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GENDER-BASED ANALYSIS OF RISK MANAGEMENT AND IMPROVED TECHNOLOGY ADOPTION AMONG SMALL-SCALE MAIZE FARMERS IN KWARA STATE

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ABSTRACT

This study examines the gender-based analysis of risk management strategies and improved technology adoption among small-scale maize farmers in Kwara State, Nigeria. The specific objectives are to: compare the risk management strategies by gender; analyze the gender-based effect of the adoption of improved varieties on output and evaluate factors influencing the adoption of improved technologies among male and female farmers in the study area. A random sampling procedure was used to select a total of 250 male and female farmers in the study area. A structured questionnaire was used to obtain the data for the study. The collected data were analyzed using descriptive statistics, Propensity score matching, and logit model. The findings of the study were that: early planting was the most common risk management strategy among the men (79.86%) and women (73.12%) farmers followed by diversification, use of improved varieties and bush fallowing. The result also showed that the adoption of improved varieties increased the yield (productivity) of both male and female farmers. The factors influencing the adoption of improved among the men farmers include extension access, educational level, output and labour while for the women farmers, the price of improved seed, output, herbicide and credit availability were the factors that significantly influenced their adoption of improved varieties. The study recommended that the price of the improved seed should be made affordable for women farmers, information sharing should be encouraged among male farmers and the government should empower extension agents in sensitizing farmers on risk management strategies especially the adoption of improved crop varieties and diversification into other agricultural related activities towards improving their livelihood.

Keywords: Gender, Risk management, Improved varieties, Maize farmers, Propensity score

Introduction

Agricultural production is highly characterized by risks. Particularly, production decisions are generally made in an environment of risk and uncertainties (Meijer et al., 2015). Yield, product prices, and to a more limited extent, input prices and quantities are usually not known with certainty when investment decisions are being made (Kahan, 2013). In many cases, farmers are confronted with the risk of pests and diseases which may cause product prices to decline. Such characteristics result in returns displaying high variability (Gabre-Mahdin et al., 2003). Returns vary with the farming system, and policy institutional setting amongst others; these in turn affect production decisions. Each decision needs to be analyzed with the risk being accounted for. Analyzing and revealing the risk management strategies by small-scale agricultural farmers is a requisite to good planning in agricultural production and innovation (Wencong, et al., 2006). These small-scale farmers exist at the margins of the modern economy. They have one foot in the market economy and the other in subsistence. They are thus neither fully integrated into that economy nor wholly insulated from its pressure. Hence, they are more exposed to risk than other segments of the population.

Drought is a major risk in agriculture. Empirical pieces of evidence have shown that the use of Drought Tolerant (DT) maize varieties stabilizes maize yields in drought-prone ecologies and also increases land area cultivated to maize (Ayinde et al., 2013). The drought-tolerant maize varieties are especially targeted towards the poor and resource-limited farming household in the more marginal rain-fed agricultural areas (Fisher et al., 2015; Kassie et al., 2017; Olagunju et al., 2019). This resource-limited farmers include rural women. Rural women are responsible for up to 60 to 80 percent of food production in developing countries, yet they are often underestimated and overlooked in technological innovation, policies and strategies. They also contribute to household subsistence and well-being. Yet, they are often underestimated and overlooked in technological innovation, policies and strategies. Despite women's role as key players in the agricultural sector, men and women do not have the same access to productive resources (Doss, 2018; Nwaobiala et al., 2019; Ankrah et al., 2020). Also, men have continued to dominate farm decision-making, which could be counter-productive, due to conflicts that arise when women are not involved in the decision process. Men and women within households do not have the same preferences or pool their resources. This has important implications for productivity. As a result, their exposure to risk varies (Simtowe et al., 2019). One of the key hindrances to agricultural advancement is the wide gender gap in agricultural productivity (Awotona et al., 2022). This has important implications on the general productivity of the household, well-being and subsequent status of their livelihood. This necessitates gender inclusion in agricultural research. The rationale for considering gender in agricultural research relates to agricultural productivity, food security, nutrition, poverty reduction and empowerment (FAO, 2011). In all of these cases, women play a critical, but often under-recognized role and face greater constraints than men. Recognizing this, sets the stage for identifying ways that the agricultural research

