FACTORS INFLUENCING CASSAVA PROCESSING AMONG SMALLHOLDER FARMERS IN BENUE STATE, NIGERIA.

Alleluyanatha E.
National Root Crops Research Institute, Umudike, Abia state, Nigeria.
alleluyanatha@gmail.com

ABSTRACT
Cassava is an important crop in Nigeria that is cultivated for food and income via processed and unprocessed forms. Decisions are made at different points on whether to process or not to process cassava and the quantity of cassava to be processed; and these decisions could vary. Hence, this study used double hurdle (Cragg) model to determine the factors that influences smallholder cassava farmers decisions to process cassava and the quantity to be processed. Data was collected from 127 and 233 smallholder cassava farmers that process and not process cassava roots for sale using a structured questionnaire. The Cragg model results from the Tier1 shows that age, membership of a village meeting, farming experience, ownership of cassava land, level of cassava commercialization and selling at farm gate, market outside the village, urban market and factory were factors that influenced farmers decision to process or not to process cassava. Also, household size, membership of a cooperative, farm size, level of cassava commercialization and selling at the market within the village were factors that inclined farmer's decision on the volume of cassava processed. This study recommended therefore that, farmers be encouraged to improve their educational status by involving in adult education and trainings on improved cassava processing technologies should be provided by the extension agents, while forming cooperatives, which could also influence farmers to be involved in cassava processing while increasing volume as well.

INTRODUCTION
Cassava is one of the most important crops grown by Nigerian farmers; it is the most widely cultivated crop and provides food and income to over 30 million farmers and large numbers of processors and traders (PIND, 2011). According to IITA (2009), cassava is the third largest source of food carbohydrates in the tropics, after rice and maize; they also contain significant amounts of phosphorus and iron, and are relatively rich in vitamin C; the leaves contain 20–30% protein and are used as vegetable for human and feed for animals. It provides a basic diet for over half a billion people; nearly every person in Africa eats around 80 kilograms of cassava per year (ibid). Cassava is also used as a livestock feed in Latin America, the Caribbean, and Europe, and is increasingly cultivated for use as a biofuel (in China, for example) (Adeniji *et al.*, 2005). Compared to other crops, it is available all year round as roots store well in the ground for months after they mature, are tolerant to low soil fertility, resistance to drought, pest and diseases (Odoemenam *et al.*, 2011).

Although cassava stores well in the ground for months, fresh cassava roots cannot be stored for a long time because they rot within 3-4 days of harvest (Parmar *et al*., 2017). Again, they are bulky with about 70% moisture content and therefore transportation of the roots to markets is difficult and expensive. The roots and leaves contain varying amounts of cyanide which is toxic to humans and animals, while the raw cassava roots are not palatable. Therefore cassava must be processed into various forms in order to increase the shelf life of the products, facilitate transportation and marketing, reduce cyanide content and improve palatability. Hence, cassava roots are processed by various methods into numerous products according to local customs and preferences such as 'garri', 'akpu/fufu', tapioca and starch; 'garri' is the most (it accounts for over 70%) common cassava product (Osuji, 2019; Muhammad-Lawal, 2013). Other by-products include chips, pellets, flour, adhesives and alcohol, which serve as raw materials for the pharmaceutical, confectionary, ethanol, textile, beverage, wood and packaging industries (Knipscheer *et al.*, 2007; Anyanwu *et al.*, 2011).

Several studies have been done on cassava and processing but little is known on the factors that influences smallholder farmers decision to process cassava and the quantity to process at each point in time. Smallholder farmers take decisions on the form and quantity of cassava to be processed at a time based on some socio-economic and physical factors such as cassava yield, household size, market availability, access road, and distance to farm among others. It could also be assumed that decisions to process cassava differ from that of quantity to be processed. Therefore, this study was focused on identifying the factors that influenced farmer's decision to process cassava and quantity to be processed in Benue State.

METHODOLOGY
This study was carried out in Benue State. The state is made up 27 Local Government Areas (LGAs) and a multi-stage sampling technique was used to select three LGAs. Three communities were randomly selected from each of the LGAs; thereafter 127 cassava farmers that do not process cassava and 233 that process cassava for the market were purposively

selected from the communities, bringing the sample size to 360.

Primary data was used and information was elicited from the farmers using a structured questionnaire.

