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Hybrid Maize Adoption Determinants in Northern Nigeria: A Gendered Perspective

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ABSTRACT

Low adoption of hybrid seeds is a major limitation to maize production in Nigeria. A field survey was conducted to assess the determinants of hybrid maize adoption in five major maize-producing States in northern Nigeria. Structured questionnaires were administered to 450 maize farming households using a simple random sampling technique. The Harvard and the Integrating Gender into Agricultural Value Chains Analytical Frameworks were adopted to develop study tools. Data were analyzed using descriptive statistics and Tobit test. Results revealed major adoption determinants as high yield, pest and disease resistance, drought tolerance, large grain and seed size, and earliness. Male-headed respondents that identified high yield, pest and disease tolerance, drought tolerance, and seed price as selection attributes are 83.0, 69.6, 59.8, and 59.6%, respectively. Only 50% of the female respondents named taste as the major determinant. Greater sensitization of all genders on the benefits hybrid adoption is key for enhanced productivity.

Keywords

Gender, Hybrid Maize, Improved Seed, Male-headed, Female-headed, Maize Value-Chain.

Introduction

Maize (*Zea mays* L.) is a major source of carbohydrates in sub-Saharan Africa (SSA). It is an essential source of income for many farmers. In Nigeria, maize is a notable staple food and cash crop [1] and it plays a significant role in the economic wellbeing and livelihoods of all the players across its value chain. However, adoption of improved maize hybrids, availability of improved hybrid varieties and accessibility to quality hybrid maize seed, which are crucial to transformative agricultural development in SSA and particularly in Nigeria, have been major limitations in maize production [2,3]. Farmers in Nigeria have over time relied on open-pollinated varieties (OPVs), which have low yield potential and are vulnerable to pests, diseases and drought stress [1,2]. The slow adoption of maize hybrid seeds, due in part to the smallholder farmers' propensity to recycle their grains as seeds, limited knowledge on the benefits of hybrid seeds, misconception on the value proposition versus pricing, and limited availability of hybrid maize varieties in key maize-growing areas are major limitations to maize productivity [2-5]. Adoption of improved

crop varieties and availability of quality seed can be major drivers of enhanced maize productivity in Nigeria.

Hybrid maize varieties, over time, have been proven to be superior to OPVs and landraces both on experimental plots and farmers' fields in terms of grain yield, tolerance to pests and diseases and other desirable agronomic attributes [6-8]. It is generally believed that hybrid varieties require a higher cost of production that discourages farmers in Nigeria [2,9]. However, the yield advantage of hybrid varieties over OPVs, which can be as high as 47% for single-cross hybrids [10], makes their cultivation under good agronomic practices more profitable. Oikeh et al. [7] attributed the superiority of hybrid varieties over OPVs to greater ability of hybrid varieties to partition dry matter to the grain known as harvest index, and to utilize the nitrogen taken up from the soil more efficiently for grain production (nitrogen-use efficiency).

Between 1991 and 2018, over 140 maize varieties (hybrids and OPVs) were registered and released for production in Nigeria (NACGRAB Varieties Released Catalogue 2016-2020). In addition, six (6) maize hybrids were released in 2019 and eight (8) hybrids in 2020 making a total of 14 new hybrid maize varieties that are still undergoing commercialization process by the various seed companies and research institutes [11]. Amongst the eight hybrids released in 2020 were two climate-smart, drought-tolerant maize known as DroughtTEGO® hybrids (SAMMAZ 62 and SAMMAZ 63) developed through ten years of excellent breeding efforts by the Water Efficient Maize for Africa (WEMA) Project [12-15]. For the African green revolution to happen, increased adoption of improved hybrid varieties and supply of quality seed to framers and development of markets will be the game changers. However, the adoption of hybrid maize varieties has some gender determinants. Amah et al. [16] reported that male farmers have more access to agro-inputs including quality seed varieties than female farmers. Other workers revealed that access to capital, land, agricultural education and information, government support, and other agro-inputs is a major deciding factor for women's adoption of new seed technologies [17,18]. Hence, equity in access to the same resources and marketing opportunities by men and women is important in increasing the adoption of hybrid varieties, productivity, and income of women, and consequently in reducing hunger and poverty [19]. Therefore, this study was conducted to identify the factors that determine the decisions of men and women in the adoption of hybrid maize varieties in selected States of northern Nigeria.

