 10%.*

Table 2: Marginal effects of post-harvest technology determinants

	Traditional technology		Improved technology		Advanced technology	
Independent Variables	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
PHT CAPACITY	0.00004***	-2.91	0.00003	2.28	-0.00008**	1.69
YEARS OF EXPERIENCE: 11to 20 years	0.15522	1.58	-0.05621	-0.52	-0.09901**	-1.73
YEARS OF EXPERIENCE:21 to 30 years	0.01264	0.10	0.01973	0.15	-0.03238	-0.56
YEARS OF EXPERIENCE: 31 to 40 years	0.15045	0.46	-0.13272	-0.43	-0.01773	-0.17
PROCESSING FOR FAMILY USE &MKT PURPOSES	-0.10349	-0.94	0.07583	0.54	0.02766	0.27
PROCESSING FOR MARKET ALONE	-0.31978***	-3.42	0.24728*	1.62	0.07250	0.57
TOTAL INCOME	-0.00000	-1.06	0.00000001	-0.01	0.000001**	2.15
AGE	0.00092	0.25	0.00207	0.48	-0.00230	-1.07
PRIMARY SCHOOL EDUCATION	-0.08426	-0.54	0.02332	0.11	0.06094	0.37
ADULT LITERACY EDUCATION	-0.03377	-0.21	0.22143	1.25	-0.18765**	-1.67
SECONDARY SCHOOL EDUCATION	0.02119	0.10	0.46543**	1.71	-0.48662**	-2.18
TERTIARY EDUCATION	0.06163	0.17	0.22404	0.59	-0.28567**	-1.79
TOTAL YEARS SPENT IN SCHOOL	-0.00800	-0.36	-0.03538	-1.24	0.04338**	1.94
MEMBERSHIP IN SOCIAL GROUP	-0.16623	-1.45	0.06037	0.49	0.10586**	1.99

Impact of improved technology on output and income

The impact of improved technology on income and output was evaluated using PSM (propensity score matching) where the observable estimated treatment effects (use of improved technology) were compared to counterfactual of no treatment. The propensity score was estimated using the Logit regression model where the dependent variable takes the value of 1 if the cassava processor uses improved technology and zero if otherwise. Kernel based matching algorithm, the caliper matching algorithm and the local linear radius matching algorithm were then used to compute impact of using improved technology on output and income of cassava processors. The outcome variables are the total output in kilograms of processed cassava products and the total income of cassava processors in naira. The ATT (average treatment of the treated), ATU (average treatment of the untreated) and

ATE (average treatment effect) were derived to establish the changes in output and income of processors as a result of using improved technology. Findings revealed that output of cassava processors in kilograms when improved technology is used increases by 179.88 for kernel-based matching, 172.92 for caliper matching and 161.17 for local linear matching while income increases by ₦38012.78 ($190.97) for kernel based matching, ₦43900 ($220.55) for caliper matching and ₦38684 ($194.34) for local linear matching.

Sensitivity Analysis

The Rosenbaum sensitivity analysis results reveal that the critical level of hidden bias range from between T=1.6-1.9; where T is the critical level at which point the question of a positive impact of improved technology on income and output of cassava processors can be queried.

Table 3: The treatment effect

Matching algorithm	Outcome	Sample	Treated	Control	Difference	T-stat
KBM	Total output	Unmatched	323.83	162.63	161.20	1.98
		ATT*	323.83	144.57	179.88	2.64
		ATU	162.63	339.51	176.88	
		ATE			178.53	
	Total income	Unmatched	55338.84	17326.087	38012.78	2.81
		ATT*	55338.84	14760.26	40578.57	3.98
		ATU	17326.09	57020.39	39694.30	
		ATE			40305.57	
CALIPER	Total output	ATT**	334.83	161.90	172.92	2.27
		ATU	146.26	476.18	329.92	
		ATE			221.03	
	Total income	ATT*	57667.44	13767.44	43900	4.07
		ATU	15782.89	67161.84	51378.94	
		ATE			46191.94	
LOCAL LINEAR MATCHING	Total output	ATT**	323.83	161.17	162.66	2.31
		ATU	162.63	340.94	178.31	
		ATE			167.50	
	Total income	ATT*	55338.84	16654.34	38684	4.00
		ATU	17326.09	55441.76	38115.68	
		ATE			38508.89	

***significant at 1%, **significant at 5% and * significant at 1%

Table 4: Sensitivity analysis for hidden bias

Matching algorithm	Outcome variable	ATT	Critical hidden bias
KBM	Total output	179.9	1.6
	Total income	40578.8	1.9
Caliper matching	Total output	172.9	1.6
	Total income	43900	1.8
Local linear matching	Total output	162.7	1.6
	Total income	38684	1.9

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