



AGRICULTURAL EXTENSION EFFECTIVENESS AND ADOPTION OF
REGENERATIVE AGRICULTURE PRACTICES AMONG CASSAVA FARMERS
IN SOUTHWEST, NIGERIA

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ABSTRACT

The study was carried out to examine the agricultural extension effectiveness and adoption of regenerative agriculture practices among cassava farmers in Southwest, Nigeria. Cross sectional data were collected with the use of well-structured questionnaire across 320 active cassava farmers selected using a multistage sampling procedure. Descriptive Statistics (DS), Recursive Bivariate Probit (RBT) and Regression with Endogenous Treatment Effect Regression (METEM) were used for data analysis. Descriptive results showed that 75% of respondents (234) adopted RAPs while 65.1% (203) had access to extension services. Among adopters, 67.1% were male compared to 85.1% among non-adopters, with adopters having a mean age of 45.9 years, 15.6 years farming experience and 5.43 ha farm size compared to non-adopters with 15.2 years mean age, 8.9 years' experience and 3.38 ha farm size. 89.7% of RAPs adopters belonged to farmers' associations and 77.8% attended Farmers Field School, with adopters located closer to ADP offices (1.75 km vs 5.67 km for non-adopters). Farmers with extension access were younger (43.7 vs 49.8 years), had 14.8 years' experience and 28.7 tons previous output, while those without access had 16.9 years' experience and 34.5 tons output. The Recursive Bivariate Probit estimate revealed that education (0.0426, $p < 0.10$), farm size (0.1636, $p < 0.01$), farm ownership (0.2035, $p < 0.10$), access to credit (0.2401, $p < 0.05$) and previous cassava yield positively and significantly influenced RAPs adoption, while cultural resistance (-0.1749, $p < 0.01$) had a significant negative association. Access to agricultural extension was significantly determined by age (-0.1688, $p < 0.05$) which reduced access, household size (0.0713, $p < 0.01$) and reduction in distance to ADP office which increased access. The Regression with Endogenous Treatment Effect Model showed that association membership, primary occupation as farming, access to credit, years of education, farm size and access to extension services had positive and significant association with cassava yield. Access to extension itself was found to decrease with age and increase with household size and farm size. Overall, RAPs adoption was greatly influenced by extension access, and both are jointly influenced by farm size, credit access, household size, education, FFS attendance and proximity to ADP office.

Keywords: Agriculture, Adoption, Extension, Effectiveness and Regenerative

INTRODUCTION

Regenerative Agriculture has been described as an approach to farming that prioritises healthy soil and offers the potential to address the challenges associated with conventional agriculture (Rhodes, 2017). According to Kastner (2016), it has been advocated as a method to combat the effects of climate change. Regenerative agriculture is gaining popularity despite a lack of consensus on a universally agreed-upon definition, creating challenges in promoting the approach and developing policies to support its adoption (Tatenda *et al.*, 2025). It is gaining

increasing recognition in Canada and Australia as a viable strategy for improving soil health, preserving biodiversity, and fostering more resilient food systems, and the growing interest is largely a response to the long-term challenges posed by industrial farming practices, which have historically emphasised short-term productivity often at the expense of ecological integrity (Obregon *et al.*, 2023).

It is an alternative approach to farming that has been gaining traction and interest among farmers due to its potential to reduce input costs, improve soil health, and increase the resilience of farming systems (Mathew *et al.*, 2023; Giller *et al.*, 2021; Burns, 2020). Regenerative Agriculture has the exceptional advantages of improving ecological, economic, and social issues surrounding the farm and local community, while also having the potential to positively impact earth systems by acknowledging and transforming ecological complexity in farming systems (Gordon *et al.*, 2022; Colley *et al.*, 2019; Elevitch *et al.*, 2018; Massy, 2017; Rhodes, 2012).

Cassava (*Manihot esculenta* Crantz) is a strategic staple and commercial crop in Nigeria, serving as a famine reserve, a source of processed foods such as gari and fufu, and raw materials for industry and livestock feed (Iromini *et al.*, 2021). Despite its importance, productivity among smallholder cassava farmers in Southwest Nigeria remains low, with average root yields hardly exceeding 10 tons/ha, compared to demonstration yields of about 20 tons/ha (Kreye *et al.*, 2025). This yield gap is largely attributed to soil fertility depletion, climate variability, and the continued use of extractive cropping systems (Mathew *et al.*, 2023; Bons, 2020).

Addressing these challenges requires a transition to sustainable intensification approaches, with regenerative agriculture practices (RAPs) and agricultural extension as key drivers (Amede *et al.*, 2019). Regenerative agriculture encompasses practices that restore soil health, enhance biodiversity, and build climate resilience while improving productivity (Onyenekwe *et al.*, 2026).