Materials and Methods

The Harvard Analytical Framework and the Integrating Gender into Agricultural Value Chains (INGIA-VC) Analytical Framework were used to evaluate the determinants of the adoption of hybrid maize varieties by men and women. The Harvard Analytical Framework was deployed to examine the type and amount of work that men and women do across the entire maize value chain. The INGIA-VC was used to scrutinize the gender inequalities that arise in relation to the adoption of hybrid maize varieties. Generally, the INGIA-VC Analytical Framework considers five areas which include: (i) mapping out gender roles and relations along the value chain; (ii) moving from gender inequalities to gender-based constraints; (iii) assessing the consequences of gender-based constraints; (iv) taking actions to remove gender-based constraints; and (v) measuring the success of actions. Tools for the survey were developed with this analytical framework.

A survey that was aimed at deciphering the factors that shape the adoption of hybrid maize varieties among men and women was conducted in five leading maize-producing States in northern Nigeria. A mixed-methods approach combining quantitative and qualitative data collection and analyses were employed in this study. A total of 450 maize producing households led by males, females and youth (18 and 35 years) were interviewed in the selected five States (Kaduna, Niger, Adamawa, Nasarawa, and Taraba) for primary data collection (Table 1). Four different data collection tools, namely Farmer Households Interview Schedule, Focus Group Discussion (FGD) Tool, Key Informant Interview (KII) for Research and Government Institutions, and KII for Seed Companies, were developed for assembling and collecting primary and secondary data from the study area. FGDs and KIIs were conducted to solicit collective ideas from a cross section of experts and other major players along the maize value chain concerning their perspectives with respect to hybrid maize adoption by different genders in the study area. The information collected was used to validate the opinions expressed by the interviewed farmer households. More details about the study area can be found in Marechera et al. [20].

An informed consent form was presented to every willing respondent stating the main objective of the study and explaining that the data to be collected were intended decision-making to enhance maize productivity in Nigeria and for scientific publication purposes. The form clearly stated that participation in the survey was completely voluntary, and information collected will be treated with utmost confidentiality and respondents are unrestricted from withdrawing if needs be. Each willing respondent then signed an expression of consent to participate in the survey before the interview was conducted.

Data analysis

The gender disaggregated data were analyzed with the aid of INGIA-VC and Statistical Package for Social Sciences (SSPS, Version 23), and summarized using descriptive statistics such as percentages, mean scores, and standard deviations. Tobit model based on Tobin [21] was used to determine factors affecting the adoption of hybrid maize varieties in the study area. Tobit model is one of the models commonly employed to determine factors affecting the adoption and intensity of use of innovation in agriculture. Tobit model is particularly efficient in determining both factors affecting adoption and the intensity of adoption [21,22]. This is made possible by presenting adoption variable in percentage or proportion of area of land allocated to a given technology being used.

Tobit model based on Tobin [21] is specified as follows:
$y_t = X_t\beta + u_t$ if $X_t\beta + u_t + u_t > 0$
$= 0$ if $X_t\beta + u_t \leq 0$
T = 1,2,....,*N*,

Where *N* is the number of observations, y_t is the dependent variable, X_t is a vector of independent variables, β is a vector of unknown coefficients, and u_t is an independently distributed error term assumed to be normal with zero mean and constant variance σ^2.

