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Analyzing the Adoption of Improved Production Technologies among Cassava Contract and Non-Contract Farmers in Kogi State, Nigeria

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ABSTRACT

This study assessed the adoption of improved production technologies among cassava contract and non-contract farmers in Kogi State, Nigeria. These technologies are improved variety, recommended time of planting, recommended planting space and depth, use of herbicide for weed control, and tractorization, among others. Primary data obtained were analysed using descriptive and inferential statistics. Education, sex, access to extension services, awareness of contract farming, and farming experience were found to influence farmers' participation in contract farming. Most of the cassava contract farmers are in the trial and actual adoption stages, while the non-contract farmers are in the interest and evaluation stages. Furthermore, 69.2% and 10.8% of the contract and non-contract cassava farmers, respectively, are in the high adoption category; 24.2% and 57.5% of the contract and non-contract farmers are in the medium adoption category, while 6.7% and 31.7% of the contract and non-contract cassava farmers are in the low adoption category. The ordered logit regression model indicated that participation in contract farming, household size, education, and awareness of contract farming have a significant influence on the likelihood of adoption of improved cassava production technologies. Cassava contract farmers recorded an annual average output of 48.77 tons, while the non-contract farmers obtained a mean annual output of 19.03 tons. The mean difference among the two groups was 29.74 tons with a calculated z-value of 15.47, significant at the 1% significance level. The study recommended cassava farmers' enrolment in formal education programme and participation in contract farming.

تحليل اعتماد تقنيات الإنتاج المحسنة بين مزارعي الكسافا المتعاقدين وغير المتعاقدين في ولاية كوجي ، نيجيريا

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الخلاصة

قامت هذه الدراسة بتقييم اعتماد تقنيات الإنتاج المحسنة بين مزارعي الكسافا المتعاقدين وغير المتعاقدين في ولاية كوجي، نيجيريا. وتتمثل هذه التقنيات في تحسين التنوع، والوقت الموصى به للزراعة، ومساحة وعمق الزراعة الموصى بهما، واستخدام مبيدات الأعشاب لمكافحة الأعشاب الضارة، والجر، من بين أمور أخرى. وقد تم تحليل البيانات الأولية التي تم الحصول عليها باستخدام الإحصاء الوصفي والاستنتاجي. وتبين أن التعليم والجنس والحصول على الخدمات الإرشادية والوعي بالزراعة التعاقدية والخبرة الزراعية تؤثر على مشاركة المزارعين في الزراعة التعاقدية. معظم مزارعي الكسافا المتعاقدين هم في مراحل التجربة والتبني الفعلي، في حين أن المزارعين غير المتعاقدين هم في مرحلتي الاهتمام والتقييم. علاوة على ذلك، فإن 69.2% و10.8% من مزارعي الكسافا المتعاقدين وغير المتعاقدين، على التوالي، ينتمون إلى فئة التبني العالي؛ 24.2% و57.5% من المزارعين المتعاقدين وغير المتعاقدين ينتمون إلى فئة التبني المتوسط، بينما 6.7% و31.7% من مزارعي الكسافا المتعاقدين وغير المتعاقدين ينتمون إلى فئة التبني المنخفض. أشار نموذج الانحدار اللوغاريتمي المرتب إلى أن المشاركة في الزراعة التعاقدية وحجم الأسرة والتعليم والوعي بالزراعة التعاقدية لها تأثير كبير على احتمالية اعتماد تقنيات إنتاج الكسافا المحسنة. وسجل مزارعو الكسافا المتعاقدون متوسط إنتاج سنوي قدره 48.77 طن، في حين حصل المزارعون غير المتعاقدين على متوسط إنتاج سنوي قدره 19.03 طن. وكان متوسط الفرق بين المجموعتين 29.74 طن مع قيمة z محسوبة قدرها 15.47، وهي مهمة عند مستوى دلالة 1%. وأوصت الدراسة بالتحاق مزارعي الكسافا ببرنامج التعليم الرسمي والمشاركة في الزراعة التعاقدية.

الكلمات المفتاحية: التبني، الكسافا، الزراعة التعاقدية، التقنيات

INTRODUCTION

Adopting improved agricultural technologies has been linked to various positive outcomes, including higher earnings and reduced poverty, better nutritional status, lower staple food prices, and more employment opportunities for landless labourers (Kasirye, 2010). According to Ravallion and Chen (2004), this adoption is a key driver of enhanced productivity and improved welfare for farmers.

Contract farming in Nigeria is associated with linking smallholder farmers to potential markets. According to Dubbert *et al*. (2021), contracting companies usually provide farmers with production inputs such as fertilizer and pesticides to grow the contract crop under predefined conditions for export. Contract farmers are required to achieve higher output levels and maximize profits. Contract farming is an agreement between a buyer and farmer(s), which provides conditions for producing and marketing agricultural produce or products (FAO, 2008). Contracts with farmers can help mitigate the risks associated with disease and adverse weather conditions, as well as simplify the process of obtaining certifications increasingly required by developed markets. Additionally, contract farming can offer significant advantages for national economies by promoting economies of scale. This approach is likely to contribute to a more vibrant and dynamic agricultural sector (Collier and Dercon, 2014).

The concept of contract farming, as explained by the Food and Agriculture Organization (FAO) in 2008, refers to collaborative agricultural production governed by an agreement between farmers and a buyer. This agreement sets forth the terms and conditions for the cultivation and marketing of agricultural products. Engaging in contracts with farmers not only serves to mitigate risks associated with diseases and adverse weather conditions but also facilitates the attainment of certification, a requirement increasingly mandated by sophisticated markets. Moreover, contract farming holds the potential to yield advantages for national economies by fostering economies of scale. Collier and Dercon (2014) posit that such economies of scale can contribute to the dynamism of the agricultural sector.

