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ANALYSIS OF ADOPTION OF DOWNY MILDEW RESISTANT MAIZE TECHNOLOGY IN GUINEA SAVANNA AGRICULTURAL ZONE OF NIGERIA

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ABSTRACT

This study examined the adoption of downy mildew resistant maize technology in Guinea Savanna agricultural zone (Kogi State) Nigeria. Primary data were collected using structured interview schedule and personal interview of 120 maize producers. Multistage sampling technique was used to select the respondents. Data analysis was carried out using frequency counts, percentage and logit regression. The results revealed that access to credit facility and farming experience significantly influenced adoption of downy mildew resistant maize variety at 5% and 1% levels. The study further revealed that the adoption of downy mildew resistant maize variety kept on increasing from 2.17 in 2008 to 3.89 in 2013. The constraints to adoption of downy mildew resistant maize variety includes, high cost of tractor hiring for land preparation with a mean score of (2.90), inaccessibility to tractor (2.72), unavailability of tractor (2.36), unavailability of downy mildew resistant maize seed variety (2.33), while inadequate knowledge of planting downy mildew resistant maize variety (2.10), high cost of downy mildew resistant maize variety (2.05) and inadequate extension contact (2.03) were also identified as constraints. Increase in the number of visit to the maize farmers by well trained extension agents for knowledge sharing of downy mildew resistant maize variety practice was recommended to improve the adoption and output of downy mildew resistant maize variety in Nigeria.

Keywords*:* Adoption, Downy mildew Resistant, Maize, Rural farmers.

INTRODUCTION

Downy mildew is a disease that affects maize and other plants. It is a fungal infection that causes lesion on leaves and flowers. Downy mildew disease is caused by *Peronosclerospara sorghi*, and other fungal species from the three genera *Peronosclerospora, Sclerophthora and Sclerospora. It* causes yield loss on cereals especially maize worldwide. Yield losses caused by downy mildew disease on maize in Nigeria are about 90% (Thakur and Mathur, 2002). Canopy formation that gives shaded, moist environment with dead leaves is ideal breeding ground for these fungi. They appear as small yellow spots on leaves and eventually turn brown. Downy mildew outbreak develops when germinating oospores from sporangiophores, which resemble a bunch of grapes, emerge from the plant stomat. Each grape is a sporangium, and each sporangium is filled with dozen of zoospores that swim to susceptible plant even when just a film of free water is available (Beckerman, 2009). Downy Mildew Disease (DMD) affects maize on the field. It causes stunted growth and crazy top. The primary infection of downy mildew disease starts in tender leaves as small pale yellow spots, with undefined borders on the upper leaf surface starting from the base and gradually progressing to the upper part of the leaf. Infection results in plants with stiff, narrow, erect, yellow leaves and inflorescence that are distorted resulting in abnormal cobs.

Downy mildew is one of the most important foliar maize diseases in the tropical lowland worldwide. The disease was reported in African countries with severe outbreak in Mozambique, Uganda, Republic of Congo and Nigeria in 1993 (International Institute of Tropical Agriculture (IITA), 1999). Downy mildew resistant varieties were then introduced. These varieties produced more than 3 tonnes/ha under severe downy mildew pressure and where susceptible varieties may give very low yield of about 1 tonne/ha (Fakorede *et al;* 1993).

The concept of adoption is regarded as a decision to make full use of an innovation or technology as the best course of action available (Adekoya and Tologbonse, 2005). Hence, van dan Ban and Hawkins (1996) said the term innovation is an idea, object or method which is regarded as new by an individual, but which may not always be the result of recent research. Most farmers are said to go through a logical, problem-solving process known as adoption process when considering any new technology or innovation. A farmer decision about whether or not to adopt a recommended agricultural practice is recognized to occur over a period of time in stages rather than instantaneous (Adekoya and Tologbonse, 2005). Adoption of downy mildew resistant maize goes along with a package of technologies such as the use of fertilizer, herbicides and tractor to increase the size of farm to enjoy economy of scale. According to Iken and Amusa (2004a) the maize plant must be supplied with adequate nutrients particularly nitrogen, phosphorus and potassium for good growth and high yield. The required quantity of these nutrients particularly Nitrogen will depend on the status of the pre-cleared vegetation, organic matter content, tillage method and light intensity. The most important of the micro-nutrients for maize growth are Sulphur, Zinc and Magnesium particularly in Savanna vegetation that is under continuous cropping of maize. The nutrient requirement is satisfied by application of the right form of fertilizer containing the requisite combination of the above elements.

