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Effects of Socio-demographic Characteristics on Adoption of Improved Sorghum Farming Practices in Dodoma Region

Peter B. Kadilikansimba[1,2] *, Alfred S. Sife[2] and Gervas M. Machimu[2]
[1]*Moshi Co-operative University (MoCU), Moshi, Tanzania*
[2]*Local Government Training Institute (LGTI), Hombolo, Tanzania*
[*]*Corresponding author email: pbkadilikansimba@gmail.com*

Abstract

The low adoption of improved sorghum farming practices, including the use of improved seed varieties, fertilizers, pest control, and post-harvest management, has led to reduced agricultural productivity and increased food insecurity among farmers in developing nations, including Tanzania. This scenario can be attributed to a breakdown in communication, resulting in essential information not clearly understood and used by its intended recipients. This study focused on investigating how the socio-demographic characteristics of sorghum farmers influence the adoption of improved farming practices in the Dodoma Region of Tanzania. The main objective was to examine whether demographic factors affect the acceptance and use of agricultural information necessary for the adoption of improved sorghum farming techniques. Based on Sengupta's (1967) classification of adoption levels, the research reveals distinct categories: non-adopters (14.79%), low adopters (39.35%), medium adopters (16.04%), and high adopters (29.82%) of improved sorghum farming practices. The results from linear mixed model analysis revealed that only farming experience and information-seeking behaviour significantly and positively influenced the adoption of improved practices (p-value < 0.05). These results underscore the key roles of experience and proactive information-seeking habits in driving the uptake of improved sorghum farming practices. Therefore, this study offers valuable insights into the challenges and aids that farmers face when considering and implementing changes in their sorghum cultivation techniques. By illuminating the factors that influence agricultural behaviour and decision-making, this research enhances our comprehension of sustainable farming practices in the Dodoma Region. Furthermore, the practical implications of these findings provide a strategic guide for policymakers, development organizations, and agricultural extension services to create tailored and context-specific strategies that effectively encourage the adoption of improved sorghum farming practices. This, in turn, contributes to enhancing agricultural sustainability and productivity within the region.

Keywords:
Sorghum, Socio-demographic characteristics, Adoption, Farming Practices, Agricultural Information, and Dodoma

1. Introduction

Sorghum cultivation holds a significant role in guaranteeing food security and sustaining the livelihoods of smallholder farmers, especially in arid and semi-arid areas owing to its remarkable ability to thrive under challenging growing conditions. According to Andiku et al., (2021) and Kazungu et el. (2023) sorghum crop is widely cultivated in the arid regions of Africa, China, and India. Based on Yahaya et al., (2023) study, the primary global producers of sorghum are the United States, with an annual grain production of 8.7 million tons cultivated on 2.0 million hectares of land. Nigeria closely follows with 6.9 million tons from 5.4 million hectares, while Ethiopia produces 5.3 million tons from 1.9 million hectares, and Sudan yields 3.7 million tons from 6.8 million hectares.

The rising interest in cultivating this crop stems from its natural ability to withstand drought, quick maturation, and cost-effective cultivation (Yahaya and Shimelis, 2022; Mansour et al., 2021; Santana et al., 2020). These attributes make it a valuable strategic cereal crop in addressing pressing global issues such as food insecurity, poverty, and climate change. By providing sustenance and generating income for numerous smallholder farmers, it plays a vital role in tackling these challenges (Motsi et al., 2022; Karki et al., 2020). As a result, smallholder farmers are striving to enhance sorghum production by adopting a range of improved farming practices and technologies. Adopting improved agricultural practices, such as utilizing certified seeds and fertilizers, effectively managing pests, weeds, and diseases, and implementing strategies to reduce post-harvest losses, can have a substantial positive impact on sorghum yields. Makate (2019) and McLennon et al., (2021) posit that the key approach to achieving the desired sorghum production levels lies in embracing emerging agricultural innovations and practices. Nevertheless, the extent to which farmers adopt these improved practices is notably influenced by the effectiveness of communication between those disseminating agricultural information and those on the receiving end. This viewpoint aligns with the National Agricultural Policy (2013), which identifies inadequate communication links among agricultural stakeholders as a cause for the limited adoption of improved technologies such as certified seed varieties, fertilizers, suitable farm implements, rainwater harvesting, and post-harvest technologies (URT, 2013).