system can redress these problems and contribute to productivity through technology and innovation to ensure equity and subsequent increase in the livelihood of the household.
Despite their central role in agriculture and food security, women in Nigeria often face constraints that limit their capacity to improve food production, enhance food and nutritional outcomes and subsequent contribution to household livelihood. Gender inequalities also exist in accessing resources such as land, credit, agricultural inputs, innovation and technology, education, and extension services. These inequitable accesses to productive resources partly stem from the reality that women's contributions are often unrecognized in mainstream agricultural policies and research agendas. As a result, women's exposure to risk in agriculture has not been properly addressed in research and policy (Doss, 2018; Ankrah et al., 2020). Education is a necessary tool for knowledge in modern society. In Nigeria, rural women's access to education (formal and informal) is limited compared to men's. Despite these challenges, the role of women in household subsistence keeps increasing by the day. Women face the difficult task of maintaining a balance between the agricultural production process and household sustenance (Doss & Morris, 2001). These challenges also expose women to risk more than men and hence the need for the inclusive investigation on proper risk management on a gender basis for sustainable livelihood of the rural farmers.

Despite a growing supply of gender-disaggregated data and studies on women's contributions to agriculture and food security, household-level data tend to ignore the intra-household distribution of agricultural responsibilities, resources, as well as risk exposure. Research and policies thereby fail to account for the gender needs of men and women in managing risk in farming communities, which often lead to more detrimental impacts on rural women. Transformation of Nigerian agriculture for sustainable improvement in livelihood will require the need to address men's and women's concerns; especially in risk exposure and management. It will also require creating enabling conditions for gender-sensitive technology and innovation at all levels of agricultural research, policy and value-chain to support full, fair, and viable participation of women in sustainable systems of food production. With the foregoing, the specific objectives of this study are to: compare the risk management strategies by gender; analyze the gender-based effect of the adoption of improved varieties on output and evaluate factors influencing the adoption of improved technologies among male and female farmers in the study area.

METHODOLOGY

Study Area

The study area is Kwara State, Nigeria. The geographical location of the state is between latitude 70 20' and 110 05' north of the equator and longitude 20 5' and 60 45' East of the prime meridian (KWSG Diary, 2006). It shares local boundaries with Oyo, Ondo, Ekiti,

Osun States to the South; Kebbi and Niger to the north; Kogi to the East and an international border with the Republic of Benin to the West (KWSG Diary, 2006). There are 16 Local Government Areas in Kwara State. It has a total population of about 2,371,089 million and covers a total land mass of 32,500 square kilometers out of which 75.3% is cultivable (National Population Commission, 2010). The average temperature ranges between 27º and 35ºC with a mean annual rainfall of 1,000-1,500mm. It has two main seasons; wet and dry. The wet season is between early April and late October while the dry season is between November and late March. The natural vegetation cover consists of rainforests in the South and Guinea Savannah to the North. The climatic condition, soil type, topography and vegetation cover in the state support the cultivation of several crops of economic importance like maize, cassava, vegetables, millet, rice, yam cowpea, sorghum, etc. The State is also suitable for raising livestock.

Sampling Technique

The sampling procedure comprised three stages. The first stage was a random selection of five villages from the adopted villages of Faculty of Agriculture research stations in Kwara State. The adopted villages were established with the fund from West Africa Agricultural Productivity programme and Institution Based Research (IBR) Tetfund. Improved seeds such as drought-tolerant seeds were introduced to the farmers at adopted villages from 2016 to 2020. The second stage was a random selection of fifty farmers per village. This comprises of a random selection of twenty-five women farmers and twenty-five men farmers. A total of two hundred and fifty (250) women and men farmers were selected, only a total of two hundred and forty-five (245) respondents gave complete information which was used for this study. This comprises one hundred and twenty-seven (127) male farmers and one hundred and eighteen (118) female farmers.