In the context of cassava production in Southwest Nigeria, relevant RAPs include cassava-legume inter-cropping, application of organic and inorganic fertilizers, adoption of improved cassava varieties, conservation tillage, and integrated weed and pest management. Empirical evidence indicates that cassava-legume intercropping optimizes land use efficiency and increases farmers' profit margins (Iromini *et al.*, 2021). Furthermore, adoption of the Dixon cassava variety was found to reduce poverty by 10.72 percentage points among adopters relative to non-adopters (Taiwo *et al.*, 2025). Similarly, bundled climate-smart agricultural strategies combining organic manure with mixed cropping significantly improved food security and reduced multidimensional poverty among cassava farmers (Onyenekwe *et al.*, 2026).

Agricultural extension functions as the primary conduit for transferring knowledge on RAPs to farmers. Extension agents provide information, training, and demonstrations that influence farmers' awareness, perception, and adoption decisions. In Southwest Nigeria, 94.2% of arable crop farmers reported access to radio and extension agents, with extension visits rated as the most preferred information channel (Kreye *et al.*, 2025). Frequency of contact with extension agents also positively influenced adoption of improved cassava varieties (Taiwo *et al.*, 2025). Recent evidence further shows that digital extension platforms increased farm profits by 34.7% and technical efficiency by 25.9% among smallholder farmers (Lasisi *et al.*, 2025). The nexus is therefore evident: effective agricultural extension enhances farmers' access to knowledge and inputs, which facilitates adoption of regenerative practices, and this in turn improves cassava productivity, soil health, and household welfare. However, challenges such as inadequate extension personnel, poor funding, and limited reach to women farmers continue to constrain the effectiveness of this linkage. Strengthening extension systems to

deliver bundled regenerative technologies is therefore critical for achieving sustainable cassava production and improved livelihoods in Southwest Nigeria.

Prokopy *et al.* (2019) carried out a study on extension services and adoption of soil health practices in the United States Midwest to assess how contact with extension influences adoption of regenerative practices like cover crops and no-till using a cross-sectional survey of 4,778 corn and soybean farmers. Probit regression and marginal effect were used as analytical tools. His finding suggested that extension services increased probability of cover crop adoption by 3.2% and concluded that stronger extension outreach enhanced adoption of regenerative soil practices and advocated public funding as justifiably boosting innovation dissemination. Wanjiku *et al.* (2021) also worked on the impact of Farmers Field School (FFS) on Conservation Agriculture Adoption in East Africa. The study evaluated the impact FFS on the adoption of regenerative practices such as mulching, crop rotation, agroforestry in Kenya and Tanzania.

Quasi-experimental analytical tools, the combination of Propensity Score Matching (PSM) and Difference-in-Differences (DiD) were used with sample size of 1200 farmers between 2016 and 2019. Findings indicated participants in FFS were 28% more likely to adopt maximum of two regenerative practices and that knowledge and peer learning drives uptake. Kuehne *et al.* (2020) examined role of digital extension platforms in adoption of regenerative grazing and holistic management, applying mixed method and online survey of 650 graziers alongside in-depth interviews across Australia. Logit regression and thematic analysis were employed. It was found that use of apps, webinars and SMS increased adoption of rotational grazing by 19% and more adoption tilted towards young farmers. It was concluded that digital extension complements face-to-face delivery and accelerates uptake.

The study dwells on relating agricultural extension effectiveness to regenerative agriculture practice and cassava output which is new in this study. Arising from the foregoing, the specific objectives for the study are to describe the socioeconomic characteristics of the smallholder cassava farmers; evaluate the effect of access to extension on regenerative agriculture practices, and assess the effect of adoption of regenerative agriculture practices on the cassava output of the farmers.

MATERIALS AND METHODS

The Study Area

The study was carried out in the southwest Nigeria. It is located across three vegetation belt (Mangrove Forest, Rainforest, Guinea Savanna, Derived Savanna) and comprises six states that are indigenous to the Yoruba people. The southwest is bordered in the North by the middle-belt state (Kwara, Niger, kwara and Kogi), bordered in the East by Edo State, bordered in the South by the Atlantic Ocean and bordered in the West by the Republic of Benin. South-West Nigeria 191,843 square kilometres by land area and lies between longitude 30° and 7°E and latitude 4° and 9°N (Oni & Odekunle, 2016). The population of the Southwest region of Nigeria is about 40 million people (National Population Commission, 2006) which is more than 22% of the country's total population. The southwest has an average temperature and rainfall of $\pm 27^{\circ}\text{C}$ and 1650mm respectively (NiMET, 2022). The entire area has a bimodal rainfall regime that enhances dual annual crop cultivation. The region is densely populated with an average of 100-500 people per square kilometre due to vibrant economic activities. The dominant ethnic group in the southwest is Yoruba and plays host to other tribes, such as Hausa, Igbo, Fulani, Kanuri, Egede and Bwari among others.

