academicJournals

Vol. 6(10), pp. 437-442, October, 2014
DOI: 10.5897/JDAE2013.0532
Article Number: B43709247451
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of farmers' adoption decisions for improved pearl millet variety in Sahel savanna zone of northern Nigeria

Okeke-Agulu, K. I.[1] and Onogwu, G. O.[2]*

[1]Department of Agricultural Extension and Management, Federal College of Forestry, P.M.B. 2019, Jos, Plateau State, Nigeria.
[2]Department of Agricultural Economics and Extension, Federal University Wukari, Taraba State Nigeria.

Received 30 October, 2013; Accepted 14 April, 2014

Millet is a staple food mainly from local varieties, throughout the Sahel and in parts of the Sudan Savanna. Improved millet varieties are higher yielding and of better quality than the local varieties. This study was carried out after the Yobe State Agricultural Development Program had carried out series of extension services to assess the determinants of adoption of the improved varieties. Multistage systematic and purposive random sampling techniques were used to select 300 farmer respondents. Descriptive statistics was used to describe the socioeconomic characteristics of the farmers while logit regression analysis was used to determine factors that affect the adoption of the technology in the study area. The result showed that household size, farm size, farming experience, maturity period of millet, yield of millet, and access to credit were positively significant in predicting the farmers' probability of adopting improved pearl millet variety. On the other hand, distance to source of technology (improved pearl millet seeds) negatively influenced the probability of adoption. The study recommends improving the funding of the extension organizations and making concerted effort to increase the quantity and quality of human resources available if food security is to be guaranteed in the region.

Key words: Pearl millet, adoption decision, Sahel savanna, agricultural extension.

INTRODUCTION

Nigeria is an important millet producing country with an average annual production of 3.4 million tons (about 7.06 metric tons were produced in Nigeria in 2003 syngenta foundation, 2003). The production increased to 4.8 million tons in 2008/2009 cropping season (NBS, 2013). It ranks second after India in global millet production. While at the National level it ranks third after maize and sorghum among cereal food crops. It is a staple food throughout the Sahel and in parts of the Sudan Savanna. The crop is therefore very important to the nations` agricultural sector because of their high degree of adaptation to stress environments, such as severe drought, poor soils and high temperature is a great relief to life in the Sahel (Rai and Kumar, 1994).

*Corresponding author. E-mail: okekeaguluki@gmail.com, Tel: +2348037158297.

The crop can grow where even certain weeds cannot survive. Previous research conducted by the Institute for Agricultural Research (IAR) Samaru, Zaria and the current research efforts of the Lake Chad Research Institute (LCRI) Maiduguri, demonstrated a three-fold yield increase through the adoption and use of improved pearl millet varieties and improved management practices. The current agricultural extension service system in Nigeria is prosecuted by the Agricultural Development Project (ADP). The ADPs were established in the Mid 1970s as enclave integrated agricultural development projects with funding assistance from the World Bank. Its objectives were to increase the production of food and industrial crops through systematic extension programme, adaptive research and input delivery system as well as provision of rural infrastructure (rural feeder roads and water supply).

The relative success of the first enclave projects encouraged the Nigerian government to accept the ADP system as the main strategy for promoting agricultural production at the small holder farmer level. The ADPs has thus been established on a state wide basis in all 36 states of the country including FCT Abuja.

However, the success of the ADPs in achieving its objectives in recent times has become questionable especially in facilitating the adoption of new and improved technologies. Singh and Emechebe (1998) had posited that the rate of adoption of a new technology is subject to its profitability and the degree of risk and uncertainty associated with it, the capital requirement, agricultural policies as well as the socio-economic characteristics of the farmers.

In a situation where these attributes are positively available and yet the farmers seem not to have embraced the technology; the Agricultural extension organization may then be held liable for failing in their duty of creating awareness. The case of improved pearl millet varieties and its adoption in sahel savanna of northern Nigeria thus presents itself for study.

The millet grains are used primarily for human consumption because of its high level of fat and protein (the protein vary between 10.9 to 16.9% content (Okoh et al., 1985). The starch and lipids are similar to those of sorghum and maize. However, pearl millet has higher protein content and more desirable levels of essential amino acid than sorghum.

In general, its digestibility is better than that of Sorghum (Rooney and McDonough, 1987). In Nigeria from 1992 to 1994, 3.3 million tons of millet was used directly as food, 1.2 million tones for seed, beer, and only 0.1 million tons were used as livestock feed (ICRISAT/FAO, 1996). The issue is that the adoption of improved pearl millet variety in the study area seems to be at its lowest ebb because of perceived high number of farmers who still grow the local varieties which include, Ex-Borno, Ex-Gashua, Ex-Tukur, Gwagwa, Buduma, Buduma-Damasak and Zango. According to Mijindadi et al. (1998), improved pearl millet varieties are higher yielding. They mature earlier (60 to 70 days as against 70 to 100 days for local varieties). They are resistant to *striga spp*, drought, pests and diseases. They respond optimally to fertilizer and other management practices. More importantly, the grain size is larger while the panicle is more compact.

