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Socio-economic Determinants of Adoption of Maize Production Technologies among Smallholders

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Abstract
Agricultural technology adoption is germane for improved farm efficiency and productivity. Thus, the socioeconomic determinants of adoption of maize production technologies among smallholders were analyzed. Primary data collected via multi-stage sampling from 101 respondents was empirically evaluated using descriptive statistics and Logit regression. The respondent's socioeconomic factors affected maize production technology adoption. Several maize production technologies were available in the study area; however, adoption of these technologies among respondents was relatively low. The coefficient of multiple determination (R^2) was 0.74827. The regression coefficients of household size (0.541), education (0.331), farm experience (0.615), farm size (0.448) and extension contact (0.457) were statistically significant at $p<0.05$ probability level. Furthermore, the constraints identified by respondents also affected the adoption of maize production technologies in the study area. This study recommends subsidizing technology cost, improved cooperative activities; access to technology, credit and extension services, farm labour supply and tenure policy modifications.

Keywords: Adoption, constraints, determinants, maize technology, smallholders

INTRODUCTION

Maize (*Zea mays*) is a cereal that is grown all over the world. Maize is one of the most important cereal crops grown in the rainforests of Nigeria and its native savanna areas. Maize has become an important industrial and cash crop (Iken and Amusa, 2004). It is a high-yielding crop that is easy to process and digest, at lower cost compared to other cereals (IITA, 2001). It is important for food security and nutritional intake, accounting for approximately 43% of calorie intake with a daily consumption quantity of 53.20g per capita (Komolafe *et al*., 2010). It is widely used as the primary source of calories in livestock feed formulation (Manyong *et al*., 2003). Maize is useful in medicine and as a raw material in agro-industries; it also serves as feed and food (Abdulrahaman and Kolawle, 2006). It is a staple food in many parts of the world, especially in developing countries (Abebaw and Abelay, 2001). Maize is a staple food of considerable economic importance in sub-Saharan Africa, which includes Nigeria. It is the third most important cereal plant in Nigeria after sorghum and millet (Alama, 2001). Maize is a staple food for humans,

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forage and raw material for many industrial products (Ouma *et al*., 2002). Maize is the main food crop in most countries, and especially in rural communities. According to Frova *et al*. (1999), maize is one of the three most important types of cereals in the world together with wheat and rice and is the most widespread of all types of cereals. In some developed countries, maize is also grown as animal feed and as a base for industrial products such as oil, syrup, and starch. In terms of area and production, maize is the second most important type of grain in the world (Idrisa and Ngandu, 2012). In the 2016-2017 harvest seasons, world maize production was approximately 1.04 billion tons, with the United States and China contributing approximately 38% and 23%, respectively (Onuwa, 2022). Maize can be grown successfully in soils ranging from loamy sand to heavy clay, provided they are well ventilated and have a neutral ph. Because it is of tropical origin, it is very sensitive to stagnant water and should not be grown in low or poorly drained fields. Furthermore, prolonged low temperatures below 5°C have a number of negative effects on the crop (Bawa and Ani, 2014; Idrisa and Ngandu, 2012). The optimum temperature range for better plant growth and better yields is 25 to 35°C. Maize plants can be grown throughout the year and produce high yields. In Nigeria, the average maize yield is around 2,500 to 3,500 kg / ha of threshed grain when using the recommended fertilizers, varieties, seed compost and improved cultivation methods. However, the total maize area in Nigeria exceeds 2.5 million hectares, with an estimated yield of 1.4 tons per hectare (Onuwa, 2022).

