DETERMINANTS OF IMPROVED COCOYAM TECHNOLOGY ADOPTION AMONG SMALLHOLDER FARMERS IN BENUE STATE, NIGERIA

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ABSTRACT
This study examines the influencing effects of education, income, and access to information on the adoption of improved cocoyam technologies by smallholder cocoyam farmers in Otukpo LGA, Benue State, Nigeria. A multi-stage sampling approach was employed to collect primary data from 100 cocoyam farmers who were interviewed using structured questionnaires. Descriptive statistics and a logistic regression model were used to analyze the data. The descriptive results revealed that cocoyam farming is predominantly practiced by females (58%) and married individuals (74%), and that the average age of farmers is 45 years, indicating a productive workforce. Additionally, most respondents had some formal education (80%), whereas contact with extension services was extremely low (5.7%). Access to information was through mobile phones (15.7%) and peer networks (15.6%). The results of the inferential analysis indicate that educational status ($p < 0.05$) and annual income were significant determinants of cocoyam production technology adoption, whereas age, gender, and household size were not. The implication is that the ability to adopt innovations depends more on human capital and financial capacity than on demographic characteristics. The study concluded that limited extension coverage hampers the diffusion of improved practices and therefore recommended that BNARDA prioritize digital extension strategies to improve current access to low-interest credit, thereby enhancing farmers' financial resources and technical capacity and accelerating the transition from traditional cocoyam production in the region.

Keywords: *Adoption, Cocoyam, Education, Information Access and Smallholder Farmers*

INTRODUCTION
Agriculture remains the backbone of Nigeria's economy, accounting for more than three-quarters of rural employment and 23-26% of the country's GDP (World Bank Group, 2025). Within this framework, cocoyam (*Colocasia esculenta and Xanthosoma sagittifolium*) plays both a food security and income-generating role for rural households. Nigeria produces 3.0-3.3 million metric tonnes annually contributing about 28-30 percent of the total 11.3 million global annual production (FAOSTAT, 2022). Despite Nigeria being one of the leading producers of cocoyam globally, the crop remains underutilized and largely cultivated by smallholders using traditional methods and limited inputs.

Benue State is commonly regarded as the 'Food Basket of the Nation'; cocoyam is of great importance to its culture and economy. However, cocoyam production has remained low in the region, due to poor allocation of land for its production and lack of investment in new technologies (Anani & Onumah, 2025).

Despite the large expanse of land available for its production Benue contributes only about 1.5% to the entire Nigeria annual output of cocoyam (NAERLS, 2023). To turn around such a situation, more land needs to be committed to cocoyam production as well as better technologies such as high yielding, disease-resistant varieties, seed dressing techniques, and herbicide for weed with the aim of making cocoyam a viable commercial crop. However, the greatest challenge remains convincing farmers to put more of their land to cocoyam and to take advantage of available technologies and market (Gouroubera *et al.,* 2025).

Despite advances in cocoyam production technologies, adoption among small farmers remains modest to low. The limiting factor is a knowledge as farmers are aware but cannot apply it; there are also structural constraints, such as ineffective extension services and costly inputs, that offset productivity gains (Umar and Sani, 2025).

The government's disregard for cocoyam in the country's agricultural policies has been shown in no incentive to cocoyam producers specifically. In Otukpo Local Government Area, the producers still endure heavy vulnerability to pests and diseases, which affects efficiency in profits (Abdulrahman et al., 2015). Though age and farm size have been put forward, it's quite evident there's no concrete evidence to show how the intersection of education, annual income, and new information affects the cocoyam value chain's adoption. By not specifying the factors, the extension work is diffused rather than focused, which holds production at the subsistence level (Omotesho et al., 2020).

The focus on food security and poverty alleviation articulated in the United Nations' Sustainable Development Goals (SDGs) is the driving force behind this research. According to NAERLS (2023), even though the region has high potential to produce and take advantage of the cocoyam market it has grossly failed in that regard. More specifically, the people of Otukpo LGA are well positioned within the state to become a hub for cocoyam due to their cultural attachment to the crop as well as other available resources at their disposal. There is also on the other hand the issue of limited research about the crop within the zone to enable government and development partners play a role in providing support to this underutilized crop towards helping the people attain food security and alleviate poverty. Hence the right data will allow BNARDA the state extension outfit to focus its extension outreach and design intervention programs. The targeted extension is crucial because the development of human capital is a major trigger for the modernization of agriculture (Umar & Sani, 2025). Hence identifying the farmers needs will help not only in the area of micro-credits to enable them invest in cocoyam but also guidance on adoption of better technology (Anani & Onumah, 2025). With more data about the people cocoyam production, it would be easier to deliver them farming information using ICT via cell phones (Gouroubera *et al.,* 2025). This will eventually help the farmers improve their cocoyam output and income, and the research will provide an academic platform for the revitalization of the cocoyam value chain in Nigeria.