In essence, the successful adoption of improved farming practices hinges on effective communication between information providers and recipients. Effective communication serves to bridge comprehension gaps, foster meaningful connections, and ensure the accurate sharing and reception of information, leading to desired outcomes. Therefore, understanding the socio-demographic characteristics of the information recipients becomes paramount. Nyamba et al., (2020) further emphasize the vital role of effective communication in enabling the exchange of information to enhance agricultural productivity. This underscores the significance of proficient communication in navigating the complex web of socio-demographic traits, facilitating a continuous flow of information that directly shapes agricultural productivity outcomes.

Reichelt and Nettle (2023) as well as Atinaf et al., (2023) emphasize from a similar standpoint that the adoption of improved agricultural technologies and farming methods hinges on the communication between experts, researchers, and extension services to farmers and other involved parties. This highlights the importance of acknowledging the socio-demographic attributes of the farmers involved in this process. As such, factors like age, education, gender, household size, farming experience, and information-seeking behaviour assume a vital role in influencing farmers' capacity to acquire and proficiently utilize information. This becomes especially notable when they are making informed decisions regarding the adoption of improved farming practices.

Worldwide, a large and growing body of literature has investigated the influence of socio-demographic factors on the adoption of various introduced innovative agricultural technologies and farming practices. Age has been identified as one of the influential factors in decision-making and subsequent adoption. In New Zealand, a study by Brown et al., (2019) found that older farmers were less likely to adopt agricultural technologies because they were more risk-averse and less willing to experiment with new farming practices. Older farmers may feel less inclined to change long-standing farming practices that have served them well over time. In contrast, research conducted in China by Thinda et al., (2020) has shown that age can have a negative impact on smallholder farmers' adoption. Similarly, Blok et al., (2020) point out that farmers of young age are more aware and ready to adopt new technologies for long term benefits. In this regard, the influence of age on technology adoption is contingent upon various factors, including personal attributes, socio-cultural characteristics, and notably, the specific context in which the adoption takes place.

Household size is frequently used as a metric to assess the accessibility of labour and its impact on the acceptance of novel agricultural technologies. It is believed that households with more members have a greater amount of labour at their disposal, thereby facilitating the uptake of new farming methods and technologies. The notion is also reinforced by the study carried out by Lamptey et al., (2022) in Ghana, where their research illustrated a distinct and significant relationship between the uptake of improved rice seed varieties and the presence of family labour. However, despite this assumption, Dhakal and Rai (2020) discovered that such households were hesitant to adopt agroforestry practices in Nepal. This finding highlights the importance of socio-demographic and contextual factors in the uptake of agricultural innovations. Hence, interventions that emphasize the social and cultural norms that shape farmers' decision-making may be more effective in certain contexts. Studies have indicated that as the level of education increases, farmers become more aware of modern farming technologies through various sources of information. Serebrennikov et al., (2020) established that the acceptance of organic farming in Europe was significantly influenced by education levels of household heads. In Nigeria, the research undertaken by (Obazi et al., 2022) uncovered that demographic aspects, such as lower levels of education, played a role in the low adoption of organic manures among fluted pumpkin vegetable farmers. This circumstance was linked to concerns about pollution and the likelihood of pest infestations. Moreover, greater degrees of formal education and a deeper comprehension of climate change were

observed to significantly increase the likelihood of adopting various climate-smart agricultural practices, thereby fostering agricultural sustainability in Ethiopia (Teklu et al., 2023). In Burkina Faso, Mujeyi et al., (2020) conducted reports that gender played a significant role in the adoption of technological innovations, with men being more likely to adopt such practices than women. Carranza and Niles (2019) found that in Uganda, male-headed households were more inclined to adopt new farming methods than female-headed households. In Kenya, Ngigi and Muange (2022) identified that the adoption of climate-smart agriculture was influenced by several factors, including gender. Similarly, the research conducted by (Neway and Zegeye, 2022) demonstrated that the choice to adopt agricultural technology was markedly impacted by factors such as the household's gender composition, the educational attainment of the household head, and the marital status of the household head. Conversely, Liliane et al., (2020) found no significant correlation between gender of participants and their adoption of agroforestry practices in Rwanda. The inconsistent and conflicting results found in the literature indicate that the association between socio-demographic characteristics and the adoption of agricultural technologies is intricate and dependent on specific contexts. To enhance food security and improve the livelihoods of rural households, especially in regions prone to drought like Dodoma, where sorghum farming is both agro-ecologically favorable and highly recommended. Several interventions have been implemented. These measures aim to promote the adoption of various recommended farming practices that can contribute to sustainable agricultural production and mitigate the impact of climate-related challenges. Among the initiatives made are those that support research such as the establishment of the TARI-Hombolo Centre which is mandated to undertake research and disseminate information on drought-tolerant crops mainly sorghum and millets. The centre is also responsible for improvement of extension services, involvement of the private sector in the development and delivery of agricultural inputs, and improving agricultural markets and marketing for various agricultural products including commercialization for sorghum and millet, and importation of new sorghum varieties into Tanzania (Hambloch et al., 2021; Ndossi et al., 2021; Orr et al., 2020; AGRA, 2019).

