Rural Planning Journal, Volume 24, Issue 2, December 2022 ISSN 0856-3460

RURAL PLANNING JOURNAL
Journal home page: http://www.rpj-rsc.irdp.ac.tz

Factors Influencing the Adoption of Improved Oil Palm Variety in Kigoma Rural District of Tanzania

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Ikisiri

Mabadiliko ya tabia nchi yameripotiwa kusababisha madhara kwenye kilimo duniani kote. Kuasili kilimo cha kuzingatia mabadiliko ya tabia nchi ikiwemo matumizi ya mbegu zilizoboreshwa imethibitika kuwa njia mbadala ya kupunguza madhara haya. Utafiti huu ulilenga kutathmini mambo yaliyoathiri kukubalika kwa aina ya mbegu iliyoboreshwa ya michikichi inayojulikana kama Tenera katika Wilaya ya Kigoma Vijijini nchini Tanzania. Takwimu zilikusanywa kutoka kwa sampuli ya wakulima wadogo 166 wa michikichi waliopatikana katika kata tatu ambazo ni: Bitale, Mwandiga na Mahembe. Takwimu zilikusanywa kupitia mahojiano, mapitio ya taarifa mbalimbali, na kuchunguza hali halisi. Toleo la 20.0 la "IBM SPSS" lilitumika katika kuchakata taarifa zilizokusanywa kwa njia ya mahojiano. Matokeo yalionesha kuwa asilimia 79.5 ya wahojiwa walikuwa na ufahamu wa mbegu iliyoboreshwa na asilimia 47.6 ya wahojiwa wanaitumia. Matokeo yalifichua zaidi kwamba, umri, kiwango cha elimu, ubora wa udongo, upatikanaji wa mvua, asili ya teknolojia, umiliki wa ardhi, na ukaribu wa makazi ya nyumbani kwa kiasi kikubwa ($p<0.05$) viliathiri kukubalika kwa mbegu iliyoboreshwa. Utafiti ulihitimisha kuwa mambo mbalimbali ya kijamii na kiuchumi yaliathiri kwa kiasi kikubwa kukubalika kwa mbegu iliyoboreshwa. Pia kiwango cha utumiaji wa mbegu iliyoboreshwa bado ni mdogo na unatumika katika mashamba madomadogo. Utafiti unapendekeza kwamba, uhamasishaji zaidi unahitajika ili kuongeza uelewa wa wakulima kuhusu mbegu iliyoboreshwa ili kuongeza kukubalika kwake na hatimaye kuongeza uzalishaji kwa mapato zaidi na kukuza uwezo wao wa kukabiliana na madhara ya mabadiliko ya tabia nchi katika kilimo.

Abstract

Climate change has been reported to pose negative effects on agriculture globally. Adoption of Climate Smart Agriculture (CSA) practices such as using improved seeds has been widely recognized as a promising and successful alternative to minimize the adverse impacts. This study aimed to assess factors influencing the adoption of Improved Oil Palm Variety (IOPV) known as Tenera in Kigoma Rural District of Tanzania. Data were collected from a sample of 166 palm oil smallholder farmers found in three wards namely: Bitale, Mwandiga and Mahembe. Data were collected through interview, documentary review, and observation. IBM SPSS Version 20.0 was used in data analysis, whereby both descriptive and inferential (binary logistic regression) analyses were employed. Results showed that 79.5% of the respondents were aware of IOPV and 47.6% of them have adopted it. Findings revealed further that, age, education level, soil quality, rainfall, nature of technology, land ownership, and proximity to homestead significantly ($p<0.05$) influenced the adoption of IOPV. The study concluded that various socio-economic factors significantly influenced the adoption of IOPV. Moreover, the adoption of IOPV among smallholder farmers in the study area is still low and it is practiced in small farms. The study recommends that *more sensitization campaigns are required to raise farmers' awareness towards IOPV to increase its adoption and ultimately increase production for more income and consequently enhance their capacity to offset climate change effects on agriculture.*

Keywords: Climate Smart Agriculture, Adoption, Livelihood, Tenera, Climate change