Data was analysed using descriptive statistics such as means and Cragg Double Hurdle (DH) model.

Model specification

To estimate the factors that influenced the smallholder farmers decision in cassava processing, it was assumed that the factors influencing the decision to process cassava is independent of the decision on the quantity of cassava to be processed. Hence, Cragg, a double hurdle, model was adopted to explain the factors affecting the decisions to process cassava and intensity of cassava processed. Cragg is model as follows:

$w_i^* = X_i\beta + \varepsilon_i \quad \varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ (1)

Where: w_i = 1 if w_i^*> 0 otherwise 0 and,

$y_i^* = Z_i\delta + \epsilon_i \quad \epsilon_i \sim N(0, \sigma_\epsilon^2)$ (2)

Where: y_i = 1 if y_i^*> 0 and w_i = 1 otherwise 0

Where w_i^* is the latent variable indicating smallholder farmer's decision to process cassava and w_i is the observed value to process cassava = 1 if farmer process cassava and 0 if otherwise. $y_i^*$is the latent variable indicating the extent of cassava processed and y_i is the observed responses on the quantity of cassava process. In other words, y_i = 0 for farmers that did not process cassava and some positive values for farmers that processed cassava that is: w=1 if y>0 and w=0 if y=0. β and δ are the coefficients to be estimated, X_i and Z_i are vector of factors that influenced the decisions to process and the quantity of cassava processed respectively while ε_i and ϵ_i are the respective error terms that follows a normal distribution assumed to be independent (Cragg, 1971, Wooldridge, 2010). The assumption of conditional independence of distributions of $\varepsilon_i$andϵ_i, i.e., $D(y^*|w, x) = D(y^*|w)$ is important for unbiased estimation (ibid).

Equations (1) and (2) are assumed to be independent and following Cragg (1971) and Tambo and Abdoulaye (2013), the joint likelihood function of the Cragg model is as follows:

$$f(w, y|X, Z)\{1 - \Phi(\mathrm{X_i}\beta)\}^{1(w=0)}\left[\Phi(\mathrm{X_i}\beta)(2\pi)^{-\frac{1}{2}}\sigma^{-1}\exp\left\{\frac{-(y-Z_i\delta)^2}{2\sigma^2}\right\}/\Phi\left(\frac{Z_i\delta}{\sigma}\right)\right]^{1(w=1)} \quad (3)$$

Where w is a binary indicator equal to 1 if w is positive and 0 otherwise. Y is continuous variable for non-censored portion which is observed only when w = 1. The model shows that the probability if w > 0 and the value of y, given that y>0, may be determined by different mechanisms (vectors β and δ respectively). There are no restrictions on the elements of X and Z, implying that each decision can be explained altogether by a different vector of explanatory variables (Burke, 2009). Again, the tobit model is nested within Cragg's alternative because if X = Z and $\beta = \delta/\sigma$, the models become identical.

RESULTS AND DISCUSSION

Distribution of socio-economic characteristics and other variables used

Table 1 shows the distribution of the socio-economic characteristics as well as other variables used in the estimation of factors that influences smallholder farmers decision to process cassava for sale or not and the quantity of cassava processed. The two dependents variables: log of quantity of cassava produced has the mean of 6.70 while form in which cassava was sold has the mean of 0.35 implying that approximately 65% of the farmers processed cassava while 35% did not process cassava for the market.

Table 1 shows that sex of farmer had a mean of 0.7 indicating that 70% of the farmers interviewed were male with mean age of 47.93, implying that most farmers were at their productive and active age. About 75% of the farmers were full-time farmers with average educational status of 7.66, indicating that respondents spent approximately eight years in school. This implies that majority of the farmers interviewed did not complete their secondary education. On average, household size was 9.74, meaning that the farmers had large household size. About 65% and 29% of the farmers respectively, belonged to the village meeting and cooperative. It is important to note that village meeting was used to capture membership of an association as majority of the farmers used in the study did not belong to any cooperative society. Belonging to a village meeting is common in rural settings as members of the same community use the forum to organize themselves, maintain law and order as well as ensure development. Again, farmers belonging to associations could be influenced by the low level of education observed in the study area.