Nevertheless, despite its strategic importance and significant efforts to promote the adoption of various improved sorghum farming practices in Tanzania, there is still low uptake of these practices. For example, while new seed varieties have been introduced to enhance sorghum production, only 5% of local farmers have adopted them (Orr et al., 2016). Moreover, the average rate of fertilizer application is much lower than the global guideline, at just 15.9 kg ha-1, as compared to 162 kg ha-1 (Zhang et al., 2020). As a result, sorghum production in Dodoma averages only 0.99 tonnes per hectare, well below the recommended threshold of 5 tonnes per hectare (Mapesa, 2020). Additionally, post-harvest losses of cereals, including sorghum, account for a substantial proportion of the total annual crop production in Tanzania, ranging from 30% to 40% (Maziku, 2019). Previous studies (Prokopy et al., 2019; Pathak et al., 2019; Donkoh, 2019) have predominantly focused on connecting the adoption of agricultural technologies and farming practices with technical and economic considerations. While conventional socio-demographic studies focus on identifying direct relationships between factors like age, education, and adoption rates, this work delves into the intricate role of communication as a mediating factor. It recognizes that effective communication acts as a bridge between socio-demographic characteristics and technology adoption outcomes. This unique perspective underscores the need to not only consider the socio-demographic traits in isolation but also explore how they interact with communication dynamics. Moreover, this study introduces a fresh perspective by underscoring the importance of considering information-seeking behaviour as a socio-demographic attribute. In contrast to the typical approach of socio-demographic research that focuses on fixed characteristics, this viewpoint acknowledges the proactive involvement of farmers in seeking information, which significantly impacts their adoption of technology. By incorporating this behavioural aspect, this study enhances the breadth of understanding regarding the determinants of adoption choices. Agriculture transcends individual action; it is deeply interwoven with social and cultural contexts. Similarly, the adoption process, particularly within agriculture, is inherently social, necessitating effective information sharing. It's crucial to acknowledge that farmers should not be perceived as a uniform or homogeneous collective, as their attitudes, behaviours, and decision-making processes are shaped by a diverse array of social factors (Gao et al., 2023; Bourceret et al., 2023; García-Avilés, 2020).

Therefore, this research effectively addresses a noticeable gap in current socio-demographic inquiries related to the adoption of improved farming practices and agricultural technology. It accomplishes this by shifting the focus away from isolated characteristics and towards the intricate interplay among socio-demographic variables, communication trends, and conduct. Through the utilization of a model centered on information-seeking and communication, the study aims to illuminate the understanding of the complex dynamics inherent in the adoption of technology, alongside the socio-demographic attributes of smallholder farmers. Furthermore, by highlighting farming experience and information-seeking conduct as pivotal determinants of adoption, the study provides precise insights that can orient policymakers, extension services, and agricultural stakeholders in shaping their strategies to suit specific needs. The following hypothesis was tested:

Ho: Socio-demographic characteristics have no effects on adoption of improved sorghum farming practices in Dodoma Region, Tanzania.

1.1 Theoretical Framework

Information Seeking and Communication Model

This study is underpinned by Information Seeking and Communication Model (ISCM) developed by (Robison and Robison, 2015). The ISCM suggests that individuals' actions are shaped by how they search for and share information. It provides a deeper understanding of how people seek, utilize, and communicate information, highlighting the interactive nature between the sender and receiver. It also considers the various factors that influence these behaviours, taking into account the specific circumstances and environments in which they occur. The ISCM framework acknowledges two main categories of context that influence communication: environmental and personal. Environmental context pertains to the physical surroundings in which information sources and receivers operate, including their living or working environments. Personal context encompasses the demographic attributes of information actors, such as education level, age, gender, household income, and farming experience. ISCM suggests that individuals have an inherent motivation to seek information and engage in communication based on their specific needs and challenges. In the context of sorghum farming, farmers who possess a strong desire to acquire knowledge about new practices are more likely to adopt them. However, their communication patterns may be influenced by their socio-demographic characteristics.