Cassava is explicitly suited for this study because it is the major contract crop under contract agreement among available organizations in Kogi State. Several studies have shown that participation in contract farming plays a crucial role in the transition to modern agriculture and significantly improves the living conditions of many smallholder farmers worldwide. It does not only enable smallholder farmers to overcome market and production barriers, and to sell their products on international markets, but also encourages the adoption of modern or improved farming technologies which leads to higher yields, higher incomes, and to improved food security (Dubbert *et al.*, 2021; Maertens and Velde, 2017; Minot and Sawyer, 2016; Ton *et al*., 2018; Wang *et al*., 2014).

Despite the available literature on the economic impacts of contract farming (Azumah *et* al., 2016; Setboonsarng *et al*., 2008; and Cai *et al*., 2008), studies that have examined its effects on the adoption of improved agricultural production technologies are scarce. Furthermore, aside from the geographical or locational difference, the available studies mentioned above did not consider cassava, which remains a major crop in Nigeria and Kogi State in particular.

The cassava production technologies considered in this study are recommended agronomic practices and processing. According to Nsoanya and Nenna (2011) and FAOSTAT (2020), the following cassava production practices are critical for increased productivity; use of improved variety, use of tractor to make ridges, improved or modern processing methods, recommended time of planting, recommended planting space and depth, proper site selection, purchase of inputs from recommended dealers, use of herbicides for weed control, and use of pesticides, among others. The non-adoption of these recommended practices or technologies has negative implications for the productivity and commercialization of smallholder farming.

In Nigeria, limited research has explored the benefits of farmers participating in contract farming, with insufficient focus on the factors influencing their decision to engage in such arrangements (Gabriel et al., 2017; Miet and Vande, 2017; Akanbi et al., 2019). Olomola (2010) emphasized the importance of creating effective mechanisms and institutional arrangements to enhance productivity and sustain agricultural growth through contract farming. Understanding these drivers of farmer participation is crucial for government and relevant agencies to formulate policies, legislative frameworks, and programs related to contract farming. Therefore, the findings from this study aim to encourage smallholder farmers in Kogi State, Nigeria, to participate in contract farming. The study identified socioeconomic, institutional, and other factors influencing

these decisions, and the impact of participation on the adoption of improved cassava production technologies and farmers' output.

Objectives of the Study

i. describe the socioeconomic characteristics of cassava farmers.
ii. determine factors that influence cassava farmers' participation in cassava contract farming.
iii. ascertain the stages of adoption of improved cassava production technologies by contract and non-contract cassava farmers.
iv. examine the adoption category among contract and non-contract cassava farmers.
v. determine factors that influence the adoption of improved cassava production technologies among the respondents.
vi. evaluate the effect of participation in cassava contract farming on farmers' output.
vii.

METHODOLOGY

The study area is Kogi State, Nigeria (see Figure 1). The State benefits from river valleys and swamp lands suitable for dry-season farming. Major crops include cassava, yam, maize, sorghum, rice, millet, cowpea, pigeon pea, groundnut, cocoyam, sweet potato, beniseed, melon, banana, plantain, and cotton. Additionally, the area cultivates fruits and leafy vegetables such as okra, pepper, fluted pumpkin, and spinach. Tree crops like cocoa, cashew, oil palm, citrus, coffee, and kola nut are also grown. Major animals reared are cattle, sheep, goats, and poultry. Fishing is very common along the riverine areas.

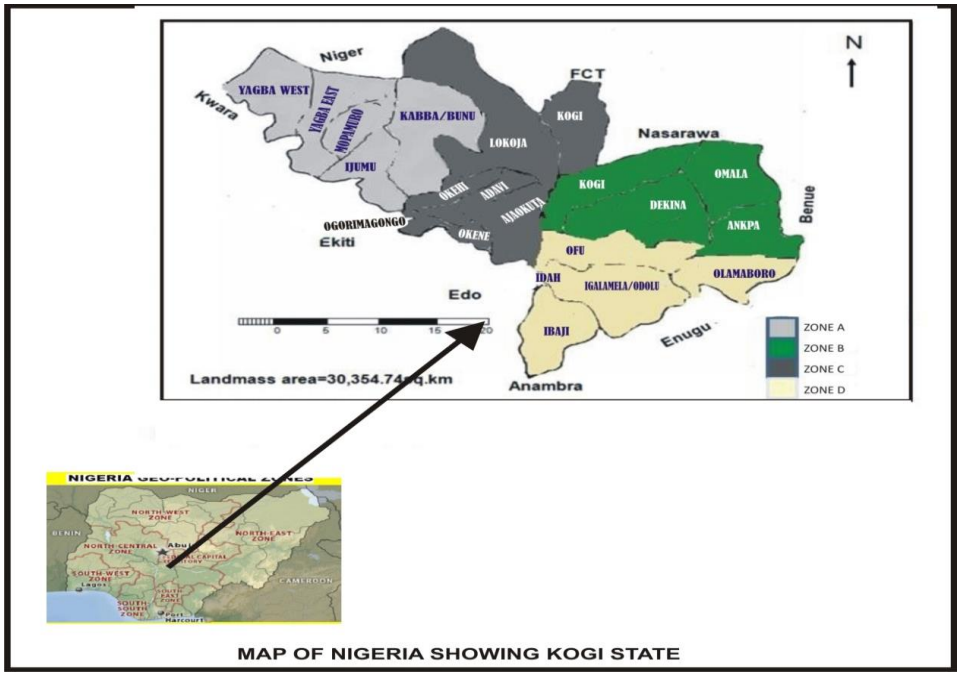

Figure 1: Geographical location of Kogi State and its agricultural zones on Nigeria's map

This study adopted the descriptive survey research design. A survey was carried out to obtain relevant data concerning the stated research objectives. The population for this study

comprised all contract and non-contract cassava farmers in Kogi State, Nigeria. To achieve the objectives of the study and test the hypotheses, two broad categories of respondents were surveyed. A sample of 120 contract cassava farmers and 120 non-contract cassava farmers were selected using a proportionate random sampling technique. Lists of registered contract cassava farmers were obtained from the available contractors in Kogi State.