1.0. Introduction

Oil palm is a tropical tree crop (Cosiaux *et al*., 2018) that is mainly grown for its industrial production of vegetable oil (Verheye, 2010). Palm oil is in around half of all packaged products sold in supermarkets, everything from processed foods to cosmetics, soaps and detergents (Shanahane, 2019). It is also used as a cooking oil (predominantly in Asia and Africa), in industrial lubricants, in animal feeds and as a fuel. In 2018, half of the palm oil imported into the European Union was destined for biodiesel (Shanahane, 2019). Various studies have established that this crop delivers higher income avenues for smallholder famers, and creates jobs for landless rural families, while making them more competitive in global agricultural supply chains (Dib *et al*., 2018; Gatto *et al*., 2017), although with differentiated outcomes across rural populations (Cahyadi and Waibel, 2016; Jelsma *et al*., 2017). It is also claimed that oil palm is a substitute to extensive cattle production in forest frontiers in Latin America, offering opportunities for intensifying land use (de Carvalho *et al*., 2015; Garcia-Ulloa *et al*., 2012). All of these signify that cultivation of oil palm could play a big role in poverty alleviation if it properly done.

Oil palm is something of a wonder crop as it yields 4-10 times more oil per hectare than other sources of vegetable oil such as soybeans, and coconut palms (Shanahane, 2019). Oil palm crops globally produce an annual 81 million tonnes (Mt) of oil from about 19 million hectares (Mha). In contrast, the second and third largest vegetable oil crops, soybean and rapeseed, yield a combined 84 Mt oil but occupy over 163 Mha of increasingly scarce arable land (Murphy *et al*., 2021). This makes it an efficient and profitable use of land.

In Indonesia and Malaysia, around 4.5 million people earn their living from the palm oil industry. In Indonesia alone, another 25 million people depend indirectly on palm oil production for their livelihoods (Shanahane, 2019). Furthermore, smallholder farmers play a significant role in palm oil value chains in countries such as Costa Rica, Honduras, Mexico, and Peru, where development policies have provided them with significant support (in the form of seedlings, low-interest credit, and even mills), fostered their organization and ensured their access to land (Castellanos-Navarrete *et al*., 2021).

In Tanzania, palm oil accounts for more than a quarter of the country's food imports and three percent of the country's total imports (OEC, 2018; Fuchs, 2016). Failure to meet the cooking oil demand for the country is attributed to; the underdevelopment of the palm oil sub-sector; low productivity of the oil palm crop; lack of organized market for the crop; limited infrastructure and equipment including processing plants; and consequently, little investments in the crop (Uckert *et al*., 2015; URT, 2018). Moreover, drop in oil palm production also has been linked to climate change effects which has negatively impacted the agricultural sector across the globe (Abegunde *et al*., 2019; Sarkar *et al*., 2020). Sarkar *et al*. (2020) reported that, climate change had played a big role on the reduction of oil palm production in Malaysia, suggesting practicing of appropriate mitigation and adaptation strategies, including promotion and development of climate resilient varieties.

Oil palm farming is one of the agricultural activities practiced in Tanzania. Palm oil trees have been cultivated in the Kigoma, Mbeya and Tanga regions. However, Kigoma region is the leader in oil palm farming, accounting for 61.4% of oil palm production in the country (Fuchs, 2016; URT, 2018). The crop was introduced in Kigoma region in the early 1920s and currently, over 30,000 smallholder farmers are engaged in oil palm farming. These smallholder farmers are very important to oil palm production globally (Obidzinski *et al*., 2012; McCarthy *et al*., 2012). The main type of oil palm variety currently grown in the area is Dura. This variety is characterized by a low growth rate and yield. Most farmers in Kigoma grow exclusively Dura type (Figure 1b) with low yielding potential in old farms, thus this is one of the main causes for low oil palm yields in Kigoma region. In addition to this, the palm trees (Dura) which are currently grown in Kigoma region were planted about 30 to 40 years ago and hence have very low yields which appeals for farmers to adopt a new improved variety so as to increase the yield (Fuchs, 2016; URT, 2018). It has been figured out that, new breeding and management approaches are providing the promise of improvements, such as much higher yielding varieties, improved oil profiles, enhanced disease resistance, and greater climatic resilience (Murphy *et al*., 2021).