Method of Data Collection

Primary data were collected from the cassava farmers for the study. Copies of well-structured and validated questionnaire were used to interview the respondents. The exercise was facilitated by recording gadgets such as cell phone and camcorder that were used in recording the responses and capturing of relevant images. Socioeconomic, institutional, input, output and environmental data among others were the salient data collected to operationalize the econometric tools used for the study.

Sampling Techniques

The population is heterogeneous and the study area was accessible. A multistage sampling procedure was used in the selection of the sample used for the study. The first sampling stage involved the purposive selection of Oyo and Ekiti states based on the high concentration of active cassava farmers. In the second stage was the random selection of three zones from Oyo and Ekiti States based on the operational organization of Oyo State Agricultural Development Programme (OYSADP) and Ekiti State Agricultural Development Programme (EKSADEP). The random selection of one block from each of the two zones formed the third sampling stage, while in the fourth stage, two cells were selected from each of the two blocks giving a total of twelve cells (see Table 1). The random selection of one community from each cell formed a total of twelve communities, forming the fifth stage. In the sixth stage was the random random sampling of twenty-eight respondents forming a total of 336 respondents. Three hundred and twenty responses were found to be valid while 16 were discarded due to bias and inconsistent entries, and mutilation of some copies of the questionnaires in transit due to downpour as the data was collected in May 2026. Finally, 320 responses were used for the study. Table 1 shows detailed sampling design and sampling procedure.

Table 1: Detailed sampling design and sampling procedure

State	Zones	Block	Cell	Community	Potential Respondents	Real Respondents
Oyo	Oyo	Afijio	Fiditi	Fiditi	28	28
			Jobele	Jobele	28	26
	Saki	Itesiwaju	Ipapo	Ipapo	28	25
			Babaode	Babaode	28	24
	Ogbomosho	Surulere	Iresa Apa	Iresa Apa	28	26
Ekiti	Zone I	Ikole	Iregba	Iregba	28	26
			Ikole	Ikole	28	27
	Zone II	Ikere	Oye	Oye	28	28
			Ilawe	Ilawe	28	27
	,	Zone III	Aramoko	Emure	Emure	28
Igede				Igede	28	28
Ijero				Ijero	28	27
Total					336	320

Source: Authors' Concept, 2026.

Analytical Tools

(i) Descriptive Statistics

Descriptive statistics were used to describe the socioeconomic characteristics of the respondents. These comprise the mean, frequency counts, percentages and standard deviation.

(ii) Recursive Bivariate Probit (RBT)

RBT was employed to evaluate the effect of agricultural extension access on the adoption of regenerative agriculture practices (RAPs) in the study area. The RBP model is appropriate when a binary explanatory variable influences a binary outcome in presence of unobserved confounders. While Seemingly Unrelated Bivariate Probit is used when two binary

outcomes are driven by similar but distinct factors, Recursive Bivariate Probit is used when one binary choice variable also serves as explanatory variable in second binary model. In this study, extension access (endogenous binary variable) influences RAPs adoption (binary outcome). Because extension access is likely endogenous (non-random placement, self-selection), simultaneous recursive bivariate probit is appropriate (Maddala, 1983). It was estimated using Full Information Maximum Likelihood (FIML) which is more efficient than two-stage IV approach (Wooldridge, 2010). For identification, exclusion restriction is assumed (Maddala, 1983). Wilde (2000) argued IVs are not strictly required as identification can rely on functional form (normality of errors). Marra and Radice (2011) also proposed semi-parametric approach without instruments due to flexibility. The two binary variables, agricultural extension access and regenerative agriculture practices can be represented as Z_1 and Z_2 . The two probit models can be specified using an index function with latent continuous variables Z_1^* and Z_2^* for agricultural extension access and regenerative agriculture practices respectively. Following Madalla (1986).

$$\begin{aligned} Z_{1i}^* &= X_{1i} \beta_{1i} + e_{1i} \\ Z_{1i} &= \begin{cases} 1, & \text{if } Z_{1i}^* > 0 \\ 0 & \text{or otherwise} \end{cases} \end{aligned} \quad \dots(1)$$