Table 1: Sampling Procedure

Senatorial Districts	**Clusters**	**No. of Contract Farmers**	**Sample Size for Contract Farmers**	**Sample Size for Non-Contract Farmers**
Kogi Central	Adavi, Achabo, Gegu, Lokoja (Crest farmers)	1,390	31	31
Kogi East	Ojapata, Olamaboro, Ajaokuta, Ankpa	2,810	62	62
Kogi West	Ado Ape, Egbeda, Iyara, Ayere	1,206	27	27
Total	**12**	**5,406**	**120**	**120**

A total of 240 smallholder farmers were sampled and used for the study. The proportionate model is as specified: nh = Nh (n/N)
where; nh = sample size from contract list, Nh = sample frame, n = sample size from each group, N = Total number of farmers from the selected location.

A multi-stage sampling technique was used for the selection of the respondents for the study. The first stage involves the selection of the three (3) senatorial districts (Kogi West, East and Central) in the State. In stage two, four (4) farmer clusters as delineated by contracting organizations in Kogi State were randomly selected from each senatorial district. A total of twelve (12) cassava contract clusters in Kogi State were used for the study. The third stage involves the random selection of ten (10) cassava contract farmers from each of the selected clusters. Therefore, the sample size for cassava contract farmers is 120. To ensure balance in sample selection, an equal number of non-contract cassava farmers were selected from each of the locations where contract cassava farmers were randomly selected.

The primary source of data collection was used for the study. The primary data were collected with the aid of a structured questionnaire which was administered to the respondents by the researcher and research assistants. The research assistants were properly trained on the content of the questionnaire so that they could approach the farmers in their local dialect and apply relevant research ethics.

The content validity of this research instrument was determined experts in the Department of Agricultural Economics and Extension, Kogi State University, Anyigba, Nigeria through proper scrutiny. The instrument was pilot-tested with 30 cassava farmers in Ologba, Dekina Local Government Area of Kogi State, who were not included in the main study. Necessary adjustments were made to enhance clarity and reliability. The reliability of the instrument was assessed using Cronbach's alpha, resulting in a coefficient of 0.79, confirming its reliability.

Primary data obtained for this study were analysed using descriptive and inferential analytical tools. Objective 1 was achieved using descriptive statistics of frequency distribution and percentages. Objective 2 was achieved using the binary logit regression model. Objective 3 was achieved using descriptive statistics and mean scores from the Likert scale (following Uzochukwu

et al., 2021 and Obianefo *et al.*, 2020). Objective 4 was achieved using descriptive statistics, while objectives 5 and 6 were achieved using the ordered logit regression model and z-test, respectively.

Model Specification

Binary Logit Regression Model

The explicit form of the logit regression model used in this study is specified below:

$$PCF = \frac{P_i}{1-P_i} = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + Ui$$

The explanatory or independent variables include:

X_1 = household size (number)

X_2 = education (educated = 1, otherwise = 0)

X_3 = sex (male = 1; female = 0)

X_4 = access to extension services (access = 1, no access = 0)

X_5 = farm size for cassava production (hectares)

X_6 = awareness (aware of contract farming = 1; otherwise = 0)

X_7 = cassava farming experience (years)

Adoption Score

Following Olumba and Rahji, (2014) and as used by Shaibu (2022), in developing the adoption score, a cassava farmer (respondent) scores one for each improved cassava production technology adopted. The extent of adoption was obtained from the adoption score as given below:

Extent of Adoption	**Adoption Score**
High Adoption	> 7
Medium/Moderate Adoption	4 – 7
Low Adoption	< 4

Ordered Logit Regression Model

The model can be generally stated as:

$Y_i^* = X_i\beta_i + \mathcal{E}$

Where Y_i^* is unobserved. What is observable is:

$Y = 1$ if $Y_i^* \leq 0$

$= 2$ if $0 < Y_i^* \leq \mu_1$

$= 3$ if $\mu_1 < Y_i^* \leq \mu$

$= j$ if $Y_i^* \geq \mu_{j-1}$

$\mu's$ = unknown threshold parameters to be estimated with β.

The observed ordinal variable (dependent variable) takes on values 1– 3, indexing the category of adoption (high = 3, moderate = 2, low = 1). To obtain this variable, farmers were grouped based on the extent of adoption as specified previously.

Like the models for binary data, this study is concerned with how changes in the predictors translate into the probability of observing a particular ordinal outcome.

β= a vector of estimated parameter

$\mathcal{E}$ = the error term

Xi = individual farmers' variables to be considered in the study and these include:

X_1 = Participation in cassava contract farming (1 for participants, otherwise, 0)

X_2 = Household size (number)

X_3 = Education (educated = 1; otherwise = 0)

X_4 = Sex (1 = male, female = 0)

X_5 = Extension access (1 = access to extension services, otherwise, 0)

X_6 = Farm size (hectares)

X_7 = Awareness (1 if aware of contract farming, otherwise, 0)

X_8 = farming experience (years)
ε_i = error term

Z-Statistics

Comparing male and female production capacities (output and income) in cassava contract farming was analysed using Z-test as given below:

$$Z = \frac{Xcf - Xnf}{\sqrt{\frac{S^2Xcf}{Ncf} + \frac{S^2Xnf}{Nnf}}}$$

Where:
Xcf = Mean of the contract cassava farmers' output
Xnf = Mean of the non-contract cassava farmers' output
S^2Xcf= Squared variance of the contract cassava farmers' output
S^2Xnf = squared variance of non-contract cassava farmers' output
Ncf = Number of contract cassava farmers' output
Nnf = Number of non-contract cassava farmers' output

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Results of the socioeconomic characteristics of contract and non-contract farmers are presented in Table 2.

