**Gender Disparities in The Adoption of Akilimo Cassava Advisory Tools and Productivity in Ogun State, Nigeria**

***Abstract***

*This study investigates Nigeria's low digital agricultural technology acceptance rates by studying gender disparity and developing inclusive policies for both sexes. It presents empirical evidence on the use of the Akilimo Cassava Advisory Tool, a digital tool that provides cassava farmers with agronomic guidance to help them make better decisions. The data for this study was collected through interviews and questionnaires distributed to 329 farmers who cultivate cassava and who were chosen randomly through multistage sampling technique. Descriptive statistics, logit regression model and Average Treatment Effects (ATE) model served as the basis for conducting the analysis. The study reveals that male farmers had higher adoption rates of the Akilimo tools at 33.03% compared to female farmers who adopted at 27.93%. Overall, only 31% of cassava farmers adopted the tools. Their low rate of adoption are due to low awareness of the tool, inability to get the recommended cassava and maize varieties, high herbicide prices and tool skepticism. The barriers to adoption particularly oppressed female farmers which intensified the gender gap in adoption rates. Factors influencing adoption included household farming members, income contributors, native status, cooperative membership, marital status (single), and food expenditure. Male farmers showed superior advantages from Akilimo than female farmers because they received better resources coupled with advisory information. The statistical evidence validates that Akilimo tool adopters achieved higher cassava yields at a significance level (p-value = 0.048). All agricultural farm sizes derive improved productivity benefits from implementing Akilimo cassava advisory tools. Therefore, the Akilimo tool developers should team up with various government agencies to develop new training initiatives to teach farmers about the platform usage. To achieve widespread coverage of these programs, farmer cooperatives and radio broadcasts, along with community demonstrations, should be used. Also, the Akilimo tools developer should develop offline capabilities, which will minimize data expenses.*

**Key words:** Cassava productivity, Akilimo Cassava Advisory Tools, Gender disparities, Technology adoption, Nigeria

**Introduction**

Cassava is an important food crop and source of income for rural people in Nigeria, because of its drought-tolerant, pest and disease resistant, and resilient on marginal soils. Its tubers are abundant in carbohydrates, predominantly starch and year-round availability. It has multiple uses and is preferred over seasonal crops such as grains, peas, and beans for food security, and poverty reduction, making it economically significant for millions of smallholder farmers (OECD-FAO, 2015; Sanusi *et al.,* 2020). According to Okebiorun *et al.* (2018), cassava is an inexpensive and dependable source of food for about 700 million people in developing countries. Agunbiade and Oke (2019), also highlighted that cassava crop has always played critical roles, including revenue for farmers, serving as a low-cost food sources for both rural and urban dwellers, and contributing to household food security.

Nigeria has been the leading cassava producer in both Africa and the world for the past six decades, accounting for 19.5% of the world's total cassava production (FAOSTAT, 2021). In 2022, Nigeria maintained its position as the largest producer of fresh cassava in Africa, with a production volume exceeding 60.8 million metric tons (Sasu, 2024). However, the country faces challenges in meeting international and domestic market demands due to climate change, soil fertility issues, pests and diseases, weed management, storage problems, land degradation, slow adoption of improved cassava varieties, limited market access, food policy changes, inefficiencies in the extension delivery system and Limited access to modern technologies (Osuji et al., 2023; Bethel and Nwokah 2024).

To fully harness cassava production, productivity and processing capacities and also effectively fulfill market demands in Nigeria, the Federal and State governments have launched initiatives programs such as the Presidential Cassava Initiative (PCI, implemented between 2001 and 2007), the Integrated Cassava Project (ICP), implemented between 2002 and 2010; the Root and Tuber Expansion Programme (RTEP); and the Agricultural Transformation Agenda (ATA), implemented between 2015 - 2019 (Donkor et al., 2017; Omolehin et al., 2020). In addition to these programs, the use of digital tools has improved cassava production, productivity, and processing. Notable examples include the eWallet System (introduced in 2012 as part of the Growth Enhancement Support [GES] scheme), Farm Radio International Programs (since 2015), the IITA Herbicides Calculator (launched in 2018), and the Akilimo Cassava Advisory Tool (implemented in 2020).

Akilimo Cassava Advisory Tool is a digital agricultural service designed to provide farmers with valuable agronomic advice, empowering them to make well-informed decisions regarding their farming practices. It was developed by Africa Cassava Agronomy Initiative (ACAI) and coordinated by the International Institute of Tropical Agriculture (IITA). Akilimo has been developed to provide site-specific recommendations for fertilizer application, weed management strategies, best planting practices, and intercropping practices with sweet potato (in Tanzania) and maize (in Nigeria) to improve cassava farmers’ profits, livelihoods and agricultural practices (ACAI, 2021).

