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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Commercialization of Pigeon Pea Production: Its Determinants and Constraints

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Abstract

Commercialization of neglected and underutilized species is a reasonable pathway to food security, employment growth, and reducing poverty. Pigeon pea is one of the underutilized crops with great economic value and health benefits. Despite its potential, pigeon pea is still a minor crop. This study, therefore, examined the level of pigeon pea commercialization, influencing factors of the commercialization of pigeon pea production and the constraints faced in its commercialization in Nigeria. The descriptive statistics, the household commercialization index, and the Tobit regression model were used to analyse primary data collected from 160 randomly selected pigeon pea farmers. The results showed that the mean household commercialization index was 29.2%, implying that the farmers still had a gap of a minimum of 45.8% to attain a high level of commercialization in pigeon pea production. The positive influencing factors for the commercialization of pigeon pea production were access to credit, farming experience, farm size, farm output, extension services, the use of farm machinery, and pesticides. The distance to the market had a negative influence on the commercialization of pigeon pea production. Farmers' major challenges in commercializing pigeon pea production included a lack of credit, insufficient extension contacts, a poor transportation system, pests and diseases, high production input costs, inadequate storage facilities, and insufficient access to timely market information. Therefore, this study recommends encouraging pigeon pea commercialization by the government and non-governmental organizations through the provision of farm credits, production inputs, a good transportation system, and an improved agricultural extension system.

Keywords: Commercialization, Constraints, Factors, Neglected and underutilized species, Pigeon pea

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1. Introduction

Food insecurity is a global challenge, especially in many developing countries (FAO, IFAD, UNICEF, WFP and WHO 2021; Mukaila et al. 2022a). The challenge has grown due to the COVID-19 pandemic as recent statistics show that 30% of the world population lacks adequate access to food while up to 811 million people are hungry (FAO, IFAD, UNICEF, WFP and WHO 2021; World Bank 2022). The report further revealed that hunger is on the increase in almost all African countries as the continent hosts over one-third of the world's hungry people, with sub-Saharan Africa having the highest level of prevalence of undernutrition. Nigeria is not immune to this menace, as the prevalence of food insecurity in the total population between 2014-2016 and 2018-2020 was about 36.5% and 57.7%, respectively (FAO, IFAD, UNICEF, WFP and WHO 2021). This could affect achieving the second Sustainable Development Goal of zero hunger by 2030 if proper and immediate measures are not in place. Thus, this situation calls for the need for farmers and other relevant stakeholders in agricultural development to diversify their attention from the production of conventional crops to the neglected and underutilized species (NUS) to enhance food availability, affordability, and consequently food security. It would further enhance farmers' income and enable sustainable agriculture (Ghosh, 2021).

The NUS are the crops that have been given insignificant attention or ignored by policymakers, plant breeders, and agricultural researchers (Padulosi et al., 2013). They have great opportunities to alleviate food insecurity and poverty among low-income communities and worldwide. They can also assist in making agricultural production more enduring to climate change, advancing agricultural development and empowering rural farming households (Padulosi et al., 2013). Among the NUS is pigeon pea (*Cajanus cajan*). It is a leguminous crop with many impressive socioeconomic, nutritional, and health benefits. The crop has a high protein content that is comparable with those in other legumes like groundnut and cowpea and is also rich in minerals and fibre content (Emefiene et al., 2014). Thus, it can help in fighting malnutrition. It also has tremendous medicinal value, including the prevention and treatment of gynaecological cancers and menopausal symptoms, as well as the treatment of coronary heart disease angina and fractures (Odeny, 2007). Studies have also revealed that its health benefits also include the ability to boost heart health, prevent anaemia, manage blood pressure, and stimulate growth. It can also help to eliminate inflammation, increase energy, strengthen the immune system, improve digestion, and reduce obesity (Ayenan et al., 2017a). Apart from these, pigeon pea serves as animal feed. The leaves, seeds, and seed processing by-products are rich in protein, which is used in livestock feed (Waldman et al., 2017). In addition to its nutritional values, pigeon pea can adapt to dry conditions, is suited to different production systems and cropping cycles, and is more resistant to diseases (Valenzuela, 2011). However, its production in Nigeria has been largely at the subsistence level despite the good ecological and edaphic conditions of the country, which can support its production in large quantities for commercialization (Ezeaku et al., 2016).