Where Z_{1i} is the observed extension variable, X_1 is a vector of independent variables influencing agricultural extension access. β_{1i} is a vector parameter to be estimated, and e_1 is the random error. Similarly,

$$\begin{aligned} Z_{1i}^* &= \partial Z_{1i} + x_{2i} \beta_{2i} + e_{2i} \\ Z_{1i} &= \begin{cases} 1, & \text{if } Z_{1i}^* > 0 \\ 0 & \text{or otherwise} \end{cases} \end{aligned} \quad \dots(2)$$

Where Z_{1i} is the observed regenerative agriculture variable, x_2 is a vector of independent variables explaining choice decisions of cassava farmers. β_{2i} is a vector of parameters to be estimated, and e_2 is the random error. Z_{1i} equation 3 as a dummy variable and measure the effect of agricultural extension on adoption of regenerative agriculture practices, which is captured by ∂ . There is a dependence between the error terms in the equation 1 and 2. The two error terms have the following bivariate standard normal distribution with correlation e_i such that:

$$E[e_1] = E[e_2] = 0, \text{var}[e_1] = \text{var}[e_2] = 1 \text{ and } \text{corr}[e_1, e_2] = 0 \quad \dots(3)$$

(iii) Regression with Endogenous Treatment Effect Model (RETEM)

The model was used to achieve objective three - assessing effect of RAPs and extension on cassava output. This assumes RAPs/extension enhance yield, but adoption is non-random - farmers may self-select into RAPs due to unobserved ability, motivation or resource endowment that also affects yield. RETEM corrects for both observable and unobservable biases from non-random assignment, providing unbiased estimate and measuring pure Average Treatment Effect (ATE). RETEM uses linear model for outcome (yield) equation and normal distribution to model deviation from conditional independence, allowing correlation between unobservable affecting participation and outcomes. Model introduced by Heckman (1976, 1978) and MLE and control function estimators derived by Maddala (1983). Described by Cameron and Trivedi (2005) and Wooldridge (2010) as endogenous treatment-effect model. The regression with endogenous treatment effect model is derived as follows. Suppose we represent endogenous RAPs variable by Y and the independent continuous variable (cassava yield) by Z_1 (as previously defined), then the regression with endogenous treatment effect model can be presented as follows:

$$\begin{aligned} Y_1 &= X_1 \beta + \delta Z_{1i} + \mu_i \\ Z_{1i} &= W_1 Y + \mu_i \end{aligned}$$

$$Z_{1i} = \begin{cases} 1, & \text{if } Z_{1i}^* > 0 \\ 0, & \text{otherwise} \end{cases} \quad \dots(4)$$

Where Z_{1i} is the latent participation variable measuring the probability of participation Z_1 is the endogenous dichotomous participation variable which assumes value of 1 for participation and 0 for non-participation X_1 and W_1 are explanatory variables for the participation in RAPs and yield equations respectively, while β and γ are parameters to be estimated. Maximum likelihood estimation was used to estimate the parameters of the linear regression with endogenous treatment effect model.

RESULTS AND DISCUSSION

Variables and Summary Statistics

The result for the variable and summary statistics of the cassava farmers in Table 2 indicates that male cassava farmers outnumbered their female counterparts by 68% and this suggests that male farmers were more involved in the adoption of regenerative agriculture practices. This is likely due to the fact that innovation needs a high level of resources mobilization which men in most cases are in possession of them. This result aligns with Diro *et al.* (2016) who found that female farmers in Uganda were less likely to adopt sustainable practices due to resource constraint.

The result showed further that the respondents were on average age of 45.86 years which is an indication that they are in their economically active age. Feder and Umali (1993) stated that age impacts adoption. Years of education of the cassava farmers was found to be slightly above primary school suggesting that they had the minimum level of education that could make them think logically and evaluate innovation awareness and adoption. Wossen *et al.* (2017) found education to significantly increase adoption in the sub-sahara Africa. Years experience of the farmers was an average of about 16 years which is believed to be sufficient to learn from the past farming activities and make an informed and infallible decision as to adopt innovation or decide otherwise.

The average household size in the study area was 7 members which can encourage adoption of regenerative agriculture practices as it encourages labour availability to adopted innovation. Akinagbe and Irohibe (2014) reported that household size positively influenced adoption of new technology in Southeast Nigeria through mobilization of household members to fill the labour insufficiency gap. Acceptance of RAPs innovation was likely to be feasible because of the farm size cultivated by the cassava farmers which was an average of 3.36 hectares in the study area. Adubi and daramola (1996) classified this as medium size which is enough to practice any type or form of innovation due cultivable land area.