In this study, the ISCM model was utilized to examine how socio-demographic factors are associated with the adoption of improved sorghum farming practices. The aim was to understand the dynamic relationship among socio-demographic characteristics, and the adoption of improved sorghum farming practices, employing the Information Seeking and Communication Model as a guiding framework.

2. Materials and Methods

2.1 Research Design

To investigate the influence of socio-demographic characteristics on the adoption of improved sorghum farming practices, a cross-sectional design was used, which enabled the inclusion of participants with varying characteristics at one point in time. A mixed methods approach was utilized to gather data, consisting of a household survey given to 399 smallholder sorghum farmers. This approach allowed for the collection of quantitative data on the extent of adoption of improved farming practices and qualitative data on the reasons behind the association of certain socio-demographic characteristics with the adoption.

2.2 Population and Sampling

The study included sorghum farmers from Kongwa, Kondoa, and Bahi districts in the Dodoma region. A simple random sampling method was employed to select these three districts out of seven districts in the region. This method ensured that each district had an equal chance of being included in the study sample, making the chosen districts representative of the remaining four districts. To investigate the influence of socio-demographic characteristics on the adoption of improved sorghum farming practices, a cross-sectional design was adopted, which enabled the inclusion of participants with varying characteristics at one point in time. A mixed methods approach was utilized to gather data, consisting of a household survey given to 399 smallholder sorghum farmers. This approach allowed for the collection of quantitative data on the extent of adoption of improved farming practices and qualitative data on the reasons behind the association of certain socio-demographic characteristics with the extent of adoption. The minimum sample size needed for this study was 384 respondents, based on Cochran's (1963) estimate for an infinite population given by equation 1 where Z=1.96, q=0.5, p=0.5, and e=0.05. However, the researchers were able to obtain a sample of 399 respondents, which was included in the study.

$$n_o = \frac{Z^2 pq}{e^2} \quad (1)$$

To obtain the necessary participants, a multi-stage sampling approach was utilized. The first stage involved random selection of three districts, Kongwa, Bahi, and Kondoa out of seven disticts. The second stage involved the creation of a sampling frame by acquiring a list of all wards in the selected districts, followed by the random selection of three wards from each district. The third stage involved the random selection of villages from all the villages in the selected wards. In the fourth and final stage, a sample of households was selected randomly from the list of households in the chosen villages, and data were collected from the heads of these households. Therefore, sorghum farmers were the unit of analysis in this study, while the head of households was the unit of observation.

2.3 Data Collection Tools

A structured questionnaire with both closed and open-ended questions were used to obtain data from a sample of sorghum farmers. Furthermore, an interview guide was used to collect data from key informants which included TARI agricultural experts and ward extension officers.

2.4 Measurememts of Variables

The dependent variable in this study was the adoption of improved sorghum farming practices. The study identified six specific practices, namely farm preparation, use of improved seed varieties, application of fertilizers/manure, control of weeds, control of pests and diseases, and management of post-harvest losses. Each practice had several aspects (items) used to measure adoption, in total there were 22 items. Each item was assessed using a 5-point Likert scale, ranging from 1 (Not at all adopted) to 5 (Highly adopted). During data analysis, an adoption index was obtained for each farmer by summing all the 22 items related to adoption level.

$$Adoption\ Index = \sum_{i=1}^{22} Adoption\ of Item_i$$

Also an adoption quotient was obtained by finding the percentage of adoption using the formula below (Sengupta, 1967) adopted by Prodhan and Khan, 2018; Gawde et al., 2006. In this case the scales for each item were from 0 to 4, 0 indicating not adopted at all 4 indicating highly adopted the specific item.

$$Adoption\ Quotient\ (in\ \%) = \frac{Total\ adoption\ level\ for\ all\ items}{Total\ maximum\ level\ of\ adoption} \times 100\%$$

The independent variables in the study were socio-demographic characteristics. These variables included information-seeking behavior, age, gender, education level, marital status, farm size, household size, farming experience, and location. These variables were considered as factors that could potentially influence the adoption of improved sorghum farming practices