Agricultural commercialization is the share of farmers' output that is taken to the market for public consumption. Agricultural commercialization involves the transition of agricultural production from a subsistence-oriented level to an increasingly market-oriented level (Yaro et al., 2017). It involves a deliberate action by a farmer to use his limited factors of production in a manner that the larger portion of the crop produced is for exchange or sale (Falola et al., 2017). Agricultural commercialization is premised on the goal of increasing the income of farm households, thus reducing unemployment, poverty, and food insecurity levels in local communities and at the global level (Abdullah et al., 2019; Adepoju, 2018; Carletto et al., 2017). It also enhances the food supply in urban areas and has a large welfare impact (Ogutu and Qaim, 2019). Studies have also established that farmers who commercialize their production have a better standard of living than those who operate at a subsistence level (Rabbi et al., 2019; Tipraqsa and Schreinemachers, 2009). This calls for the need to concentrate on market-oriented production of not only common crops but also neglected and underutilized species in many countries.

Understanding factors driving the commercialization of underutilized species is a key component of designing strategies for improving their level of production. Over the years, many studies have focused on the levels of commercialization of common (conventional) crops and their determinants (Abdullah et al., 2019; Gbaguidi et al., 2013; Asuming-Brempong et al., 2013; Falola et al., 2017; Hailua et al., 2015) with little or no emphasis on underutilized species. As regards the pigeon pea, the few studies were on its profitability, farmers' practices, and preferred traits. Emefiene et al. (2014) assessed the profitability of pigeon pea production in Nigeria and reported that pigeon pea production was a profitable venture. While analysing farmers' practices and preferred traits of

pigeon pea production in Benin, Ayenan et al. (2017b) noted that pigeon pea could augment food security, environmental protection and alleviate poverty among farming households. They, however, lamented that the crop is still a minor crop in West Africa. The case is not untrue about Nigeria despite its good ecological and edaphic conditions that are suitable for pigeon pea production.

Based on the foregoing, the broad objective of this study is to investigate the commercialization level of pigeon pea production. The specific objectives are to describe pigeon pea farmers' socioeconomic characteristics; determine the current level of commercialization of pigeon pea production by the farmers; identify the determinants of the level of commercialization; and identify the constraints to pigeon pea production commercialization. This would allow relevant policy intervention to enhance the production of neglected and underutilised crops to solve the food insecurity menace. It would also enhance farmers' well-being and the growth of the rural economy.

2. Materials and Methods

2.1. Study area and data collection

The study was conducted in Ekiti state, located in the southwest region of Nigeria. The state lies between latitudes 70°151'N and 80°51'N and longitudes 40°51'E and 50°451'E. It shares a national border with Kwara State, Kogi State, Ondo State, and Osun State. The state is blessed with good ecological and edaphic conditions that are suitable for agriculture. Agriculture is the mainstay of the state as the majority of its population engages in farming and allied activities. Some of the food crops grown in large quantities in the area are cassava, yam, and grains such as maize and cowpea. Other notable crops cultivated in commercial quantities in the study area are kola nuts and fruits of various kinds. However, pigeon pea is grown as a minor crop in some farming communities of the state.

Primary data were used for the study. The target population were farmers involved mainly in pigeon pea production. The snowball technique was used to sample the respondents. The strategy entails expanding the sample by starting with a respondent who assists in the identification of other potential respondents (Kirchherr and Charles, 2018; Biernacki and Waldorf, 1981). The choice of this technique was premised on the quest to interview only farmers involved in pigeon pea production. Using this technique, 160 pigeon pea farmers were reached in seven farming communities (*Table 1*). Data saturation was considered reached when new respondents provided no additional information. When new respondents supplied no further information, it was considered that data saturation had been reached. (Kirchherr and Charles, 2018; Mason, 2010; Guest et al., 2006). The field survey was conducted between March and May 2021.

Table 1. Sample distribution

Communities	Number of Respondents
Omuo (Oke-Iloro, Egunje, Omodowa, Apoge, Adumari)	65
Isan Ekiti	23
Omu Ekiti	10
Ijelu Ekiti	12
Ese	15
Olorunda	18
Odilowo	17
Total	160

2.2. Data analyses

Descriptive statistics, the household commercialization index (HCI), and Tobit regression were used to analyse the data. Descriptive statistics analyses such as means, percentages, and frequency distribution were used to describe the socioeconomic profile of the pigeon pea farmers and to identify the barriers to the commercial production of pigeon peas. The HCI was employed to examine the degree of market-oriented production of pigeon pea by the farmers.