The use of effective and efficient herbicide will prevent weed from competing with downy mildew resistant maize. Weeds cause severe yield reduction in maize in Nigeria because they compete with the crop for nutrient, water and light. Weed control is the most expensive operation in traditional maize farming since it is done manually. Often, labour is too expensive causing many farmers to abandon weed control thereby resulting in very low yields (Iken and Amusa, 2004b). Use of appropriate herbicide such as Glyphosate, metalaxyl- m plus fludioxonil, Diuron, Pendimentalin etc, at recommended doses, will wipe out all weeds on the field. Use of herbicide as control measures of weed is faster and safer to the use of mechanical means of weed control or weeding by hand (United State Agency for International Development (USAID), 2010).

The use of tractor efficiently will increase the size of the maize farm. According to Onwualu (2009) tractors recently have become one of the most vital and efficient mechanism used extensively in agricultural operation in Nigeria. In essence adoption of downy mildew resistant maize variety entails the use of other forms of

technologies such as fertilizer, herbicides and tractor. The need to control this stubborn disease is however very important. Non-adoption of this maize variety may drastically reduce the yield of maize.

If susceptible maize varieties are grown, the infected plant may produce cobs resulting in 100% single plant yield loss. When many plants are infected, overall yield is compromised. Yield losses caused by downy mildew on maize in Nigeria are about 90 percent (Thakur and Mathur, 2002).

Scientist (breeders and pathologists) in National Agricultural Research Institutes (NARI) have developed high–yielding disease resistant/tolerant varieties. Resistance to both downy mildew and streak has been bred into maize (DMR-SR varieties) through the effort of research institutions in Nigeria. Nigeria has resorted to the recommendation of both short and long-term effective control strategies which include breeding of resistant, hybrid and open pollinated maize varieties, such as downy mildew resistant maize. Downy mildew resistant varieties of maize are now adopted by some farmers. However many of the farmers are fond of continuous use of the seeds of previous years for successive planting. There may be a reduction in genetic expression of the tolerant varieties.

In Kogi State which is in Guinea Savanna agro-ecological zone in Nigeria, maize production is a major enterprise among rural farmers. Downy mildew disease is a common disease that reduces the output especially during the late maize production (between August and October). Some of the farmers adopted downy mildew resistant varieties, while some continued to plant other improved seeds that were adopted. Many may not adopt the varieties at all.

Hence, it is imperative for one to know the socio-economic characteristics of maize farmers in the study area and to equally ask the following fundamental questions: What are the general attitudes of farmers to Downy Mildew Resistant Maize in the study area? What are the stages and levels of adoption of other technologies needed to accomplish successive adoption downy mildew resistant maize? What are the constraints to the adoption of the technologies? The general objective is to analyze the adoption of Downy Mildew Resistant Maize (DMRM) variety technologies in Guinea Savanna agroecological zone of Nigeria.

METHODOLOGY

Study Area

The research was carried out in Kogi State which is centrally located at the Guinea Savanna agro-ecological zone of Nigeria. The State was created on the 27th August, 1991 by the Government of General Ibrahim Babangida from part of Kwara and Benue States. Kogi State lies between Longitude 5º18`E to 7º49`E and Latitude 6º31`N to 8º42`N. It is centrally located in between the Northern and Southern part of the country. It shares boundaries with eight (8) States. The State is bordered in the North by Niger, Plateau, Nassarawa States and Federal Capital Territory (FCT), in the South by Enugu and Edo States and in the West by Ekiti and Ondo States.