2.5 Data analysis

Descriptive analysis was conducted on both the independent variables and the dependent variable in order to gain an understanding of the data. The findings of the descriptive analysis were then conveyed through the use of tables and figures. To determine the influence of socio-demographic characteristics on the adoption of improved sorghum farming practices, this study employed a linear mixed model (LMM). LMMs are a type of linear regression model, and as such, all the assumptions associated with linear regression apply except for the assumption of independence of observations and errors (Field, 2013). Unlike linear regression models, which consider only fixed effects, LMMs incorporate both fixed and random effects. The study selected a sample of three districts out of seven in Dodoma Region, with these three districts being representative of the others. If the study had employed a linear regression model, the effect of district would have been considered a fixed effect, and the results would not have been generalizable to other districts. To address this issue, the study utilized an LMM with the effect of district treated as a random effect, allowing for the results from the random effect to be extended to the other districts beyond the three involved in the study. The model used in the study had the following general form:

$$Y_{ij} = \beta_0 + u_{0j} + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{3ij} + \beta_4 X_{4ij} + \beta_5 X_{5ij} + \beta_6 X_{6ij} + \beta_7 X_{7ij} + \beta_8 X_{8ij} + \varepsilon_i$$

In this equation, the variables were defined as follows:

Y_{ij}: The adoption of improved sorghum farming practices for the i-th household in the j-th district

X_1: An indicator variable for the gender of the head of household (0=male, 1=female)

X_2: An indicator variable for marital status (0=single/divorced/separated/widowed, 1=married)

X_3: Education level, measured on an ordinal scale (1=no formal education, 2=primary education, 3=secondary and above)

X_4: Age (in years) of household head

X_5: Farm size (in acres)

X_6: Household size (number of people)

X_7: Farming experience (in years)

X_8: Information seeking behaviour (in a scale of 1 to 5)

Where, β_0 is the fixed intercept, u_{0j} is the random effect for the j-th district, and ε_i is the random error term.

Data were analysed using STATA version 15 and any tests conducted were deemed to be statistically significant if the p-value was less than 0.05, which corresponds to a 5% level of significance. The data were analysed using STATA version 15 and any tests conducted were deemed to be statistically significant if the p-value was less than 0.05, which corresponds to a 5% level of significance.

2.6 Validity and reliability

To ensure the reliability and validity of the research tool used for data collection in this study, a pilot was carried out in Mlowa-Barabarani Village, Chamwino district with 38 sorghum farmers who shared similar population characteristics to the actual study population. The researchers evaluated the internal consistency of all Likert-type scale questions using Cronbach's alpha, which indicated that the questions had good reliability (Cronbach's Alpha > 0.7 for all questions). Face validity was assessed to ensure that the items used to measure the constructs were appropriate, and content validity was evaluated by experts who reviewed the questionnaire before it was administered for data collection. The accuracy of a questionnaire in measuring the intended construct is referred to as its validity (Knekta *et al*., 2019)

2.7 Statistical treatment of data

Quantitative data were collected to test the hypothesis and draw statistical explanations and draw inferences on the socio-demographic influence on adoption of improved sorghum farming practices. Qualitative data were also collected to explore farmers lived experience in sorghum farming practices. Overall qualitative data were used to supplement quantitative information and informed consent was obtaining prior to their inclusion in the study. Maximum confidentiality of respondents' information was maintained.

2.8 Ethical consideration

An approval letter from Dodoma Regional Administrative Secretary Office was obtained to collect data in Kongwa, Kondoa and Bahi districts. Clear explanation on the purpose of the research was explained to respondents.

3. Results and Discussion

The study sought to determine the influence of socio-demographic characteristics on adoption of improved sorghum farming practices in Dodoma, Tanzania. The results are presented in accordance to research question and hypothesis.