The HCI is the ratio of the gross value of farm products sold to the value of the ones produced (Onyebinama, 2012; Falola et al., 2022a). It shows the extent to which a producer is commercialization-oriented, with a value

ranging between 0 and 1. This was converted to percentage for easy understanding and interpretation. A closer HCI value towards 100 suggests a high level of commercialization, while an index of 0 indicates that the pigeon pea farmer is operating for consumption only (subsistence agriculture). The model is specified as:

$$HCI = \frac{GVS}{GVP} \times 100\% \quad \text{(Eq. 1)}$$

Where:

GVS is the Gross value of pigeon pea sold

GVP is the Gross value of pigeon pea produced

The levels of commercialization of pigeon pea production by the farmers were grouped into three, following Asuming-Brempong et al. (2013). These were: low when ≤ 30% of the output was sold, medium when 30%–75% was sold, and high when >75% was sold.

Tobit regression was used to identify the driving factors of the commercialization of pigeon pea production. The Tobit model can be used to estimate the expected value of Y_i, censored at 1, as a function of a set of independent variables (Oladele, 2005). The model was expressed as:

$$y_i^* = \beta X_i + \mu_i \qquad \mu_i \sim N\,(0, \sigma^2) \quad \text{(Eq. 2)}$$

$$y_i = \max(0, y_i^*), \qquad y_i = y_i^* \quad if\ y_i^* > 0 \qquad y_i = 0 \quad \text{(Eq. 3)}$$

The conceptual model of both Equations (2) and (3) is a stochastic and simultaneous decision model (Adesina and Zinnah, 1993). If y* > 0, the observed qualitative variable, that is, the commercialization index (Yi) becomes a continuous function of the independent variables. But if y* ≤ 0, the observed qualitative variable (y_i) will take a zero value. Equations (2) and (3) represent a censored distribution of the data.

y_i is the HCI. The explanatory variables include:

X_1 = Sex (dummy)
X_2 = Age (years)
X_3 = Educational level
X_4 = Farm size (hectares)
X_5 = Farming experience (years)
X_6 = Membership of farm-based organization (1 if yes, 0 if otherwise)
X_7 = Access to credit (Amount in NGN, ₦)
X_8 = Distance to market (Km)
X_9 = Farm output (kg)
X_{10} = Use of farm machinery (1 if yes, 0 if otherwise)
X_{11} = Non-farm income (Amount in NGN)
X_{12} = Access to extension services (number of extension contacts)
X_{13} = Fertilizer (kg)
X_{14} = Pesticides (litres)

3. Results and discussion

3.1 Socioeconomic characteristics of the respondents

Table 2 shows the socio-economic characteristics of the pigeon pea farmers. The majority of the pigeon pea farmers were of the male gender. A major proportion of the pigeon pea producers were above 50 years of age; 18.2% were within 31– 40 years of age; a lesser proportion was within 41 – 50 years of age; and the least (3.1%) fell below 30 years of age. Their average age was 52.5 years, suggesting that the pigeon pea farmers were relatively advanced in age. The majority of the farmers were married and had a large household of nine people. The large household size is a result of the polygamous and extended nature of rural sub-Saharan African households (Mukaila et al., 2022b). Most of the farmers were literate, with 55.6% having a secondary school education while 25.6% had primary education. The farm size of the respondents ranged from 0.42 hectares to 3.6 hectares. A large proportion of the farmers had between 1.01 and 2.00 hectares. Further analysis showed that the mean farm size was 1.76 hectares, indicating that pigeon pea production was on a small scale. This supports the assertion of Gbigbi

(2021) that Nigerian farmers were small-scale farmers. The major source of farmland used for pigeon pea production among the farmers was through inheritance. About 46% of the farmers had been in pigeon pea production for more than 10 years. Further analysis showed that the average farming experience of the farmers was 15.3 years. This indicates that pigeon pea production is an age-long venture among the respondents, and farmers are equipped with the required skills. The majority of the farmers were members of farm-based associations. However, only 11.9% of the farmers had access to credit. This could lower their level of investment in agricultural production as capital is an important factor in agricultural production activities (Falola et al., 2022b; Mukaila et al., 2021). The major source of funds used by the farmers (87.5%) was personal savings. Meanwhile, all the farmers used both hired and family labour for their farming operations.