The transition of cocoyam from subsistence to commercial production depends on the adoption of improved technologies, such as high-yielding varieties, seed dressing, and weed control through herbicides. However, adoption of these technologies and practices can be limited by socio-economic considerations. Studies in the existing literature have shown that farmers' capacity to process technological information and incur new technological investment costs largely depends on knowledge and income (Tiamiyu *et al.,* 2024). The underlying research, therefore, seeks to determine the roles of socioeconomic factors and technological information in the adoption of improved cocoyam farming practices in Otukpo, Benue State.

METHODOLOGY

The study was conducted in Otukpo Local Government Area (LGA), Benue State utilizing a multi-stage sampling technique. In the first stage, four (4) council wards (Otukpo North, South, East, and West) were purposively selected due to the high concentration of smallholder cocoyam farming. In the second stage, settlement from each of the selected council wards were purposively selected and a proportional allocation of six percent (0.06) across board was used to determine the sample size to give one hundred (100) respondents. Only Primary data was collected from the farmers who were the respondents using structured questionnaires and interview schedules. The data collected was analyzed using descriptive statistics (frequencies, percentages, and means) to describe socio-economic profiles and information sources while Inferential statistics, specifically the Logit Regression Model, was employed to determine the factors influencing adoption.
The model is implicitly expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e$$

Where Y is the adoption status, and $X_{1\text{-}n}$ represent socio-economic variables.

RESULTS AND DISCUSSION

Socio-economic profile of respondents

The socio-economic profile (Table 1) reveals a mean age of 45 years, suggesting a workforce within the productive age bracket. This is consistent with Anani and Onumah (2023), who noted that middle-aged farmers are more likely to adopt innovations due to a balanced risk-taking ability. Females dominated the enterprise (58%), reinforcing the findings of Obinne *et al.* (2022) that cocoyam is traditionally viewed as a "woman's crop" in North-Central Nigeria. The high literacy rate (80%) among respondents is a positive indicator for extension service delivery. As argued by Umar and Sani (2024), formal education reduces the complexity of understanding technical manuals and chemical application rates. The average farm size was 1.86 hectares, confirming the smallholder nature of production (Adekoya & Tologbonse, 2021).

Table 1: Socio-Economic Characteristics of Respondents (N = 100)

Variable	Category	Frequency (N)	Percentage (%)	Mean
Age	<= 25.00	7	7.0	**45**
	26.00 - 45.00	48	48.0	
	46.00 - 65.00	37	37.0	
	66.00+	8	8.0	
	Total	100	100.0	
Sex	Female	58	58.0	
	Male	42	42.0	
	Total	100	100.0	
Marital Status	Single	26	26.0	
	Married	74	74.0	
	Total	100	100.0	
Educational Status	Non-formal	20	20.0	**45.00**
	Formal	80	80.0	
	Total	100	100.0	
Farm Experience	2.00 - 6.00	76	76.0	**5 yrs**
	7.00 - 11.00	16	16.0	
	12.00+	8	8.0	
	Total	100	100.0	
Household Size	<= 2.00	19	19.0	**9 persons**
	3.00 - 10.00	42	42.0	
	11.00 - 18.00	34	34.0	
	19.00+	5	5.0	
	Total	100	100.0	
Farm Size	<= 1.00	49	49.0	**2 ha**
	2.00 - 3.00	47	47.0	
	4.00+	4	4.0	
	Total	100	100.0	
Income	<= 200000.00	26	26.0	**443569.00**
	200001.00 - 600000.00	47	47.0	
	600001.00 - 1000000.00	20	20.0	
	1000001.00+	7	7.0	
	Total	100	100.0	

Field Survey: 2025

Information on Improved Cocoyam Production

Table 2 shows the Information source of respondents about improved cocoyam production which revealed more of modern and informal channels.