Adoption of improved crop varieties has been cherished as one of the Climate Smart Agriculture (CSA) practices which help smallholder farmers to enhance their resilience capacity to climate change effects on agriculture. Studies by Nkumulwa and Pauline (2021) as well as Xiong and Tarnavsky (2020), divulged that improved access to better seeds and other agricultural inputs, as well as to market and financing provide better harvest security for smallholder farmers in Africa, boosting their incomes and increasing food security.
Comparison of households cultivating improved maize with households cultivating local maize in East Africa has disclosed that the first group is significantly wealthier and more food secure than the latter (Westengen *et al.,* 2019). The study by Imran *et al.* (2019) in Pakistan disclosed a significant difference between farmers who have adopted CSA and non-adopters with the likelihood of reducing the cost of production by 12% and 21%, respectively, without declining productivity. Smale *et al*. (2018), recounted that effects of using hybrid seeds on yields are large, widening the range of food items consumed, reducing the share of sorghum in food purchases, and contributing to a greater share of the sorghum harvest sold in Mali. Wordofa *et al*. (2021) discovered that households using improved agricultural technologies

in Ethiopia had higher annual farm income compared to those households not using such technologies. These findings cement the fact that, adoption of CSA practices including use of improved crop varieties is embedded with substantial benefits to smallholder farmers.

Cognizant of the importance of the oil palm sub-sector in the Tanzania, there has been deliberate efforts by the government and some NGOs in recent years to promote the crop and boost its production. Among the interventions is the introduction of the Improved Oil Palm Variety (IOPV) called Tenera in Kigoma Rural District. Farming for Energy for better Livelihoods in Southern Africa (FELISA), an NGO planted its first hybrid oil palm seedlings (IOPV) in the district in 2005. Tanzania Agricultural Research Institute (TARI) is involved in the production of hybrid oil palm seedlings (IOPV) under the Ministry of Agriculture which has engineered the introduction of IOPV in the area since 2007. However, since its introduction, there has been a paucity of information on the awareness, perception, and uptake (adoption) of the variety among smallholder farmers and the associated factors influencing the adoption of IOPV. Therefore, this study aimed at assessing the factors that influence the adoption of the improved oil palm variety by smallholder farmers in Kigoma Rural District.

2.0. Methodology

2.1. Study area

This study was conducted in Kigoma Rural District, one of the seven districts in the Kigoma region of Tanzania which lies about 5° south and 30° east of Greenwich. The study covered three wards namely: Bitale, Mahembe, and Mwandiga. This district was selected because it is ranked second in terms of oil palm cultivation in the region.

2.2. Research design and sampling

This study used a cross-sectional research design, which allowed data from respondents to be collected at a single point in time. The sampling frame in this study was all oil palm smallholder farmers in Bitale, Mwandiga, and Mahembe wards. The sampling unit in this study was an individual smallholder farmer who grows oil palm in the study area. The sample size was 166 respondents i.e., 56, 55 and 55 for Bitale, Mwandiga, and Mahembe wards respectively. Simple random sampling was used to get representatives from the groups of smallholder farmers. Purposive sampling was used to select key informants who were; Ward agricultural extension officers in the three wards and research officers from TARI Kihinga. Purposive sampling also was employed in selecting the three studied wards because they were the main producers of oil palm in the Kigoma Rural District.

2.3. Data collection

Primary data were collected from oil palm smallholder farmers, key informants, and observations. Secondary data were obtained from both published and unpublished documents, which include journal articles and reports from various sources related to the topic of the study. The interview was done by using a questionnaire, which contained both open and closed-ended questions. The non-participant observation method was used to view oil palm farming activities in the study area. A checklist was employed for data collection through this method. The documentary review method was used to collect secondary data, whereby relevant documents were reviewed to get information related to the study topic.

2.4. Data analysis

IBM SPSS version 20 software was used for processing the collected data from the field. The analytical techniques used to analyse the data were descriptive and inferential statistics. These include frequencies, percentages, and means. A binary logistic regression analysis was used to examine the factors that influence the adoption of improved oil palm varieties by farmers. The model for the binary logistic regression is indicated below:

$$\text{Log}(p/1-p) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \ldots\ldots\ldots + \beta_{19} X_{19i}$$

Where:
Log (p/1-p) = log-odds ratio
p: Probability that farmers adopted IOPV given X (Y:1= adopted, 0 = not adopted)
Y: Dependent variable
$X_1, X_2, \ldots, X_{19}$: Independent variables
$\beta_0, \beta_1, \ldots, \beta_{19}$: Parameters of model

The independent variables used in the analysis were:

X_1 = Age, X_2 = Sex, X_3 = Education level, X_4 = Marital status, X_5 = Income, X_6 = Land ownership, X_7 = Farm size, X_8 = Access to extension services, X_9 = Access to credit services, X_{10} = Access to input, X_{11} = Access to irrigation, X_{12} = Membership to farmers' organization, X_{13} = Soil quality, X_{14} = Rainfall, X_{15} = Pests and diseases, X_{16} = Nature of technology, X_{17} = Oil palm farming experience, X_{18} = Proximity to homestead, X_{19} = Cultural factors.