Table 2. Socio-economic profile of the pigeon pea farmers

Variables	Category	Frequency	Percentage
Sex	Male	98	61.25
	Female	62	38.75
Age	≤ 30	5	3.1
	31 – 40	29	18.2
	41 – 50	28	17.5
	51 – 60	49	30.6
	> 61	49	30.6
Marital status	Single	1	0.6
	Married	123	76.9
	Widowed	36	22.5
Household size	4-8	67	41.9
	9-12	93	58.1
Education level	No formal education	41	25.6
	Primary education	89	55.6
	Secondary	30	18.8
Farm size	≤1.00	42	26.3
	1.01 – 2.00	75	46.9
	2.01 – 3.00	29	18.1
	>3.01	14	8.8
Ownership of farmland	Inheritance	82	51.2
	Purchase	51	20.6
	Hire/rent	45	28.1
Farming experience	≤10	86	53.8
	11 – 20	30	18.8
	21 – 30	42	26.2
	> 31	2	1.3
Membership in farm-based associations	Member	116	72.5
	Not a member	44	27.5
Access to credit	Had access	19	11.9
	Did not have access	141	88.1
Source of capital	Owned funds	140	87.5
	Friends/relatives	1	0.6
	Cooperative society	19	11.9
Source of labour	Both family and hired	160	100.0

3.2 Analysis of the extent of pigeon pea commercialization

Table 3 summarizes the value of the pigeon pea produced, consumed, or sold by a typical farming household. Analyses revealed that a typical farming household (operating on 1.76 hectares) produced an average of 2.746 tonnes, out of which about 1.945 tonnes were consumed. For this study, the quantity consumed includes those used as food, given out as gifts, stored for the future season, or lost at harvest. Meanwhile, only 0.801 tonnes of the pigeon pea produced were sold. Investigations from the field also revealed that a tonne of pigeon pea was sold for ₦485,850 (USD 1,168.27) in the study area. Thus, the values of the pigeon pea produced, consumed, and sold by a typical farming household were USD 3,208.08, USD 2,272.29, and USD 935.79, respectively. Despite the low level of commercialization among pigeon pea farmers, pigeon peas contributed significantly to their income. Thus,

a high commercialization level of pigeon pea will further enhance farmers' economic status and consequently improve the rural economy and lower rural poverty.

Table 3. Summary of pigeon pea produced, sold and consumed by the respondents

Variable	Mean Quantity (tonnes)	Value (₦)	Value (USD)
Quantity produced	2.746	1,334,144.1	3,208.08
Quantity consumed	1.945	944,978.25	2,272.29
Quantity sold	0.801	389,165.85	935.79
Mean HCI	29.2%	-	-

Table 4 summarizes the HCIs of the respondents by their levels. The HCI of the farmers ranged from 0 – 93.3%. Analyses revealed that 32% of the respondents had HCIs of 0%, implying that they produced mainly for their family consumption. Meanwhile, the modal group (66.9%) was composed of those with HCIs of not more than 30%. In other words, they had low HCIs. Further analysis showed that the average HCI of the pigeon pea farms was 29.2%. About 36.9% of the farmers were operating above this average, while 63.1% were either operating below or exactly at that level. The average HCI obtained in this study implies that over two-thirds (69.8%) of the pigeon pea produced was consumed by the farming households while only 29.2% was available to the members of the public to compete through market forces. It also indicates that the farmers still have a gap of a minimum of 45.8% (75% - 29.2%) to attain a high level of commercialization in pigeon pea production.