Table 2 Sources of Information on Improved Cocoyam Production

Variables	Frequency	Percent	Rank
Radio	72	11.7%	4
Relative or Friends	96	15.6%	2
Extension Agents	35	5.7%	8
News paper	43	7.0%	7
Television	81	13.1%	3
Magazines	31	5.0%	9
Circulars	22	3.6%	10
Phones (GSM)	97	15.7%	1
Yam Farmer's Association	72	11.7%	4
Internet	67	10.9%	6

***Field Survey**: 2025. Note: Multiple responses utilized*

Further breakdown shows that mobile phones (15.7%) and peer-to-peer networks (15.6%) ranked as the highest source of information among the respondents about cocoyam production indicating a shift toward reliance on ICTs and their peer which aligns with Bolarinwa *et al.* (2025), who observed that the decline in traditional extension services has forced farmers to rely on mobile-mediated information. The result also shows that there was low extension contact (5.7%) thereby highlighting a critical gap in the public agricultural advisory system, a trend which has also been noted by Zakaria et al. (2021). This gap and increasing reliance on ICT among farmers provide the perfect window for extension agencies to step up their e-Extension services and reach more farmers especially in the face of poor funding for outreaches. The implication of this finding is that extension outfits should invest more in electronic dissemination of Agricultural information as farmers are increasingly getting connected to telecommunication network.

Determinants of improved Cocoyam technology adoption

The logistic regression results (Table 3) show the determinants of cocoyam production in the study area. The result indicate that educational status ($p = 0.013$) and annual income ($p = 0.002$) were the primary drivers of adoption. The significant effect of income suggests that farmers with higher liquidity are better positioned to purchase improved seeds and herbicides. This corroborates the work of Eze and Mbah (2023), who stated that financial capital is the "engine" of technological uptake in rural Nigeria. Interestingly, age and farming experience were not significant, suggesting that adoption in the study area is driven more by capability (knowledge and money) than by years in the field, a finding that mirrors Odoemenam *et al.* (2022). The implication of this finding of significant relationship between educational status and adoption is that there is need for the state extension agency to utilize extension as the platform to strengthen the average cocoyam farmers knowledge on improved technology in cocoyam production as well as the market potential of the products so as to give them the educational needed to make informed adoption decision.

The relationship between income and adoption also means only financially empowered cocoyam farmers can adopt viable technology hence the provision of subsidized improved cocoyam production tools as well as credit line will go a long way in boasting adoption.

Table 3 Test of Hypothesis (Binary Logistic Regression)

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Sex	.634	.537	1.394	1	.238	1.886
Marital Status	1.104	.794	1.932	1	.165	3.016
Age	-.035	.028	1.620	1	.203	.965
Educational Status	-.329	.769	.183	1	.013	.720**
Farm Size	.408	.343	1.414	1	.234	1.503
Farm Experience	.065	.073	.785	1	.376	1.067
Household Size	.051	.053	.926	1	.336	1.052
Income	.000	.000	1.607	1	.002	1.000**
Constant	-1.698	1.423	1.423	1	.233	.183

Field Survey: 2025. * ** *Significant at 1% and 5% level*

CONCLUSION AND RECOMMENDATIONS

The study established that cocoyam is majorly cultivated in Otupko LGA of Benue state Nigeria by farmers mostly of the female gender, aged 25- 45 years, with formal education and cultivate at least 1 hectare. Their major source of information about improved cocoyam production technology comes from ICT (mobile phone) and their peers as well as television and radio. The farmers educational status and income were identified as significant determinants to their adoption of improved cocoyam production technology. This shows they have ability to comprehend technical manuals and scientific process that would help them improve their production as well as independently search information on internet making them clienteles who are very much open to innovation if properly guided.

Based on the above findings the following strategic recommendations are made;

Firstly, it has become obvious that the traditional model of physical extension visits is failing hence with the farmers already utilizing mobile phones extension outfits should adopt the e-Extension model to bring about digital advisory service.

Secondly, localized SMS alerts, weather forecasts, and voice-recorded tutorials in the native Idoma or English languages on technical methods can be delivered directly to the farmer's pocket.

Thirdly, the Benue state extension outfit (BNARDA) should collaborate with the government to roll out Cocoyam-Specific Micro-credit Schemes offered to farmers at flexible repayment schedules to enable them adopt improved cocoyam production technologies.

Lastly, technologies such as yam miniset production can be started by farmers who have such skills to enable farmers buy seedling while it can be expanded into training for others to learn if sponsored by the LGA Agriculture department or BNARDA zonal office.