3.1 Results

3.1.1 Socio-demographic Characteristics of participants

Table 1 presents data regarding the socio-demographic characteristics of the study participants. The breakdown by district shows that 138 participants (34.59%) were from Kongwa, while Bahi and Kondoa had 133 (33.33%) and 128 (32.08%) participants, respectively. In terms of gender, male participants slightly outnumbered females, with 228 (57.14%) and 171 (42.86%) participants, respectively. The majority of respondents, 333 (83.46%), were married, while 66 (16.54%) were single, divorced, separated, or widowed. When it came to education level, a significant portion of respondents, 301 (75.44%), had completed primary education, while 69 (17.29%) had no formal education, and 29 (7.27%) had achieved secondary education or higher. Regarding agricultural information seeking behavior, the findings showed that 140 (35.09%) participants reported sometimes seeking information. Another response category was rare information seekers, with 102 (25.56%) respondents. Furthermore, 72 (18.05%) participants reported seeking information often, while 75 (18.80%) stated that they never sought information. Only a small proportion of respondents, 10 (2.51%), reported always seeking information on agricultural activities.

The study gathered information on household size, revealing that more than half of the participating households (54.89%) had a size between 4 and 6 individuals. There were also households with 1 to 3 individuals (27.82%) and households with more than 7 individuals (17.29%). The average age of the respondents was 46.89 years, ranging from 18 to 86 years. The average farm size was 2.16 acres, ranging from 1 to 3 acres. The respondents had an average farming experience of 17.43 years, ranging from 1 to 50 years.

3.1.2 Adoption of improved sorghum farming practices

Table 2 displays the distribution of adoption levels for improved sorghum farming practices among 399 respondents. It categorizes them into non-adopters, low adopters, medium adopters, and high adopters, based on the classification by Sengupta (1967). The table shows that 14.79% of the respondents were non-adopters, indicating no adoption of improved practices. The largest group, comprising 39.35% of the respondents, were classified as low adopters, having partially adopted the practices but to a lesser extent than medium and high adopters. The study identified 16.04% of respondents as medium adopters, representing a moderate level of adoption, while 29.82% were classified as high adopters, demonstrating extensive adoption of the improved sorghum farming practices.

Table 1. Socio-demographic characteristics of participants (N=399)

Variable	Freq.	Percent (%)
District		
Kongwa	138	34.59
Bahi	133	33.33
Kondoa	128	32.08
Gender		
Male	228	57.14
Female	171	42.86
Marital Status		
Single/divorced/separated/widowed	66	16.54
Married	333	83.46
Education Level		
No formal education	69	17.29
Primary education	301	75.44
Secondary education and above	29	7.27
Information seeking behavior		
Never	75	18.80
Rarely	102	25.56
Sometimes	140	35.09
Often	72	18.05
Always	10	2.51
Household Size		
1 to 3	69	17.29
4 to 6	219	54.89
7 and above	111	27.82

	Mean	Std.Dev	Min	Max
Age (in years)	46.89	13.46	18	86
Farm Size (in acres)	2.16	0.62	1	3
Farming Experience (in years)	17.43	11.79	1	50

Table 2. Adoption of improved sorghum farming practices (N = 399)

Adoption	Frequency (n)	Percent (%)
Non-adopters	59	14.79
Low adopters	157	39.35
Medium adopters	64	16.04
High adopters	119	29.82

3.1.3 Influence of socio-demographic characteristics on adoption of improved sorghum farming practices

The study aimed to examine how socio-demographic characteristics influence the adoption of improved sorghum farming practices. A linear mixed model was utilized to analyze the effects of socio-demographic factors on adoption, and the results are summarized in Table 2. The analysis considered eight socio-demographic characteristics, including gender, marital status, education level, age, farm size, household size, farming experience, and information seeking behaviour. The findings indicated that out of these eight factors, only farming experience and information seeking behaviour exhibited a positive and statistically significant impact on the adoption of improved farming practices.

3.1.4 Test for multicollinearity

The Variance Inflation Factor (VIF) and Tolerance values were used to assess the presence of multicollinearity in the model. Table 3 displays the VIF and Tolerance values for each variable. The results indicate that there is no severe multicollinearity among the variables in the model. All the VIF values are less than 10, and the corresponding Tolerance values are greater than 0.1. The largest VIF value is 2.10, corresponding to a Tolerance value of 0.476. These values suggest that there is a relatively low level of multicollinearity among the variables. The findings indicate that the variables can be considered individually in the model without significant concerns about multicollinearity.

This suggests that the variables have a low correlation with each other, allowing for independent interpretation and analysis within the model.

3.1.5 Test for Influential outliers

Studentized residuals were utilized to identify influential outliers within the model. The summary statistics of the studentized residuals are presented in Table 4. The results indicate that the residuals fall within the range of [-3, 3], indicating the absence of influential outliers among the observations. The findings from LMM indicated that out of these eight factors, only farming experience and information seeking behaviour exhibited a positive and statistically significant impact on the adoption of improved farming practices (Table 5).