The empirical form of the model for abandonment decision is specified as:

$$Y_i = \beta_1 + \beta_2 GENDER + \beta_3 MARITAL + \beta_4 MALEHEADED + \beta_5 AGE + \beta_6 EDUCATION + \beta_7 OCCUPATION + \beta_8 CONTROL + \beta_9 HOUSEHOLDSIZE + \beta_{10} EXPERIENCE + \beta_{11} QUANTITY + \beta_{12} FERTILIZER + \beta_{13} PRICE + \beta_{14} EXTENSION + \beta_{15} OUTPUT$$

GENDER = Gender of the respondent
MARITAL = Marital status of the household head
MALEHEADED = Proxy defining if the household was male headed
AGE= Age of household head (years)
EDUCATION = Education level of household head
OCCUPATION = Primary occupation of the household head
CONTROL = The person that decided the variety of maize planted
HOUSEHOLDSIZE = Number of persons in the households
EXPERIENCE = Farming experience gained in maize cultivation in years
QUANTITY = Quantity of maize seed planted (kg)
FERTILIZER = Quantity of fertilizer applied (kg)
PRICE = Maize price (Naira)
EXTENSION = Number of extension visits
OUTPUT = Quantity of maize produced (kg)

The independent variables included in the model are the household-specific characteristics such as gender of the respondent (*GENDER*), marital status of the household head (*MARITAL*), Proxy defining if the household was male-headed (*MALEHEADED*), age of household head in years (*AGE*). Other household characteristics are the level of education of household head (*EDUCATION*), main or primary occupation of the household head (OCCUPATION), the person in the household that made the choice of variety of maize planted (*CONTROL*) and farming experience gained in maize cultivation in years (*EXPERIENCE*). Farm-specific characteristics included in the model are quantity of maize planted in kilogram (QUANTITY), quantity of maize fertilizer applied (*FERTILIZER*), maize price (*PRICE*) and quantity of maize produced (*OUTPUT*). Moreover, institution characteristic included in the model is the number of extension visits (*EXTENSION)* received by the household in the cropping season.

The inclusion of the household-, farm- and institutional-related variables in the model is based on *a priori* expectation of agricultural technology adoption. Demographic variables are expected to have influence on the adoption of improved technologies. Demographic variables like age, education level, household size, marital status and gender are supposed to be either positively or negatively related with the adoption of innovations [23]. There exist differences in adoption behavior of improved technologies as a result of demographic features like gender, age and education [24]. These variables have been identified to play major role in understanding the technology adoption process of different categories of people.

The effect of age (*AGE*) on decision whether to adopt an improved technology may be negative or positive. Many studies showed that age of farmers can have influence on their mental attitude to a new technology thereby determining adoption decisions in several ways. Farmers in their early years have a high tendency of being more knowledgeable about innovation and may be willing to bear the risk to adopt and use the new technology. In order word, as farmers get more advanced in age, they tend to be conservative. Therefore, it is hypothesized that farmer's age and adoption decision are expected to be indirectly related. As farmer age increases, probability of adoption is expected to decrease [25,26].

Education (*EDUCATION*) attempts to quantify the literacy level of individual farmers. The study expects that education will positively influence farmers' adoption decisions since as farmers gain access to better education, their ability to obtain, process, use new information increases thereby influencing their adoption decisions positively [27,28].

Experience, farming household gained overtime (*EXPERIENCE*) is likely to have a range of influences on adoption. Household members with higher experience are expected to have better information and understanding to evaluate the advantage of the technology [28-30]. Older farmers on the other hand could have tendency to take risks about their farming operations thereby unwilling to adopt innovations on their farms. The effect of farming experience in adoption decisions to use a new technology could be positive or negative. The study expects that farming experience could have negative or positive effects on the decision to use improved maize varieties.

The household size (*HOUSEHOLDSIZE*) is a measure of the number of available household labour living together under a roof. A large number of household members living together under a roof and operating together in the same farm activities on the farm will reduce the farms' external labor requirements and is therefore expected to positively influence adoption decisions of agricultural technologies [31]. This study hypothesized a positive relationship between household size and improved maize varieties' adoption.