Method of Data Collection and Data Description

Primary data was used for this study. A pre-test was conducted before the actual administration of the questionnaire to ascertain that the survey instrument was adequate for the study before the actual field survey. The study ensured that plot managers within the households were interviewed using a questionnaire.

Method of Data Analysis

The descriptive analysis was used to analyze the gender-based risk adaptation strategies in the study area. Propensity Score Matching (PSM) was used to analyze the effect of adoption of Drought Tolerant (DT) Maize on men's and women's farm output, while the Logit regression model was used to investigate factors influencing the adoption of improved maize varieties among male and female farmers.

Propensity Score Matching

In this study, propensity score matching (PSM) was used to evaluate the effect of adoption of improved crop varieties on productivity outcomes of men and women smallholder farmers in the study area. The PSM allows evaluators to calculate the mean effect of treatment (productivity) on the treated. The PSM can be used to examine the average treatment effects (ATE) by comparing the expected outcomes of various outlets.

$$ATE = E(Y_1 - Y_0) \quad (1)$$

For this study the outcome variable include: output, and yield. Both the propensity score matching and nearest neighbor matching method were used.

Logistic Regression Model

This was used to determine the factors affecting the adoption of improved varieties among male and female maize farmers in the study area. The model is expressed below as:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon_i \quad (2)$$

Where: Y= Adoption of improved crop variety (Adopters = 1, Non adopters = 0); X_1 = Farmer's age (years); X_2 = Price of improved variety (Naira); X_3 = Household size (number of members); X_4 = Extension access (Yes = 1, No = 0); X_5 = Household income (Naira); X_6 = Farm size (ha); X_7 = Years of Schooling (years); X_8 = Output (kg); X_9 = Price of labour (Naira); X_{10} = Credit Availability (Frequency of access); m_2 = Error term; a and b are parameters.

RESULTS AND DISCUSSION

Descriptive Statistics of the Maize Farmers by Gender

Table 1 shows the summary statistics of sampled farmers assessed for any significant differences between the male and female farmers using a t-test. The result showed that the male farmers are older than the female farmers. The mean household size for male farmers is 8 members while the mean household size for female farmers is 7 members. The male farmers on average have more experience, bigger farm sizes and are more educated than the female farmers. In addition, the male farmers had an average maize yield of 1571.44 kg/ha while the female farmers had an average maize yield of 812.68 kg/ha with a mean difference of 758.76 kg/ha showing that the male farmers have more yield than the female farmers.

Table 1: Descriptive Statistics of the Maize Farmers by Gender

Variables	Male (n = 127)	Female (n = 118)	Mean difference	t-test
Age	37.378	34.389	2.989	1.116
Education	10.778	3	7.778	10.516***
Household size	8.83	7.81	0.622	1.378
Farm size	2.84	1.85	0.993	4.852***
Farming experience	21.2	12.4	8.801	1.811***
Maize yield	1571.44	812.68	758.76	5.766***

Comparing Gender-based Risk Management Strategies

The disaggregated results of the risk management strategies used by farmers are presented in Table 2. The result revealed that the risk management strategies used by farmers include; the use of improved crop varieties, diversification, early planting of seeds, using insurance, bush fallowing, irrigation, leased out their land.

The result showed that early planting was the most common risk management strategy used by the farmers. A larger percentage of the male farmers (63.78%) also diversified into other agricultural-related activities as a risk management strategy compared to 62.71% of the female farmers. These agricultural-related activities include aquaculture, animal production, and agroforestry which the farmers were introduced to in the study area.

Table 2: Gender-based Risk Management Strategies

Variables	Male (N=127)	Percentage	Female (N=118)	Percentage
Use improved maize varieties				
No	84	66.14	77	65.25
Yes	43	33.86	41	34.75
Diversification				
No	46	36.22	44	37.29
Yes	81	63.78	74	62.71
Early Planting				
No	26	20.47	31	26.27
Yes	101	79.53	87	73.73
Insurance				
No	121	95.28	114	96.61
Yes	6	4.72	4	3.39
Fallowing				
No	80	63.99	88	74.58
Yes	47	37.01	30	25.42
Irrigation				
No	114	89.76	97	82.20
Yes	13	10.24	21	17.80
Leased land				
No	100	78.74	102	86.44
Yes	27	21.26	16	13.56

This result also shows that the use of improved crop varieties is the third risk management strategy used by the farmers. This further shows that both the male and female farmers have not fully exploited the use of improved crop varieties as a risk management strategy.