Gender disparities in the adoption of technology in cassava production have been extensively researched, with multiple studies demonstrating how unequal access to resources and socio-cultural factors affect productivity. Teeken et al. (2018) examined trait and varietal preferences of men and women cassava farmers in eight communities in Southwest and Southeast Nigeria. Results showed high genetic diversity, high yield, early maturity, and root size as important traits, with gender preference influencing access to stem sources. Olupona et al. (2022) evaluated agricultural cooperative participation, gender disparities, and adoption of biofortified cassava varieties (BCVs) among cassava farmers in Oyo State, Nigeria. Their findings showed that non-adopters, particularly males, are older, and that men possess more land than women. The majority of farmers are aware of biofortified cassava varieties (BCVs), but only slightly more than average have adopted them, with female farmers accounting for the lowest percentage. Similarly, Adesiyan et al. (2023) investigated a gendered approach to determinants of adoption of cassava-legume intensification technology and its impact on households’ poverty status in innovation platforms of Southwestern, Nigeria. The study found that cassava-legume intensification technology adoption was low (28.06%), with female households having a 3.20% higher adoption rate than male households. Abioye et al. (2024) investigated the factors influencing smallholder farmers’ willingness to adopt digital application tools in Ogun State, Nigeria, focusing on the IITA herbicide calculator and Akilimo mobile applications. The study found that education, training, internet connection, smartphone ownership, readiness to utilize paid applications, application tools awareness, and the cost of digital tools positively affect farmers' adoption. Female farmers, on the other hand, were less eager to use digital application tools.

Despite government support for agricultural technology, adoption rates remain low in Nigeria, hindering agricultural productivity and growth. Gender disparities further affect technology adoption, limiting the benefits for male and female farmers, as digital advisory tools like Akilimo may not be equally accessible to all. Understanding these disparities is crucial for designing gender-inclusive policies.

Based on this backdrop, this study aims to bridge these gaps by providing empirical evidence on gender differences in the adoption of the Akilimo Cassava Advisory Tool and identifying strategies to enhance its accessibility and effectiveness among farmers. Specifically, it will examine the socioeconomic characteristics of farmers, the determinants of adoption, productivity differentials between adopters and non-adopters, and the overall impact of Akilimo adoption on cassava productivity.

**2.0 Methodology**

**2.1 Study Area**

The study was carried out in Ogun State. The state is located between latitudes 60 20' and 70 58' and longitudes 20 40' and 40 35' East of the Greenwich Meridian with a population of over 7 million people (Ogun State, 2020). It shares an international boundary with the Republic of Benin to the west, and interstate boundaries with Oyo State to the north, Lagos State to the south, and Ondo and Osun States to the east. The state covers 16,432 square kilometers of land in the tropics, and has 20 local government areas (LGAs), with Abeokuta as its capital (Ogun State, 2020; Ibrahim et al. 2023). To facilitate agricultural administration, the Agricultural Development Programme (ADP) splits Ogun state into four (4) ADP zones: Abeokuta, Ikenne, Ijebu-Ode, and Ilaro. Ogun State is located between rainforest and derived savanna zones that are suited for mass food production (Adekoya, 2014). The majority of the state's rural residents are farmers (Ibrahim et al., 2019), and they grow a variety of food crops including cassava, maize, yam, banana, rice, and cocoa.

**2.2 Data Collection**

The study employed primary data which included structured questionnaires together with an interview guide. A multistage random sampling technique was used to choose cassava farmers who were both men and women in Ogun State. The first stage was a purposive selection of three ADP zones, namely Abeokuta, Ijebu ode, and Ilaro, out of four ADP zones. This choice is made due to the massive cassava production and the concentration of cassava farmers who have received training in the adoption of Akilimo tools in the zones. Two blocks were chosen from each selected ADP zone during the second stage according to their participation in training activities. The Agricultural Development Programme (OGADEP) provided the information. During stage three, four (4) cells were randomly selected from each of the previously chosen blocks. In the fourth stage, fourteen (14) cassava farmers were randomly selected from each of the previously chosen cells. This gave rise to three hundred and three hundred and thirty-six (336) farmers selected as the sample size. Non-response and incomplete data in combination with farmer unavailability reduced the sample size to 329 farmers who completed the study.