The estimated population of the State is 3,592,789 as reported in the 2006 census (FRN, 2007), with a total land area of 29,833km^2. Kogi State has two main rivers – Niger and Benue running through it and meeting at Lokoja, its capital. Other rivers and wet land exist in the state. The seasons oscillate between the wet and dry, with a daily temperature of between 24^{0}C – 27^{0}C while annual mean rainfall is between 1250 – 1700 mm spreading over eight (8) months as reported by Kogi State Economic Empowerment and Development Strategies (KOSEED, 2004). The wet season spans between middle of March and October while dry season usually occur between the months of November and March. These conditions make the area favourable and suitable for extensive practice of agriculture. Crops cultivated includes maize, rice, guinea corn, yam, millet, cassava, sweet potatoes, cowpea, groundnut, soybean, beniseed and vegetables. Considerable livestock activities comprising mainly of Fulani cattle, grazing small ruminant and poultry rearing are predominant. The vegetation of the State is a mixture of Guinea Savanna, Fadama and Forest; Mineral resources available in Kogi State include coal, limestone, iron and tin.

Sampling Procedure

The study was conducted in Kogi State, Nigeria. Kogi State was purposively picked in the Guinea Savanna, agroecological zone of Nigeria because of its popularity in maize production. A multistage random sampling technique was also used. At the first stage four (4) Local Government Areas (L.G.A) were randomly selected from the four (4) sub-agroecological zones, zone A (Ijumu L.G.A), zone B (Dekina L.G.A.), zone C (Kogi L.G.A) and zone D (Ofu L.G.A.) in accordance to Kogi Agricultural Development Project (KADP) extension structure. At the second stage, one cell was selected from each of the chosen LGA. At the third stage, thirty (30) maize farmers were randomly selected from the registered maize farmers with each of the cells making a total of one hundred and twenty (120) maize farmers. Finally one hundred and twenty (120) sets of structured interview schedule were administered to maize farmers.

Method of Data Collection

The data were collected through primary source; the primary source involved the use of structured interview schedule which was administered personally to the 120 maize farmers.

Method of Data Analysis

Description of socio-economic characteristics of maize farmers was analyzed using frequency and percentage while the influence of social economic characteristics on adoption of Downy mildew resistant maize variety was analyzed using logit regression model, and the model is specified as follows:

Lny = Ln (p/1-p)..... Equation 1

Ln (p/1-p) = $b_0+b_1x_1+b_2x_2$……b_8+e.....Equation 2

Where:

Y = DMRM variety adoption. (1 = adoption, 0 = otherwise)

P = probability of the use of DMRM variety.

Ln = natural logarithm function.

b_0 = constant.

b_1-b_8 = Logit regression coefficients.

X_1 =Age of farmers (in years)

X_2 = Level of education (in years)

X_3 = household size (number of persons)

X_4 = Farm size (in hectares)

X_5 = Farming experience (in years)

X_6 = Access credit (loan for maize production in naira)

X_7 = Extension contact (Number of visit within 1 year)

Description of attitude of farmers to the use of downy mildew resistant maize variety was analysed using means score or weighted mean from 4 point likert scale of strongly agree = 4, agree =3, Disagree = 2, and strongly disagree = 1. Mean score used as presented by the formula below:

$$X = \frac{\Sigma fi\ (Ai)}{N} \text{..... Equation 3}$$

Where X= mean score
Fi = frequency
Ai = value assigned to each response.
N = Sample size
Σ = Summation

Finding the stages of adoption of other technologies needed for DMRA, was analyzed using means score from a 5 point likert type of scale as per equation (3) to identify the various stages that Downey Mildew resistant adopters were on the adoption process of other related technologies. That is, stages on the adoption process such as; awareness, interest, evaluation, trial and adoption.