Gender of the respondent (*GENDER*), Marital status of the household head (*MARITAL*) and male-headedness of household head (*MALEHEADED*) are all expected to be positively related to adoption decisions in using improved varieties of maize. Male and married household members are expected to have better access

to information on improved technologies. In facts, land holding ability, a precondition for adoption of new technologies is expected to be in favor of male members of households [28]. Decisions to adopt may also be positive with respect to male household members because of existing socio-cultural and religious biases that tend to limit women participation in agricultural activities. Therefore, gender of the respondent, marital status and male-headedness of the household are expected to be positively related to adoption of improved maize varieties. Similarly, the person who actually decides varieties to plant (*CONTROL*) in the household is expected to have positive influence on adoption of improved varieties, Farm-specific characteristics quantity of maize planted (QUANTITY), quantity of maize fertilizer applied (*FERTILIZER*), maize price (*PRICE*) and quantity of maize produced (*OUTPUT*) are all expected to be positively related to the adoption decisions of the farming household members. This is because, as farmers expect more output and increased profit, the greater the likelihood that farmers will adopt improved maize varieties [32,33] This implies that farm households will be encouraged by profit/output maximization thereby applying increasing fertilizer for higher returns [32].

Extension visits (*EXTNVISION*) emphasizes the number of effective visits on technology awareness farmers had with extension agent in last cropping season. Therefore, extension visits are hypothesized to have a positive effect on farmer's adoption decision improved maize varieties. It is believed that frequent visits will facilitate the understanding of the benefits inherent in improved technologies [27,34].

Results and Discussion

Sex-disaggregated socio-economic attributes of respondents in five northern States of Nigeria

The sex-disaggregated socio-economic attributes of the 450 respondents in the five States are presented in Table 1. The percentages of respondents of the male-headed and female-headed farming households that were 35 years and below across the five States were 14.6 and 13.8%, respectively. The mean percentages for respondents within the age brackets of 36-45 and 46-55 years were 24.8 and 28%, respectively, for male-headed households, and about 30.8 and 28.8%, respectively, for the female-headed households. The relatively higher percentages of respondents within these two age brackets that are considered suitable for agricultural activities are indications that an active and energetic section of the population participates in maize production across the five States in northern Nigeria.

The mean percentages in this study were lower than the 31.6% for male farmers and 45.5% for female farmers that were reported as being active and youthful maize farmers in another northern State of Plateau in Nigeria [16]. Other workers also regarded the innovativeness and doggedness of the people in these age brackets as the qualities that are required to overcome the drudgery often associated with agricultural activities [35]. These farmers fell within the ages of 30 and 50 years that Enete and Okon [36] regarded as people that are productive, virile, and constituting the active workforce for any community assignment. In total, 81.4% of the male-headed and 80.2% of female-headed households possessed at least primary school education (Table 1), with men having a little edge over the women. This critical mass of the respondents with formal education are expected to be able to read and understand the information about the agronomic procedures that the seed producers provide on the seed packets and bags of their hybrid maize varieties and other inputs such as fertilizers and agrochemicals. Adam et al. [37] also reported in a study conducted in Tanzania that a higher percentage of the male respondents that were involved in maize production had formal education when compared to the female respondents. In contrast to our results, Amah et al. [16] reported that a higher percentage of female respondents (82.3%) possessed formal education when compared

Table 1: Gendered distribution of the socio-economic attributes of the respondents across five States of northern Nigeria.