Table 4. Farmers' distribution based on household commercialization indices

HCI (%)	Frequency	Percentage	Min.	Max.
≤ 30.0	107	66.9	0	30.0
30.1 – 75.0	46	28.8	33.3	74.3
> 75.00	7	4.4	76.0	93.3
Total	160	100	0	93.9

3.3 Determinants of commercialization of pigeon pea production

Table 5 shows the factors that influenced the commercialization of pigeon pea. Eight variables were found to be significant factors related to pigeon pea commercialization. They were farm size, farming experience, distance to market, access to credit, and farm output. Others were the use of farm machinery, extension services, and pesticides. Farm size had a positive influence on the commercialization of pigeon pea production ($P < 0.05$). This implies that farmers who had large farmlands were able to produce pigeon pea in quantities that were market-oriented. In other words, this implies that farmers who had limited farmland were less likely to engage in the commercial production of pigeon pea. This is because farm output depends on the size of land under cultivation, ceteris paribus. Farming experience was very highly significant ($P < 0.01$) in determining the commercialization of pigeon pea production. This implies that farmers who have more experience in pigeon pea production produce more of the crop for the market than those who do not. This could be because experienced farmers are likely to be acquainted with relevant agribusiness skills, especially as regards input sources and market outlets, which may help them in managing production and marketing risks (Falola et al., 2022a).

Access to credit was highly significant ($P < 0.05$) and positively influenced farmers' ability to commercialize pigeon pea production. This indicates that farmers who have access to credit are more able to operate their farms at a market-oriented level. Farmers' ability to produce at a commercial level could largely involve high financial costs, which may be difficult for those who do not have much financial strength to undertake. This may explain why access to credit has a significant positive effect on the commercialization of pigeon pea production. This supports Falola et al. (2022a), who recently reported that access to credit positively influences household commercialization. Distance to the market had a significant but negative effect on the commercialization of pigeon pea ($P < 0.01$). This suggests that the farther the farm is from the market, the fewer farmers produce at a market-oriented level. This may be due to the possibility of postharvest loss that such farmers are likely to incur in the form of spoilage or degradation during handling, storage, and transportation between farm and market outlets (Affognon et al., 2015).

As expected, *Table 5* further shows that the higher the farmers' output, the more they had left for the market ($P < 0.01$). Farmers who have a higher output would have more pigeon peas to be channelled to the market for public consumption. Similarly, the use of machinery had a positive and significant ($P < 0.05$) influence on the commercialization of pigeon pea production. This implies that farmers who used farm machinery in their production had more pigeon peas for the market than their counterparts. This could be because the use of machinery tends to improve agricultural productivity and consequently increase the quantity taken to the market (Mamudu et al., 2012; Nin et al., 2003). Likewise, the use of pesticides had a positive and significant influence on the commercialization of the crop ($P < 0.10$). This suggests that farmers that controlled pests on their farms with pesticides had more pigeon peas to sell in the market than those who did not control pests on their farms. This could be because infestation of pigeon pea by pests would result in low productivity and postharvest loss; thus, controlling pests would enhance the output and, consequently, the quantity available for commercial purposes. Access to agricultural extension services had a positive influence on the commercialization of pigeon pea production ($P < 0.05$). In other words, those who had access to extension services produced more for the market than those who did not. This could be due to the possibility of receiving training on how to operate their farms beyond the subsistence level (Falola et al., 2017).

Table 5. Factors influencing commercialization of pigeon pea production

Variables	Coefficient	Standard error	t-value
Constant	0.1176	0.0527	2.23
Sex	-0.0051	0.0060	-0.85
Age	0.0053	0.0065	0.82
Educational status	-0.0091	0.0263	-0.35
Farm size	0.0153**	0.0065	2.35
Farming experience	0.3337***	0.0878	3.80
Membership in farm-based associations	0.0217	0.0267	0.81
Access to credit	0.0235**	0.0106	2.22
Distance to market	-0.0341***	0.0122	-2.80
Farm output	0.2336***	0.0778	3.00
Use of farm machinery	0.0577**	0.0267	2.16
Non-farm income	-0.0091	0.0262	-0.35
Access to extension services	0.0497**	0.0252	1.97
Fertilizer	0.2030	0.1534	1.32
Pesticides	0.0337*	0.0178	1.89
LR chi 2(14) = 54.13			
McFadden's pseudo R^2 = 0.2898			
Log likelihood = -657.92576			
Prob > chi2 = 0.0000			