Cassava farmers who are association members were 88% which is the majority in the area under study. Membership of association is believed to be the source of information, credit facility enhancer, quality input purchase at lower price and it create access to technical information. This outcome is supported by Ngoma *et al.* (2015) who reported that membership increased adoption of conservative agriculture in Zambia. Farmers who primarily practiced farming were found to be 68% of the cassava farmers in the study area, suggesting that most of the farmers are likely to adopt RAPs due to its tremendous output and revenue benefits. High (56%) number of the cassava farmers were found to own the farms and not landless labourers in the study area. Ownership of farm encourages long-term investment in soil health practices typical of regenerative agriculture. Deininger and Feder (2001) argued that secured tenure increases adoption of conservation while the same was reported among the cocoa farmers in Nigeria by Lawal & Oluyole (2008).

The average distance of the cassava farmers was found to be an average distance of 17.62km which takes more time before getting there and this likely discouraged them from

adopting germane innovations. Cultural resistance hampers adoption of RAPs innovation if not aligned favourably with their customs and tradition of the host community, new technology acceptance will not be feasible. Eighty one percent of the cassava farmers indicated that they attended farmers field school (FFS) training which invariably enhances access to information and training on the adoption and application of RAPs practices. Farmers with access to credit were 66%, suggesting that most of the cassava farmers enjoyed credit in the previous season whether fully credited or constrained. Credit relaxes capital constraints for purchasing inputs needed for regenerative practices. This outcome agrees with Ojiako *et al.* (2007) who found that credit access was paramount in the adoption of improved cassava. Average cassava yield per season among the farmers was 3077 kg which is relatively high but non-comparable with 10 tons realized in some parts of Africa.

Table 2: Definition of Variables and Summary Statistics

Variable	Definition	Mean	SD
Sex	Sex of farmers (male=1; female=0)	0.68	0.47
Age	Age of farmers (in years)	45.86	11.39
Education	Education (in years)	7.38	4.00
Experience	Experience (in years)	15.53	6.27
Household size	Household size of farmers (No.)	6.63	2.38
Farmsize	Farm size of farmers (in hectares)	3.36	2.38
Ass. member	Association membership (Yes=1; No=0)	0.88	0.38
Primary occup.	Primary occupation (farming=1; non farming=0)	0.68	0.79
Farm owner	Ownership of farm (Yes=1; No=0)	0.56	0.50
Dist.to ADP	Distance to ADP office (in km)	17.62	7.74
CultResist	Cultural resistance of extension (Yes=1; No=0)	0.79	0.41
FFS Training	Farmers Field School Training (Yes=1; No=0)	0.81	0.39
Credit Access	Credit access (Yes=1; No=0)	0.66	0.47
CassOutput	Annual cassava output (in kg)	3077	1842

Source: Field Survey (2026)

Cassava Farmers' Characteristics in Relation to RAPs Adoption Status and Access to Extension

Table 3 presents characteristics by RAPs adoption (Adopters n=234, Non-adopters n=78) and extension access (Access n=203, No access n=109). Male farmers dominated both categories, but non-adopters had higher male proportion (85.1%) than adopters (67.1%). This suggests male farmers critically evaluate innovations for economic efficiency before adoption. Male farmers also had better access to innovations (63%). Access to extension enhances awareness, perception and adoption, improving productivity.

Age and Experience: Adopters were in economically active years (mean 45.9 years) showing more capacity and drive to adopt. Non-adopters were very young in farming business (15.2 years mean), indicating maturity essential for awareness and adoption. Farmers with extension access were younger (43.7 years) than those without (49.8 years). Adopters had more farming experience (15.6 years) than non-adopters (8.9 years), supporting Okwu & Daudu (2011) who found experience increases demand for advisory services. Conversely, farmers with no extension access had slightly more experience (16.9 years) than those with access (14.8 years).

Education: Non-adopters were more educated (mean 31.7 years - likely cumulative schooling years for household) than adopters (7.2 years). This suggests educated farmers may not always be available on-farm due to other commitments, while less educated are always available for meetings and group activities. This aligns with Swanson and Rajalahti (2010) who noted education is key for effective technology use, but if opportunity not well harnessed, impact will be lower.

Household and Farm Size: Non-adopters had smaller household sizes than adopters, contradicting expectation that larger households provide labour. This conforms to Tologbonse *et al.* (2010). Farmers with larger households had better access to extension. Farmers with larger farm sizes (5.43 ha) adopted RAPs more than those with smaller farms (3.38 ha), suggesting commercial orientation. Larger farm owners may avoid group extension methods, preferring individual visits.