3.0. Results and Discussions

3.1. Socio-economic characteristics of farmers

Findings in Table 1 show that the majority (70.5%) of the respondents in this study were males, which indicates that oil palm cultivation is dominated by males. A study by Carrere (2010) reported that, in rural areas, women are in charge of boiling and milling palm oil as well as selling palm oil products such as oil and soap, leaving the cultivation activities in the hands of men. Sex is an essential characteristic when it comes to the adoption of improved technology and land ownership. It is widely acknowledged that male farmers are more likely to adopt agricultural technologies than their female counterparts (Belachew *et al*., 2020; Mwungu *et al*., 2019; Tesfay, 2020). This can be attributed to norms and beliefs existing in the society (Wordofa and Sassi, 2017) and difficulty access to inputs by female farmers (Degefa *et al.,* 2019).

Results in Table 1 further revealed that the majority (84.4%) of farmers belong to the active age group with a mean age of 23 years. According to the World Bank (2003) people aged 20 years and above have family responsibilities such as raising and providing education for their children. Therefore, they are likely to be engaged in economic activities including cash crops cultivation.

Findings in Table 1 also show that 58.4% of the respondents have household sizes ranging from 6-10 people with an average size of 6.7. According to Mignouna *et al*. (2011), household size is simply used as a measure of labour availability. It determines the adoption process in that, a larger household can relax the labour constraints required during the introduction of new technology. Correspondingly, Feder *et al*. (1985) and Danso-Abbeam *et al*. (2017) asserted that some new agricultural technologies, including improved varieties are more labour-intensive compared to the traditional varieties. Thus, a household with large numbers of family members who are available to work on the farm is more likely to adopt new technologies than a household with a few family members. However, in case where the monetary outlay of adopting the new technology is high and most of the family members income heavily comes from the household head and one source, the likelihood of adopting the technology will diminish for households with large family size (Massresha *et al*., 2021).

Moreover, findings revealed that the majority (89.8%) of the respondents were married (Table1). This correlates with the age distribution of respondents whereby the majority fall between 21 years and above. According to the world fertility reports of the UN (2013), the mean marriage age in Tanzania is 21.4 years while it is 18.9 and 23.8 years for women and men, respectively. These findings suggest that married farmers are dominant in oil palm production, therefore, their engagement in oil palm production is conceived to be the means of livelihood to sustain their families. This implies that married farmers are more highly dependent on oil palm farming than their counterparts, while it is argued that the higher the dependency on agriculture the higher the rate of adoption of improved technology (Uaiene *et al*., 2009). A similar observation was reported by Senya (2009), in the study conducted in the Pangani District of Tanzania. Also, Andati *et al*. (2022) in Kenya testified that male-headed households were more likely to employ certified seeds for soil nutrient management and crop quality management.

In addition, results in Table 1 indicated that the land is controlled by both males and females (93.4%) in Kigoma Rural District compared to 6.6% of the land which is controlled separately by males and females. This connotes that the farming activities that are taking place in Kigoma Rural District are controlled by both males and females together. The study by Njenga *et al*. (2012) shows that lack of access to productive land impedes both youth (male) and some women to excel in the agricultural sector. For married women, whereas they may have access to productive land from their husbands, they often do not have control over its usage.

