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Socio-economic factors affecting the adoption of farm chemicals by small-scale rice farmers in Abuja, Nigeria

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ABSTRACT: This study examines the socio-economic factors influencing the adoption of farm chemicals among small-scale rice farmers in Abuja, Nigeria, with four specific objectives. Questionnaire was used to solicit for information from 200 rice farmers for the study. Descriptive statistics and logit regression model were employed to analyze the primary data. The study's findings revealed that approximately 27.5% of farm chemical adopters were female, while 53.5% were male. Moreover, 64.5% of the farm chemical adopters were married, contrasting with 14.5% of the non-adopters who were married. Additionally, around 47% of farm chemical adopters possessed fields measuring between 1 and 1.75 hectares. Furthermore, 39% of the adopters were affiliated with more than one farmer group or cooperative. Analyzing the data, the study determined that the Chi^2 value was 3601.125, with a corresponding likelihood ratio statistic of $p<0.0000$. The results of the regression analysis indicated that out of the eight variables examined, only two exhibited statistically significant and positive influences on the adoption of farm chemicals. These two factors were farm size ($p<0.01$) and membership in a cooperative society or farmer-group ($p<0.05$). The study also observed diversified sources for farmers obtaining farm chemicals, such as Agricultural Development Programme (17.4%), marketplaces (78.3%), cooperative societies (3.1%), and Non-Governmental Organizations (1.2%). The research identified several constraints faced by the farmers, including the high cost of improved rice varieties for planting (10%), inadequate extension services (25%), scarcity of improved rice varieties for planting (5%), insufficient funds for investing in rice production (20%), damages caused by grazing livestock and conflicts with herdsmen (7.5%), inadequate processing facilities (2.5%), limited access to tractors (1.5%), restricted access to markets (12.5%), inadequate land access (15%), and instances of theft on the farm (1.0%). To enhance the livelihoods of small-scale farmers, the study recommends that Government should provide subsidies or grants for small-scale rice farmers who cannot afford improved varieties of rice seeds and farm chemicals such as fertilizers and herbicides.

Keywords: Adoption, farm, chemical, small-scale, rice.

INTRODUCTION

Rice (*Oryza sativa*) is a cereal belonging to the grass family called *Poaceae*, with about 700 genera and 12,000 species (Christenhusz and Byng, 2016). It is considered the most important staple food for more than half of the world's population and is the second most cultivated grain in the world after wheat. More than half of the world's population depends on rice as their main source of calories (Kouekam *et al*., 2018). It is grown on around 162.35 million hectares per year, which is more than 11% of the world's cultivated area (FAO, 2017); with

more than 90% grown and consumed in Asia (Bandumula, 2018). It is the fastest growing staple food source in most African countries and provides most of the dietary energy for the growing population (Akinbode, 2013). The studies of Adiel et al. (2020) and Chenoune et al. (2016) from research stations showed that the adoption of technology and best management practices should lead to significant yield increases in rice production.

In Nigeria, the agricultural sector has been a pivotal driver of economic growth and food security, with rice emerging as a vital staple crop contributing significantly to the nation's food supply. The escalating population demands sustainable and efficient agricultural practices to meet the increasing need for rice production. While Nigeria remains a substantial rice producer, meeting domestic demand remains a challenge (World Bank, 2016). To bolster rice productivity and achieve food security, the adoption of modern agricultural practices, including farm chemicals, is deemed crucial. However, rice cultivation faces the burden of biotic stress, including weeds, pests, and diseases, which can reduce yields by 30 to 40% (Kim and Shin, 2011; Achukwu *et al*., 2023). To address these challenges, appropriate and effective chemical control techniques are vital for optimizing rice yields in Nigeria.