The use of bush fallowing comes up as the fourth common risk management strategy used by the farmers. The result also revealed that other risk management strategies used by farmers include; leasing of their farmland, usage of irrigation as well as agricultural insurance.

Average Treatment Effect by Gender

The estimated population effect parameters for the matching estimators are presented in Table 3. The table shows the result from two matching methods used. The estimated average effect of using improved crop varieties on the male and female farmers was denoted by average treatment effect (ATE) and Average treatment effect on the treated (ATET). The result of ATE and ATET for male farmers implies that adoption increases the productivity (yield) of male farmers by 447.214 kg/ha among the population of farmers and 387.463 kg/ha among the adopters of improved maize variety respectively. The result of ATE and ATET for female farmers implies that adoption increases the productivity (yield) of female farmers' by 443.411 kg/ha among the population of farmers and 395.449 kg/ha among the adopters respectively. Overall, the results showed that the adoption of improved maize variety has a positive impact on the productivity of the farmers in the study area. The result of the analysis established the presence of heterogeneity in the impact of STMA adoption among farmers by gender. Comparing the results, the impact is higher for the male farmers (447.214 kg/ha) than the female farmers (443.411 kg/ha) among the whole population (ATE) while the impact is higher for the female farmers (395.449 kg/ha) than the male farmers (387.463 kg/ha) among the adopters (ATET).

Table 3: Result of Average Treatment Effect of adoption of Stress Tolerant Maize

Variable	Method	Treatment effect	Coefficient	Standard Error	z-value
Male	PSM	ATE	447.214***	53.559	8.35
		ATT	387.463***	83.446	4.64
	Nearest neighbour	ATE	349.273***	85.286	4.10
		ATT	391.661***	100.086	3.91
Female	PSM	ATE	279.583***	59.876	4.67
		ATT	326.378***	107.656	3.03
	Nearest neighbour	ATE	443.411***	48.670	9.11
		ATT	395.449***	56.806	6.96

Disaggregated Determinants of Adoption of Improved Variety for Men Farmer

Table 4 presents the result of the logistic regression of the determinant of adoption of improved variety among men farmers. The result revealed that extension access (at 5%), education level (at 1%), output (5%) and labour (1%) were the significant variables that affect the men farmers' adoption of improved crop variety. The result further revealed that a unit increase in access to extension services will increase the probability of male farmers to adopt improved crop variety which agrees with the findings of Donkoh et al. 2019, Kumara et al. 2020 and Chete, 2021.

Table 4: Logistic regression results of determinants of adoption of improved maize varieties among Men Farmers

Variables	Coefficient	Standard Error	Z	P>z
Age	0.056	0.097	0.58	0.563
Farm size	0.268	0.220	1.22	0.222
Household Size	0.008	0.031	0.25	0.801
Extension access	0.058	0.370	0.16	0.005
Household Income	0.294	0.358	0.83	0.407
Price of improved variety	-0.008	0.018	-0.47	0.641
Level of Education	0.073	0.027	2.70	0.007
Output	-0.034	0.017	-2.02	0.043
Labour	-0.041	0.016	-2.61	0.009
Credit availability	-0.010	0.042	-0.24	0.808
Constant	0.719	0.164	4.40	0.000
Log likelihood -153.68937**				
Number of observations 250				
LR chi2(14) 24.76				
Pseudo R2 0.1156				

The result revealed that education is an important determinant for the adoption of improved crop variety among male farmers in the study area. A unit increase in the level of education of male farmers will lead to a 7% increase in the probability that the male farmers will adopt improved crop variety. This also agrees with the findings of Kudi et al. 2011; Abadi et al. 2015 and Assaye et al. 2022. Chete et al. 2021 noted that the level of education contributes to farmers' knowledge and helps in deciding whether to adopt it or not.