Table 1: Socio-economic characteristics of farmers (n=166)

Variable	Frequency	Percent
Sex		
Male	117	70.5
Female	49	29.5
Total	**166**	**100**
Age		
18-35	56	33.7
36-50	35	21.1
51-60	49	29.5
Above 60	26	15.6
Total	**166**	**100**
Household size	Frequency	Percent
1-5 people	54	32.5
6-10 people	97	58.4
11-15 people	15	9.0
Total	**166**	**100**
Education level		
No formal education	24	14.5
Primary school	129	77.7
Secondary school	11	6.6
University	2	1.2
Total	**166**	**100**
Marital status		
Married	149	89.8
Single	7	4.2
Widow/ widower	10	6.0
Total	**166**	**100**
Land ownership		
Jointly	155	93.3
Men	5	3.0
Female	6	3.6
Total	**166**	**100**

3.2. Farm size and experience in oil palm cultivation

Results in Table 2 revealed that the majority (79.5%) of farmers had farm sizes from 0.25-2.0 ha, while few (5.4%) owned farm sizes above 4 ha. This implies that majority of farmers in the study area are smallholder farmers, which concurs with the report by FAO (2015).

Farm size plays a critical role in the adoption process of new agricultural technologies (Adamopolous and Restuccia, 2014; Yi *et al*., 2022, Etongo *et al*., 2022, Massresha *et al*., 2021).

Additionally, findings in Table 2 revealed that the majority (74.1%) of the respondents had more than 10 years of experience in the cultivation of oil palm, yet only 47.6% of them (Table 4) had adopted the IOPV. A small number (8.4%) of the respodents had an experience of 1-5 years. The number of years in cultivating oil palm is an important factor for the farmers decision to adopt new varieties due to their experience in oil palm farming. These findings concur with those of Degnet and Belay (2001) who reported that the number of years engaged in maize production among smallholder farmers in Ethiopia had an inverse relationship with adoption. These findings are further supported by Kumar *et al*. (2020) who reported that, longer farming experience correlated with lower rates of the adoption of new agricultural technologies in Nepal. This may be because these technologies have been introduced recently and well experienced smallholder farmers may be resistant to switch to the new variety.

Table 2: Farm size and experience in oil palm cultivation (n=166)

Variable	Frequency	Percent
Farm size		
0.25-1.0 ha	77	46.4
1.1-2 ha	55	33.1
2.1-3 ha	15	9.0
3.1-4 ha	10	6.0
Above 4 ha	9	5.4
Total	**166**	**100**
Number of years in oil palm cultivation		
1-5	14	8.4
5.1-10	20	12.0
10.1-20	69	41.6
Above 20	54	32.5
Unknown	9	5.4
Total	**166**	**100**

3.3. The awareness among farmers' towards IOPV

The results in Table 3 revealed that 79.5% of the respondents were aware of improved variety while 20.5% were not. This implies that there is a flow of information between Agricultural Extension Officers (AEOs), Tanzania Agricultural Research Institute (TARI) Kihinga centre, and smallholder farmers. The results corroborate with those of Juma *et al*. (2020) and Ogola and Ouko (2021), who established that as the effects of climate change become more apparent, smallholder farmers tend to seek information on the best alternative agricultural technologies such as climate-smart farming practices since awareness often precedes the adoption of new innovations. Additionally, Kaliba *et al.* (2018) reported a positive correlation between lack of information and decreased incidence and intensity of adoption of improved sorghum varieties in five regions of Tanzania namely; Dodoma, Singida, Shinyanga, Kilimanjaro and Manyara.

These findings were backed up with one of the agricultural extension officers who stated that:
"*We have been conducting awareness raising campaigns to smallholder famers in Kigoma region on the new improved oil palm variety and its benefits. However, adoption of the new improved variety is a subject of many factors*".

Table 3: Awareness of farmers towards IOPV

Variable	Frequency	Percent
Aware	132	79.5
Not aware	34	20.5
Total	**166**	**100**

3.4. Rate of adoption and farm size under IOPV

Findings in Table 4 revealed that only 47.6% (79 out of 166) of the respondents have adopted the IOPV (Figure 1a). This implies that despite high awareness among the smallholder farmers in the study area just few of them had adopted the IOPV. These findings are in line with those of Ademiluyi (2014), who reported low level (49.2%) of adoption of improved maize variety in Nigeria despite the fact that the smallholder farmers were aware of the improved variety. Also, Ouma *et al*. (2006) and Omolehin *et al*. (2007) discovered that in some cases smallholder farmers fear trying improved agricultural technologies because they do not have the necessary financial resources to do so.