Table 3. Test for multicollinearity

Variable	VIF	Tolerance (1/VIF)
Age	2.10	0.476
Farming Experience	1.95	0.512
Gender	1.27	0.789
Marital Status	1.23	0.815
Household Size	1.18	0.848
Education Level	1.18	0.851
District	1.11	0.899
Farm Size	1.11	0.901
Information seeking behavior	1.09	0.921
Mean	1.36	

Table 4. Summary statistics for the studentized residuals

Variable	Observations	Mean	Std.dev.	Minimum	Maximum
Studentized residuals	399	2.845	0.178	-2.221	2.235

Table 5. Influence of Socio-demographic characteristics on Adoption of Improved Sorghum Farming Practices

Characteristics	Estimate (β)	Std. Error	P-value
Gender			
Male	Ref	-	-
Female	-0.491	2.908	0.866
Marital Status			
Single/divorced/separated/widowed	Ref	-	-
Married	3.884	3.809	0.309
Education Level	3.041	2.836	0.284
Age (in years)	-0.231	0.135	0.087
Farm Size (in acre)	0.265	0.508	0.602
Household Size	0.710	0.624	0.256
Farming Experience (in years)	0.655	0.152	<0.001
Information seeking behavior	4.415	1.249	0.001

3.1.6 Farming experience

The results of the linear mixed model demonstrate a significant positive relationship between farming experience (measured in years) and the adoption of improved sorghum farming practices. The estimated coefficient (β) of 0.655 indicates that, on average, for each additional year of farming experience, the adoption of improved sorghum farming practices increases by 0.655 units. This relationship is statistically significant, as indicated by the p-value of <0.001. In summary, the findings from the linear mixed model provide evidence that long farming experience is associated with a higher likelihood of adopting improved sorghum farming practices.

3.1.7 Information Seeking Behaviour

In terms of seeking information, the linear mixed model analysis also demonstrates a noteworthy and positive influence on the adoption of improved sorghum farming practices. The estimated coefficient (β) of 4.415 suggests that an increase in information-seeking behaviour corresponds to an average increase of 4.415 units in the adoption of

improved sorghum farming practices. This association is statistically significant, with a p-value of <0.001. Essentially, the results derived from the linear mixed model provide empirical support for the idea that a higher level of information-seeking behaviour is connected to a greater likelihood of adopting improved sorghum farming practices.

3.1.8 Other Socio-demographic variables

Nevertheless, for other socio-demographic factors like gender, education level, farm size, household size, age, and marital status, their respective p-values exceeded the predetermined threshold of 0.005. Consequently, it can be inferred that these characteristics did not have a statistically significant effect on the adoption of improved sorghum farming practices. Therefore, there is insufficient evidence to conclude that these socio-demographic variables influenced the adoption. Any disparities observed in adoption rates among these factors may be attributable to chance or unaccounted factors within the model.

3.2 Discussions

The findings reveal that a significant proportion of respondents had an average sorghum farming experience of 17 years. This suggests that most farmers have been actively engaged in farming for a considerable period, allowing them ample time to become acquainted with emerging agricultural technologies and practices. Such farming experience offers advantages in enhancing agricultural productivity by facilitating the rapid adoption of improved farming techniques. These findings are consistent with a study conducted by Michels et al., (2020), which observed that farmers' experience in agricultural activities played a pivotal role in the adoption of smartphones for agricultural purposes in Germany. Similar results were also reported by Abegunde et al., (2019), who found that farming experience influenced the adoption of climate-smart agriculture (CSA) in South Africa. Additionally, research conducted by Liliane and Charles (2020) indicated that the age of the farmer positively influenced both the awareness and adoption of agricultural technologies and practices. Older farmers with extensive farming experience are exposed to a wide range of information from various sources, thereby increasing their likelihood of adopting new practices compared to younger farmers.

Nevertheless, farmers with extensive experience may occasionally show a preference for traditional practices that have proven successful in the past. They might approach the adoption of new techniques with caution, especially if they perceive them as unfamiliar or potentially risky. It is essential to understand that while farming experience can sometimes hinder adoption, it does not imply that experienced farmers are resistant to all innovations. The decision to adopt is influenced by various factors, including familiarity with traditional farming methods, risk aversion, and limited access to information. This is supported by Ngoma et al., (2019) who found that risk aversion and impatience were negatively correlated with the likelihood of adopting Climate Smart Agriculture in USA.