**2.3 Data Analysis**

The respondents’ socio-economic characteristics, the extent to which Akilimo cassava advisory tools have been adopted among farmers, and productivity differentials among adopters and non-adopters of Akilimo cassava advisory tools were described using descriptive statistical measures such as frequency tables, means, and standard deviation. The logit regression was used to estimate the determinants of the adoption of Akilimo cassava advisory tools among the respondents. The choice of the logit regression is that its dependent variable showcases binary characteristics where it represents Akilimo cassava advisory tool adoption or non-adopter status. The logistic regression model is expressed as:

 $Y^{\*}=Xβ+ ε (1)$

$$Y\_{i}=\left\{\begin{array}{c}1 if Y\_{i}^{\*} >0 \\0 if Y\_{i}^{\*} otherwise \end{array}\right.$$

Where:

Y\* is the underlying response variable in which Yi = 1 if the respondent adopts Akilimo cassava advisory tools, and zero if otherwise

$x\_{1}$= Sex of the respondent (1 if male, 0 female)

$x\_{2}$= Age of the respondent (years)

$x\_{3}$= Marital Status

$x\_{4}$= Number of household members (adults) involved in farming

$x\_{5}$= Number of household members contributed to household income

$x\_{6}$= Years of formal education of the respondent (number)

$x\_{7}$= Access to government extension services (1 if respondent had access to extension, 0 otherwise)

$x\_{8}$= Membership of farmers' association membership (1 if the respondent is a member, 0 if otherwise)

$x\_{9}$= Native Status of the respondents (1 if the respondent is a native, 0 if otherwise)

$x\_{10}$= Monthly food expenditures

The Average Treatment Effects (ATE) model was used to examine the effects of the adoption of Akilimo cassava advisory tools on respondents’ cassava productivity. The model was selected because it assesses causality effectively while dealing with selection biases and unobserved heterogeneity for observational studies when random assignment is not possible. It is expressed as:

 $ATE = E [Y\_{1}\_{i}- Y\_{0}\_{i}] $ (2)

 Where:

 $Y\_{i} $ = Observed cassava productivity index outcome for unit i (villages)

 $Y\_{1}\_{i}$ = Potential cassava productivity index outcome for respondents that adopt Akilimo cassava advisory tools in unit i

 $Y\_{0}\_{i}$ = Potential cassava productivity index outcome for respondents that did not adopt Akilimo cassava advisory tools in unit i

 $E$ = is the mathematical expectation

The cassava farming productivity was analyzed using land productivity index specified as:

$$ \frac{LandProd}{ha}\_{i}= ^{Cassava yield\_{i}}/\_{Cassava Farm in ha\_{i} } \left(3\right)$$

**3.0 Results and Discussion**

**3.1 Demographic Characteristics of the Cassava Farmers’**

Table 1 below shows the demographic characteristics of the respondents. The variables investigated were gender, along with age, marital status, household size, level of education, farm size, mobile phone usage, membership in the cassava farmers’ association, and access to extension services. The data reveal that males comprise the majority (67.78%) of cassava farmers in the study area, but females make up 32.22% of the total respondents. This is because the communities in southwest Nigeria view cassava farming as a male-dominated activity. Abioye et al. (2024) validated these findings when they discovered that men were extensively involved in Ogun State's cassava farming activities in Nigeria. Almost every cassava farmer across the study area falls within the age group of 20–69 years and totals 96% of survey respondents while having an average age of 48 years. These findings indicate that farmers primarily come from their peak working age range, which could boost their willingness to use technologies that enhance cassava productivity. Marital status data revealed that 54.71% of the respondents were married, 38.91% of the respondents were single, and 3.34% of the respondents were widowed, while 3.04% of the respondents were separated. Similar findings were observed in a study by Oladoyin et al. (2022), which showed that married farmers made up the bulk of cassava farmers in Ondo State, Nigeria. Most (55.02%) of the respondents have 4-6 household members, with a mean household size of 6. This implies that respondents had access to family labor, which will reduce labor cost constraints during cassava farming production. Results corroborate Oladoyin et al. (2022), who discovered 55.3% of cassava farmers in Ondo State possess household sizes ranging from 4 to 6 persons. The majority (93.31%) of the respondents had formal education, but 6.69% lacked any formal education training. The educational breakdown of respondents showed primary was at 31.0% and secondary was at 37.39%, while tertiary education reached 24.92%. This implies that respondents in the study area were educated and more likely to adopt digital technologies to enhance cassava productivity. The study results matched findings from the Sanusi et al. (2021) and Abioye et al. (2024) studies that showed Ogun State cassava farmers were largely educated.