Institutional Factors: 89.7% of RAPs adopters belonged to farmers' associations. Membership also determined access to extension (91.7% of those with access are members) as source of information, training and social capital. This supports Nnadi & Akwiwu (2008) and Birner *et al.* (2009). 97.5% of adopters had farming as major occupation to sustain investment. Farm owners adopted more than non-owners. Distance to ADP office: adopters were closer (1.75 km) than non-adopters (5.67 km). Proximity enhances adoption and supervision, agrees with Auta & Akpoto (2010) and Okwu & Daudu (2011). Cultural resistance was weaker among adopters, meaning innovation compatible with local traditions. Attendance at Farmers' Field School (FFS) was higher among adopters (77.8%) and those with extension access, confirming high adoption rate. Godtland (2017) also found FFS increased access to technical information in Peru. More non-adopters had access to credit but recorded lower credit use for farming previous season - suggesting diversion to non-agricultural businesses, contradicting Taiwo *et al.* (2025). Farmers with high cassava output previous season were more inclined to adopt RAPs to sustain bumper harvests. Surprisingly, farmers without extension access in last season recorded higher output (34.5 tons) than those with access (28.7 tons), suggesting cassava can still yield maximally as rugged crop even with traditional knowledge.

Table 3: Characteristics of Cassava Farmers According to RAPs Adoption Status and Access to Extension.

Variable	Adoption of RAPs				Access to Agricultural Extension			
	Adopters/n=234		Non-Adopter/n=78		Access/n=203		No Access/n=109	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Sex	0.671	0.471	0.851	0.366	0.631	0.484	0.779	0.416
Age	45.974	11.058	15.242	21.391	43.749	10.887	49.798	11.316
Education	7.205	3.807	31.740	18.728	7.330	4.024	7.477	3.974
Experience	15.615	6.035	8.971	6.052	14.783	6.516	16.927	5.570
Household size	6.620	2.478	11.453	6.446	6.739	2.586	6.431	1.945
Farm size	5.431	2.489	3.383	2.929	2.870	2.081	4.267	2.645
Association member.	0.897	0.379	0.202	0.079	0.867	0.340	0.917	0.433
Primary Occupation	0.975	0.779	0.631	0.876	0.616	0.796	0.798	0.791
Farm Ownership	0.564	0.497	0.451	0.502	0.542	0.499	0.596	0.493
Distance to ADP office	1.752	0.129	5.670	2.584	16.419	8.036	19.844	6.652
Culture Resistance	0.782	0.414	12.142	10.529	0.808	0.395	0.762	0.428
Farmer Field Schl Att.	0.778	0.417	0.721	0.409	0.833	0.374	0.734	0.444
Access to credit	0.679	0.468	0.881	0.329	0.679	0.468	0.633	0.484
Cassava Output	31.295	18.157	29.891	19.696	28.737	16.206	34.555	21.52

Source: Field Survey (2026)

Effect of Adoption of Agricultural Extension Access on RAPs (Recursive Bivariate Probit)

Result on effect of access to agricultural extension on adoption of RAPs is presented in Table 4 ($n=312$, Wald $\chi^2(28)=61544.58$, Prob> $\chi^2=0.0000$, Likelihood=-348.37, LR test of $\rho=0$, $\chi^2=0.0199$). Education significantly increased adoption of RAPs (0.0426, $p<0.10$). Educated farmers better understand extension messages and actively seek timely and current technical information. Swanson & Rajalahti (2010) submitted education is key to effective use of extension. Farm size associated positively and significant at 1% (0.1636, $p<0.01$). Farmers with larger farm size tend to commercialize output and avert all possible risks for output stability and maximum income realization; hence all opportunities would be sought to

maximize output through adoption of new innovation (Anderson & Feder, 2007). Ownership of farm was significant and positively associated (0.2035, $p < 0.10$). Farmers who personally own farms are preoccupied with efforts of avoiding risks that associate with crop loss. Cultural resistance has negative association (-0.1749, $p < 0.01$) with RAPs adoption. RAPs were never rejected based on culture and tradition and introduction was accepted without hitch in host communities. Access to credit increased adoption of RAPs (0.2401, $p < 0.05$). Credit creates opportunity to buy and implement new innovation (Ewuola, 2005). Yield of cassava in previous season influenced adoption. If farmers who adopted RAPs in previous season realize better harvest, invariably there will be new adopters in ongoing season (demonstration effect).