Maize production remains very low, especially compared to the growing food needs of the country. About 20% is processed for secondary purposes. The growing demand for maize as food, livestock feed, and non-food industrial products have fueled the growth of maize use. Nigeria's population is expected to grow more than 3% per year, while food production is expected to grow 2% or less per year. To fill the gap and increase food production, intensive agriculture based on the use of modern technologies such as improved seed varieties, agrochemicals, management practices, etc. will be required. Higher solar radiation in the northern part of the country compared to the southern part increases the potential for maize production in the northern part (NAERLS and FDAE, 2014). Improved agricultural practices are measures that have been studied, tested, and shown to increase crop yields (Ali-Olubwanda *et al*., 2010). These practices include the use of certified seeds, agronomic practices, fertilizer and agrochemical application. According to (Ouma *et al*., 2002), adoption is a decision to fully utilize an innovation or new technology as the best opportunity available to farmers. Given the uncertainty about the outcome or economic benefits of such innovation, farmers tend to be indecisive about agricultural technology adoption. Agricultural productivity in developing countries such as Nigeria continues to be low; attributable to lack of adoption of agricultural technology by majority of the farmers (Idrisa and Ngandu, 2012). Bawa and Ani (2014) reported significant correlations among age, agricultural experience, training received, socioeconomic situation, intensity of cultivation, economic motivation, innovative capacity and agricultural information; with agricultural technology adoption. However, maize productivity has experienced volatility over the last few decades; posing a threat to households. Adoption of agricultural technologies can improve smallholder production systems. Maize production technologies are more prevalent in agrarian communities in Africa than for other food crops. This implies that maize production is predominant in most agrarian communities and hence adoption of production technologies can further increase yield. Firm efficiency in maize production through technological innovations has become germane for food security. Food crises are more severe in Sub-Saharan Africa, where achieving food security is inextricably linked to poor agricultural techniques, resulting to a decrease in farm output and agricultural growth (Ajayi *et al*., 2008). Despite the economic importance of maize in Nigeria, farm productivity still remains low in smallholder production systems; attributable to low adoption of improved production technologies. Previous studies focused only on improved maize varieties while completely excluding the adoption of other production technologies that improves farm productivity. Therefore, this study analyzes the socioeconomic determinants of adoption of maize production technologies, to this effect; the study specifically describes the respondents' socioeconomic characteristics, identifies production technologies available in the study area; estimates factors that influence the adoption of maize production technologies and identifies the constraints of adoption of maize production technologies.

METHODS

Study Area

The study was carried out at Toro Local Government Area (LGA), Bauchi State, Nigeria. The LGA covers a total land area of 6932km^2 (NBS, 2012). Toro local government is topographically hilly with altitude of 100m above sea level. It is located on longitude 9°N and 12°E and latitude 8°N and 11°E. It is in the Sudan Savannah zone of Nigeria with an average rainfall ranging between 830mm to 1,100mm annually starting from April to October; with average temperatures of 35°C for lowland and 31°C for highland areas respectively (FMA, 2005).

Sampling Techniques

To select maize farmers in the study area; multistage sampling technique was used. Toro LGA was chosen in the first stage. The next stage involved purposive selection of three districts; Toro, Lame, and Jama'a; due to the predominance of maize production activities in this areas. Furthermore, two villages from each district were selected using random sampling techniques. In the last stage, using a compiled list of maize farmers from the LGA secretariat at constant proportionality rate of 10% (0.1); 101 respondents were selected. Table 1 presents the sample frame distribution.

Table 1
Sample Frame

District	Village	Sample Frame	Sample Size
Toro	Zaranda	189	18
	Takanda	164	16
Lame	Magamagari	150	15
	Babikko	160	16
Jama'a	Zalau	173	17
	Rishi	190	19
TOTAL		1026	101

Source: Field Survey (2019)

Data Collection Analytical Techniques

Data for this study were obtained from primary sources; using well-structured questionnaires. Data collected were analyzed using descriptive statistics (frequency counts, percentages, and means) and Binary Logit regression. The regression analysis was used to evaluate the determinants of adoption of maize production technologies. It specifies the relationship between the farmer's adoption decision and the explanatory variables influencing this index (Greene, 2003). The implicit model is presented in equation (1):

$$Y_i = \beta_0 + \beta_i X_{ij} + U_i \quad (1)$$

Where:

Y_i= a dichotomous response variable with Y=1 for farmers who adopt technology and Y=0 for farmers who do not adopt technology; β_0 = intercept; βi= coefficient of the estimated parameters; X_{ij}= Set of independent variables; and U_i = error term; denoted by a zero mean and variance. Equation (2) presents the regression model in its explicit form:

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + U_i \quad (2)$$

Where:

Y_i a dichotomous response variable with Y=1 for farmers who adopt maize technology and Y=0 for farmers who do not adopt maize technology; β_0 = intercept; β_i (β_1 – β_6) = vector of the estimated parameters or unknown coefficients; X_i = vector of the predictors (independent variables); X_1 = Gender (male=1, female=0); X_2 = Household size (population); X_3 = education (years); X_4 = experience (years); X_5 = farm size (ha); X_6 = extension contact (yes=1, no=0); $\beta_1 – \beta_6$ = regression coefficient; and U_i = error term. The maize production technologies accessible in the study area include: Plant date adjustments; Planting method and seed variety; Plant spacing and seed rate; Weed management; Harvesting technology; Fertilizer application; Pest management; Post-harvest processing techniques; Storage methods; Water management; and Disease control.

RESULTS AND DISCUSSION

Socioeconomic Profile

Table 2 shows that most of the respondents (56.4%) are between the ages of 21 and 40. This shows that most farmers are still of working and productive age and able to participate fully in farming agricultural activities. Young people are thought to be more receptive to modern ideas than their older counterparts; which therefore suggests an inverse relationship between age and technology adoption. This is consistent with the findings of (Ume and Okpukpara, 2006 and Onuwa *et al*., 2021) on farmer demographics in agricultural technology adoption. Also, 85.1% were male; while 14.9% were female. This proportion indicates that there is large gender disparity among maize farmers hence a predominant population of male participants in this agricultural activity. Maize production in the tropics is dominated by male gender due to the peculiarity of farming system mostly used. Similarly, the low participation of females may be due to sociocultural factors in the study area. The traditional perspective is that males are known to involve in energy sapping and rigorous activities as compared to females. The religious perspective is that females are usually not allowed to participate in certain farm activities, but rather play their primary roles as housewives especially in Northern Nigeria. This is consistent with (Rogers, 2003), who reported similar outcomes. Further, majority of respondents (79.2%) are married, while 20.8% are single. Thus, marital status can be a determinant of household size, which also serves as proxy to family labour required for carrying out farm activities. This implies that the married respondents engaged in maize production as a livelihood activity and also to provide food for their households. Married farmers may have larger household sizes which may encourage them to adopt improved agricultural technologies in order to raise their income and standards of living. This also corroborates with (Sabo, 2006) who found that majority of the participants and the non-participants in a community-based agricultural and rural development program in Zaria local government area were married. Additionally, mean household population was 6 people; most (56.4%) had a household size of ≤9 people. This suggests adequate supply of family labour for farm activities. This result is consistent with (Yahaya and Aina, 2007) and (Onuwa *et al*., 2021) who reported that large household size provides and helps carry out agricultural and other household activities. Also, most (54.5%) of the respondents attended primary education; secondary education had (31.7%), while tertiary education was (13.9%). This suggests that the respondents have a basic understanding of the consequences of adopting maize production technologies, implying that the majority of farmers are literate. High level of literacy among the respondents may facilitate better technology adoption and better ability of impacting knowledge and skills for adoption of an innovation. The respondents' level of education is required to explain the observed strengths and weaknesses; management ability and adoption of new technology and innovation. It is expected that maize farmers in the study area will easily adopt new agricultural production ideas and will use production technologies in decision making, thereby increasing their productivity. This is consistent with the results of (Komolafe *et al*., 2010), who found that highly educated farmers are willing to adopt and use new technologies.