Again, mean of farming experience was 20.35, entailing that the farmers were well experienced cassava farmers. The mean value of farm size was 2.62 and 50% of the farmers owned their farm land; in other words, there was equal share of owning and renting of land for cassava farm purposes. Level of commercialization was 0.46 implying that majority of the farmers has not commercialized cassava production. Majority of the farmers (79%) in the study area sell their cassava produce/products in the village market while 8%, 21%, 11% and 3% sell at farm gate, market that is located outside the village, urban market and factory respectively. On average, the farmers covered a distance of 8.25km to the market. This was not surprising why most of the farmers sell their products in their village market which took place at interval of four days.

Table 1: Distribution of socio-economic characteristics and other variables used

			Benue State		Unprocessed		Processed	
Variable	**Description**	**Unit**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Dependent variables								
Log of cassava processed			3.46	4.69	0.00	0.00	9.79	0.27
Processed cassava	Unprocessed cassava = 1 otherwise 0	Number	0.35	0.48	0.00	0.00	1.00	0.00
Independent variables								
Sex of farmer	Male = 1 otherwise 0		0.70	0.46	0.69	0.46	0.72	0.45
Age of farmer		Years	47.93	10.37	46.26	10.33	50.99	9.75
Occupation	Full-time farmer = 1 otherwise 0		0.75	0.44	0.72	0.45	0.80	0.41
Years of school		Years	7.66	5.61	7.75	5.66	7.50	5.54
Household size		Number	9.74	3.95	9.43	3.78	10.31	4.19
Member of a village meeting	Yes = 1 otherwise 0		0.65	0.48	0.65	0.48	0.65	0.48
Member of a cooperative	Yes = 1 otherwise 0		0.29	0.46	0.29	0.45	0.30	0.46
Farming experience		Years	20.35	9.70	20.55	10.30	19.99	8.53
Farm size		Hectares	2.62	1.66	2.57	1.12	2.72	2.35
Ownership of cassava land	Yes = 1 otherwise 0		0.05	0.22	0.03	0.18	0.09	0.28
Level of commercialization	Quantity of cassava sold/Quantity of cassava harvested		0.46	0.20	0.46	0.21	0.44	0.20
Perceived price of cassava			2.19	0.96	2.19	0.95	2.20	0.98
Market - farm gate	Yes = 1 otherwise 0		0.08	0.27	0.01	0.09	0.20	0.41
Market – within the village	Yes = 1 otherwise 0		0.79	0.41	0.81	0.40	0.76	0.43
Market – outside the village	Yes = 1 otherwise 0		0.21	0.40	0.18	0.39	0.24	0.43
Market – urban	Yes = 1 otherwise 0		0.11	0.31	0.15	0.36	0.04	0.20
Market – Factory	Yes = 1 otherwise 0		0.03	0.16	0.01	0.09	0.06	0.24
Distance to market		kilometers	8.25	9.28	8.95	9.78	6.98	8.16
Access to credit	Yes = 1 otherwise 0		0.33	0.47	0.31	0.46	0.35	0.48
Non-farm income			0.30	0.46	0.28	0.45	0.32	0.47
Years of selling cassava		Years	16.31	10.37	15.51	10.51	17.76	9.99

The table also shows that about 33% of the farmers had access to credit and 30% had other sources of income while 70% sourced their income from cassava production and processing. On average, the mean years of participating in the cassava market was 16.3 years.

Determinants of cassava processing and degree of processing decisions among smallholder farmers

Table 2 represents the factors influencing farmer's decision to process cassava and the quantity to be processed in Tier1 and Tier2 respectively of the Cragg model. The model was found to be significant at 1% with a Wald Chi2 test value of 65.72, implying that the model fitted significantly better. The log-likelihood (--134.9643) indicated that there is no close relationship within the variables.

Age had a positive coefficient and significantly, at 1%, influenced farmers decision to process cassava implying that the probability of processing cassava increases with age of the farmer. This could be attributed to the fact that processed cassava yields more income as compared to the roots. This finding contradicted Okebiorun and Jatto (2017), Agwu *et al*. (2015) and Kuwornu *et al*. (2014) that observed a negative association between farmers age and the decision to process cassava. However, the results correspond with Onyemauwa (2012) though it was not significant.