Furthermore, the respondents who cultivated farm sizes within 2–5 hectares were the most common (43.47%) occupying a mean size of 3 hectares. Research findings indicate that the majority of the respondents operate on small-scale farm sizes. This result is consistent with findings by Akinde and Adekunle (2024), who revealed cassava farming is dominated by small-scale farmers in Ogun State, Nigeria. A total of 60.18% of respondents in the study used Android phones whereas 39.82% of respondents did not use Android phones. The availability of mobile technology among a majority of respondents creates favorable conditions for the acceptance of the Akilimo application, which seeks to enhance cassava productivity. On membership of cassava farmers, the study revealed that 69.91% of the respondents were members of cassava farmers’ association, while the remaining 30.09% were not members of cassava farmers’ association. This indicates that most of the respondents belong to cassava farmers’ associations, which enhance farmers' livelihoods by offering essential services like credit, information, and technical advice. This is in line with the findings of Nwankwo et al. (2024), who reported that more than half (52.5%) of the cassava farmers in Anambra State, Nigeria, belong to cassava farming associations. Lastly, the majority (94.22%) of the respondents had access to government extension services, while only 5.78% of the respondents lacked access. This implies that the majority of the respondents had interactions with extension agents, providing them with technical guidance. This is in agreement with the findings of Abioye et al. (2024), who revealed that the majority (93.44%) of the cassava farmers in Ogun State, Nigeria, had access to extension services.

**Table 1: Demographics Characteristics of Cassava Farmers (N = 329)**

|  |  |  |
| --- | --- | --- |
| **Characteristics** | **Frequency** | **Percentage** |
| **Gender** |  |  |
| Male | 223 | 67.78 |
| Female | 106 | 32.22 |
| **Age (years)** |  |  |
| 20 – 29 years | 23 | 6.99 |
| 30 – 39 years | 62 | 18.84 |
| 40 – 49 years | 89 | 27.05 |
| 50 – 59 years | 91 | 27.66 |
| 60 – 69 years70 – 79 years | 5011 | 15.203.34 |
| 80 – 83 years | 3 | 0.91 |
| Mean = 48 years |  |  |
| **Marital Status** |  |  |
| Single | 128 | 38.91 |
| Married  | 180 | 54.71 |
| Widowed | 11 | 3.34 |
| Separated | 10 | 3.04 |
|  **Household Size** |  |  |
| * 1. household size
 | 27 | 8.21 |
| 4-6 household size | 181 | 55.02 |
|  7-9 household size | 92 | 27.96 |
|  > 10 household size  | 29 | 8.81 |
|  Mean = 6 household size |  |  |
|  **Education Level** |  |  |
|  No formal Education | 22 | 6.69 |
|  Primary Education | 102 | 31.00 |
|  Secondary Education | 123 | 37.39 |
|  Tertiary Education | 82 | 24.92 |
|  **Farm Size** |  |  |
|  < 2 hectares | 131 | 39.82 |
|  Between 2 hectares and 5 hectares | 143 | 43.47 |
|  < 5 hectares | 55 | 16.72 |
|  Mean = 3 hectares |  |  |
|  **Mobile Phone Usage** **(Android)** |  |  |
|  Yes | 198 | 60.18 |
|  No | 131 | 39.82 |
| **Membership in Cassava Farmers Association** |  |  |
|  Yes | 230 | 69.91 |
|  No | 99 | 30.09 |
|  **Access to Government Extension Services** |  |  |
|  Yes | 310 | 94.22 |
|  No | 19 | 5.78 |

 Source: field survey, 2024

**3.2 Extent of Adoption of Akilimo Cassava Advisory Tools**

Table 2 demonstrates that cassava farmers exhibit awareness of Akilimo cassava advisory tools at a rate of 33.43% while the remainder, 66.57%, lack knowledge of these tools. The survey indicates that about one-third of respondents understand these tools, yet there are significantly more respondents who remain unaware of the tools, thus affecting adoption rates. Abioye et al. (2024) confirmed similar findings, showing that Akilimo tools and IITA herbicide calculators exhibit low awareness rates.

**Table 2: Awareness of Akilimo Cassava Advisory Tools**

|  |  |  |
| --- | --- | --- |
| Awareness of Akilimo Cassava Advisory Tools  |  Frequency  |  Percentage  |
|  Yes |  110 |  33.43 |
|  No |  219 |  66.57 |
| Total  |  329 |  100 |

Source: field survey, 2024

### The survey data in Table 3 showed that 31.31% of farmers used Akilimo tools, along with 68.69% who did not embrace the tools. These results show limited adoption of Akilimo cassava advisory tools because farmers lack knowledge about the tools while herbicide costs remain high, and accessing TME 419 cassava stem and Sammaz 35/48 maize seed from IITA proves challenging. Simultaneously, some farmers struggle with Akilimo mobile application usage. **Akilimo developer** (ACAI) **recommends TME 419 cassava variety to farmers because it contains high starch contents, disease resistant and early maturity thus, promising better output. The Sammaz 35/48 maize hybrid seeds were specifically developed to be resilient against drought stress and they mature early while producing abundant yields. Akilimo utilizes these varieties as foundational components for its digital recommendations because they respond best to specific site conditions when its decision-support tools are used.** This results aligns with Ogunseye and Adekunle (2024), who reported that few farmers utilize AKILIMO cassava advisory services in Ogun State.