Farm chemicals, encompassing fertilizers and pesticides, play a pivotal role in augmenting agricultural productivity by enhancing crop yields and safeguarding crops from pests and diseases. However, the adoption of farm chemicals among small-scale rice farmers in Abuja, Nigeria, has been an area of concern and interest due to notable variations in usage patterns. In recent decades, the use of farm chemicals has increased significantly due to factors such as market availability, affordability, water scarcity, and labor shortages (Beltran *et al*., 2013; Dokubo *et al*., 2023). The shift in rice cultivation from transplanting to no-till has made the use of farm chemicals a necessity, as flooding is no longer viable for weed control. Consequently, some farmers resort to indiscriminate application of farm chemicals, leading to negative externalities. Despite these concerns, there is a growing inclination among farmers to use farm chemicals, as the marginal increase in pesticide use appears to be profitable when compared to alternative weed control methods (Khan *et al*., 2015). However, Ayoola and Adedzwa (2006) have advocated an integrated approach involving manual, farm chemicals, and intercropping techniques, which have shown higher yields, lower costs, and higher profit margins in cassava and soybeans. Consequently, fostering the responsible and judicious utilization of farm chemicals has emerged as a pivotal approach to enhancing agricultural production in Nigeria (Ojo *et al*., 2021).

Even in the present day, farmers in FCT, Abuja, continue to experience a 70% reduction in yields due to various delays, such as untimely weeding and work limitations. This results in small-scale rice yields averaging 1 to 2 tons per hectare, whereas commercial farmers and research stations in Nigeria achieve significantly higher yields of 8 to 10 tons per hectare (Gianessi, 2013; Oyewole and Sennuga, 2020). To address this issue, the adoption of modern inputs, including farm chemicals, has become crucial in boosting agricultural productivity. The persistent low productivity in agriculture significantly contributes to ongoing poverty, particularly in agrarian regions like Africa (Toit, 2019; Adeyemi *et al*., 2023).

The use of farm chemicals in rice production offers several advantages. By reducing the labour required for weed control, farm chemicals allow additional resources to be invested in food crops, thereby benefiting the country's food security (Hossain, 2015; Haruna *et al*., 2023). Moreover, the adoption of farm chemicals can lead to increased income and reduced physical strain for farmers. Currently, the majority of farmers in sub-Saharan Africa rely on hand hoes for weeding, with only a small minority using farm chemicals (Selejio and Lasway, 2019). Nonetheless, farm chemicals are gradually being recognized as a cost-effective weed control method in Abuja (Muoni *et al*., 2014).

Despite substantial growth in the rice sub-sector, there remains a significant gap between the potential and actual productivity of rice crops. The utilization of farm chemicals has been touted as a promising solution to address this yield gap. However, despite various efforts to promote their adoption, small-scale rice farmers in Abuja have exhibited diverse attitudes and practices regarding their use. Understanding the underlying socio-economic factors that shape farmers' decisions on farm chemical adoption is essential to devise targeted strategies for sustainable agricultural development. The specific objectives are to:

1. describe the socio-economic characteristics of rice farmers in the study area.
2. determine the factors that influence adoption of farm chemicals among rice farmers in the study area.
3. identify sources of farm chemicals used by the small-scale rice farmers in the study area.
4. identify the constraints experienced by small-scale rice farmers in adoption of farm chemicals in the study area.

MATERIALS AND METHODS

Study area

This study was conducted in Abuja, the Federal Capital Territory of Nigeria which is located between the Latitude 8°25' and 8°25' North of the equator and longitude 6°45' and 7°45' East of Greenwich. The entire Federal Capital Territory occupies an approximate land area of 8,000 km^2, with elevation of about 536 meters above sea level and a total population of 776,298 according to the 2006 census. It shares borders with four states namely; Kogi, Niger,