Examination of Constraints to the adoption of Downy Mildew Resistant Maize in the study area was measured on a 3 point Likert type scale of very serious = 3, serious = 2, and less serious = 1 to get the mean score based on equation (3):

RESULTS AND DISCUSSION

Socio-Economic Characteristic of Maize Farmers

The aim of this sub-section is to describe the socio-economic characteristics of the maize farmers. These include age, educational status, household size, farm size, farming experience, access to credit facility and extension contact.

Distribution of Respondents by Age

The results presented on Table 1 indicate that over 49.2 percent and 22.5 percent of the respondents were aged between 21-30 and 31-40 years respectively. This age range is considered as the economically productive age. This finding is in line with previous findings of Ajani and Onwubuya (2012) that most of the maize farmers studied in Anambara State were in their productive ages.

Distribution of Respondents by Educational Status

It was found as shown on Table 1 that the majority of the respondents (22.5% and 36.7%) acquired between (1-6) and (7-12) years in formal education, respectively. Farmers who belong to this category were likely to have less opportunity to civil service job therefore, engaged in farming such as maize farming and are more willing to accept technological changes. About 36.7 percent of the Maize farmers did not attend any formal school. This may not contribute significantly to the quick adoption of the maize variety. This result does not agree with that of Adebayo and Oyetoro (2011) who said that majority of the maize farmers (60.90%) in Kwara State had no formal education.

Distribution of Respondents by Household Size

Table 1 showed that 41.7%, 35%, 18.3% and 5% of maize farmers had family size ranging from 1-5, 6-10, 11-15, and 16-20 respectively. This implies that most maize farmers have small family size. They may need to look for labour outside their family because of the small size of their family.

Table 1: Socio-economic Characteristics of Respondents

Variables	Frequency	Percentage	Mean/Mode
Age (years)			
11-20	6	5.0	
21-30	59	49.2	
31-40	27	22.5	
41-50	23	19.2	
51-60	5	4.1	
Sub-Total	**120**	**100**	**32**
Educational Status (Years)			
1-6	27	22.5	
7-12	44	36.7	
13-18	5	4.1	5
None	44	36.7	
Sub-Total	**120**	**100**	
Household Size (Head)			
1-5	50	41.7	
6-10	42	35.0	
11-15	22	18.3	
16-20	6	5.0	
Sub-Total	**120**	**100**	**7**
Farm Size (Hectares)			
1-2	71	59.2	
3-4	42	35.0	
5- and above	7	5.8	
Sub-Total	**120**	**100**	**2**
Farming Experience			
1-5	66	55.0	
6-10	48	40.0	
11-15	5	4.2	
16-20	1	0.8	
Sub-Total	**120**	**100**	**8**
Access to Credit Facility (Source of capital)			
Access Credit facilities	14	11.7	
Personal savings	46	38.3	
Wages (Non Farming Activities)	22	18.3	
Income from business	30	25.0	Personal savings
Family assistance	8	6.7	
Sub-Total	**120**	**100**	
Extension Contact Within a Year			
No contact	69	57.3	
Once	12	10.0	
Twice	22	18.3	
More than thrice	17	14.2	No contact
Sub-Total	**120**	**100**	

Source**:** Field survey, 2013

Distribution of Respondents by Farm Size

The study revealed that majority of the respondents (59.1%) had farm size ranging from 1-2 hectares, followed by 35% with the range of 3-4 hectares while 5.8% had farm size 5 and above as shown in the Table. This result is not in agreement with that of Saliu and Adedayo (2010) who reported that most of the respondents (88.00%) in Yagba East Local Government Area of Kogi State had a farm size of 2 hactares and below.