The dominance of male cassava farmers over their female counterparts for both contract and non-contract farmers is typical of farming households in Africa. The result could be associated with the nature of cassava farming activities which require some level of energy. However, the study found an impressive percentage for the level of female involvement in cassava production among the non-contract farmers. This is in tandem with the position of the FAO that, over 70% of smallholder farming operations are carried out by women. This result agrees with Ajieh (2014). The findings of this study further agree with Uzochukwu *et al*., (2021) when they reported that 51.67% of cassava farmers in Anambra State were males.

The mean age of 37.20 years and 56.77 years recorded among the cassava contract and non-contract farmers in the study area implies that cassava farmers in the area are in their active productive age and this age will help encourage easy adoption of improved cassava production technologies. This is so because existing studies confirm that, youths are early adopters of agricultural innovations compared to aged farmers. The outcome of this study on age distribution is in tandem with Uzochukwu *et al.* (2021) and Omolehin *et al*. (2020) who reported an average age of 46 years among cassava farmers under the Nigeria Agricultural Transformation Agenda.

Table 2 further shows that 84.17% and 82.50% of the contract and non-contract farmers are married. The higher percentage of married cassava farmers among the contract and non-contract farmers is an indication that cassava farming is dominated by the married population. A smaller percentage of the respondents are in other martial categories. The result of this study could imply the sustainability of cassava production. This agrees with Omolehin *et al*. (2020) who reported that 68.33% of cassava farmers were married.

Table 2: Socioeconomic Characteristics of Contract and Non-Contract Cassava Farmers

	Contract Farmers			Non-Contract Farmers			Pooled		
Socioeconomic Variables	**Freq.**	**%**	**Mean**	**Freq.**	**%**	**Mean**	**Freq.**	**%**	**Mean**
Sex									
Male	87	72.50		61	50.83		148	76.67	
Female	33	27.50		59	49.17		92	38.33	
Age									
20 – 40	91	75.83	37	39	32.50	57	130	54.17	55
41 – 60	27	22.50		30	25.00		57	23.75	
61 – 80	02	1.67		51	42.50		53	22.08	
Marital Status									
Divorced	01	0.83		03	2.50		04	1.67	
Married	101	84.17		99	82.50		200	83.33	
Single	18	15.00		18	15.00		36	15.00	
Occupation									
Farming	46	38.33		65	54.17		111	46.25	
Civil Service	24	20.00		31	25.83		55	22.92	
Public Service	15	12.50		10	8.34		25	10.42	
Trading	25	20.83		12	10.00		37	15.42	
Artisanship	10	8.33		02	1.67		12	5.00	
Education									
Informal	01	0.83		30	25.00		31	12.92	
Primary	15	12.50		16	13.33		31	12.92	
Secondary	60	50.00		34	28.33		94	39.17	
Tertiary	44	36.67		40	33.33		84	35.00	
Farming Exp.									
1 – 10	86	71.67	10.4	23	19.17	21.95	109	45.42	18.75
11 – 20	27	22.50		67	55.83		94	39.17	
21 – 30	07	5.83		30	25.00		37	15.42	
Farm Size									
0.1 – 2	25	20.83	3.14	63	52.50	0.77	88	36.67	2.83
2.1 – 4	91	75.83		47	39.17		138	57.50	
4.1 and above	04	3.33		10	8.33		14	5.83	
Family Size									
1 – 4	61	50.84		55	45.83		116	48.33	
5 – 8	52	43.33	5	62	51.67	5	114	47.50	5
9 – 12	07	5.83		03	2.50		10	4.17	
Extension									
Access	118	99.16		28	23.33		146	60.83	
No access	01	0.84		92	76.67		93	38.75	
Annual Income									
Below 100,000	18	15.00		41	34.17	131,40	59	24.58	144,550.
100,000 – 200,000	55	45.83	309,55	43	35.83	9.66	98	40.83	88
201,000 – 400,000	21	17.50	5.38	29	24.17		50	20.83	
Above 400,000	26	21.67		07	5.83		33	13.75	

Source: Field Survey, 2022

Farming was recorded as the major occupation among the contract and non-contract farmers. This shows that most of the respondents took farming as their main occupation. This finding agrees with Adejo *et al*., (2019) who reported that farming was the major occupation among rural households in Kogi State, Nigeria. The impressive percentage of literate cassava farmers reported in this study is expected to increase farmers' likelihood of adopting improved cassava production technologies. This finding agrees with Uzochukwu *et al*. (2021) who found

that most of the cassava farmers in Anambra State, Nigeria attained at least, the secondary educational qualification.

The study recorded an average farming experience of 10.4 years and 21.95 years among cassava contract farmers and non-contract farmers, respectively. The reported mean years spent farming in this study implies that cassava farmers in the study area have adequate farming experience which is one of the important factors in the adoption of improved agricultural production technologies. This result agrees with Jean *et al*. (2019) who reported that 66.8% of cassava farmers in Kabare Territory, Eastern Democratic Republic had an experience ranging between 11 to 20 years.

The higher average farm size among the contract farmers when compared with their counterparts who are not into any form of contractual agreement could be associated with the former's access to productive resources. Contract farmers have access to resources such as finance, technical advisory services, agrochemicals, and ready markets, which influence their scale of production. The reported average farm size among the non-contract farmers is like the report of Uzochukwu *et al*. (2021) when they found a mean farm size of 0.15 hectares among cassava farmers in Anambra State, Nigeria.

The average household size among both contract and non-contract cassava farmers in the study area was about five persons. This suggests that cassava farmers had a sufficient household size to rely primarily on family labour rather than hired labour. This observation aligns with Margaret and Samuel's (2015) findings, which indicated that household size is often a measure of labour availability in developing countries, including Nigeria.