Gender/	Age (%)						Education (%)					Occupation (%)					HN
State	≤ 35	36-45	46-55	56-65	66-75	> 75	None	Pri.	Sec.	Coll.	Tert.	Never	Agra	Worker	Prof	Others	
MALE																	
Adamawa	34	16	21	12	13	4	28	24	38	10	0	0	91	5	4	0	8
Kaduna	8	49	29	5	5	4	2	20	37	34	7	0	77	6	5	12	12
Nasarawa	7	35	16	34	6	2	28	21	43	4	4	0	71	29	0	0	8
Niger	8	13	30	30	19	0	7	15	39	39	0	1	88	2	0	0	13
Taraba	16	11	44	20	3	6	28	28	8	16	20	0	98	2	0	0	11
MEAN	*14.6*	*24.8*	*28.0*	*20.2*	*9.2*	*3.2*	*18.6*	*21.6*	*33.0*	*20.6*	*6.2*	*0.2*	*85.0*	*8.8*	*1.8*	*2.4*	*10.4*
STDEV	*11.44*	*16.56*	*10.65*	*12.09*	*6.65*	*2.28*	*12.99*	*4.83*	*14.16*	*15.22*	*8.26*	*0.45*	*10.89*	*11.43*	*2.49*	*5.37*	*2.30*
FEMALE																	
Adamawa	25	31	32	9	3	0	20	27	32	21	0	0	74	26	0	0	2
Kaduna	2	45	43	4	4	2	29	48	10	0	13	0	84	16	0	0	1
Nasarawa	17	24	36	19	4	0	5	25	30	22	18	2	95	2	0	1	3
Niger	14	41	5	25	9	6	20	40	32	3	5	0	78	22	0	0	0
Taraba	11	13	28	24	23	3	25	28	0	40	7	0	92	4	4	0	3
MEAN	*13.8*	*30.8*	*28.8*	*16.2*	*8.6*	*2.2*	*19.8*	*33.6*	*20.8*	*17.2*	*8.6*	*0.4*	*84.6*	*14*	*0.8*	*0.2*	*1.8*
STDEV	*8.4*	*12.9*	*14.4*	*9.3*	*8.4*	*2.5*	*9.1*	*10.0*	*14.9*	*16.2*	*7.0*	*0.9*	*8.9*	*10.7*	*1.8*	*0.4*	*1.3*

Pri.=Primary, Sec.=Secondary, Coll.=College, Tert.=Tertiary, Agra=Agrarian, Prof=Professional, HN=Number of people in a household
Source: Field Survey, 2021.

with male respondents (76.3%) in Plateau State of northern Nigeria. Formal education has been identified as a key driver for adoption of new agricultural technologies and innovations [38] because it enables the farmers to make decisions that will improve their crop yields and enhance their livelihoods; and also manage the risks that are associated with maize production [16].

Preferred attributes for selection of hybrid maize varieties

Results from the FGDs conducted in each of the five States of the study to identify the preferred attributes for selecting hybrid maize varieties are presented in Table 2. Respondents in the five States preferred maize varieties that are high yielding and tolerant to pest, diseases and drought. Extra early (< 85 days from planting to physiological maturity) or early (between 85 and 90 days from planting to physiological maturity) maturity and large grain size were also important for adoption of a hybrid variety.

Percent gendered distribution of important attributes for selecting a maize variety in selected States

Results of the analysis of some agronomic, morphological, market and culinary attributes that the genders consider in selecting a maize variety for cultivation across the five States are presented in Table 3. For the male-headed farming households, yield ranked topmost among the attributes in all the States, with the highest mean value of 83% of the respondents. Further, 59.6–69.6% of the male respondents named tolerance to pests and diseases, tolerance to drought, and seed price as important attributes in selecting maize varieties. Only 22.2–26.2% of interviewed male farmers preferred taste and maturity period as important attributes of maize varieties for cultivation.