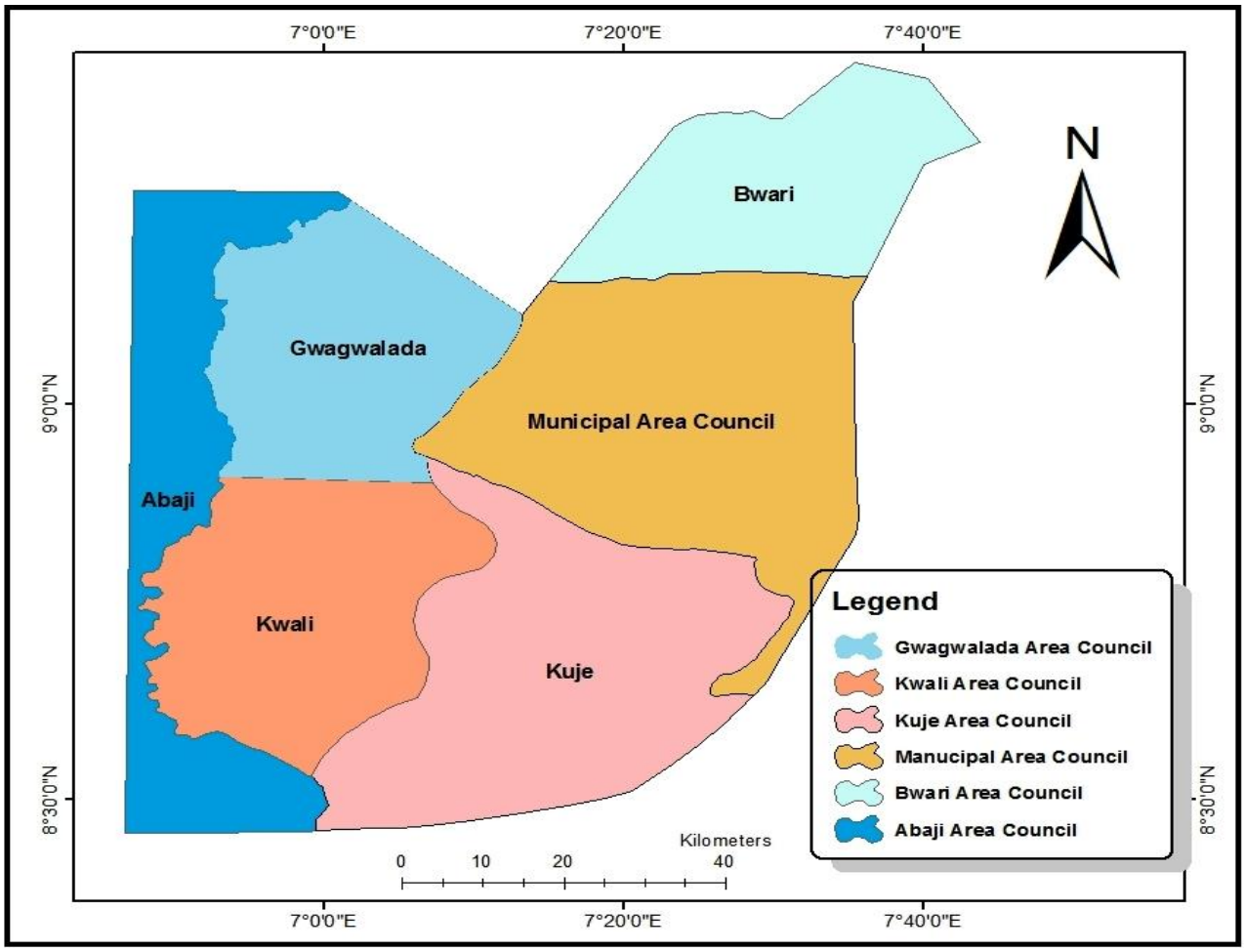

Figure 1. Map of the Federal Capital Territory, Abuja.

Nasarawa and Kaduna. Abuja is made up of six Area councils namely; Abaji, Bwari, Gwagwalada, Kuje, Kwali and Abuja Municipal Area Council (AMAC) (Figure 1). It has a climate of Guinea Savannah Grassland of the North and Middle Belt with the richness of the tropical forests of the south. The nature of climate has endowed the Nation's capital with fertile land for agriculture. The annual total rainfall is in the range of 1100-1600 mm. The rainy season runs from April-October and dry season runs from October-April with an average temperature of 29°C. The high altitude and undulating terrain of the territory provides a regulating influence on the weather.

Sampling procedure and Sample Size

For the study, which employed simple random sampling, a total sample size of 200 rice farmers from the six Area Councils in the study area was required, which 161 were adopters and 39 were non-adopters of farm chemicals. To be sure, every unit in the population of the study has a known chance of being included in the sample, making the sampling technique the most appropriate for this research.

Data collection

In order to accomplish the study's objectives, this study utilized primary data that was acquired via the use of a structured questionnaire. The questionnaire was revised and using the analyses generated from the test or pilot survey. For randomly chosen members of the different groups, the questionnaire included both open-ended and closed-ended questions. The questionnaire was intended to collect adequate and pertinent data from the respondents, with the goal of capturing as much information as possible that was important to the study's objectives. The primary data contained data extracted from the questionnaires in which the respondents gave answers by ticking in front of a question and/or writing a statement.