Cassava farmers with contractual agreements had more access to agricultural extension services than their counterparts. The higher percentage recorded among the contract farmers could be associated with the nature of the contractual agreement which includes technical advisory services to ensure Good Agricultural Practices (GAP). The result among non-contract farmers confirms the existing farmer-extension gap in Nigeria. The finding among cassava contract farmers agrees with the findings of Alarima *et al*. (2020) who revealed that the majority (87.3%) of the farmers had an extension contract.

Following the higher farm size recorded which is associated with access to production inputs, the cassava contract farmers had higher annual income from cassava production than the non-contract farmers. The average annual income recorded was ₦309,555.38 and ₦131,409.66 among the cassava contract and non-contract farmers, respectively. This suggests that cassava production is a profitable endeavor, allowing farmers to use the income generated to invest in improved cassava production technologies. This finding is consistent with Udousung et al. (2018), who studied the adoption of indigenous methods for treating malaria among cassava farmers in Akwa Ibom State, Nigeria.

Factors that Influence Cassava Farmers' Participation in Contract Farming

The outcome of the binary logit regression on factors that influence cassava farmers' participation in contract farming is presented in Table 3. The table further shows the marginal effect derived from the logit regression model. Considering the econometric importance of marginal effects, interpretation and discussion of the result are based on the outcome of the marginal effects.

Table 3: Estimates of binary logit

Variables	Coeff.	Std. Error	Prob.	mfx (marginal effect)
Household size (numbers)	-0.124	0.079	0.116	-0.029 (0.117)^{NS}
Education (dummy)	1.384	0.465	0.003	0.275 (0.000)***
Sex (dummy)	0.946	0.387	0.015	0.213 (0.010)***
Extension access (dummy)	4.401	1.131	0.000	0.542 (0.000)***
Farm size (hectares)	0.195	0.197	0.321	0.046 (0.317)^{NS}
Awareness (dummy)	2.927	0.442	0.000	0.541 (0.000)***
Farming experience (years)	-0.073	0.027	0.008	-0.017 (0.007)***
Constant	-6.908	1.535	0.000	
Log likelihood = -97.937				
LR Chi^2 = 136.84 (0.000)***				
Pseudo R^2 = 0.411				

Source: Computed from Field Survey Data, 2022 Figures in parentheses are probability values. *** = significant at 1%, ^{NS} = Not Significant

The model's log-likelihood ratio of -97.937 and $\chi 2$ value of 136.84 indicates that all variables in the model significantly determined farmers' cassava farmers' participation in contract farming at a 1% level of significance. By implication, the model is a good fit and results obtained from the model can be discussed.

Table 3 shows that, out of the seven (7) explanatory variables included in the binary logit regression model, variables relating to education, sex, access to extension services, awareness of contract farming, and farming experience were found to be highly significant at 1 % level of significance, implying that these variables were the important factors influencing farmers' participation in contract farming in the study area. The marginal effect of household size and farm size were not significant at the level of probability measurement, implying that these variables were not important factors influencing cassava farmers' participation in contract farming in the study area.

The marginal effect of education was positive and significant at a 1% level of significance. This implies that cassava farmers' participation in contract farming increases by 27.5% among the literate cassava farmers compared with the farmers who cannot read and write. This finding could be associated with the fact that educated farmers can search for relevant information or digest extension service messages on contract farming and its related benefits. The finding of this study is in line with the report of Swain, (2012) among gherkin and paddy seed contract farmers in Andhra Pradesh, India. It however contradicts Nazifi and Hussaini (2021) who found that more formally educated farmers are less likely to decide to participate in contract farming; this may be because those educated farmers mostly rely on off-farm activities as a means of income, hence affecting their decision on contract farming participation. The magnitude of sex was positively significant in influencing farmers' participation in contract farming and this magnitude was significant at a 1% level of significance. This finding implies that the likelihood of farmers' participation in contract farming increases among the male cassava farmers by 21.3% compared with the female farmers. This finding could be associated with the decision-making abilities of male household heads or farmers, a typical situation in an African setting. The magnitude of access to extension services is also positively signed and significant at a 1% level of significance in influencing the decision to participate in contract farming. This result implies that the likelihood of participating in contract farming among cassava farmers in the study area is favoured among farmers who have access to extension services by 54.2% than those who have not. This finding is

consistent with Azumah et al. (2016), who reported that Ghanaian farmers with more frequent interactions with agricultural extension officers were significantly more likely to engage in contract farming than those with fewer or no contacts. They found that the likelihood of contract participation increased by approximately 46.6%. The crucial role of extension services in influencing farmer decisions has been highlighted in numerous studies, including those by Doss and Morris (2001) and Ransom et al. (2003).

The magnitude of awareness was positive and significant at a 1% level of significance. This is in line with the *a priori* expectation. This result implies that the probability of participating in contract farming is increased among farmers who are aware of contract farming than those who are not. The likelihood of participation among the aware farmers increases by 54.1%. This finding is in tandem with Nazifi and Hussaini (2021) who found that period of awareness of maize contract production influenced farmer's decision to participate in contract farming. The authors positioned that farmers with adequate knowledge of contract farming operations are more likely to participate in the agreement.

The magnitude of farming experience was negative and significant at a 1% level of significance. The finding on farming experience is however not in line with the *apriori* expectation. This result implies that cassava farmers' participation in contract farming decreases with an increase in the number of years spent farming. The likelihood of participation in contract farming reduces by 1.7% with a one-year increase in farming experience.

Stages of Adoption of Improved Cassava Production Technologies

The distribution of cassava contract and non-contract farmers in their stages of adoption of improved cassava production technologies is presented in Table 4.