**Table 3: Level of Adoption of AKILIMO Cassava Advisory Tools**

|  |  |  |
| --- | --- | --- |
| Adoption of Akilimo Cassava Advisory Tools  | Frequency  | Percentage  |
| Adopters of Akilimo  | 103 | 31.31 |
| Non-Adopters of Akilimo | 226 | 68.69 |
| Total  | 329 | 100 |

Source: field survey, 2024

Table 4 showed the gender disaggregation of Akilimo tools adopters. **The findings revealed that among Akilimo adopters, 33.03% of male cassava farmers adopted Akilimo tools compared to 27.93% of female cassava farmers. This implies that male farmers adopt Akilimo tools more than female farmers because they have better access to advisory tool information along with resources. Non-adopters of Akilimo tools showed that more female farmers (72.07%) did not adopt Akilimo tools as compared to the 66.97% of non-adopting male cassava farmers. This implies that women encounter obstacles when trying to adopt Akilimo tools. Therefore, there is gender inequality in the adoption of Akilimo tools, with male farmers receive greater advantages than female farmers.** The results is in line with Awuor (2021) who **found similar outcomes during his research which showed male farmers received greater impact from land ownership and services of agricultural agents compared to females farmers.**

### ****Table 4: Gender Disaggregation of AKILIMO Cassava Advisory Tools Adoption****

|  |  |  |  |
| --- | --- | --- | --- |
| **Akilimo Adoption Status** | **Male (n = 218)** |  **Female (n = 111)** | Total (n = 329) |
| **Adopters of Akilimo** | 72 (33.03%) | 31(27.93 %) | 103 (31.31%) |
| **Non-Adopters of Akilimo** | **146 (**66.97%) | **80 (**72.07%) | 226 (68.69%) |

 Source: field survey, 2024

The level of utilization for Akilimo cassava advisory tools among cassava farmers is presented in Table 5. Best planting practices showed the highest adoption rate among Akilimo tools, with 20.67% acceptance from farmers. Traditional practices continued for 79.33% of farmers. 19.76% of farmers implemented the six-step weed management practices, making it the second most prevalent Akilimo tool usage. The high acceptance rate stems from the effectiveness of this tool in reducing labor-costly weeding operations that commonly trouble cassava producers. Among the respondents who didn't employ these practices, the majority (80.24%) rejected them because of herbicide cost. 14.59% of farmers engaged with intercropping methods to enhance crop cultivation capacity. The adoption rate of these practices demonstrates farmers' perception that they work better by optimizing land use without requiring substantial resources. Most farmers (85.41%) failed to adopt intercropping practices because they lacked required knowledge and had insufficient resources at their disposal. Fertilizer application practices have the lowest adoption rate, with just 8.21% of farmers using them. The high cost of fertilizer was the primary reason farmers adopted fertilizer application practices at a low level. The tool received non-use from 91.79% of the respondents.

**Table 5: Extent** **of Adoption of AKILIMO Cassava Advisory Tools (N = 329)**

|  |  |  |  |
| --- | --- | --- | --- |
| Extent of Adoption of Akilimo cassava Advisory Tools | Adopters  | Non-adopters | Rank  |
| Frequency | percentage | frequency | percentage |
| Best planting practices | 68 | 20.67 | 261 | 79.33 | I  |
| Intercropping practices | 48 | 14.59 | 281 | 85.41 | III |
| Fertilizer Application | 27 | 8.21 | 302 | 91.79 | IV |
| Six step weed management | 65 | 19.76 | 264 | 80.24 | II |

 Source: field survey, 2024

Table 6 revealed that the majority (68.69%) of the respondents did not employ any of the Akilimo tools, thus representing the largest category in the group. Low awareness of the tools coupled with resource constraints involving TME 419 hybrid cassava stems and Sammaz 35/48 maize hybrid seed recommendations and high herbicide prices and skepticism about tool benefits prevented the adoption. The Akilimo tool practices encompass best planting practices, intercropping practices, fertilizer application, and six-step weed management practices. 15.20% of the respondents fall in the low adoption group for adopting one Akilimo practice, while 11.55% of the respondents fall in the medium adoption group for adopting any two Akilimo practices, and 4.56% of the respondents fall in the highest adoption group for adopting any three or four Akilimo practices.