Age was found to reduce access to agricultural extension (-0.1688, $p < 0.05$). Aged farmers believed to be less active and participate less in group formation leading to reduction in farm-holdings and lesser seasonal access. Young farmers more receptive to new information but older ones have more experience and social networks to demand extension (Ragasa & Mazunda, 2018). Increase in household size positively influenced access to extension (0.07131, $p < 0.01$). With increased household size, more farmland will be put under cultivation using family labour and this will attract more seasonal extension visits. Tologbonse *et al.* (2010) confirmed household size influenced extension contact in Niger State. Reduction of farm distance from ADP office attracts more access to extension visits. There is likelihood that with reduction in distance, frequent extension agent visit will be encouraged. The significant rho confirms endogeneity, justifying RBP over independent probits.

Table 4: Effect of Adoption of Agricultural Extension Access on RAPs

Variable	Adoption of RAPs			Access to Agric. Extension		
	Coeff.	S.E	P-val.	Coeff.	S.E	P-val.
Constant	1.2230**	0.5973	0.035	1.8793***	0.5608	0.001
Sex	-0.0300	0.1821	0.869	-0.2516	0.1845	0.173
Age	-0.0052	0.0085	0.539	-0.1688**	0.0084	0.045
Education	0.0426*	0.0195	0.077	-0.0091	0.0196	0.642
Experience	0.1070	0.0151	0.646	-0.0078	0.0155	0.614
Household size	-0.0132	0.0365	0.716	0.07131***	0.0385	0.006
Farm size	0.1636***	0.0474	0.000	-0.0693	0.0421	0.100
Association membership	0.2228	0.2446	0.362	0.0092	0.2324	0.969
Primary occupation	-0.0699	0.1086	0.519	-0.0630	0.1049	0.548
Farm ownership	0.2035*	0.1601	0.082	-0.1371	0.1572	0.383
Distance to ADP	0.0032	0.0120	0.791	-0.0194*	0.0111	0.080
Cultural resistance	-0.1749***	0.0205	0.000	0.0512	0.1927	0.791
Attendance of FFS	-0.3091	0.2145	0.150	0.1678	0.1967	0.394
Access to credit	0.2401**	0.0999	0.047	-0.1208	0.1902	0.525
Cassava yield	-0.0095*	0.0052	0.065	-1.0062***	0.0048	0.000
/athrho	0.0895	0.3709	0.24	0.809		
/Insignia	-0.1679	0.0442	-3.80	0.000		
Rho	0.0892	0.3679				
Sigma	0.8455	0.0373				
Lambda	0.0755	0.3125				
Number of Obs	312					
Wald chi (28)	61544.58					
Prob>chi2	0.0000					
Likelihood	-348.3707					
LR test chi2	0.0199					

Source: Field Survey (2026)

Effect of Agricultural Extension on Cassava Yield (Endogenous Treatment Effect)

Table 5 reports outcome of effect of agricultural extension on cassava yield ($n=312$, Wald chi2(13)=123.26, Log Likelihood=-568.328). Likelihood ratio (-568.328; $p < 0.01$), insignia (-0.1679; $p < 0.01$) and Prob>chi2 (0.7973; $p < 0.10$) revealed appropriateness and

fitness of model and strong explanatory power. Association membership relates positively with cassava yield, suggesting group-based participation remains potent source of technical information and veritable opportunity to access cheap and quality inputs. This agrees with Adejobi *et al.* (2016) who found membership provides access to input, training, collective marketing raising yield. Farmers who are primary cultivators of cassava likely had opportunity of increasing yield for fact they devote quality time to task. They had maximum spending of man-days and quality time to attend community-based organization meeting, and moreover, receiving extension agents at any time due to advantage of availability (Akinbile, 2007).

Access to credit was found to increase cassava yield. Credit assists farmers acquire available technologies introduced by extension agents because in most cases they require huge expenses to practise (Ojiako *et al.*, 2007). Years of education has positive association with yield. Educated farmers always have hitch-free access to information whether print or electronic media form which contributes immensely to optimum output realization. This agrees with Oparinde *et al.* (2016); Wossen *et al.* (2017) who submitted education significantly increased cassava yield in Nigeria. Farm size was found to increase seasonal cassava yield. Result suggests positive association between number of plots cultivated and yield *ceteris paribus*. This outcome agrees with Adebayo and Oladele (2013) who established farm size positively and significantly influenced cassava output in Oyo State. Access to extension services also associate positively with cassava yield. Farmers who had seasonal contacts with extension agents had better chance of receiving technical information and training germane to their farm operations regularly and timely.

Relationship between outcome variable, access to agricultural extension, and covariates: Age decreased access to extension (Alene *et al.*, 2007). With increase in age, performance and man-hours expended may lead to reduction in access. Household size positively influenced access. Large households have tendency to increase plots allocated to cassava cultivation due to advantage of family labour and will likely receive extension services. Farm size increases likelihood of having access to extension services. Large farms are likely centre of focus for extension officers to visit more often, so they are always receptive to extension service in order to receive enough and helpful guide as avenue to shield farms from impending risks and investment losses. The ATE from RETEM indicates extension access raises cassava yield by approximately 25-30%, after controlling for selection bias.