Distribution of Respondents by Farming Experience

The number of years spent on maize production by the respondents as shown in Table 1 revealed that 55% of farmers had less than 5 years of experience, 40% of the total sample had farming experience in maize production ranging between 6-10 which was followed by 4.2% of respondents with a range of 11-15 and about 0.8% percent of the respondents ranging between 16-20 while no respondent had farming experience above 21 years. The implication of this finding is that majority of the farmers were young in maize farming. This implies that maize production is being embraced by fresh farmers who could be young in employment. Graduates, and or some enterprising youth who must have just discovered farming as a means of generating income could be the fresh adopters of these maize varieties. This result is not in consonance with that of Adebayo and Oyetoro (2011) who reported that majority of the maize farmers in Kwara State had farming experience of above 25years.

Distribution of Respondents by Access to Credit Facility (Source of Fund)

Table 1 indicates that 11.7% of maize farmers had access to credit facility within the study area while 38.3%, 18.3%, 25% and 6.7% sourced their capital from personal savings, basic salary, income from business and family assistance respectively. This suggests that a lot of farmers do not have access to credit and such might limit their production capacity. Langyntuo and Mekuria (2008), also opined that access to credit facility enables farmers to buy inputs such as improved maize variety to enhance the quality and quantity of their produce.

Distribution on Respondent by Number of Extension Contact within a Year

From the study, Table 1 indicated that 57% of the respondents had no access to extension services which could be as result of inavailability of extension agents. Accessibility to extension agent should have positive influence on the adoption of improve maize variety. Regular contact with extension agents make farmers to be aware of new technologies and how to use it as affirmed by Amaza *et al.* (2007). The implication is that, the farmers within this study area might not have the opportunity to enjoy the current needed knowledge and technique for the utilization of Downy Mildew Resistant Maize Variety.

Influence of Socio-Economic Characteristics of Respondents on Adoption of Downy Mildew Resistant Maize (DMRM) Variety by Logit Regression

Table 2 shows logit regression on the influence of socio-economic characteristics of farmers on the adoption of Downy Mildew Resistant Maize (DMRM) Variety. The logit regression here shows the relationship between dependent variable and independent variables in maize production. The dependent variable was the adoption of DMRM variety while the independent variables were age, educational status, farming experience on maize production, number of extension visit within a year, farm size, household size and access to credit facility.

Table 2 Result of the Logit Regression on the influence of
Socio-Economic Characteristics of farmers on the Adoption of
Downy Mildew Resistant Maize Variety

Variables	Coefficient	Standard Error	Significant Level
Age	0.1357857	0.0898779	0.131
Educational status	0.4668472	0.4861724	0.337
Household size	-0.076786	0.1309946	0.558
Farm size	0.3722537	0.2921179	0.203
Farming Experiencee	-0.1951315	0.0771128	0.011**
Access to credit	1.37161	510847	0.007*
Extension contact	0.4268377	0.419662	0.309

Source: Field survey 2013
LR Chi^2 (7) = 60.60
Prob>Chi^2 = 0.0195
Pseudo R^2 = 0.6616
**5% significant level
* 1% significant level

The result from Table 2 has chi^2 of 60.60 which is significant at 1% show that the model was fit for the data and pseudo R^2 of 0.6616 implying that 66.1 percent in the variation of the dependent variable are accounted for by the independent variables. The regression result showed that farming experience has a negative relationship and significant at 5% level. The implication of this result is that, the higher the years of farming, the less the probability of adopting downy mildew resistant maize variety. This result is consistent with Ayinde *et al*. (2010), who reported that the more farming experience the less likely the farmers adopt new technology. This implies that experience alone might not significantly influence adoption. That is, there could be a stronger determinant of adoption than experience.

Access to credit shows a positive influence and significant level at 1%. This implies that the more access to credit facility the more likelihood a farmer adopts downy mildew resistant maize variety. Langyntuo and Mekuria (2008) reported that access to credit had positive influence on the adoption of improve maize variety.