Data analysis

Using the Statistical Package for Social Sciences (IBM SPSS software version 25.0) and Microsoft Office Excel., the data acquired was examined. Descriptive statistics in the form of frequency and percentage was used to analyze objectives 1, 3 and 4. The logistic regression approach was used to analyzed objective 2 of the study respectively.

RESULTS AND DISCUSSION

The socio-economic characteristics of the respondents

The results presented in Table 1 shows that about 27.5% of farm chemical adopters were females while about 53.5% were males. The findings revealed that the proportion of males were higher among adopters and non-adopters of farming chemicals than the females. This could be attributed to male farmers being more familiar with innovations and education offered by advisers, such as extension agents, due to their higher participation in community gatherings and visits to demonstration locations or research facilities. (IFPRI, 2012).

The results on the marital status presented in Table 1 showed that amongst the farm chemical's adopters, 64.5% of the farmers were married while the remaining 14.5% were married among the non-adopters of farm chemicals. The proportion of married farmers was higher among adopters than among non-adopters, implying that the respondents are more likely to adopt farm chemicals. This may be due to the strong concern of married farmers to improve production at the lowest possible cost over limited and competitive resources (Bonabana-Wabbi, 2002; Ekele *et al*., 2023). According to Martey *et al*. (2013), marriage enhances the farmer's concern regarding the household well-being, which boosts engagement in agricultural innovation adoption.

Cross-tabulating household size with adoption of farm chemicals, Table 1 revealed that, 35% respondents with household sizes ranging from 1 to 5 adopted farm chemicals while 11% of the sample population, in the same household size range did not adopt farm chemicals. Of the respondents with household sizes ranging from 6 to 10, 53% adopted farm chemicals and 9.4% did not adopt. The reality that farm chemicals are labour intensive than other forms of agrochemicals backs up the results. Larger family size could make room for more labour needed to employ farming chemicals (Ajewole, 2010).

Results in Table 1 showed that 38.5% of the respondents were between 42 years and 51 years and 21% of respondents were between 32 and 41 years. This implies that most of them were relatively young and therefore can easily adopt new technologies or innovations. Despite the fact that the difference was significantly small, the adopters were on average younger than the non-adopters. Ajewole (2010) argued that younger farmers are more likely to use farm chemicals on their farms in Nigeria. This may be because younger farmers tend to be less risk averse and more willing to try out new technologies (Mwangi and Kariuki, 2015).

Farmers who had rice farming experience of 1 to 10 years made a largest group (40.5%) among adopters. According to Obisesan (2014), having more farming experience allows small-scale rice farmers to assess the advantages of agricultural technology and embrace new technologies sooner.

Results in Table 1 showed that, about 39% of adopters are affiliated to more than one farmer group or cooperative, whereas 5.5% of non-adopters were related to at least one farmer group. The majority of farmer groups were adopters as compared to non-adopters. Farmer groups are potential sources of information. Unlike mass media such as television and radio, information obtained through membership in a particular small-scale rice farmers group involves a two-way discussion that the small-scale rice farmers can easily understand. For this reason, the availability of such organizations can increase the frequency of discussions among member farmers and thus improve communication dissemination for development (Berhe, 2014).

In terms of education, those that attained secondary school education among adopters and non-adopters represented 39.5% and 7.5% respectively. Post-secondary represents 18.5% among adopters and 6.5% among non-adopters. Education could probably enable farmers to make efficient decisions and be first to take advantage of new technologies (Orinda, 2013). The implication of a relatively high level of education as the last group (primary school level) is that they can understand the innovations and the new technologies such as farm chemicals that are readily needed in this new commercial world.

In terms of farm size, the majority of the rice farmers (47%) who adopted farm chemicals were those that owned fields of sizes between 1 and 1.75 hectares. The current study had predicted that farmers with larger farm size are likely to adopt farm chemicals. This could be mainly due to lower marginal costs associated with the introduction of labour-intensive technology on the larger area of agricultural land (FAO., 2017). The result also revealed that farmers with larger farm lands used farm chemicals, possibly due to lower marginal costs.