Table 4: Stages of Adoption of Improved Cassava Production Technologies

	Contract farmers							Non-Contract Farmers						
Technologies/Stages	**1**	**2**	**3**	**4**	**5**	**Mean Score**	**Remark**	**1**	**2**	**3**	**4**	**5**	**Mean Score**	Remark
Site selection	02	0	03	17	98	4.7	Stage 5	21	10	77	08	04	2.7	Stage 3
Use of tractor to prepare land	0	0	0	41	79	4.6	Stage 5	53	33	19	11	04	2.0	Stage 2
Input from approved dealer	0	0	0	0	120	5.0	Stage 5	74	45	0	0	01	1.4	Stage 1
Use of improved variety	0	0	0	0	120	5.0	Stage 5	69	27	0	0	24	2.0	Stage 2
Ridge planting	0	11	30	71	08	3.6	Stage 4	77	28	10	0	05	1.6	Stage 2
Recommended time of planting	0	0	16	05	99	4.7	Stage 5	16	15	08	62	19	3.4	Stage 3
Recommended planting space and depth	0	0	0	10	110	4.9	Stage 5	29	33	30	18	10	2.1	Stage 2
Fertilizer application	02	14	09	07	88	4.4	Stage 4	48	21	10	31	10	2.5	Stage 3
Herbicide for weed control	0	0	02	0	118	4.9	Stage 5	52	18	8	5	37	2.6	Stage 3
Processing	10	09	22	13	66	3.9	Stage 4	75	08	19	11	07	1.9	Stage 2
Time of harvest	19	08	27	15	51	3.6	Stage 4	44	18	25	17	16	2.4	Stage 2
AGGREGATE MEAN						**4.5**	**Stage 5**						**2.2**	Stage 2

Source: Field Survey, 2022 Stage 1 = Awareness; Stage 2 = Interest; Stage 3 = Evaluation; Stage 4 = Trial; Stage 5 = Adoption

Most of the farmers are already in stages 4 and 5. These stages represent the trial stage and actual adoption. The result further shows that a very few proportion of the cassava contract farmers are in the awareness stage for technologies like processing and time of harvest.

Results in Table 4 also indicate that most of the cassava non-contract farmers are still in stages 2 and 3 of the adoption process. Stages 2 and 3 represent the interest stage and evaluation stage, respectively. A reasonable proportion of the cassava non-contract farmers are also in the awareness stage for most of the improved cassava production technologies considered in this study.

The findings of this study had a cluster mean of 5 and 2 among the contract and non-contract farmers, respectively. The result showed that improved cassava production technologies have been fully adopted by the cassava contract farmers in the study area but have however not been fully adopted by all the non-contract cassava farmers in the State.

The result found that most of the cassava contract farmers are in the adoption stage of the adoption process while very few are in the trial stage. Specifically, contract farmers in the stage were found to be in the adoption stage for technologies such as site selection, tractorization, purchase of inputs from approved dealers, use of improved variety, recommended time of planting, and herbicide control for weeds. It was further shown that contract farmers in the State were found in the trial stage of adoption for technologies such as ridge planting, fertilizer application, processing, and time of harvest. The findings on contract farming could be associated with the mandates of contracting organizations in ensuring the transition of agricultural practice from traditional form to modern method which encourages the use or adoption of improved farming techniques.

Table 4 also reveals that the majority of the non-contract cassava farmers are still in the interest stage of adoption for technologies such as tractorization, use of the improved variety, ridge planting, recommended planting space and depth, processing, and time of harvest. The non-contract farmers were also mostly found in the evaluation stage of the adoption process for technologies such as site selection, recommended time of planting, fertilizer application, and herbicide for weed control. Additionally, most of the non-contract farmers were found in the awareness stage of the adoption process to the purchase of inputs from recommended or approved dealers. The finding of this study among non-contract farmers is like the report of Uzochukwu *et al*. (2021) when they found non-adoption of any of their listed improved cassava production technologies among farmers in Anambra State.

Category of Adoption of Improved Cassava Production Technologies

The adoption of improved cassava production technologies and the category of adoption of the technologies among the contract and non-contract farmers in the study area are presented in Table 5 and Figure 2, respectively.

Table 5: Adoption of Improved Cassava Production Technologies

	Contract Farmers			Non-Contract Farmers			Pooled		
Technologies/Stages	**Freq.**	**%**	**Remark**	**Freq.**	**%**	**Remark**	**Freq**	**%**	**Remark**
Site selection	98	81.7	6th	04	3.3	9th	102	42.5	**6th**
Use of tractor to prepare land	79	65.8	8th	04	3.3	9th	83	34.6	**8th**
Input from approved dealer	120	100	1st	01	0.8	11th	121	50.4	**3rd**
Use of improved variety	120	100.	1st	24	20.0	2nd	144	60.0	**2nd**
Ridge planting	08	6.7	11th	05	4.2	8th	13	5.4	**11th**
Recommended time of planting	99	82.5	5th	19	15.8	3rd	118	49.2	**5th**
Recommended planting space and depth	110	91.7	4th	10	8.3	5th	120	50.0	**4th**
Fertilizer application	88	73.3	7th	10	8.3	5th	98	40.8	**7th**
Herbicide for weed control	118	98.3	3rd	37	30.8	1th	155	64.6	**1st**
Processing	66	55.0	9th	07	5.8	7th	73	30.4	**9th**
Time of harvest	51	42.5	10th	16	13.3	4th	67	27.9	**10th**

Source: Field Survey, 2022

Figure 2 shows the extent of adoption of improved cassava production technologies (categorization of farmers' adoption) for both contract and non-contract farmers (pooled statistic). The categorization was done using the adoption score (a cassava farmer scores one for each improved production technology adopted). From the result (Figure 2), 69.2% and 10.8% of the contract and non-contract cassava farmers, respectively, are in the high adoption category; 24.2% and 57.5% of the contract and non-contract farmers, respectively, are in the medium adoption category, while 6.6% and 31.7% of the contract and non-contract cassava farmers are in the low adoption category.