Table 2: Estimates of Double-Hurdle (Cragg) Model of the determinants of cassava processing and degree of processing

	Coefficients	Std. Err.	Z test	P>z
Tier1				
Sex of farmer	0.061	0.180	0.34	0.736
Age of farmer	0.026	0.009	3.04	0.002
Occupation	0.284	0.205	1.38	0.166
Years of school	0.003	0.016	0.16	0.873
Household size	0.021	0.026	0.8	0.422
Member of a village meeting	0.338	0.184	1.84	0.066
Farming experience	-0.027	0.009	-2.95	0.003
Farm size	0.096	0.067	1.43	0.153
Ownership of cassava land	0.638	0.347	1.84	0.066
Level of commercialization	-1.003	0.497	-2.02	0.044
Market - farm gate	2.434	0.446	5.46	0
Market – Factory	1.280	0.521	2.46	0.014
Market – outside the village	-0.391	0.225	-1.73	0.083
Market – urban	-0.819	0.335	-2.45	0.014
Distance to market	-0.007	0.011	-0.61	0.543
Access to credit	0.128	0.185	0.69	0.489
Non-farm income	0.141	0.209	0.67	0.5
Constant	-1.475	0.612	-2.41	0.016
Tier2				
Sex of farmer	-0.041	0.038	-1.08	0.278
Age of farmer	-0.001	0.002	-0.4	0.689
Years of school	-0.004	0.003	-1.34	0.18
Household size	0.026	0.005	4.87	0
Member of a cooperative	-0.082	0.039	-2.07	0.039
Farm size	-0.089	0.010	-9.16	0
Ownership of cassava land	-0.020	0.066	-0.31	0.759
Level of commercialization	1.154	0.094	12.31	0
Years of selling cassava	0.001	0.002	0.35	0.727
Market – within the village	-0.079	0.037	-2.16	0.031
Market – Outside the village	0.020	0.049	0.41	0.683
Market – Factory	-0.024	0.063	-0.38	0.702
Non-farm income	-0.037	0.037	-1.01	0.311
Distance to market	0.004	0.002	1.79	0.073
Constant	9.422	0.114	82.5	0
sigma Constant	0.164	0.010	15.94	0
Wald test	65.72***			
Log likelihood	-134.9643			

Number of observation	360

Source: Stata, 2014

Member of a village meeting was significant at 10% and positively related to the tendency of processing cassava or not. This shows that when farmers are part of the village meetings, the probability of processing cassava increases as well. Debucquet *et al*. (2020) reported that belonging to a social group increased access to information, market and improved technologies among members.

Farming experience was negatively significant at 1%, implying that as years of experience increases, the likelihood of processing cassava reduces. This shows that additional one year to farming experience reduces cassava processing by 2.7%. This could be connected with the extra labour linked to processing of cassava which may not be encouraging for older farmers who might rather sell cassava roots than to process. This is in line with Akrong *et al*. (2021) but contradicted Aniekan *et al* (2019).

Owning the cassava land also was significant at 10% and negatively related to the probability of processing cassava by the farmers, suggesting that famers that own land might not be processing cassava. In other words, cultivating on rented land encouraged farmers decision to process cassava. Leasing of land is done with specific number of years and a farmer on rent would like to remove all the cassava on the land before the lease expiration. As such, there could be need for the farmer to process the cassava to increase income instead of selling the roots. On the other hand, farmers that own land may be processing cassava at piece meal for family consumption as cassava stores well in the soil for longer years. This result aliens with Alabi and Oyelere (2017).