**Table 6: Categorization of cassava farmers, According to their Adoption Level of Akilimo Tools**

|  |  |  |
| --- | --- | --- |
| Category | Frequency | Percentage |
| Non-Adopters of Akilimo | 226 | 68.69 |
| Low Adopters of Akilimo | 50 | 15.20 |
| Medium Adopters of Akilimo | 38 | 11.55 |
| High Adopters of Akilimo | 15 | 4.56 |
| Total | 329 | 100 |

Source: field survey, 2024

**3.3 Determinants of Adoption of Akilimo Cassava Advisory Tools**

Table 7 displays the logistic regression results which identify the adoption determinants of Akilimo cassava advisory tools. The model was significant at 1%. The analysis demonstrates that important factors determining adoption are Number of adult household members involved in farming, Number of household members contributing to household income, native status, cooperative membership, marital status (single), and monthly food expenditure. Results revealed that the coefficient number of household adults who farmed showed a negative relationship with the adoption of Akilimo cassava advisory tools, as it produced statistically significant results at P < 0.05. This implies that households with a large agricultural workforce will prefer traditional farming methods over modern digital advisory systems. This result is in line with Yang and Sang (2020), who reported that households with choose to stick with traditional techniques rather than adopt modern tools that could reduce labor demand. There is a positive relationship between years of formal education and Akilimo tools adoption, which reached statistical significance (P < 0.10). This means that when farmers obtain additional years of formal education, they show increasing interest in using Akilimo tools. This outcome matches the findings of Oyinbo et al. (2019), who discovered that better-educated individuals adopt technology at higher rates. Also, Adams and Jumpah (2021) discovered in their research that formal education is an important factor of agricultural technology adoption among smallholder farmers because it improves their ability to grasp and use new innovations successfully. The adoption of Akilimo tools revealed a positive relationship between the number of household members contributing to household income and statistical significance (P < 0.004). This indicates that households with various incomes have greater financial resources to invest in Akilimo tools. The research findings are consistent with Jena and Tanti's (2023) studies, which found that higher-income households embrace agricultural technologies, increasing productivity and food security, and that financial stability allows for investment in modern agricultural tools.

### Marital status, with reference to single farmers was negative and statistically significant (P < 0.043) with the adoption of Akilimo. This implies that single farmers show lower inclination toward adopting Akilimo tools in comparison to married farmers probably due to their differing commitments to risk exposure. Farmers’ cooperative membership showed both significance at P < 0.008 and a positive relationship with adoption of Akilimo. This analysis demonstrates that cooperative membership increases farmers' access to vital resources that are critical for applying Akilimo tools. The findings are consistent with Olagunju et al. (2021), who demonstrated that cooperative membership improves access to inputs such as fertilizers, improved seed types, and irrigation infrastructure, which are required for agricultural technology adoption. Native status was positive and statistically significant (P < 0.004) with the adoption of Akilimo tools, indicating that native farmers established as study area residents demonstrated higher Akilimo tool adoption rates since their place-based identity produces both enhanced extension service trust and superior community network accessibility. **Native status includes people born within the study area and those who have historical family connections to the community.** Food expenses over one month show a positive correlation with Akilimo tool adoption (P < 0.019). This implies that households possessing higher financial resources show greater capacity to purchase the innovative productivity-enhancing Akilimo tools. The findings match Jena and Tanti (2023), who discovered that farmers with greater financial stability were more inclined to use agricultural technology tools to increase productivity and efficiency.

On the other hand, some variables, such as gender, age, and access to extension services, did not establish statistical importance regarding Akilimo adoption. In terms of Akilimo adoption rates, the age variable showed a non-significant negative relationship (P < 0.618). This implies that as farmers get old, they exhibit a linear decline in interest toward using Akilimo tools. The findings are consistent with Patil and Veettil (2024) studies, who discovered that as farmers aged, they became more risk-averse about technological adoption. Gender, with reference to male farmers, was positive and not significant (P < 0.752) with the adoption of Akilimo, implying that male farmers have a marginally greater tendency to take up Akilimo tools. Thus, gender cannot account for variations in tool usage among rural farmers. This result is consistent with the findings of Villarroel-Molina et al. (2022), who observed that gender alone did not explain differences in agricultural technology adoption among farmers. The relationship between farmers who have access to agricultural extension expertise and Akilimo adoption was positive yet statistically insignificant at (P < 0.888). This shows inconsistency in extension service delivery in practice.