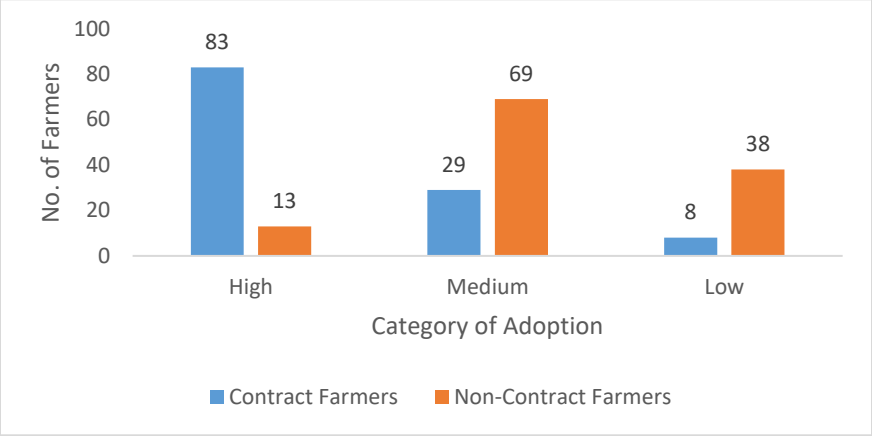

Figure 2: Categorization of Contract and Non-Contract Cassava Farmers on Adoption of Improved Cassava Production Technologies

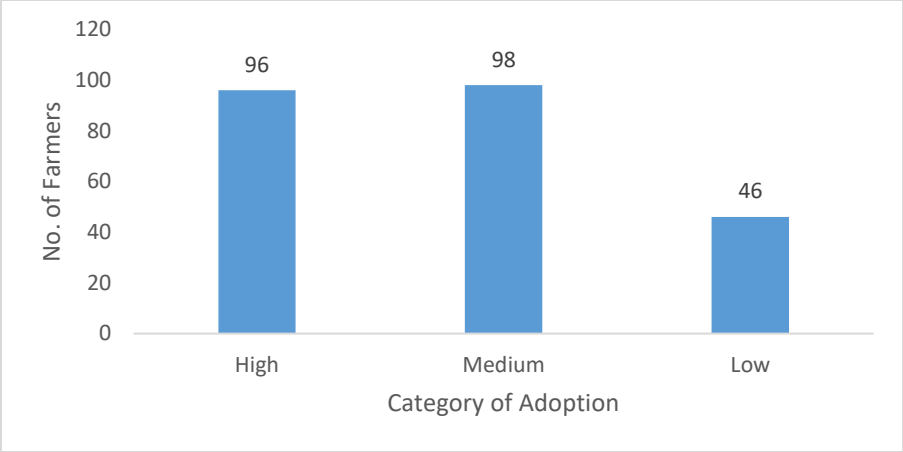

Figure 3: Pooled Statistics on Farmers' Adoption Category

The pooled statistic on farmers' categorization is presented in Figure 3. The essence of this pooled categorization is to help in establishing the determinants of cassava farmers' adoption of improved cassava production technologies during the ordered logit regression analysis. The pooled result reveals that 40%, 40.8% and 19.2% of the cassava farmers are in the high, medium, and low adoption category, respectively.

Factors that Influence Adoption of Improved Cassava Production Technologies

The output of the ordered logit regression model on factors that influence the adoption of improved cassava production technologies is presented in Table 6. The Log Likelihood Ratio (LR) Chi-square statistics of 75.60 was statistically significant ($p< 0.01$) at a 1 % level of significance (99 % confidence). This implies that the included variables in the ordered logit regression model jointly influence cassava farmers' probability of being found in any of the measured adoption categories in this study. Other indicators such as the log-likelihood value of -225.527 and Pseudo R^2 value of 0.144 confirm the viability of the model and hence, interpretations or discussions from this result remain valid. The marginal effects in Table 6 indicate the ordered levels of adoption of improved cassava production technologies. Adoption categories were used as low, medium, and high. The adoption score for individual cassava farmers aided the categorization or grouping of farmers into these three groups. Estimates of the marginal effects were used because its coefficients have direct interpretation and hence aided discussion of the results. The result in Table 6 shows that participation in contract farming, household size, education, and awareness of contract farming have a significant influence on the likelihood of adoption of improved cassava production technologies.

The result indicates that participation in contract farming decreases the probability of cassava farmers being found in the low adoption and medium category by 41.8% and 3.1%, respectively. The likelihood of cassava farmers being found in the high adoption category is increased by 44.9% among farmers who participate in contract farming than those who are not.

The result also found that an increase in household size decreases the probability of farmers being found in the low and medium adoption categories but increases the probability of being found in the high adoption. The result implies that, as the number of persons per household increases, the likelihood of being found in the low and medium adoption categories decreases by 1.7% and 0.1%, respectively; while cassava farmers' likelihood of being found in the medium adoption category is favoured by increased family size at 1.8%.

Educated cassava farmers were also found to be in the higher adoption category than uneducated farmers. The likelihood of being found in the high adoption category increases by 10.5% among educated cassava farmers while the likelihood of being found in the low adoption category decreases by 9.8%. The finding on education is in line with the *apriori* expectation. Expectedly, education will increase farmers' literacy level to improve their ability to follow some adoption instructions for an improved yield. This finding agrees with the study of Onugwu *et* al. (2019) on constraints to the adoption of good agronomic practices among rice farmers in the Anambra State Value Chain Development Programme.