3.4 Constraints to commercialization of pigeon pea

Table 6 shows the constraints to the commercial production of pigeon pea as perceived by the farmers. The table shows that the most severe constraint perceived by the farmers was inadequate access to credit. The majority of the farmers complained that the reason they could not produce at a commercial level was that they did not have adequate access to credit facilities. Some complained that they did not have the collateral that most financial institutions usually requested to be eligible for loans. Some reported that the problem was due to the high-interest rates being charged by banks, which they could not afford. Others lamented that the problem was due to the absence of financial institutions, like banks, in their area (rural). Another major constraint perceived by the respondents was the lack of access to extension services. About 72% of the farmers lamented that they did not have adequate agricultural extension contacts. This, according to them, debars them from adequate training for the economic potential of pigeon pea production compared to other crops. Other major challenges highlighted by the respondents include poor storage facilities, poor transportation systems, high costs of inputs, incidences of pests and diseases, and inadequate access to timely market information. These findings are in line with some previous studies (Esan and Ojemola, 2018; Jaganathan and Liu, 2014; Dasbak et al., 2012; Marin et al., 2004).

Table 6. Perceived constraints to the commercial production of pigeon pea

Constraints	Frequency	Percentage
High cost of inputs	88	55.0
Poor road network/transportation problem	108	67.5
Inadequate access to credit	120	75.0
Poor storage facilities	97	60.6
Incidences of pests and diseases	83	51.9
Lack of extension contacts	115	71.9
Inadequate access to timely market information	92	57.5

4. Conclusions

Most of the previous studies on factors influencing the commercialization of crop production in sub-Saharan Africa (especially West Africa) have largely focused on conventional crops, with little emphasis on underutilized ones. This study bridges the gap by examining the determinants of commercial production of pigeon pea (a minor crop) in Nigeria. The study reveals that the current level of household commercialization of pigeon pea production is low despite its untapped potential. The study further reveals that the significant factors influencing commercial production of the crop were access to credit, farming experience, farm size, distance to market, farm output, extension services, and use of farm machinery and pesticides. It also reveals that the major constraints limiting the effort of the farmers in producing the crop on a commercial scale include inadequate access to credit, lack of extension services, poor transportation systems, poor storage facilities, and the high cost of inputs. Addressing these challenges would enhance the commercialization of pigeon pea production. When this is done, there would be more pigeon peas available for public consumption, which would consequently enhance food security.

Based on these findings, there is a need for policies that will encourage the commercial production of pigeon pea. The government, through the Ministry of Agriculture, should encourage farmers to invest in pigeon pea production by making inputs such as improved pigeon pea seeds, farm machinery, pesticides, and storage facilities available to them at subsidized rates. Besides, agricultural extension services should be overhauled to disseminate useful information on the commercialization of the crop. These could include the recruitment of more agricultural extension agents and providing incentives for them to carry out their responsibilities effectively. It could also be done by creating awareness of innovations in pigeon pea production through radio and television programmes and print media such as daily newspapers. In addition, financial institutions such as banks should encourage pigeon pea producers by enhancing their access to credit facilities. These could include providing loans at no or low interest rates and reducing the bottlenecks involved in loan acquisition by farmers. In the same vein, the farmers could be given grants as this will help them expand their pigeon pea farms. Moreover, the transportation system in farming communities should be improved. There should be construction and/or rehabilitation of roads to enhance the easy and effective movement of farmers and their products. Similarly, the Ministry of Transportation and other relevant agencies could provide vehicles in the farming communities, as this will ease the transportation of output to the urban market, where the farmers would get good prices for the products. It is worthy of note that this study analysed the commercialization of pigeon pea production in terms of output. More studies should be carried out to consider it from the perspective of the inputs used in pigeon production. To ensure the effectiveness of such studies, effort should be made to delineate the inputs used in pigeon pea production, given that the crop could be intercropped with other crops.

References

Abdullah, R.F., Ahamad, R., Ali, S., Chandio, A.A., Ahmad, W., Ilyas, A. (2019). Determinants of commercialization and its impact on the welfare of smallholder rice farmers by using Heckman's two-stage approach. *Journal of the Saudi Society of Agricultural Sciences*, 18 (2):224–233.

Adepoju, A.A. (2018). Investigating endogeneity effect of agricultural commercialization on household poverty status in Oyo State Nigeria : A Cdsimeq Approach. *International Journal of Agriculture Innovations and Research*, 7 (1):93–101.

Adesina, A.A., Zinnah, M.M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit application in Sierra Leone. *Agricultural Economics*, 9:297-311.

Affognon, H., Mutungi, C., Sanginga, P., Borgemeister, C. (2015). Unpacking postharvest losses in sub-Saharan Africa: A meta-analysis. *World Development*, 66:49–68.