Figure 1a: Tenera Oil Palm variety (IOPV)

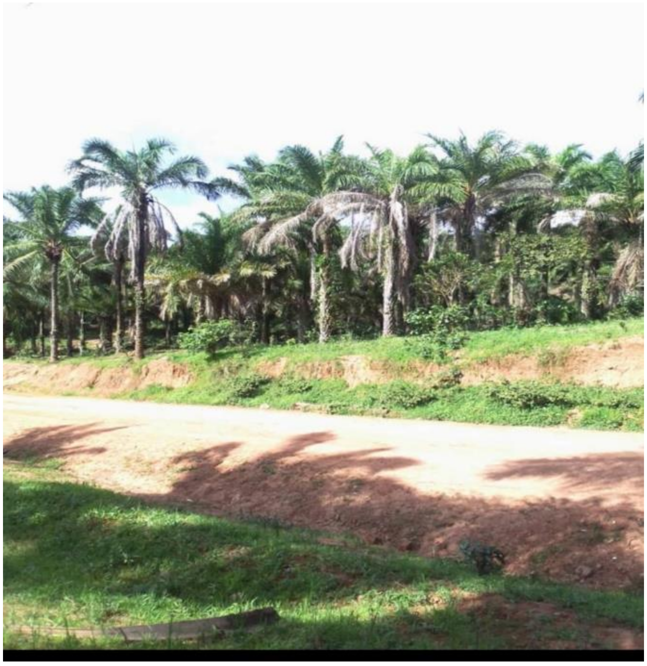

Figure 1b: Dura Oil Palm variety (Traditional)

The results show that the average farm size under IOPV seeds in the study area is 1.5 ha. Also, results in Table 4 indicate that 51.9% of the respondents had farm sizes ranging from 0.5-1 ha. Only 3.8% of them had farms larger than 3 hectares. This implies that most of the farmers in the study area fall in the category of small-scale farmers (also known as smallholder famers). According to FAO (2015), a small-scale farmer is defined as the one with less than 2.2 hectares of land that is used in production. Previous studies have reported a positive relationship between farm size and adoption of new agricultural technologies (Uaiene *et al*., 2009; Mignouna *et al*., 2011, Kilave, 2010)). Mitiku *et al*. (2005) found that farm size positively influenced the adoption of improved chickpea varieties in Ethiopia; Mulwa *et al*. (2017) reported a positive association between land size and crop diversity in Malawi among smallholder famers; Danso-Abbeam *et al*. (2017) informed that the probability of farmers to adopt and intensify the improved maize variety in Ghana was higher in households with larger farm sizes than those with smaller ones. One of the reasons being that, having a large land area creates a room for smallholder farmers to try out different crop varieties as a hedge against adverse outcomes unlike those with small farm sizes (Mulwa *et al*., 2017, Uaiene *et al*., 2009). However, in this study farm size was not statistically significant in influencing smallholder farmers to adopt IOPV indicating that factors influencing adoption of new agricultural technologies is a combination of factors which can vary from one place to another.

Table 4: Farm size under IOPV

Farm size	Frequency	Percent
0.5-1 ha	41	51.9
1.1-2 ha	24	30.4
2.1-3 ha	11	13.9
Above 3 ha	3	3.8
Total	**79**	**100**

3.5. Factors influencing adoption of IOPV

Binary logistic regression was employed to analyse factors influencing the adoption of IOPV among smallholder farmers. Findings in Table 5 show that variables included in the model were good predictors (Negelkerke R^2=0.753) of factors that influence the adoption of IOPV by 75%. Among the factors; age, education level, soil quality, rainfall, nature of technology, proximity to homestead, and land ownership had significant ($p<0.05$) influences on the adoption of IOPV. Furthermore, the results revealed that there was no significant ($p>0.05$) influence of sex, marital status, farm size, oil palm farming experience, pests and diseases, access to extension services, cultural factors, access to credit services, access to inputs, access to irrigation, income, and membership in farmer's organizations in the adoption of IOPV among smallholder farmers in Kigoma Rural District.

Age: Age had a negative regression coefficient (β) of -2.385 and the odds ratio (Exp β) of 0.92 (Table 5). The results revealed that an increase in age, which was statistically significant ($p<0.05$), decreases the adoption of IOPV by a factor of 0.92 given other variables in the model held constant. This implies that there is a negative relationship between the age of a farmer and the adoption of IOPV. This means that an increase in age would decrease the likelihood to adopt IOPV. According to Mauceri *et al*. (2005) and Adesina and Zinnah (1993), age has a negative relationship with the adoption of technology which explains that, as farmers grow older, there is an increase in risk aversion and a decreased interest in long-term investment in the farm. On the other hand, younger farmers are typically risk takers and more willing to try new technologies. Findings of this study were in good agreement with Alexander and Van Mellor, (2005) who reported that the adoption of genetically modified maize in Indiana, US increased with age for younger farmers as they gained experience and increased their stock of human capital but declined with age for those farmers closer to retirement.