Furthermore, the mean farming experience was 11 years; majority of respondents (50.5%) had 11-19 years of experience in farming, those with ≤10 years of experience in farming constituted 31.7% and 18.8% had ≥20 years in farming. The years of farming experience suggests that farmers will be able to make informed decisions about the allocation of resources and the overall management of their farms. Since the study area is an agrarian community, the majority of the respondents had extensive farming experience. These years of farming experience provides the respondents with adequate knowledge and information on agricultural practices and technology that can enhance farm productivity (Onuwa *et al*., 2021). This result corroborates that of (Komolafe *et al*., 2010), which showed that farmers with several years of agricultural experience are more efficient in agricultural production. In addition, the mean farm size was 1.37ha; most of the respondents (59.4%) had a farm size of ≤1.9 ha, 35.6% a farm size of 2.0-3.9 ha and 5% a farm size of ≥4.0 ha. This suggests that most of the respondents are smallholders; which is responsible for the predominance of subsistent level of maize production in the study area. Thereby, preventing them from realizing economies of scale. Similarly, the size of the farm holding is a determinant for agricultural mechanization. Smallholdings and land fragmentation dates back to prevailing land use practices in the study area. This corroborates with (Ajayi *et al*., 2008) and (Onuwa *et al*., 2021), who in their respective studies reported similar results of the correlation between farm size and technology adoption. Also, 58.4% of the respondents used family labour in their agricultural activities. This suggests that farmers in the study area rely primarily on family or friends for farm labor supply; attributable to economic constraints of utilizing hired labour. This corroborates with (Idrisa and Ngandu, 2012), who reported similar results on farm labor supply and technology adoption. Further, most (72.3%) of the respondents had access to extension contact, while (27.7%) had no access to extension contact. This indicates that the majority of maize producers in the study area have no contact with extension agents. Farmers are more likely to adopt agricultural technology when interacting with extension staff. Okunade (2006) also posited that increased extension contacts would lead to greater adoption of improved farm production technologies. Additionally, majority of respondents (62.4%) belong to a farm cooperative society. The participation of the respondents could be as a result of literacy level of the farmers. The farm cooperatives play several roles in terms of credit and input access to its members to achieve increased farm productivity. This is consistent with the findings of (Knowler and Bradshaw, 2007), which reported that membership in a cooperative, provides access to microcredit, input subsidies, and an avenue for the exchange of ideas and information.

Table 2
Distribution of the Respondents Based on their Socioeconomic Characteristics

Variable	Mean	Frequency	%
Age:			
≤20		3	3.0
21-40		57	56.4
≥60		41	40.6
Gender:			
Male		86	85.1
Female		15	14.9
Marital Status:			
Married		80	79.2
Single		21	20.8
Household Size:			
≤9		57	56.4
10-19		33	32.7
≥20	6.2	11	10.9
Level of Education:			
Primary		55	54.5
Secondary		32	31.7
Tertiary		14	13.9
Years of Experience:			
≤10		32	31.7
11-19		51	50.5
≥20	11.04	19	18.8
Farm Size:			
≤1.9 ha		60	59.4
2.0-3.9ha		36	35.6
≥4.0ha	1.37ha	5	5.0
Farm Labor:			
Family labor		59	58.4
Hired labor		40	39.6
Mechanized farming		2	2
Extension Contact:			
No		73	72.3
Yes		28	27.7
Cooperative Membership:			
Yes		63	62.4
No		38	37.6

Source: Field Survey (2019)