Asuming-Brempong, S., Anarfi, J.K., Arthur, S., Asante, S. (2013). Determinants of commercialization of smallholder tomato and pineapple farms in Ghana. *American Journal of Experimental Agriculture*, 3 (3): 606-630.

Ayenan, M.A.T., Danquah A., Ahoton L.E., Ofori, K. (2017a). Utilization and farmers' knowledge on pigeon pea diversity in Benin, West Africa. *Journal of Ethnobiology and Ethnomedicine*, 13:1-13.

Ayenan, M.A.T., Ofori, K., Ahoton, L.E., Danquah, A. (2017b). Pigeonpea [(*Cajanus cajan* (L.) Millsp.)] production system, farmers' preferred traits and implications for variety development and introduction in Benin. *Agriculture & Food Security*, 6:48.

Biernacki, P., Waldorf, D. (1981). Snowball sampling: problems and techniques of chain referral sampling. *Sociological Methods & Research*, 10:141–63.

Carletto, C., Corral, P., Guelfi, A. (2017). Agricultural commercialization and nutrition revisited: empirical evidence from three African countries. *Food Policy*, 67:106– 118.

Dasbak, M.A.D., Echezona, B.C., Asiegbu, J.E. (2012). Field insect pests and crop damage assessment of pigeon pea (*Cajanus cajan (L.) Huth*) grown under ratoon and in mixture with maize. *Chilean Journal of Agricultural Research*, 72 (1):45-52.

Emefiene, M.E., Joshua, V.I., Nwadike, C., Yaroson, A.Y., Zwalnan, N.D.E. (2014). Profitability Analysis of Pigean Pea (Cajanus cajan) Production in Riyom LGA of Plateau State. *Academic Journal of Interdisciplinary Studies, 3*(7): 44-54.

Esan, V.I., Ojemola, O.I. (2018). Evaluation of production systems, traditional knowledge of pigeon pea (*Cajanus cajan*) and risks of extinction of pigeon pea, jack bean (*Canavalia ensiformis*) and lubia bean (*Lablab purpureus*) in some parts of South-West Nigeria. *Journal of Experimental Agriculture International*, 21 (4):1-11.

Ezeaku, I.E., Ajeigbe, H.A., Okechukwu, E.C. (2016). Evaluation of introduced pigeon pea *(Cajanuscajan* (l.) Millsp.) genotypes for growth and yield performance in Sudano-Sahelian ecology of Nigeria. *The Journal of Animal & Plant Sciences*, 26 (1): 163-169.

Falola, A., Achem, B.A., Oloyede, W.O., Olawuyi, G.O. (2017): Determinants of commercial production of wheat in Nigeria: A case study of Bakura Local Government Area, Zamfara State. *Trakia Journal of Sciences*, 15(4): 397-404.

Falola, A., Mukaila, R., Ahmed, A.O. (2022a). Commercialization of Bambara nut production in Nigeria. *Yuzuncu Yil University Journal of Agricultural Sciences*, 32(2): 351-361.

Falola, A., Mukaila, R., Abdulhamid, K.O. (2022b). Informal finance: its drivers and contributions to farm investment among rural farmers in Northcentral Nigeria. *Agricultural Finance Review*, 82(5): 942-959.

FAO, IFAD, UNICEF, WFP & WHO. (2021). *The State of Food Security and Nutrition in the World 2021. Transforming food systems for food security, improved nutrition and affordable healthy diets for all*. Rome, FAO.

Gbaguidi, A.A., Dansi, A., Loko, L.Y., Sanni, A. (2013). Diversity and agronomic performances of the cowpea (*Vigna unguiculata* Walp.) landraces in Southern Benin. *International Research Journal of Agricultural and Soil Sciences*, 3:121–33.

Gbigbi, T.M. (2021). Technical efficiency and profitability of cassava production in delta state: a stochastic frontier production function analysis. *Journal of Tekirdag Agricultural Faculty*, 18 (1): 21-31.

Ghosh, B.K. (2021). Changing scenario of crop diversification in Nepal: delineating the role of trade openness, urbanization and rural infrastructure. *Journal of Tekirdag Agricultural Faculty*, 18 (4): 599-612.

Guest, G., Bunce, A., Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, 18 (1): 59–82.