Attitude of Farmers to the Usage of Downy Mildew Resistant Maize (DMRM) Variety

The result of the analysis on Table 3 revealed the attitudes to adoption of (DMRM) variety for maize production. Attitudinal statement on planting more of local variety to downy mildew resistant maize variety had a mean score of 2.95 which is above the average mean score of 2.5 and representing 65.0% of the respondents. This implies that majority of respondents' still plant local variety even though they adopt downy mildew resistant maize variety in the study area. This suggests that, there are some qualities in the local varieties that are not found in downy mildew resistant varieties adopted. Truong and Ryuichi (2002) opined that the attitude of farmers towards adoption of downy mildew resistant maize variety was that some farmers did not believe in the taste of resistant variety of maize. The statement that "technologies associated with the adoption of downy mildew resistant maize variety are for large scale farmer" had a mean score of 2.49 which is slightly below the average mean score representing 49.7% of the respondents. This indicates that about half of the respondents agreed with this statement. This could be as a result of the fact that some maize farmers could not

cope with the additional cost involved in adopting downy mildew resistant maize variety along with other technologies such as use of fertilizer, pesticides, herbicides and the use of tractor for land preparation which cannot be practiced on small scale farm and may not be necessary for local varieties.

Table 3. Attitude of Farmers to Adoption of Downy Mildew Resistant Maize Variety

S/N	Attitudinal Statement	4(SA)	3(A)	2(D)	1(SD)	Total No of Respondent	Total Sum of Attitude (F.A)	Mean Score	Proportion of Respondents in %
1.	Use more of local variety to downy mildew resistant maize variety.	59	13	31	17	120	354	2.95	65.0
2.	The Technologies that associated with mildew resistant maize variety adoption are for large scale farmers.	6	55	51	8	120	299	2.5	49.7
3.	Downy mildew resistant maize do not make much difference in output from other maize varieties	0	30	80	10	120	260	2.1	38.9
4.	Downy mildew resistant maize variety Adoption is too complex for my understanding.	17	14	55	34	120	254	2.1	37.7
5.	I practice replanting of the previously adopted downy mildew resistant maize seed on yearly basis	0	22	82	16	120	246	2.05	35.0
6.	I do not notice decrease in output of maize as a result of replanting of DMRM seed of previous years	2	20	88	10	120	254	2.1	37.2
7.	The market is not attractive to make me go into large scale production of maize using downy mildew resistant maize variety.	0	5	101	14	120	231	1.92	30.8

Source**:** Field survey, 2013

A mean score of 2.1 which is below the average mean score (2.5) and represents about 38. 9 of the total respondents indicated that "downy mildew resistant maize do not make much difference in the output than other maize variety" was not a popular attitudinal statement. This may be interpreted to mean that downy mildew disease does not affect the maize output of this group of farmers. They might also be the group who adopted a local variety more than the said variety.

A mean score of 2.05 which is below the average mean score and representing 35% of the total respondents agreed with the statement. "I practice replanting of the previously adopted DMRM seed on yearly basis". The practice was not a popular attitudinal statement that may hinder the adoption level of downy mildew resistant maize seed.

"Downy mildew resistant maize variety adoption is complex for my liking" and "I do not notice decrease in output of maize as a result of replanting of DMRM seed of previous years" both had a mean score of 2.1 which is below the average mean score and represents about 37.2% of the total respondents. This implies that "Downy mildew resistant maize variety was only too complex for very few farmers and not many farmers had noticed decrease in output as a result of replanting DMRM. However the mean score of 2.1 shows that it was not a popular practice.

"The market is not attractive to inspire me into large scale production of maize using downy mildew resistant maize variety". Had a mean score of 1.92 which is below the average mean score (2.5) and represents 30.8% of the total respondents. This result reveals that it is a weak attitudinal statement to the adoption of downy mildew resistant maize variety.

Table 4, Mean score of Adoption stages of other Technologies Adopted Along with Downy Mildew Resistant

		Stages of Adoption					
	Technology	Awareness (1)	Interest (2)	Evaluation (3)	Trial (4)	Adoption (5)	Mean score
1	Fertilizer	23	13	0	2	82	3.89
2	Herbicides	70	2	2	3	23	2.06
3	Tractor hiring	76	43	0	0	1	1.39
4	Field pesticides	22	14	0	1	83	3.9
5	Post-field pesticides	43	15	0	1	61	3.1

Source**:** Field survey, 2013

Mean score of stages of Adoption of technologies along with Downy Mildew Resistant Maize Variety.