REFERENCES

Abdulrahman, S., Yusuf, O., & Suleiman, A. (2015). Profit efficiency of cocoyam production in Kaduna State, Nigeria. *American Journal of Experimental Agriculture*, *7*(4), 231-241. https://doi.org/10.9734/ajea/2015/16219

Anani, P. Y., & Onumah, E. E. (2025). The potential and productivity of agriculture in Nigeria: Evaluation of production factors and socio-economic barriers. *Preprints.org*. https://doi.org/10.20944/preprints202507.0223.v1

Gouroubera, M. W., Adechian, S. A., Segnon, A. C., Moumouni-Moussa, I., & Zougmoré, R. B. (2025). Drivers and impacts of mobile phone-mediated scaling of agricultural technologies: A meta-analysis. *Frontiers in Sustainable Food Systems*, *8*, Article 1514546. https://doi.org/10.3389/fsufs.2024.1514546

Omotesho, K. F., Kayode, A. O., Adebayo, S. A., Akinrinde, A. F., & Mohammed, A. J. (2020). Potentials for the commercialization of cocoyam in Oyun Local Government Area, Kwara State, Nigeria. *Agro-Science*, *19*(3), 8-14. https://doi.org/10.4314/as.v19i3.2

Umar, I. S., & Sani, R. M. (2025). Training needs and human capital development as determinants of profit efficiency among farmers. *Nigerian Journal of Agriculture and Agricultural Technology (NJAAT)*, *5*(1A), 53-62. https://njaat.com.ng/index.php/njaat/article/view/1177

Adekoya, A. E., & Tologbonse, E. B. (2021). Smallholder farming systems and the challenge of food security in Nigeria. *Journal of Agricultural Extension*, 25(3), 45-58. Retrieved from https://aesonnigeria.org/journal/index.php/jae

Anani, P. Y., & Onumah, E. E. (2023). Adoption of climate-smart agricultural practices and its impact on smallholder farming households in some rural areas of North-Western Nigeria. *Agricultura Tropica et Subtropica*, 57(1), 1-14. https://doi.org/10.2478/ats-2024-0003

Bolarinwa, O. A., Olaniyi, O. A., & Adewale, J. G. (2025). The role of ICT in transforming agricultural extension in West Africa. *International Journal of Agricultural Economics*, 10(2), 88-101. Retrieved from https://dspace.ksaeu.kherson.ua/handle/123456789/8627

Eze, C. C., & Mbah, E. N. (2023). Survey data on determinants and barriers to the adoption of improved maize seeds among smallholder farmers in the Katangese Copperbelt. *Data in Brief*, 51, 109724. https://doi.org/10.1016/j.dib.2023.109724

FAOSTAT (2022). Crops and livestock products: Taro production data by country and region. Available on https://www.fao.org/faostat/

NAERLS (2026). Agricultural performance survey of 2023 Wet Season (state cocoyam production data). https://www.naerls.gov.ng
Obinne, C. P., Agwu, A. E., & Uzokwe, U. N. (2022). Gender analysis of sweet potato production: The case of farmers in Delta State, Nigeria. *Journal of Agricultural Extension and Rural Development*, 14(2), 210-224. Retrieved from https://dergipark.org.tr/en/pub/jaerd

Odoemenam, I. U., Ayoola, J. B., & Abu, O. (2022). Technical efficiency and technology adoption among cocoyam farmers in Benue State. *Nigerian Journal of Agricultural Economics*, 12(1), 33-44. Retrieved from https://njas.org.ng/index.php/njas

Osuji, E. E., Okwara, M. O., & Anyanwu, U. P. (2023). Value chain analysis of cocoyam enterprise in Southwest Region, Nigeria. *Journal of the Austrian Society of Agricultural Economics*, 17(3), 610-622. https://doi.org/10.35062/jasae.v17i03.610

Tiamiyu, S. A., Akinnagbe, O. M., & Madukwe, M. C. (2024). Human capital development and agricultural innovation systems in Nigeria. *Journal of Extension Systems*, 40(1), 77-92. Retrieved from http://www.jesonline.org/

Umar, I. S., & Sani, R. M. (2024). Training needs of farmers for maize cultivation in Niger State, Nigeria. *Nigerian Journal of Agriculture and Agricultural Technology*, 4(4A), 82-92. https://doi.org/10.59331/njaat.v4i4A.862

World Bank. (2025). Agriculture, forestry, and fishing, value added (% of GDP) – Nigeria. World Bank Data. https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=NG

Zakaria, A., Azumah, S. B., & Appiah-Twumasi, M. (2021). Adoption of climate-smart agricultural practices among farm households in Ghana: The role of farmer participation in training programmes. *Technology in Society*, 63, 101388. https://doi.org/10.1016/j.techsoc.2020.101388