Factors influencing the adoption of farm chemicals

Using the selected variables, a statistical test of a relationship between the dependent variable and the combination of independent variables was performed. The Chi^2 value given by 3601.125 and the corresponding likelihood ratio statistic (p<0.000) suggests that the explanatory

Table 1. Summary of socio-economic characteristics of respondents (n=200)

Category	Adopters (n=161)		Non-adopters (n=39)		Total	
	Freq.	(%)	Freq.	(%)	Freq.	(%)
Gender						
Male	107	53.5	24	12.0	131	65.5
Female	54	27.5	15	7.0	69	34.5
Marital status						
Married	129	64.5	29	14.5	158	79.0
Single	19	9.5	7	3.5	26	13.0
Divorced	2	1.0	-	-	2	1.0
Separated	1	0.5	2	1.0	3	1.5
Widow/widower	10	5.0	1	0.5	11	5.5
Household size						
1-5	35	17.5	22	11.0	57	28.5
6-10	106	53.0	17	8.5	123	61.5
11-15	20	10.0	-	-	20	10.0
Age						
22-31	14	7.0	11	5.5	25	12.5
32-41	42	21.0	8	4.0	50	25.0
42-51	77	38.5	16	8.0	93	46.5
>51	28	14.0	4	2.0	32	16.0
Year of experience						
1-10	81	40.5	29	14.5	110	55.0
11-20	43	21.5	8	4.0	51	25.5
21-30	22	11.0	1	0.5	23	11.5
>30	15	7.5	1	0.5	16	8.0
Group membership						
Member	78	39.0	11	5.5	89	44.5
Not member	83	41.5	28	14.0	111	55.5
Education						
No School at all	12	6.0	7	3.5	19	9.5
Primary School	32	16.0	5	2.5	37	18.5
Secondary School	79	39.5	15	7.5	94	47.0
Post-secondary	37	18.5	13	6.5	50	
Farm size						
0 – 0.75	18	9.0	4	2.0	22	11.0
1 – 1.75	94	47.0	26	13.0	120	60.0
2 – 3	43	21.5	9	4.5	52	26.0
More than 4	6	3.0	-	-	6	3.0

Source: Field survey, 2023.

variables included in the model are capable of explaining the farmers' probability of participating in adoption of farm chemical, as well as the underlying parameters included in the model were able to explain the likelihood of farmers adopting of farm chemicals.

From the regression results (Table 2), the age of respondents also influence the adoption of farm chemicals negatively and significantly at 5% probability level. This could be ascribed to the fact that older farmers are more likely to be cautious about adopting farm chemicals due to their experience and knowledge of traditional farming practices. They may have grown up in an era when organic farming was more prevalent, and may be aware of the potential risks associated with farm chemical use and thus, discourages them to adopt it. Mwangi and Kariuki (2015) found that older farmers may face health issues that limit their ability to handle farm chemicals. Regarding the gender of the small-scale rice farmers in the study area, male farmers are more likely than female farmers to adopt farm chemicals, hence a negative relationship. This is due to the fact that female farmers may have limited access to land ownership and control, which can restrict their ability to make decisions to adopt farm chemicals. Akpan *et al.* (2012) found that women may face economic barriers in

Table 2. Results of Logistic Regression model on socio-economic determinants of adoption of farm chemicals.

Variables	Coef.	Std. Err.	*z*-value	Sig.
Age	-0.003	0.011	-0.11	-0.011**
Gender	-0.002	0.263	-0.01	-0.001
Household Size	-0.076	0.035	-2.17	-0.023**
Experience	-0.002	0.011	-0.19	-0.001
Farm size	0.210	0.200	1.05	0.064***
Membership	0.331	0.153	2.16	0.101**
Marital status	0.370	0.218	1.24	0.082
Education	0.016	0.029	0.56	0.002
Constant	-1.518	0.781	-1.72	
N	200			
Log likelihood	-700.5651			
Wald chi^2 (42)	3601.125			
Prob.> χ^2	0.000			

Note: ***, ** and * indicate significance at 1%, 5% and 10% probability level respectively (Source: Field survey, 2023).

adopting farm chemicals, such as limited access to credit or financial resources.

The result (Table 2) showed that an increase in a farmer's household size decreased the likelihood of using farm chemicals and thus; an increase in household size tends to significantly discourage the use of agricultural chemicals at the 5% probability level. Tedla (2011) found that household size has a positive influence on the decision to use agricultural technology. He explained that the larger the household size comes with the expectation of more work in the family. The result (Table 2) showed that the years of rice farming experience as a socio-economic characteristic showed a negative relationship with the adoption of farm chemicals. Martey *et al.* (2013) found that farmers with many years of rice farming experience may have developed a deep understanding of the local environment and the natural ecosystem.