Hailua, G., Manjureb, K., Aymutc, K.-M. (2015). Crop commercialization and smallholder farmers livelihood in Tigray region, Ethiopia. *Journal of Development and Agricultural Economics*, 7 (9): 314-322.

Jaganathan, G.K., Liu, B. (2014). Traditional method of storing pigeonpea (*Cajanus cajan* L.) seeds using red. *Research Journal of Recent Sciences*, 3 (10): 48-52.

Kirchherr, J., Charles, K. (2018). Enhancing the sample diversity of snowball samples: Recommendations from a research project on anti-dam movements in Southeast Asia. *PLoS ONE* 13(8): e0201710.

Mamudu, A.A., Emelia, G., Samuel, K.D. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? *Journal of Biology, Agriculture and Healthcare*, 2 (3): 1–13.

Marin, A., dos Santos, D.M.M., Banzatto, D.A., Ferraudo, A.S. (2004). Seed germination of pigeon pea (*Cajanus cajan* (L.) Millsp.) under water stress and aluminium sub-lethal doses. *Bragantia*, 63: 13-24.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Social Research.*, 11(3): 1-19.

Mukaila, R., Falola, A., Egwue, L.O. (2021). Income diversification and rural smallholder farmers' income in Enugu state Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 21 (3): 585–592.

Mukaila, R., Falola, A., Akanbi, S.O., Egwue, L.O., Obetta, A.E., Onah, T.L. (2022a). Effects of vegetable production on income and livelihood of rural households in Nigeria. *Mustafa Kemal University Journal of Agricultural Sciences*, 27 (2): 213-223.

Mukaila, R., Falola, A., Akanbi, S.O., Aboaba, K.O., Obetta, A.E. (2022b). Drivers of poverty among rural women in Nigeria: Implications for poverty alleviation and rural development. *Journal of Rural and Community Development*, 17 (1): 32–48.

Nin, A., Arndt, C., Precktel, P. (2003). Is agricultural productivity in developing countries really shrinking? New evidence using a modified nonparametric approach. *Journal of Development Economics*, 71: 395-415.

Odeny, D.A. (2007). The potential of pigeon pea [*Cajanus cajan* (L.) Millsp.] in Africa. *Natural Resources Forum*, 31: 297–305.

Ogutu, S.O., Qaim, M. (2019). Commercialization of the small farm sector and multidimensional poverty. *World Development*, 114: 281–293.

Oladele, O.I. (2005). A Tobit analysis of propensity to discontinuous adoption of agricultural technology among farmers in south-western Nigeria. *Journal of Central European Agriculture*, 6 (3): 249-254.

Onyebinama, U.A.U. (2012). Economics Incentive and Strategies for Commercialization of Agriculture in Nigeria. *African Journal of Business and Economic Research*, 1 (2): 182 – 184

Padulosi, S., Thompson, J., Rudebjer, P. (2013). Fighting Poverty, Hunger and Malnutrition With Neglected and Underutilized Species (NUS): Needs, Challenges and the Way Forward. Bioversity International, Rome.

Rabbi, F., Ahamad, R., Ali, S. (2019). Determinants of commercialization and its impact on the welfare of smallholder rice farmers by using Heckman's two-stage approach. *Journal of the Saudi Society of Agricultural Sciences*, 18 (2): 224–233.

Tipraqsa, P., Schreinemachers, P. (2009). Agricultural commercialization of Karen Hill tribes in northern Thailand. *Agricultural Economics*, 40 (1): 43–53.

Valenzuela H. (2011). Pigeon pea: a multipurpose crop for Hawaii, March–April–May edition. Hawaii: Hanai'Ai/The Food Provider. pp. 1–8.

Waldman, K.B., Ortega, D.L., Richardson, R.B., Snapp, S.S. (2017). Estimating demand for perennial pigeon pea in Malawi using choice experiments. *Ecological Economics*, 131: 222–230.

World Bank (2022). Food security and covid-19. https://www.worldbank.org/en/topic/agriculture/brief/food-security-and-covid-19. (Accessed 23/03/2022).

Yaro, J. A., Teye, J.K., Torvikey, G.D. (2017). Agricultural commercialisation models, agrarian dynamics and local development in Ghana. *The Journal of Peasant Studies*, 44 (3): 538-554.