Table 6: Output of the Ordered Logit Analysis on factors that Influence Adoption Category

Variables	Ordered Logit Estimate		Low Adoption Category		Medium Adoption Category		High of Adoption Category	
	Coeff.	**Prob.**	**dydx**	**Prob.**	**dydx**	**Prob.**	**dydx**	**Prob.**
Participation in CF	2.512 (0.367)	0.000^{***}	-0.418 (0.046)	0.000^{***}	-0.031 (0.024)	0.206^{NS}	0.449 (0.052)	0.000^{***}
Household size	0.103 (0.057)	0.073^{*}	-0.017 (0.009)	0.07^{*}	-0.001 (0.001)	0.268^{NS}	0.018 (0.010)	0.067^{*}
Education	0.588 (0.333)	0.078^{*}	-0.098 (0.055)	0.073^{*}	-0.007 (0.007)	0.307^{NS}	0.105 (0.059)	0.075^{*}
Sex	0.290 (0.274)	0.290^{NS}	-0.048 (0.046)	0.289^{NS}	-0.004 (0.004)	0.400^{NS}	0.052 (0.049)	0.287^{NS}
Extension access	-0.448 (0.380)	0.238^{NS}	0.075 (0.063)	0.232^{NS}	0.006 (0.007)	0.422^{NS}	-0.080 (0.068)	0.238^{NS}
Farm size	0.031 (0.130)	0.814^{NS}	-0.005 (0.022)	0.814^{NS}	-0.001(0.002)	0.815^{NS}	0.005 (0.023)	0.814^{NS}
Awareness on CF	-0.788 (0.330)	0.017^{**}	0.131 (0.053)	0.013^{**}	0.010 (0.009)	0.298^{NS}	0.141 (0.059)	0.016^{**}
Farming experience	0.016 (0.017)	0.363^{NS}	-0.003 (0.003)	0.361^{NS}	-0.000(0.000)	0.459^{NS}	0.003 (0.003)	0.361^{NS}
LR Chi^2	75.60	0.000						
Log likelihood	-225.527							
Pseudo R^2	0.144							

Source: Field Survey, 2022

NOTE: Figures in parentheses are standard errors. *** = sig. @ 1% ** = sig. @ 5% * = sig. @ 10% ^{NS} = Not Sig.

The study equally aligned with a study by Ironkwe *et al*. (2016) on the adoption of root and tuber technologies disseminated by the National Root Crop Research Institute in Anambra State, Nigeria.

Awareness of contract farming positively influenced the probability of cassava farmers being in any of the three adoption categories. The result implies that cassava farmers' likelihood of being found in the low, medium, and high adoption categories increased by 13.1%, 10% and 14.1%, respectively. It is said that when the farmers have awareness they will incline toward adoption. This awareness depends upon the efforts and mediums used for the dissemination of information. Awareness creation is the first step toward the adoption of innovative technology (Mahmood and Sheikh, 2005).

Effect of Participation in Cassava Contract Farming on Farmers' Output

The effect of cassava farmers' participation in contract farming on output is presented in Table 7. The result shows an estimate of the z-test on output differential among cassava contract farmers and non-contract farmers. The non-contract farmers were used as a control to show if participation in contract farming is beneficial. The study found a mean annual cassava output of 48.77 tons and 19.03 tons for cassava contract farmers and non-contract farmers, respectively. The recorded difference among the two groups was 29.74 tons. The result further indicates a standard error of 1.71 and 0.87 among the contract and non-contract farmers, respectively. The standard deviation as shown in Table 7 is 18.78 and 9.52 for the contract and non-contract cassava farmers, respectively. The calculated z-value is 15.47, significant at the 1% level of significance. This result implies that cassava contract farmers recorded higher output than their non-contract counterparts. This finding further confirms the role of contract farming in agricultural sustainability and improvement in the scale of production with its associated effect on output or productivity.

Table 7: Effect of participation in cassava contract farming on cassava output

Variable	Mean Output (tons)	Std. Error	Std. Dev.	z-value
Contract farmers	48.77	1.71	18.78	**15.47*****
Non-contract farmers	19.03	0.87	9.52	
Combined	33.90	1.36	21.04	
Difference	29.74	1.92		

Source: Field Survey, 2022 *** **= sig. @ 1%**

This finding aligns with Azumah et al. (2016), who observed that farmers engaged in contract farming typically had higher income levels than non-contracting farmers. Contractors often provide inputs on credit as part of their agreements, which farmers repay in kind or by selling their output to the contractors. These arrangements supply farmers with scarce resources such as improved seeds and fertilizers, leading to better yields. Similarly, Wang et al. (2014) reviewed empirical studies and concluded that contract farming significantly enhances farm efficiency, productivity, and farmer incomes due to the provided resources.

CONCLUSION

This study assessed the adoption of improved cassava production technologies among contract and non-contract farmers in Kogi State, Nigeria. It can be concluded from the findings of this study that cassava farmers' participation in contract farming is determined by socioeconomic, farming, and institutional characteristics. Cassava contract farmers are mostly found in the trial and adoption stages of the adoption process, while the non-contract farmers are in the interest and evaluation stage. Consequently, contract farmers are found in the high-adoption category. The adoption of improved cassava production technologies was influenced by household size, education, and farmers' awareness of contract farming. It can also be concluded from the findings of this study that, participation in cassava contract farming has a significant effect on farmers' output.

Based on findings from this study, the following policy recommendations are made:

1. Education significantly determined farmers' participation in contract farming and the adoption of improved cassava production technologies. Government and relevant stakeholders should endeavour to encourage cassava farmers to enrol in formal or adult education programme. This is necessary because it will improve the literacy level of farmers and enhance their knowledge of improved cassava production technologies.
2. The results of the study indicated that awareness of contract farming favoured farmers' participation in contract farming. Government through extension service delivery should enlighten farmers on the impact of participating in contract farming and how they can have access to contracting companies or organizations.
3. The results of the study showed that farming experience influenced participation in contract farming thus this study recommends that the contracting policies should be based on the existing strengths of the farmers and strengthen the current strategies of extension education.
4. Considering the recorded effects of contract farming on farmers' output, the government should provide a favourable environment through policy formulation and regulation for relevant actors to go into contracting with farmers. The government should also support farmers in the things that facilitate participation in contract farming such as access to credit and extension services.

CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

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