**Table 7: Determinants of Adoption of Akilimo Cassava Advisory Tools**

|  |  |  |  |
| --- | --- | --- | --- |
| Variables  | Coefficients | Standard Error | P-value |
| Sex (Male) | 0.0986  | 0.3125 | 0.752 |
| Age | -0.0057 | 0.0115 | 0.618 |
| Marital Status (Single) | -1.8658 | 0.9226 | 0.043\*\* |
| Years of Education | 0.0563 | 0.0305 | 0.065\* |
| Number of Household Adults in Farming | -0.3521 | 0.1380 | 0.011\*\* |
| Access to Extension Services | 0.0764 | 0.5409 | 0.888 |
| Number of Household Members Contributing to Household Income | 0.4254 | 0.1490 | 0.004\*\*\* |
| Native Status | 0.8012 | 0.2808 | 0.004\*\*\* |
| Cooperative Membership | 0.7576 | 0.2850 | 0.008\*\*\* |
| Monthly Food Expenditure | 0.0182 | 0.0077 | 0.019\*\* |
| Constant | -3.1103 | 0.9994 | 0.002\*\*\* |
| Significant code: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1 Number of observations = 329Prob > X2 = 0.0003 |

Source: field survey, 2024

**3.4 Productivity Differentials Among adopters and Non-adopters of Akilimo Regarding Cassava Productivity, Gender, and Farm size**

The data in Table 8 showed that Akilimo adopters produce 43,974.83kg/ha of cassava more than non-adopters, who produce 17,661.24 kg/ha. This implies that the use of Akilimo cassava advisory tools leads to higher cassava yields in agricultural fields. The standard deviation level of productivity results shows Akilimo adopters display higher variability than non-adopters of Akilimo. Nyarkoa and Kozarib (2021) agree with this finding by showing that adopting agricultural technology enhances efficiency and productivity through better extension service delivery. Also, Laborde (2022) found that 75% users of Akilimo tools produced higher cassava yields while earning better profits.

**Table 8: Productivity Differentials Based on Cassava Productivity among Akilimo Adopters and Non-Akilimo**

|  |  |  |
| --- | --- | --- |
| **Akilimo Adoption Status**  | **Mean Cassava Productivity (Kg/ha)** | **Standard Deviation (Kg/ha)** |
| **Adopters of Akilimo** | **43,974.83** | 191,471.30 |
| **Non-Adopters of Akilimo** | **17,661.24** | 51,637.90 |

Source: field survey, 2024

### Table 9 illustrates cassava productivity by gender and Akilimo adoption status. The findings showed that among Akilimo adopters, male farmers attain an average yield of 54,886 kg/ha, higher than the female farmers, which have 20,429 kg/ha, with a higher standard deviation (230,703.90 kg/ha), suggesting large variability in yield. This results in a gender gap of 34,456 kg/ha with a 363% productivity increase. Among Akilimo non-adopters, male farmers also attain an average yield of 18,556 kg/ha, higher than the female farmers, which have 16,110 kg/ha with a higher standard deviation (56,226.02 kg/ha). This results in a gender gap of 2,457 kg/ha with a 27% productivity increase. The observable disparity in cassava yield between Akilimo adopters gender demonstrates that Akilimo adoption increases cassava productivity, but male farmers gain more benefits from using Akilimo adoption than female farmers due to better access to resources or information about the advisory tools. The findings match Awuor (2021) who demonstrated that access to land, credit, agricultural extension agents and services and improved cassava cuttings together with family and hired labor and agricultural information primarily benefit men than women.

**Table 9: Productivity Differentials Based on Gender among Akilimo Adopters and Non-Akilimo**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Akilimo Adoption Status** | **Gender** | **Mean Cassava Productivity (Kg/ha)** | Gender Gap **(Kg/ha)**34,456 | Productivity increase (%)363 | **Standard Deviation (Kg/ha)** |
| **Adopters of Akilimo** | **Male**  | 54,886.04 | 230,703.90 |
| **Female** | 20,429.59 | 32,169.28 |
| **Non-Adopters of Akilimo** | Male  | 18,566.35 | 2,457 | 27 | 59,226.02 |
| **Female** | 16,109.61 | 35,648.38 |

Source: field survey, 2024

The effects of Akilimo adoption differ significantly depending on farm size levels as revealed in Table 10. Akilimo users who have more than 5 hectares of farm size achieve an average yield of 113123.50 kg/ha that exceeds the yield of 7633.33 kg/ha produced by farmers with less than 2 hectares of farm size. The yield for non-Akilimo adopters exceeds 21,572.35 kg/ha when operating farms larger than 5 hectares but records less than 12,079.27 kg/ha for farms under 2 hectares. The yields achieved by Akilimo users surpass those recorded by non-users of the same scale operations. This implies that Akilimo adoption has positive effects on cassava farming yield across different farm sizes. The standard deviation for adopters is notably high in larger farm sizes (360,559,00kg/ha), suggesting considerable variability in productivity among these farmers. The findings support the report from the African Cassava Agronomy Initiative (ACAI, 2020) that specialized agronomic advice like AKILIMO boosts cassava yields to reach between 20 tons per hectare based on farmers' ability to follow recommended practices.