Downy Mildew Resistant Maize Variety usually flourish properly under rich soil or soil support with fertilizers and proper weed control perhaps through the use of herbicides and to be cost effective the use of tractor to increase the size of farm and the use of pesticide to check the havoc of pest such as grasshopper and post harvest pest such as maize weevil, has put downy mildew resistant maize variety adoption as a package. The stages of adoption of all the above mentioned agricultural technologies could therefore affect efficient adoption of the maize variety. The result of analysis presented on Table 4 revealed the level of adoption of downy mildew resistant maize technology as a package, where mean score is 3.0. Thus technology with above 3.0 mean score can be said to be fairly adopted and those below were lowly adopted. As such tractor hiring recorded the lowest adoption score while field pesticide adoption score was highest. This suggests that majority of maize farmers within the study used field – pesticide, fertilizer, and post field pesticide as a technology package for their maize production.

Maize farmers who use tractor within the study area were few, which have a mean score of 1.39 that is obviously below the average mean score of 3.0. This implies that very few numbers of maize farmers within the study area use tractor for land preparation; this could be due to high cost or unavailability of tractor hiring, inaccessibility to tractor within the study area. Nkakini *et al*. (2006), identified lack of incentive to use of tractor in agricultural practice due to poverty, ignorance and or cheep traditional tools which are readily available to the poor farmers.

Constraints to the Adoption of Downy Mildew Resistant Maize Variety

This section is concerned with the analysis of challenges faced by maize farmers in the adoption of downy mildew resistant maize variety. The sampled maize farmers were asked to rate the constraint to adoption of downy mildew resistant maize variety on a 3 point Likert scale of very serious = 3, serious = 2, and less serious = 1. The result of the analysis presented on table 5 revealed the constraints to adoption of downy mildew resistant maize variety in declining order of seriousness as maize farmer rated high cost of tractor hiring for land preparation as the most serious, with a mean score of 2.9 that is obviously above the average mean score of 2 and representing 96.25% of the respondents. This result indicates that high cost of tractor hiring is the most critical challenge faced by maize farmers within the study area. Inaccessibility to tractor and unavailability oftractor had mean score of 2.72 and 2.36 which is above average mean of 2 and representing 86.3% and 68.3% of the respondents respectively. This indicates that the inaccessibility to tractor and unavailability of tractor were major challenges faced by maize farmers in the study area. This could be as a result of poor government policy which could not make tractor accessible and available for farmers.

Unavailability of downy mildew resistant maize variety, lack of awareness of downy mildew resistant maize variety and inadequate knowledge of downy mildew resistant maize variety practice were with mean scores of 2.33, 2.31 and 2.1 which are also above average of mean score of 2 and represent 66.7%, 65.8% and 58.75% of the total respondents respectively. This suggests that there was problem of inadequate extension contact by farmers. This could be due to poor government policy on Agricultural extension activities within the State. Schroeder *et al.* (2013) asserted that lack of awareness of newly released hybrid maize varieties was a constraint to adoption of hybrid maize varieties.

Inaccessibility to downy mildew resistant maize variety had the mean score of 2.06 which is slightly above the average mean score of 2 and representing 53.3% of the respondents. This could be due to inadequate contact with the extension agent by the farmers. The interpretation of this result is that inaccessibility of farmers to downy mildew resistant maize variety is a serious problem. Schroeder *et al*. (2013) reported in a similar study that lack of hybrid maize varieties was a constraint to adoption of hybrid maize varieties among small scale farmers in Kenya.