Education Level: The findings indicated that the respondent's educational level has a positive and statistically significant ($\beta=2.379$, $p<0.05$) effect on the adoption of IOPV (Table 5). The odds ratio (0.093) shows that a one-unit increase in the educational level of respondents is expected to change the level of adoption by 0.93 given other variables in the model held constant. This denotes that adoption increases as the level of farmers' education increases. Moreover, the more educated the farmer is, the more likely he/she will adopt IOPVs, possibly because he/she can process information more rapidly than others. These findings are in good agreement with the study by Negera *et al*. (2022) in Ethiopia which revealed that level of education of the household head influenced the adoption of Climate Smart Agriculture which included use of improved seeds. According to Mignouna *et al*. (2011), Lavison (2013), Namara *et al*. (2013), Barnes *et al*. (2019), Jamshidi *et al*. (2019) and Omerkhil *et al*. (2020) the education level of a farmer increases his ability to acquire, process, and use information relevant to the adoption of new technology.

Soil Quality: Results revealed that soil quality statistically significantly ($p<0.05$) influenced the adoption of IOPV by a factor of 100.866 (Table 5). This implies that, for small-scale farmers to adopt the new technologies, the soil must motivate them to do so. One of the foremost principles that smallholder production strives for is to adopt improved technologies similar to the plantation, thereby increasing output without necessarily increasing the land size and applying fertilizer adequately to improve soil fertility. This finding concurs with Sheil *et al*. (2009) who reported that fruit production responds well to soil nutrients and trees produce more fruits when fertilized.

Rainfall: Additionally, results revealed that the amount of rainfall significantly ($p<0.05$) influenced the adoption of IOPV by a factor of 4.572 (Table 5). This implies that rainfall is among the important factors that influence the intensity of adopting improved technologies among small-scale farmers. Furthermore, Tanzanian agriculture is virtually small-scale, subsistence-oriented, and crucially dependent on rainfall. These findings correspond well with those obtained by Nyang *et al*. (2021) who reported that variations in rainfall during periods of climate stress influences substantially the adoption of new agricultural technologies by smallholder famers in Kisii Kenya. Furthermore, Kaliba *et al*. (2000) examined factors influencing the adoption of improved technologies (maize seeds and inorganic fertilizer) by producers in Tanzania. Their results indicated that the availability of extension services, on-farm field trials, variety characteristics, and rainfall were the most important factors that influenced the intensity of adopting improved technologies among small-scale farmers.

Nature of Technology: The nature of technology has a positive regression coefficient (β) of 2.361 and the odds ratio (Exp β) of 0.94 significantly ($p<0.05$) affected the adoption of IOPV (Table 5). This implies that the more compatible the technology is with existing ways of processing, the higher the level of adoption. Also, the more affordable technology is, the more farmers will likely to adopt it. Additionally, with technologies whose adoption process does not involve many activities and is less risky to adopt, many small-scale farmers will be positively influenced to adopt them. Mignouna *et al*. (2011) stated that the nature of the technology plays a critical role in the adoption decision process. They argued that farmers who perceive the technology as being consistent with their needs and compatible with their environment are likely to adopt it since they consider it as a positive investment.

Proximity to Homestead: Proximity to homestead has a negative regression coefficient (β) of -2.401 and the odds ratio (Exp β) of 0.91 (Table 5). Moreover, results indicated that proximity to the homestead significantly ($p<0.05$) influenced the adoption of IOPV, and the far the home is from the farm the greater the decrease in the adoption of IOPV by a factor of 0.91. This implies that more distance from home to the farm has the potential to affect farm activities negatively, as farmers may feel tired by the time they reach the farm or may have to spend extra money to commute from home to the farm. These findings concur with Danso-Abbeam *et al*. (2017); who found that the adoption of improved maize varieties was influenced by distance from homestead among farm households in Ghana.