Among the female-headed households, 50% of the farmers identified seed price as the determinant for their choices of hybrid maize varieties for cultivation, while 33.6% of the female headed farmers indicated taste as the determinant of their choices, though 80–90% viewed market price and early maturity as determining factors in Kaduna State (Table 3). These results laid more credence to the claim that male farmers see maize more as an economic crop whose value can be adjudged majorly by its productivity (grain yield), which, in turn, depends on the tolerance of the variety of choice to biotic (pests and diseases) and abiotic (drought) stresses. Improved productivity of the maize crop leads to enhanced income, better livelihoods, and economic security of the farm families [16,37]. Further, the results showed that, on average, a third (33.6%) of the female-headed farming population saw maize as a staple cereal more for household consumption whose taste must appeal to the consumers and should mature early for consumption. Our findings reflect the gendered differences in decision-making between male and female farmers in the selected States of northern Nigeria in the choice of the maize varieties to grow. This underscores the importance of mainstreaming gender when it comes to participatory selection of hybrids and providing support to farmers to enhance maize production by all genders.

Table 2: Preferred attributes for selection of hybrid maize varieties in five northern States of Nigeria.

Preferred attributes	Adamawa	Kaduna	Nasarawa	Niger	Taraba
Yield	High	High	High	High	High
Reaction to major pests and diseases	Tolerant	Resistant	Tolerant	Resistant	Tolerant
Tolerance to drought	Tolerant	Resistant	Tolerant	Resistant	Tolerant
Grain size	Large	Large	Large	Large	Large
Maturity (days)	Extra early (< 85)	Early (85-90)	Extra early (< 85)	Early (85-90)	Extra early (< 85)

Source: Field Survey, 2021

Table 3: Percentage gendered distribution of important attributes for selecting a maize variety in selected States.

Gender / State	Yield	Seed price	Tolerance to major pests and diseases	Tolerance to drought	Grain size	Early maturity	Taste
MALE							
Adamawa	93	78	84	89	40	21	29
Kaduna	71	60	66	65	63	12	4
Nasarawa	78	72	52	44	29	21	40
Niger	87	27	67	43	34	23	21
Taraba	86	61	79	58	51	34	37
MEAN	*83.0*	*59.6*	*69.6*	*59.8*	*43.4*	*22.2*	*26.2*
STDEV	*8.57*	*19.73*	*12.50*	*18.81*	*13.69*	*7.85*	*14.45*
FEMALE							
Adamawa	29	41	53	0	0	18	35
Kaduna	30	90	0	0	20	80	40
Nasarawa	50	50	17	50	0	50	17
Niger	42	33	33	33	11	33	47
Taraba	36	36	36	58	36	29	29
MEAN	*37.4*	*50.0*	*27.8*	*28.2*	*13.4*	*42.0*	*33.6*
STDEV	*8.76*	*23.27*	*20.12*	*27.28*	*15.16*	*24.16*	*11.39*

Source: Field Survey, 2021

Gendered distribution of maize production challenges in the five selected States

Results of the analysis of the importance of the major challenges in maize production for male-headed and female-headed households in the five States are presented in Table 4. More than half of the interviewed male farmers across the States identified poor quality seeds (61.4%) and low market prices for their produce (61.8%) as the main challenges in maize production. Over half of the male respondents mentioned high cost of inputs (51.2%), high cost of labor (54.4%), and poor market structure as it affects the pricing of their produce (58.8%) as challenges in maize cultivation. Similarly, over half of the female respondents (50.8%) mentioned low market prices of the produce as a maize production challenge. Since the female farmers cultivated maize on average, 1.8 ha of farmland of which they allocate less than 1.0 ha for maize cultivation compared with the male farmers who cultivated on average, 4.0 ha of maize crop [20], they make little money from the sale of the produce at any given time.