Level of commercialization was negatively related to possibility of processing cassava or not and is significant at 5%, entailing that as level of cassava commercialization increases the decision to process cassava decreases. This could be related to farmers selling more of the unprocessed cassava as shown with the negative sign the volume of processed cassava had with selling in the village market. Ordinarily, the volume of processed cassava was expected to be positively related to selling at the market within the village due to high price, but it was not the case in the study area as it could be possible that more roots were sold reducing the volume processed. This result conforms to Khoza *et al*. (2019) Surprisingly, selling at the farm gate and to a factory were significant at 1% and positively related to the probability of a farmer's decision to process cassava or not. This discloses an important feature of rural agricultural trade where farmers and traders come together from different places for exchange of commodities on specific market days and times, which in turn reduce transaction costs on farmers and provide them with more market opportunities of selling directly to buyers rather than brokers (Sebatta *et al*., 2014). Fletschner and Zepeda (2002) reported that farmers with access to such market arrangements usually produce and send more to the market than those lacking such opportunities. This arrangement could favour more of the farmers that do not process than those who process cassava as cassava may not be processed at the farms especially among smallholder cassava farmers and factories (where they exist) may not purchase processed cassava. The table again depicted that selling outside the village and urban market had a negative coefficient to the probability of processing cassava at 10% and 5% significant levels respectively. This implies that selling at a market outside the village or urban area reduces the tendency of a cassava farmer to process cassava. This could be linked with transaction cost that increases with distance to market (Okoye *et al*., 2016). Hence, farmers take the advantage of selling at closer markets to reduce cost thereby enhancing farmers profit. The above findings corresponds with Ojiako *et al*. (2017) that price of roots to factory or farm gate had a positive effect on roots flow to the factories/buyers whereas open market price of roots had a negative sign. This, however, contradicts with Krissana (2015) that farmers travel far distance to buyers who offered higher prices than those in their own areas.

Table 2 also shows the results of Tier2 with the factors that influence quantity of cassava processed. Household size was positively related to the decision made on the volume of cassava processed suggesting that as household size increases, volume of cassava processed increases as well. This could be related to family labour that helps in the processing of cassava. This finding contracted studies as Haile *et al*. (2022) and Kyaw *et al* (2018).

Member of a cooperative was negatively correlated with volume of cassava processed implying that a farmer belonging to a cooperative reduced farmers decision on the volume of cassava processed. This aligned with the low number of farmers that belonged to a cooperative in the study area. The findings of this study contradicts Okafor and Umebali (2019) that cassava farmers belonging to cooperatives earned more income from processing and marketing of cassava. However, it corresponds with Okebiorun and Jatto (2017).

Farm size was significant at 1% and negatively associated with the decision on the extent of cassava processed. This implies that a unit increase in farm size results to 1.9% decrease in the farmers decision on quantity of cassava processed. This result conforms with Apata *et al*. (2019) that farmers with small farms would want to increase income by adding value to cassava roots. Again, Kuwornu *et al*. (2014) stated that farmers with large farm sizes tend to move towards commercialization and this will definitely has a negative effect on diversifying into agro-processing.

Thus, households who produce just for subsistence will have to augment their incomes through cassava processing. Furthermore, the low value of level of commercialization in table 1 confirms the subsistence level of cassava production in the study area. However, Amadi (2020) conclusion contradicted the findings of this study.

Level of commercialization was significant at 1% and positively correlated to the decision on the volume of cassava to be processed. Ojiako *et al*. (2017) reported that farmers with big farms will harvest larger volume of cassava and have surplus to process during the harvesting period, ceteris paribus.

Selling cassava products within the village was negatively correlated with the decision on volume of cassava to be processed implying a 7.9% decrease to decision on volume of cassava processed. This could be linked to the level of roots sold. When more roots are sold, the farmer may not have enough to process for the market.

Distance to market increases the decision on volume of cassava to be processed by 0.4% at 10% significant level. This implies that farmers go out of the market within the village (which was negative and significant as shown in table 2) to sell their processed produce covering more distance. This could happen if farmers envisaged a higher price from markets outside the village. This finding though contradicted the findings of Haile *et al* (2022) and Kyaw *et al* (2018).

CONCLUSION

The present study provided information on the factors that influences the decision of smallholder cassava farmers to participate in cassava processing and the extent of cassava processed. It was believed that processing and the volume of cassava processed were influenced by different decisions; thus, a Cragg model was fitted for the analysis. The results from the Tier1 shows age, membership of a village meeting, farming experience, ownership of cassava land, and selling at farm gate and factory were positively related to farmers decision to process cassava or not while level of cassava commercialization, market outside the village and urban market as well as distance to market were factors that influenced farmers decision to process or not to process cassava negatively. Also, household size, level of cassava commercialization and distance to market were positively associated with farmers decision on volume of cassava to be processed, whereas membership of a cooperative, farm size, and selling at the market within the village were factors that inclined farmer's decision to process cassava negatively. This study recommended therefore that, farmers be encouraged to improve their educational status by involving in adult education and trainings on improved cassava processing technologies could as well influence farmers to be involved in cassava processing while increasing volume as well.

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