The constraint of high cost of downy mildew resistant maize variety had a mean score of 2.04 which is also slightly above the average mean score and represents about 52% of the respondents this result may be interpreted to mean that, high cost of DMRM variety poses a threat to adoption of the maize varieties by a sizeable number of maize farmers. The possible cause of the constraint of high cost of DMRM seed could be as a result of high cost of transportation to the various locations where farmers are expected to purchase the seed.

A mean score of 2.03 representing about 51.7% of the sampled maize farmers were in support of the statement that "inadequate extension contact was a serious problem" this implies that 51.70% of the respondents do not have opportunity to interact effectively with extension agent on maize production.

Inaccessibility to credit facility had a mean score of 2.39 which is above the average mean score of 2 and represent 79.78% of the respondents. This implies that about 79.7% of farmers were faced with the problem of lack of capital. This could be due to farmers' inability to access loan for agricultural activities. A mean score of 1.10 which is below average mean score (2) and represents about 36.67% of the total respondents indicated that low profitability of the variety was not a serious problem to adoption of downy mildew resistant maize variety.

Table 5: Constraint to the Adoption of Downy Mildew Resistant Maize Variety

S/N	Constraint statement	VS (3)	S (2)	LS (1)	Total No of Respondent	Total sum of constraint score	Mean score	Proportion in %
1	High cost of tractor hiring	11	27	1	120	351	2.92	96.25
2	Inaccessibility of tractor	93	22	5	120	327	2.92	86.3
3	High cost of fertility	61	42	17	120	284	2.36	68.3
4	Unavailability of Downy Mildew Resistant maize (DMRM) variety	60	40	20	120	280	2.33	66.7
5	Inadequate knowledge of DMRM variety practices	63	5	52	120	261	2.1	58.75
6	High cost of DMRM herbicides	56	13	51	120	245	2.04	52.0
7	Inadequate extension contact	55	14	51	120	244	2.03	51.7
8	Inaccessibility to credit facility	58	51	11	120	287	2.39	79.7
9	High cost of purchasing DMRM	0	27	93	120	147	1.22	11.3
10	Low profitability	2	9	109	120	133	1.10	5.4

Source**:** Field survey, 2013

CONCLUSION

Finding from this study revealed that more than 80 percent (from 3.89 mean score of farmers who adopted fertilizer to support the adoption of maize variety) adopted downy mildew resistant maize variety though most of them did not adopt it as a package. The inability of maize farmers to adopt downy mildew resistant maize variety as a package was mostly due to inaccessibility and high cost of tractor hiring, inadequate extension contact, lack of fund, inadequate knowledge of DMRM variety practice. The constraints identified were peculiar to small scale maize producers. Enabling environment should be put in place to encourage large scale producers that can easily overcome the aforementioned constraints while collaboration between public and private local and international organizations should be encouraged to mass produce maize and establish industries to add value to the commodity which will facilitate sustainable maize production and food security. However, improvement in level of awareness, access to downy mildew resistant maize variety, availability of DMRM variety, good access to extension against, knowledge of DMRM variety practice, and reduced cost of DMRM variety as well as low cost for tractor hiring will ensure better adoption of DMRM variety as a package for increase in maize production in Nigeria.

RECOMMENDATIONS

i. Government and non-governmental organization (NGO's) should increase the number of well trained extension agents on the knowledge of downy mildew resistant maize variety practices as well as to make the variety known to the farmers, as this will improve the issue of low level of adoption of downy mildew resistant maize variety within the study area.

ii. Policies should be designed to encourage suitable access to credit facility since it was found to have positive and significant influence on adoption of downy mildew resistant maize variety. This will enable maize farmers to buy input; it will also help to boost income, productivity and food security within the study area.

iii. The study area has been found to be naturally suitable for maize production, there should be international collaboration between public and private organization to widely adopt these varieties and boost production which will also enhance food security in the world.

iv. Effort should be geared towards educating maize farmers on the effectiveness of downy mildew resistant maize variety and the control of downy mildew disease of maize by well trained extension personnel.

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