Land Ownership: Land ownership has a positive regression coefficient (β) of 5.942 and an odds ratio (Exp β) of 380.604 (Table 5). Additionally, results revealed that land ownership significantly ($p<0.05$) influenced the adoption of IOPV and this will increase the adoption by a factor of 380.604. This implies that land ownership is very important to smallholder farmers when it comes to adoption of new agricultural technologies. Land ownership influences the adoption of IOPV because farmers who own land may have a chance to apportion certain land for testing the newly IOPV compared to people who do not own land. These results are in line with Gabre-Madhin and Haggblade, (2001) and Mignouna *et al*. (2011) who reported that farmers with large land are likely to adopt new technology, as they can afford to devote part of their land to try new technology unlike those with small land.

Table 5: Binary logistic regression for factors influencing adoption of IOPV

Variables	β	S.E.	Wald	Df	Sig.	Exp(β)
Sex	-2.164	1.355	2.550	1	.110	.115
Age	-2.385	1.120	4.534	1	.033	.092
Education level	2.379	1.127	4.458	1	.035	.093
Marital status	1.499	1.502	.997	1	.318	4.478
Farm size	.639	.794	.647	1	.421	1.894
Oil palm farming experience	-2.420	1.833	1.743	1	.187	.089
Pests and diseases	-.148	.711	.043	1	.835	.862
Access to extension services	.629	.699	.810	1	.368	1.876
Soil quality	4.614	.886	27.120	1	.000	100.866
Rainfall	1.520	.713	4.548	1	.033	4.572
Cultural factors	-1.627	1.050	2.401	1	.121	.196
Access to credit	1.041	.949	1.205	1	.272	2.833
Access to inputs	-2.365	2.025	1.365	1	.243	.094
Access to irrigation	3.118	2.046	2.323	1	.127	22.608
Income	1.840	1.002	3.369	1	.066	6.294
Nature of Technology	2.361	.854	7.638	1	.006	.094
Membership to farmers organization	.964	1.306	.545	1	.460	2.622
Proximity to homestead	-2.401	.788	9.295	1	.002	.091
Land ownership	5.942	2.168	7.513	1	.006	380.604
Constant	-5.654	3.583	2.489	1	.115	.004

4. Conclusion and Recommendations

4.1. Conclusion

This study examined the factors influencing the adoption of improved oil palm variety (IOPV) in Kigoma Rural District in Tanzania. The findings indicated that the respondents (smallholder farmers) were aware of IOPV and the most important variables that influenced them to adopt the improved variety were; age, education level, soil quality, rainfall pattern, nature of the technology, proximity to a homestead, and land ownership. However, the extent of adoption of IOPV among small-scale farmers in the study area is still low and is practiced on small farm sizes. This signifies that the capacity of these small-scale farmers to confront the effects posed by climate change on agriculture is still low making them more vulnerable to this tragedy which is likely to aggravate poverty among them owing to the fact that oil palm production is one of the main sources of their livelihood. Furthermore, comparison of the findings in this study with those in previous studies done elsewhere indicated that factors influencing smallholder farmers to adopt improved agricultural technologies is a subject of various factors hence not uniform from one place to another.

Moreover, findings in this study denote that, if no strategic efforts are made to ensure adoption of the new variety so as to boost the oil palm production, the country will keep on importing cooking oil to sustain the demand of this important food product. This has a negative implication to the country's economy as more foreign exchange will be used.

4.2. Recommendations

The study recommends that more sensitization campaigns by local government, the central government, and other stakeholders (e.g NGOs) is required to raise farmers' awareness on IOPV inorder to increase its adoption. Adoption of IOPV is expected to boost the oil palm production in the country which will ultimately heighten the economy of both the smallholder farmers and the country. Similarly, policies and issues affecting land ownership should be reviewed to promote access to land by the majority of smallholder farmers. Obi (2021) and Kumar *et al*. (2020) demonstrated that informal social networks and, farmer's associations have been a good source of information which has significant impact on a smallholder farmer's decision to adopt new agricultural technologies. Hence, formulation of social groups which bring together smallholder farmers is also highly recommended.

Also access to extension services has to be improved since it has been reported to play a big role in enhancing adoption of new agricultural technologies among smallholder farmers in various countries. Moreover, further studies in other areas potential for oil palm production in Tanzania are highly recommended to establish comprehensive information on the status of IOPV adoption in the country.

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