Percentage gendered distribution of important maize production farm activities in five selected States

Manual operation formed an integral part of maize cultivation in the selected five States of northern Nigeria, and it is indeed the prominent option for the cultivation of maize and other crops in northern Nigeria [16,39]. The results of the gendered analysis of the major farm activities, often carried out manually during maize cultivation by the respondents across the five States, are presented in Table 5. More male farmers (61.8%) than their female counterparts (10%) responded that they were involved in ploughing (and other associated land preparation activities), which, without the use of a tractor, is an energy-sapping operation required in maize production – the FGDs revealed that less than 10% of farmers had access to modern farm equipment such as tractors for ploughing, ridging and planting, combine harvesters, and shellers (data not shown). Similarly, higher percentages of male than female farmers were involved in planting (51.0%), weeding (62.2%), harvesting (50.8%), and marketing (50.8%). It is only for grain shelling operation that more female (47.4%) than male

Table 4: Percent gendered distribution of maize production challenges in the five selected States.

Gender / State	Poor seeds	High cost of inputs	High cost of labor	Poor markets	Post-harvest losses	Low market prices
MALE						
Adamawa	66	57	74	89	40	78
Kaduna	64	44	52	60	25	65
Nasarawa	71	63	58	44	40	78
Niger	68	57	52	43	34	27
Taraba	38	35	35	58	51	61
MEAN	*61.4*	*51.2*	*54.2*	*58.8*	*38.0*	*61.8*
STDEV	*13.33*	*11.41*	*14.01*	*18.59*	*9.51*	*20.90*
FEMALE						
Adamawa	35	41	12	0	0	41
Kaduna	80	50	67	0	20	80
Nasarawa	57	67	100	50	0	50
Niger	4	4	2	6	2	6
Taraba	29	20	36	20	36	77
MEAN	*41.0*	*36.4*	*43.4*	*15.2*	*11.6*	*50.8*
STDEV	*28.84*	*24.81*	*40.36*	*21.10*	*16.02*	*30.18*

Source: Field Survey, 2021

Table 5: Percent gendered distribution of important maize production farm activities in five selected States.

Gender / State	Ploughing	Planting	Weeding	Harvesting	Shelling	Marketing
MALE						
Adamawa	92	79	86	63	61	80
Kaduna	68	48	78	63	45	56
Nasarawa	52	40	52	44	40	35
Niger	46	45	46	47	27	40
Taraba	51	43	49	37	24	43
MEAN	*61.8*	*51.0*	*62.2*	*50.8*	*39.4*	*50.8*
STDEV	*18.79*	*15.92*	*18.42*	*11.71*	*14.91*	*18.07*
FEMALE						
Adamawa	14	40	20	57	60	34
Kaduna	13	36	29	43	39	24
Nasarawa	13	51	32	53	49	37
Niger	7	28	21	25	43	20
Taraba	3	31	19	26	46	29
MEAN	*10.0*	*37.2*	*24.2*	*40.8*	*47.4*	*28.8*
STDEV	*4.80*	*8.98*	*5.89*	*14.87*	*7.96*	*6.98*

Source: Field Survey, 2021

(39.4%) farmers take ownership. The results revealed that more male farmers were involved in the more arduous and strenuous tasks in maize production though there were few instances in the individual States where the reverse was the case. For example, more female farmers were involved in planting and harvesting than male farmers in Nasarawa State.

Determinants of adoption of hybrid maize seeds in selected States

An econometric approach using Tobit model was employed to assess the determinants of adoption of hybrid maize seeds in northern Nigeria and the results are presented in Table 6. The dependent variable was the proportion of land under hybrid maize. The log-likelihood ratio was significant indicating that the explanatory variables could explain the change in the dependent variables. The significant explanatory variables included age of the household head, educational level, maize price, and the use of fertilizer. Age was positive and significant at 5% probability level. The coefficient estimate of age indicated that increase in age increased the prospect of adopting hybrid maize seed. Similarly, one unit change in the level of education increased the likelihood of adopting hybrid maize seed. The use of fertilizer was found to be complementary with the adoption of hybrid maize in the study area. Increased availability of fertilizer is a good driver of increased adoption of improved maize seeds. The results also showed that the higher the price of seed, the more likely it was for farmers with financial means to purchase and use good quality seeds of hybrid maize varieties. This might be an indication that farmers corresponded high price to good quality seeds; although it might also be borne out of the belief that adulterated seed would command low price while good quality seed would be expensive. The findings were also corroborated by FGDs and KIIs, showing that farmers preferred hybrid maize because of higher yield, high market value of the produce, but that the seeds were expensive and required the use of higher dosage of fertilizer. The KIIs identified financial constraints and restrictions by the husbands from travelling to locations where the seed could be purchased as some of the challenges that female farmers face from accessing good quality hybrid seeds. Accordingly, most of the farmers opined that the use of hybrid seed could be boosted with increased sensitization, subsidization of seed, and greater fertilizer availability.