Regarding farm size, the results show that an increase in farm size per unit hectare increased the adoption of farm chemicals. Farm size is an important determinant influencing the adoption of farm chemicals positively and significantly at a probability of 1%. The positive impact of farm size on farm chemical adoption can be justified in terms of better economies of scale associated with larger farm size. Larger farms have the financial resources to purchase farm chemicals and the infrastructure to handle and apply them efficiently. This can result in higher yields and low production costs, which can increase their profitability. Kpadonou *et al.* (2015) found that larger farms are more likely to face market pressures that require them to adopt modern technologies and inputs.

The result (Table 2) reveals that membership of cooperative societies positively and significantly influenced the decision to use farm chemicals with a probability of 5%. The positive effect could be due to cooperative members pooling their resources, which gives them stronger bargaining power when seeking loans from financial institutions (Tedla, 2011). Cooperatives can negotiate bulk purchases of fertilizers, pesticides, and other agricultural inputs, which often leads to cost savings for individual members. Farmer organizations in rural areas facilitate the transfer of information between farmers through a higher frequency of discussion between members (Berhe, 2014). Therefore, households whose members belong to farmer groups such as unions and cooperatives have easy access to farm chemicals (Martey *et al.,* 2013). Table 2 further revealed a positive and significant relationship between the marital status of the farmers and the adoption of farm chemicals. Berhe (2014) and Ndah (2010) found that farmers who are married may have access to more resources that can help them adopt farm chemicals. They may also have access to additional labour from their spouse or family members, which can help them handle and apply these inputs more efficiently.

Educational attainment also had a positive and significant relationship with adoption of farm chemicals. Farmers with higher levels of education have a better understanding of the risks and benefits associated with adoption of farm chemicals through training programs and workshops which provides them with knowledge and skills on the use of these inputs Adepoju *et al*., 2018).

Sources of farm chemicals

Table 3 present results on sources of farm chemicals that are used by the respondents. About 74% of the respondents indicated they bought them from the market places because they are close to the rice farmers; again, the issue of proximity and easy access is important for the adoption of a technology (Ntege-Nanyeenya *et al*., 1997; Ayeni *et al*., 2023). The remaining 28 (17.4%) and 5 (3.1%)

Table 3. Sources of farm chemicals.

Source	Frequency	Percentage
Agricultural Development Programme (ADP)	28	17.4
Market Place	126	78.3
Cooperative Societies	5	3.1
Non-Governmental Organizations (NGOs)	2	1.2
Total	161	100.0

Source: Field Survey, 2023.

Table 4. Constraints in the adoption of farm chemicals (N= 200).

Challenges	Frequency	Percentage
High cost of improved varieties of rice for planting	20	10.0%
Scarcity of improved varieties of rice for planting	10	5.0%
Inadequate money to invest in rice production	40	20.0%
Damage by grazing livestock/conflicts with herdsmen	15	7.5%
Poor extension services	50	25.0%
Poor processing facilities	5	2.5%
Poor access to tractors	3	1.5%
Poor access to market	25	12.5%
Inadequate access to land	30	15.0%
Stealing in the farm	2	1.0%
Total	200	100

Source: Field survey, 2023.

respondents reported that they either bought or received free farm chemicals from other avenues like the Agricultural Development Programme (ADP) and cooperative societies respectively. The Agricultural Development Programme (ADP) provides farm chemicals to rice farmers through various channels, including government-owned agricultural input stores, private agro-dealers and direct distribution to farmers (Fregene, 2008). Cooperative societies provide farm chemicals through collective purchasing by pooling their resources and negotiating better prices with suppliers and purchase inputs in bulk. Cooperative members often benefit from economies of scale, negotiated prices, and collective purchasing power, which may enable them to obtain farm chemicals at more favourable terms compared to individual purchases (Akpan *et al*., 2018). This is particularly important for small-scale rice farmers who may not have the financial resources to purchase inputs on their own (Ayeni *et al.,* 2023).

Constraints in the adoption of farm chemicals

Results in Table 4 showed constraints of farm chemicals' adoption by small-scale rice farmers. Majority (25%) of the respondents indicated that poor extension services pose a significant challenge to the adoption of farm chemicals. There is shortage of extension agents who are responsible for disseminating information on the new technologies such as farm chemicals, thus limiting the reach of extension services and making it difficult for farmers to access information on new technologies which can lead to improper use and negative consequences. Paltasingh (2018) concluded that extension services are responsible for providing training to farmers to help them adopt and use the farm chemicals safely and effectively.