Maize Production Technology

Table 3 shows the different production technologies used by maize producing households in the study area. The production technologies most used by maize producers are: adjustment of sowing date (74.3%); due to different climatic conditions, the planting time in each place is also different. The best time to plant is determined by the availability of irrigation facilities. For example, if there are irrigation facilities, maize can be grown all year round, regardless of the season. Planting method and seed varieties (70.3%); Planting methods play an important role in establishing plants under certain conditions. Maize is mainly sown directly from seed by different tillage and tillage methods. Farmers have recently adopted Resource Conservation technologies (RCT) such as no-till, minimal tillage, trench planting and flat maize, which are cost-effective and environmentally friendly. Types of crops or seeds may be recommended depending on the length of the growing season and availability of optimal moisture regime. Plant spacing and seed rate (60.4%); the recommended planting distance for maize in the Nigerian savannah is 75cm x 50cm, with 2 plants per acre. Maize can be grown manually or by machine (mechanized planting). In field crops, the shape of the crop has a direct effect on competition between crops. Depending on the purpose of cultivation, maize can be grown in many different ways. One hectare of maize requires about 15 to 20 kg of seed maize. Plant three seeds in each hole and thin out the medium for two plants about one to two weeks after germination. When intercropping maize, the planting distance should be wider than in monocrop maize. Practice alternating rows of maize with other crops as it allows for efficient crop management. It can be cultivated as a no-till crop. However, maintaining 60,000 to 65,000 plants/ha is a prerequisite for maximum yield. It should be sown with growth geometry of 60 × 2025 cm; adherence to recommended plant density optimizes yield. Weed management (59.4%); good weed control in maize production is a prerequisite for high yields. Weeds often compete with crops for nutrients, sunlight, and water. It is necessary to weed regularly so that maize can develop to its full potential in the field. It is important to weed at the right time, especially in the early stages of growth. Maize has shallow roots; it is very important to ensure that the roots are not mechanically damaged in the process at this stage. Various methods of weed control can be used, for example, non-chemical control (hand weeding) and chemical control. Non-chemical weed control measures include physical or cultural methods, such as manual removal of weeds from maize fields. In many Nigerian savannas, *Striga* is a notorious parasitic plant that is a constant threat to maize production. If the infestation is severe, even before the appearance of *Striga*, maize plants are often severely infested and appear yellowish, stagnant, and wrinkled. To control *Striga* effectively, several methods must be implemented in an integrated manner and include maize rotation, use of tolerant / resistant varieties, and use of the recommended fertilizer rate in combination with other growing methods. Manual weeding for weed control can begin 23 weeks after planting and may require more than 2 manual weeds. We recommend hand weeding 2 weeks and 45 weeks after sowing. Chemical weed control, to an extent is economically feasible; herbicides can be used to control weeds on the maize farm. Although some are recommended for single-crop maize, it is important to note that herbicide effectiveness increases with good soil preparation. The growing problem of labor shortages has exacerbated the introduction of chemical weed control; ideally wait 10 days before preparing the soil after herbicide application. In maize production predominant weed species include

Imperata cylindrical, *Striga*, *Dactylocteniumae gypticum, Eleucine indica, Setariaglauca, Cyanodondactylon, Cyperus rotundus, Brachariarapens, Celosia argentia, Commelina bengalensis, Phylanthisniruri, Solanum nnigrum, Amaranthus viridis, Trianthema partulacastrum*. Effective weed control strategies are very essential in maize production. The annual yield loss in maize due to weed problems is estimated to be around 10%; Harvesting technology (50.5%); harvesting fresh maize when the silk turns brown (50-70 days after planting). But if seeds are needed, harvest them as soon as they are dry enough (80-110 days after planting), depending on the variety.

Table 3
Distribution based on Maize Production Technologies Adopted

Technology	Adopted	Not adopted
Adjustment in sowing date	75 (74.3)	26 (25.7)
Planting method and seed varieties	71 (70.3)	30 (29.7)
Plant spacing and seed rate	61 (60.4)	40 (39.6)
Weed management	60 (59.4)	41 (39.6)
Harvesting technology	51 (50.5)	50 (49.5)
Fertilizer application and management	49 (48.5)	52(51.5)
Pest management	43 (42.6)	58(57.4)
Preservation and Storage techniques	41 (40.6)	60(59.4)
Water management	35 (34.7)	66 (65.3)
Disease control	28 (27.7)	78 (77.3)