Table 6: Determinants of adoption of hybrid maize seeds in selected States.

Variable	Coefficient	t
Gender	0.2858	0.79
Arital	0.202	0.45
Male headed household size	-0.5195	-1.22
Age	0.2459**	2.79
Education	0.1004**	1.94
Occupation	0.0556	0.23
Control	0.233	1.01
Household size	-0.0113	-0.7
Experience	-0.0313	-2.34
Quantity	-0.0014	-1.01
Fertilizer	0.8871**	2.04
Price	0.0034**	2.51
Extension	0.0433	0.19
Output	-0.0001	-3.38
Constant	-51561	14.04
Log-likelihood ratio	-927.29	
N =	435	
LR Chi^2 (15)	225.53	
Dependent variable	Hybrid land	
Prob >Chi^2	0	

Conclusion

This study revealed that high yield potential, tolerance to pests and diseases, tolerance to drought, large seed and grain size, and earliness were key determinants for selecting hybrid maize varieties by farmers in selected States in northern Nigeria. The male farmers, who considered maize as more of an economic than a subsistence crop, prefer high yield potential as the leading attribute for selecting hybrid maize variety for cultivation. Other important attributes for selecting hybrid maize varieties by male farmers included tolerance to biotic and abiotic stresses. Conversely, the female farmers value maize crop for household consumption, and regarded taste and earliness as key attributes in selecting hybrid varieties for cultivation.

Poor quality seeds and low market price for the produce were regarded as disincentives for maize production by the male farmers while the female farmers also mentioned low market price of the maize produce as a big challenge to maize cultivation. Male farmers do most of the arduous tasks such as manual land preparation, which involve ploughing and ridging, and weeding operations during maize cultivation. The female farmers were more involved in grain shelling than their male counterparts.

Increase in age of the farmer, an indication of farming experience, formal education, market price of maize produce, and availability of fertilizers were identified as key drivers for increased adoption of hybrid maize varieties in the study. It is recommended that government and other stakeholders that are championing the adoption of hybrid maize varieties should increase their sensitization drive among the maize farming communities considering the available safe spaces for all genders on the values that hybrid maize varieties offer farmers and all players along the maize value chain. More efforts are needed on sensitization of farmers on the increased economic returns from the adoption of hybrid seeds. Where possible, smart subsidies should be introduced to address the issue of high prices of good quality seeds and the limited availability of fertilizers to make these inputs more available and affordable to maize farmers to adopt hybrid maize varieties, particularly the climate smart DroughtTEGO® hybrids to enhance adaption to climate change.

Limitations of the study

This study covered five major maize-producing States in northern Nigeria and may not entirely represent the views across the 19 northern States. The findings, however, lay a solid base for identifying the factors that are affecting the adoption of hybrid maize varieties across different genders for decision making and

could be replicated across the other northern States. Further, relatively low percentages of females (less than 20%) were represented in the survey across the five States, in contrast to the anticipated target of 30%. The study, however, ensured that the females represented were able to intelligently articulate the issues that were raised during the interviews. Data from decision makers and major players along the entire maize value chain were also incorporated to firm up our findings.

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