**Table 10: Productivity Differentials Based on Farm Size among Akilimo Adopters and Non-Akilimo**

|  |  |  |  |
| --- | --- | --- | --- |
| **Akilimo Adoption Status** | Farm Size | **Mean Cassava Productivity (Kg/ha)** | **Standard Deviation (Kg/ha)** |
| **Adopters of Akilimo** | < 2 hectares | 7,633.33 | 11,419.37 |
| Between 2 hectares and 5 hectares | 44,065.42 | 169,972.30 |
| > 5 hectares | 113,123.50 | 360,559.00 |
| **Non-Adopters of Akilimo** | < 2 hectares | 12,079.27 | 15,945.37 |
| Between 2 hectares and 5 hectares | 20,089.28 | 52,660.54 |
| > 5 hectares | 21,572.35 | 81,055.57 |

Source: field survey, 2024

**3.5 Effects of the Adoption of Akilimo on Cassava Productivity**

The implementation of AKILIMO cassava advisory tools brought about substantial productivity enhancements to the cassava output. Propensity Score Matching (PSM) analysis was used to estimate Average Treatment Effect (ATE) and Average Treatment Effect on the Treated (ATET) simultaneously to determine the causal effect of AKILIMO tools adoption on productivity levels. An estimate of Average Treatment Effects revealed that adopters showed 123,026.3 kg/ha higher productivity than non-adopters with statistical significance at 5% (p = 0.048). This implies that cassava productivity would experience a substantial boost if every farmer used the Akilimo tools. The Average Treatment Effect on the Treated demonstrates that Akilimo adopters experienced a productivity increase of 100,493.7 kg/ha. The estimated effect on treated farmers shows a positive outcome that achieves statistical significance at the 10% level (p = 0.065) while being slightly lower than the average treatment effect. Farmers practicing cassava cultivation under AKILIMO achieved a productivity growth of 100,493.7 kg/ha relative to those not participating in the intervention. The findings are consistent with a study by Inkoom et al. (2020), who used Average Treatment Effect on the Treated (ATET) estimates to show that the adoption of Root and Tuber Improvement and Marketing Programme [RTIMP] led to substantial improvements in technical efficiency among cassava farmers.

**Table 11: Treatment Effects Estimation of Akilimo Cassava Advisory Tools Adoption on Cassava Productivity**

|  |  |  |  |
| --- | --- | --- | --- |
| Variables  | Coefficients (kg/ha) | Standard Error | P-value |
| ATE | 123,026.30 | 62,267.50 | 0.048\*\* |
| ATET | 100,493.70 | 54,510.87 | 0.065\* |
| Significant code: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1  |

Source: field survey, 2024

**4.0 Conclusion and Recommendations**

The study examined the gender disparities in the adoption of Akilimo cassava advisory tools and productivity in Ogun State, Nigeria, using descriptive statistics, logistic regression model and Average Treatment Effect model. The findings revealed that male farmers had higher adoption rates of the Akilimo tools compared to female farmers. Overall, only 31% of cassava farmers adopted the tools. Their low rate of adoption are due to low awareness of the tool, inability to get the recommended cassava and maize varieties, high herbicide prices and tool skepticism. The barriers to adoption particularly oppressed female farmers which intensified the gender gap in adoption rates. Among cassava farmers, those who adopted Akilimo tools showed higher productivity levels than non-adopters. Factors that determined the adoption rate of Akilimo tools were the number of adult household members involved in farming, the number of household members contributing to household income, native status, cooperative membership, marital status (single), and monthly food expenditure.

The implementation of Akilimo cassava tools leads to beneficial outcomes in cassava production for farms of all sizes. Hence, farmers should be encouraged to adopt Akilimo tools to increase their productivity. Akilimo tool developers (ACAI) should partner with government agencies from various levels (Federal, State and Local) to create specific training programs that will raise both farmers' understanding and awareness levels. The delivery of these programs should combine farmer cooperatives and radio broadcasts with community demonstrations to achieve wide-spread reach. Additionally, the timely distribution of TME 419 hybrid cassava stems is crucial to prevent deterioration. Further research and modification of this variety are necessary to improve its suitability for garri and fufu production address farmers' concerns, also, the Akilimo tools developer should develop offline capabilities, to minimize data expenses.

Bridging the gender gap in productivity through Akilimo adoption can be achieved through specific low-interest loans designed for female farmers, which improve access to necessary inputs. Findings from this study will offer insights into the barriers to digital technology adoption and inform policies that promote inclusive agricultural growth and sustainable food production in Nigeria.

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Details of the AI usage are given below:

1.

2.

3.

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