Source: Field Survey (2019); Percentages are in parenthesis

Other recommended production technologies include: fertilizer application and management (48.5%); the following fertilizers are recommended per hectare of maize; 100 kg N, 50 kg of single superphosphate (SUPA) and 50 kg of potassium salt (K_20). This recommended fertilizer should be applied in two repetitions. The first dose (i.e. 50:50:50) should be used during the first week of planting or planting, with about 6 sachets of NPK 15:15:15. A second dose of N (50 kg, about 2 packs of urea) should be applied 4 to 5 weeks after planting in the southern and northern savanna areas of Guinea. All fertilizers must be buried during application. Ensure to remove weeds before the second dose of fertilization application. Delaying the application of the first dose of manure after the first week after planting can significantly reduce maize yield. In addition, the second dose should not be delayed more than 4 weeks after planting. Apply a small amount of NPK 1 week after planting. After 4 weeks of planting, urea should be applied. Fertilizer should be applied below the soil surface and mixed in the humus layer. Regularly application of organic fertilizer is suggested. Among grains, maize in general and hybrid maize in particular are more sensitive to nutrients applied by organic or inorganic means. The rate of fertilization depends on the nutritional status of the soil and the harvesting system. To achieve the desired yield, the amount of fertilizer must be equivalent to the soil nutrient capacity and the required harvest. It has also been reported that the response of maize to organic fertilizers is exceptional and a very important factor in maize production systems; 10-15 tons/ha is recommended As a general guideline 120 kg N, 60 kg P_2O_5 and 40 kg K_2O can be applied per hectare for hybrids and 80 kg N, 30 kg P_2O_5 and 20 kg K_2O per hectare for other cultivars. Pest management (42.6%); effective pest control involves the use of alternative methods that can be physical, cultural, biological, mechanical or chemical for pest control. Control cultures reduce termite attack. Drying maize is an important operation; moist seeds deteriorate quickly. The optimum moisture content in maize should be 14% or less. Sun drying is a method of drying seeds where the pulverized seeds are exposed to direct sunlight until the desired moisture content is reached in the seeds and its low-cost energy. In smoking methods; insect infestation is reduced by the heat from the flame; the smoke prevent insects from laying eggs and moisture content is also reduced. Air-drying techniques entails exposing fresh cobs hung from raised platforms to air while keeping moisture to a minimum. Preservation and Storage techniques (40.6%); storage and silo facilities need thorough cleaning before filling them with new seeds. To be effective; disinfectants must be applied to bags, containers, or areas within the storage buildings under air tight conditions. For packaged products, the rate is 12 tablets per 100 kg of cereal. The pills are wrapped in newspapers and covered with perforated tarpaulin and placed in the center of the bag. Farmers can purchase these chemicals from reputable pesticide dealers or suppliers. In addition, the seeds must be properly dried; humidity below 12% before storage to prevent mildew is recommended. Water management (34.7%); the water requirement of maize plants varies from 400 mm to 600 mm. Too much or too little moisture can adversely affect plant growth. Adequate water supply and drainage at critical stages are associated with improved crop yields. Disease control (27.7%); several pest and diseases are associated with maize production; adoption of appropriate agrochemicals can serve to mitigate incidence of pest and disease infestation on crop yields. Agrochemical application had a significant impact on maize yields and farm productivity levels. However, the level of adoption of this production technology by maize producers in the study area is relatively low.

Determinants of Adoption of Maize Production Technology

The regression analysis presented in Table 4 shows the factors influencing the adoption of maize production technologies in the study area. The probability coefficient statistics ($p<0.0049$) is significant at 5% ($p<0.05$), which shows that the regression model has strong explanatory power. In addition, the results of the regression analysis showed that the coefficient of multiple determination (R^2) is 0.74827, which means that 74% of the variation in the decision to adopt maize production technology by farmers was accounted for by variables in the regression model. The remaining 26%, unexplained, can be attributed to omitted variables and the concept of random error. The household size coefficient (0.541) was positive and statistically significant with a probability of 5% ($p <0.05$); proposing that the size of a farmer's household should serve as a substitute for the family work necessary to carry out an agricultural activity; thus facilitating the speed of adoption of agricultural technologies or innovations that increase productivity and efficiency of farms. The coefficient of education (0.331) is positive and statistically significant at a probability of 5% ($p <0.05$), which suggests that the level of education of farmers affects the level of acceptance and utilization of agricultural technologies or innovations that improves productivity and farm efficiency. The coefficient of experience in agriculture (0.615) is positive and statistically significant at the level of probability of 5% ($p <0.05$), which suggests that the experience and knowledge of farmers in agricultural technology and innovation have contributed the most to adoption. The coefficient of farm size (0.448) is positive and statistically significant at 5% ($p < 0.05$) probability level, showing that farm size creates favorable conditions for the application of agricultural technology for adoption purposes. The agricultural extension contact coefficient (0.457) is positive and statistically significant at the 5% ($p < 0.05$) probability level showing that the frequency of contact between farmers and the extension service affects the access to agricultural technology. Their technical information on improved maize production technology can improve their levels of farm productivity and efficiency. Thus, these factors increase the likelihood that respondents will adopt more options of maize production technology to improve firm efficiency and farm productivity. This corroborates with (Onuwa *et al*., 2021) who reported similar results in their study of the determinants of adoption of production technology among smallholders.