According to Table 4, about 20% of the respondents indicated that they had inadequate money to invest in rice production. Farm chemicals like pesticides and herbicides are expensive and their prices can vary depending on the type and quantity needed. Obisesan (2014) concluded that inadequate money can also lead to poor inputs being used. Farmers who cannot afford high-quality fertilizers or pesticides may opt for cheaper alternatives that are less effective.

The results presented in Table 4 show that about 15% of the farmers indicated that inadequate access to land is a significant challenge in the adoption of farm chemicals. This results in smaller plots of land being allocated to farmers, making it difficult for them to adopt and use farm chemicals effectively. The results are consistent with those of Adusumilli and Wang (2019) as they found that as population increases, the demand for food also increases, leading to more pressure on available land resources, resulting in smaller land sizes per farmer. This makes it difficult for farmers who rely on agriculture and prompt the

non-adoption of farm chemicals. The results (Table 4) showed that about 12.5% of the respondents indicated that poor access to markets poses a challenge in the adoption of farm chemicals. The lack of information on market prices and demand for specific crops makes it difficult for farmers to plan their production and make informed decisions on which farm chemicals to adopt and use (Babatunde *et al*., 2020). The results presented in Table 4 show that about 10% of the farmers indicated that high cost of improved varieties of rice presents a challenge in the adoption of farm chemicals. Farmers may be hesitant to adopt farm chemicals due to investing a significant amount of money to purchase high-quality rice varieties, therefore, less willing to spend additional funds on farm chemicals such as fertilizers, pesticides and herbicides (Kumari, 2012). This may make them less willing to adopt farm chemicals which they may be viewed as an additional financial burden (Rahman, 2012).

Conclusion

Farm size has a pronounced and statistically significant positive influence on the adoption of farm chemicals, with a probability level of 1%. This positive effect can be attributed to the better economies of scale experienced on larger farms, allowing for increased financial resources to purchase farm chemicals and improved infrastructure to handle and apply them efficiently. Likewise, membership in cooperative societies significantly and positively impacts the decision to use farm chemicals, with a probability of 5%. This positive association is attributed to the opportunities presented by cooperative memberships to interact with other farmers, exchange knowledge about new technologies, and facilitate the adoption of farm chemicals. Marketplaces emerge as a primary source for farmers in acquiring farm chemicals due to their proximity to rice farmers, ensuring easy access and convenience, which proves crucial for technology adoption. On the other hand, the insufficient extension services pose a significant challenge to farm chemical adoption. The scarcity of extension agents, responsible for disseminating information on new technologies like farm chemicals, limits the reach of extension services, making it difficult for farmers to access and adopt such technologies. Furthermore, the constraint of inadequate funds for investment in rice production also poses a substantial challenge. Farmers with limited financial means may resort to cheaper and less effective alternatives for fertilizers or pesticides, impacting the adoption of farm chemicals.

Recommendations

Based on the conclusions of this study, the following recommendations are made:

1. Government should provide subsidies or grants for small-scale rice farmers who cannot afford improved varieties of rice seeds and farm chemicals such as fertilizers and herbicides. This will help reduce costs of these inputs for farmers and encourage their adoption.
2. Policymakers should undertake land reforms aimed at redistributing land to small-scale farmers to provide them to larger tracts of farmland. This will enable them adopt modern farming practices, including the use of farm chemicals, and improve their livelihoods.
3. Farmers can form groups and cooperatives that pool their resources together to purchase farm chemicals at a lower cost than individual purchases.
4. Policymakers should allocate more resources towards extension services to ensure that they have adequate staff and resources as well as conduct regular trainings to provide accurate information and advice on new technologies and best practices in agriculture.
5. Policymakers should also work with the financial institutions to provide affordable credit facilities for small-scale rice farmers who need funds for purchasing inputs and enable them lease land for farming.
6. Policymakers and other stakeholders should invest in improving infrastructure, providing information on market prices and develop innovative financing models. This will enable small-scale rice farmers adopt modern farming practices, including the use of farm chemicals, and improve their livelihoods.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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