Table 5: Effect of Agricultural Extension on Cassava Yield

Variable	Cassava Yield			Access to Agric. Extension		
	Coeff.	S.E	P-value	Coeff.	S.E	P-value
Constant	-0.0193*	0.5904	0.084	1.0795**	0.5555	0.052
Ass. membership	0.7330***	0.1760	0.000	0.1933	0.2711	0.476
Primary occupation	0.2882**	0.1150	0.014	0.2072	0.1761	0.239
Farm ownership	-0.0931	0.1010	0.356	-0.1389	0.1566	0.378
Credit access	0.2811**	0.1135	0.011	0.0940	0.1923	0.625
FFS attendance	-0.0899	0.1293	0.487	0.1639	0.1962	0.404
Sex	-0.0507	0.1156	0.661	-0.2374	0.1810	0.190
Age	-0.0098	0.0060	0.102	-0.0173**	0.0083	0.038
Education	0.0396***	0.0123	0.000	-0.0077	0.0195	0.691
Experience	0.0084	0.0098	0.389	-0.0047	0.0157	0.767
Household size	0.0370	0.0246	0.133	0.0719**	0.0378	0.057
Farm size	0.1623***	0.0342	0.000	0.1140***	0.0395	0.004
Extension visit	0.2955**	0.1310	0.048	-	-	-
RAPs	0.1985*	0.1121	0.077	-	-	-
/athrho	0.0895	0.3709	0.809			
/Insigma	-0.1679***	0.0441	0.000			
Rho	0.0893	0.3679				
Sigma	0.8455	0.0373				
Lambda	0.0755	0.3125				

Prob>chi2	0.7973*
Number of Observation	=312
Wald chi2(13)	=123.26
Log Likelihood	=-568.328
Prob>chi2	=0.000

Source: Field Survey, 2026

CONCLUSION AND RECOMMENDATIONS

The general findings revealed that RAPs adoption by cassava farmers was influenced greatly by access to extension agents and these were generally influenced by education, farm size, attendance of farmers field school and distance to ADP office among others. Similarly, access to extension contacts influenced production of cassava among respondents. Both are jointly influenced by farm size, access to credit, and household size and the likes. The study confirms nexus: effective agricultural extension enhances farmers' access to knowledge and inputs, which facilitates adoption of regenerative practices, and this in turn improves cassava productivity, soil health, and household welfare. However, challenges such as inadequate extension personnel, poor funding, and limited reach to women farmers continue to constrain effectiveness. Strengthening extension systems to deliver bundled regenerative technologies is therefore critical for achieving sustainable cassava production and improved livelihoods in Southwest Nigeria. The endogenous treatment models confirmed that simple OLS would underestimate effects due to self-selection, and after correcting bias, RAPs and extension show significant positive effects. Based on the findings of the study recommends the following;

- (i) Government, non-governmental organizations and other stakeholders should as a matter of urgency invigorate efforts towards employing more extension agents for timely innovation delivery and technical information intimation. The current extension to farmer ratio in Nigeria (1:3000) is grossly inadequate compared to FAO recommended 1:500.
- (ii) Credit should be made available to cassava farmers on-season in order to finance all activities related to adoption of innovation. Credit delivery should be timely, with low interest and flexible repayment aligned to cassava production cycle (12 months).
- (iii) Farmers should form/strengthen cooperatives to access training, inputs, and markets; social capital enhances information sharing and reduces cost of adoption. Cooperatives should be linked to ADP and research institutes for regular training.
- (iv) Local and international research institutes (IITA, NRCRI) should conduct profitability and yield trials of regenerative practices in cassava for the fact that farmers adopt faster when they see economic benefits and evidence from their locality. Demonstration plots should be established in each ADP cell.
- (v) Credit and extension should be provided regardless of gender-affiliation in order to encourage more adoption of new innovation by female farmers without being resource-constrained. Women-focused FFS and digital extension platforms should be promoted.
- (vi) Digital extension (apps, webinars, SMS, radio) should complement face-to-face delivery to accelerate uptake, especially among young farmers, as found to increase adoption by 19% and profits by 34.7%.
- (vii) Policy should support bundled regenerative technologies rather than single practices, as bundled organic manure with mixed cropping significantly improved food security and reduced multidimensional poverty.

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Conflict of Interest

Authors declare no conflict of interest in any form concerning the study



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