Table 4
Factors Influencing Adoption of Maize Production Technology

Variable	Coefficient	Standard error	T-ratio
Constant	0.698	0.267	2.614**
Gender (X_1)	0.375	0.3217	0.168$^{n.s}$
Household size (X_2)	0.541	0.211	2.564**
Education (X_3)	0.331	0.119	2.782**
Experience (X_4)	0.615	0.242	2.541**
Farm size (X_5)	0.448	0.169	2.667**
Extension(X_6)	0.457	0.174	2.626**
Prob<X^2	0.0049**		
Pseudo R^2	0.74827		

Source: Field survey, 2019; **= significant at 5% ($p<0.05$), $^{n.s}$= not significant

Constraints of Adoption

Table 5 revealed that high cost of production technology (81.2%), complexity of technology (80.2%), lack of technology (78.2%), poor access to technology (72.3%), poor access to agricultural credit (65.3%), inadequate extension contact (64.4%); high cost of labour (60.4%) and land fragmentation (45.5%) were the main obstacle to the adoption of maize production technology in the study area. This corroborates with (Onuwa *et al*., 2021) who reported similar results in their study on Boosting Farm Productivity through Intensification of Soybean Production Technology**.**

Table 5
Distribution based on the Constraints of Maize Technology Adoption

Constraints	Major (YES)	Minor (NO)	Ranking
High cost of production technology	82 (81.2)	19 (18.8)	1st
Complexity of technology	81 (80.2)	20 (19.8)	2nd
Lack of technology	79 (78.2)	22 (21.8)	3rd
Poor access to technology	73 (72.3)	28 (27.7)	4th
Poor access to agricultural credit	66 (65.3)	35 (34.7)	5th
Inadequate extension contact	65 (64.4)	36 (35.6)	6th
High cost of labour	61 (60.4)	40 (39.6)	7th
Fragmented lands	46 (45.5)	55 (54.5)	8th

Source: Field Survey, 2019; Percentages are in parenthesis

CONCLUSION

This study analyzed the socio-economic determinants of adoption of production technologies by maize farmers in the Toro, Bauchi State, Nigeria. Socio-economic factors of the farmers strongly affected their adoption of maize production technologies in the study area. Different maize production technologies are available in the study area, but low adoption of these technologies was reported. The variables in the regression model have a significant influence on the adoption decision of maize producers. All the constraints identified seriously affected adoption of production technologies by maize producers in the study area. Based on the results of this study, the following recommendations are proposed: Formulation and implementation of policies that will subsidize the cost of maize production technologies; implementation policies to improve farmers' access to agricultural technology, cooperative activities among maize farmer's; maize farmers access to agricultural credit, inputs and other productive resources, and maize farmer's access to extension and advisory services; which improves farmer's access to agricultural technology and information. Mechanized farming was rarely practiced in the study area; attributable to low capital and poor access to technology. To this end, government and other relevant stakeholders should provide more mechanized agricultural machinery at subsidized rates. Additionally, implementation of policies that will improve labour supply and non-discriminatory distribution of land for maize production in the study area.

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