The result also showed that a unit decrease in output will lead to a 3.4% increase in the probability that the male farmers will adopt improved varieties. This may be as a result of the fact that when the farmers are experiencing low output, they will probably adopt improved varieties which are expected to help increase their output. The result further revealed that as the price of labour increases the probability of the male farmers to adopt improved crop variety will reduce. The result affirmed the outcome of the work of Chete (2021) who asserted the importance of labour supply to the adoption of improved varieties.

Disaggregated Determinants of Adoption of Improved Variety for Women Farmers

Table 5 presents the result of the logistic regression of the determinant of adoption of improved variety among women farmers. The result presented in Table 5 revealed that factors like the price of seed and output were negative and significantly influence the adoption of improved crop varieties among the women farmer at 5% and 1% level of significance respectively, while factors like the herbicide and availability of credit were positive and significantly determine the adoption of improved crop varieties among the women farmer at 1%.

Table 5: Logistic Regression Results of Determinants of Adoption of Improved Maize Varieties among Women Farmers

Variables	Coefficient	Standard Error	Z	P>z
Age	0.083	0.066	1.27	0.206
Household Size	-0.009	0.032	-0.27	0.788
Extension Access	-0.019	0.050	-0.38	0.703
Household Income	-0.548	0.335	-1.64	0.102
Price of Improved variety	-0.018	0.025	-0.74	0.046
Level of Education	-0.042	0.033	-1.26	0.209
Output	-0.057	0.018	-3.21	0.001
Herbicide	0.608	0.179	3.40	0.001
Price Labour	-0.011	0.023	-0.45	0.652
Credit availability	0.178	0.045	3.98	0.000
Log likelihood	-169.393512***			
Number of obs	250			
LR chi2(14)	45.83			
Pseudo R2	0.5389			

This means that an increase in the price of the improved variety will reduce the probability of the adoption of improved crop variety by the female farmers. This probably means that the women farmer might perceive that the price of the improved variety is higher than they can pay for. This result is in consonance with the findings of Kahan (2015) who stated that input prices affect farmers' adoption behaviour. The result further showed that a unit decrease in the female farmer's output will increase the probability that the farmers will

adopt the improved crop varieties. This implies that poor harvest may increase the farmer's adoption of the improved crop varieties.

Availability of credit is important in crop production. Farmers' access to credit can encourage the adoption of improved crop variety. A unit increase in credit availability will increase the probability that the women farmers will adopt the improved crop varieties by 17.8%. This result is in consonance with the findings of Idrisa et al. (2012); Donkor and Owusu. (2014); Odoemlam & Nzeakor, (2020); Adigun, (2022) and Balana et al. (2022). The result also showed that increasing the use of herbicides in controlling weeds and pests is probably associated with the adoption of improved varieties. Increase use of herbicides will probably make the farmers adopt the improved varieties in order to save costs.

CONCLUSION AND RECOMMENDATIONS

The results from this study show that diversification and use of improved varieties are important (amongst others) risk management strategies among men and women farmers. In addition, the adoption of improved varieties increases the farmers' crop productivity. The logit model showed that the probability of a farmer adopting the improved varieties is influenced by different household socioeconomic characteristics, institutional, and input variables. The implication of this study's findings is that policies designed at helping farmers to manage production risk and increasing the adoption of improved varieties can be designed by focusing on these factors while improving crop production and rural farmers' livelihoods in the study area.

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

i. The government in collaboration with the relevant ministries and research organizations and private organizations should increase advocacy of the benefits of diversification and improved varieties among male and female farmers. This could encourage better risk management among the farmers
ii. Policies that will help improve female farmers' access to improved varieties that will also be affordable should be put in place and enforced by the Ministry of Agriculture, research organizations and private organizations. This will encourage increased usage among female farmers.
iii. Farmers should also be motivated to get involved in extension/dissemination programmes and training, for access to information about risk management strategies and improved technologies.

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