The study highlights the significant role of information seeking in empowering farmers to adopt new agricultural technologies and adapt to evolving practices. The majority of farmers demonstrated a moderate inclination towards seeking agricultural information, which had a substantial impact on their decision to adopt improved sorghum farming practices. These findings are consistent with studies conducted by Barnes et al., (2019) and Vecchio et al., (2020) in Europe, which found a significant relationship between information seeking behaviour and the adoption of various agricultural technologies. Similarly, a study by Prokopy et al., (2019) conducted in the USA showed a positive association between farmers' information seeking behaviour and the adoption of agricultural conservation practices. Likewise, a study by Acheampong et al., (2020) among rice farmers in Ghana revealed a high level of information seeking behaviour and utilization, indicating their willingness to apply acquired information to enhance productivity, particularly in areas such as fertilizer and pesticide application, disease and weed control in rice farming. Therefore, information-seeking behaviour is a significant socio-demographic trait that positively influences the likelihood of technology adoption. It achieves this by increasing awareness, reducing uncertainty, providing access to valuable knowledge, and empowering individuals to make informed decisions. This behaviour enables individuals to assess the potential benefits, risks, and feasibility associated with technology adoption. Additionally, it helps individuals identify suitable resources and support systems necessary for successful adoption.

4. Conclusion and Recommendation

The study emphasizes the significance of accessing agricultural research information in promoting the adoption of improved sorghum farming practices among smallholder farmers. However, the study also recognizes that the ability to access and adopt such information is influenced by the socio-demographic characteristics of farmers. The research specifically aimed to examine the impact of socio-demographic characteristics on the adoption of improved sorghum farming practices in Dodoma, Tanzania. The findings of the study indicate that socio-demographic factors, such as

farming experience and information-seeking behavior, play a significant role in farmers' decision to adopt improved sorghum farming practices.

The study's findings highlight the importance of considering contextual factors when promoting the adoption of specific farming practices. To increase the likelihood of successful adoption, interventions should be tailored to the local environment and designed with the specific characteristics, preferences, and needs of farmers in mind. Policymakers and agricultural extensionists can enhance the effectiveness of their interventions by implementing targeted approaches that align with the socio-demographic profiles of the farmers. This approach acknowledges the influence of contextual factors and aims to maximize the impact of interventions in promoting the adoption of improved sorghum farming practices. This research has important theoretical implications, highlighting the necessity of adopting a comprehensive and contextually aware approach when studying technology adoption in agriculture. By taking into account socio-demographic characteristics, social diffusion processes, knowledge transfer mechanisms, and contextual factors, researchers can develop more comprehensive models and theories. Such an approach enhances our understanding of the complex processes involved in technology adoption within agricultural systems. The communication of agricultural information should be customized to meet the specific needs of different socio-demographic groups, considering factors such as education, age, gender, and environmental conditions. Policymakers and stakeholders in the agricultural sector should create interventions that address the unique challenges faced by farmers in various agro-ecological regions. This may involve developing context-specific technologies and practices that align with specific crops and local conditions. By tailoring communication and interventions to specific requirements, the agricultural sector can effectively support farmers in adopting and implementing sustainable practices that are suitable for their particular contexts.

The study had limitations in terms of its geographic scope, focusing solely on sorghum farmers in the Dodoma region, which may affect the generalizability of the findings. Additionally, the reliance on self-reported survey responses introduces the potential for biases and recall errors. While the study identified associations between socio-demographic characteristics and adoption behavior, it's important to consider the presence of unmeasured factors or confounding variables that may have influenced both the socio-demographic characteristics and adoption behavior. Therefore, establishing causality based solely on socio-demographic factors becomes difficult, and other factors should be taken into account when interpreting the findings.

Longitudinal studies are recommended to gain insights into the dynamics of adoption behavior and the evolution of socio-demographic characteristics over time. Such studies would allow researchers to identify factors influencing initial adoption of improved sorghum farming practices and assess their long-term sustainability. By adopting a longitudinal approach, a deeper understanding of the dynamics involved can be obtained, enabling the development of effective strategies to promote and maintain the adoption of these practices.

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