Despite all these lofty attributes, there seem to be limited extension outreach probably due to wide ratio of extension agent to farm families. Moreover, farmers recycle their local seed varieties with implication for low yield. Kumar and Anand (1993) posited that 40% yield is attributed to use of improved seed quality. Hence farmers` continued use of local and recycled seeds will lead to yield decreases of about 40%. The study therefore aims at determining the socio-economic characteristics of the farmers as well as determining the factors that affect the adoption of improved pearl millet varieties in the study area.

METHODOLOGY

The study area Yobe state was purposively chosen because it is mainly an agricultural state located in Northern Nigeria in the Sahel Savanna Zone. The State borders with Jigawa and Bauchi in the West, Borno State in the East and South while it shares international border with the Niger Republic in the north. According to Wikipedia (2013), the estimated population is 2,532,395 in an area of 45,502 Km^2.

The majority of Yobe State inhabitants are peasant crop farmers but a significant part of the population is actively involved in livestock production as well as trading and fishing. The state is endowed with vast agricultural development potential. Crop, livestock and fishing provide employment to over 80% of the population. The major crops grown are millet, sorghum, cowpea, groundnut, rice and bambara nuts but millet is the most common (Yobe Printing Press, 1998). Currently, the study area is the hotbed of armed insurgency by Boko Haram in Nigeria. The climate of Yobe is hot and dry for most period of the year in the northern parts while the south is cooler and wetter. The hottest months are March, April and May with temperatures ranging from 30 to 40°C. The duration of the rainy season varies from place to place but generally it lasts for about 120 days in the north and more than 140 days in the south. The annual rainfall ranges from 500 to 1000 mm.

Sampling technique

Primary data used for this study was generated from a cross sectional survey conducted in 2010. A multistage random sampling technique was used to select 300 pearl millet farmer respondents in the state. The first stage was random selection of 3 LGAs (Local Government Areas) from Northern zone and 3 LGAs from the southern zone. The second stage was the random selection of 1 district from each of the LGAs. The last stage was the systematic and purposive sampling of 50 pearl millet farmers from each of these districts. A well-structured questionnaire schedule was used to elicit socio-economic attributes of the farmers as well as measuring the factors that determine the adoption of improved pearl millet variety in 2009 farming season. Descriptive statistics was used to describe the socio-economic characteristics of the farmer respondents while logit regression analysis was used to ascertain the determinants of improved pearl millet adoption decision.

Theoretical and analytical framework

In modeling the farmer's decision to adopt the use of improved pearl millet variety, we followed earlier studies that have investigated technology adoption by farmers. According to Feder et al. (1985), technology adoption is affected by such factors as availability of credit, limited access to information, aversion to risk, inadequate incentives, farm tenure systems, insufficient investment in human capital, inadequate farm size, absence of equipment to relieve labour shortages, unreliable and insufficient complementary inputs and inappropriate transportation infrastructure.

Following Ameniya (1981); Jamnick and Klindt (1985) and Kehinde (2011), the decision of farmers to adopt improved pearl millet variety is represented by "1" while the decision not to adopt is represented by "0". We further assume that the farmer is an independent decision maker who makes rational choices and maximizes his utility (Ameniya, 1981; Rahm and Hufman, 1984). In stipulating the logit model, we followed Sheikh et al. (2003) and Kehinde (2011) to assume that the farmers decision not to adopt and to adopt improved pearl millet variety equals 0 and 1 respectively. And that the utility of the technology depends on a vector S_i (farmers' socio-economic characteristics) and a vector R_i (farmers farm characteristics that is production input and output characteristics related to improved pearl millet production). Further, U_{i1} and U_{i2} are indirect utilities derived from not adopting and adopting improved pearl millet varieties, respectively. These utilities can be stated as:

$$U_{i0} = d_i S_0 + g_i R_{i0} \text{ and } U_{i1} = d_i S_1 + g_i R_{i1} \quad (1)$$

Where d_i and g_i are vectors of coefficients corresponding to the variables representing farmer's socioeconomic characteristics and a vector of farmer's farm characteristics which are attributed to adoption of improved pearl millet and e_0 and e_1 are additive error terms. A farmer therefore adopts improved pearl millet if $U_{i1} > U_{i0}$ or does not if $U_{i1} < U_{i0}$. If we now redefine improved pearl millet adoption with a qualitative variable $y_i = 0$, then the probability of adoption of improved pearl millet variety can be written as:

$$P_i = P(y_i = 1) = P(U_{i1} > U_{i0}) = P(e_{i0} - e_{i1}) < [(d_{i0} - d_{i1}) S_i + (g_{i0} - g_{i1}) R_i] = P(u_i) < (B_i X_i) = F(B_i X_i) \quad (2)$$

Where X_i includes both S_i and R_i as stated in Equation (1) and $u_i = (e_{i1} - e_{i2})$ is a random distribution term; P(.) is a probability function; and F is a distribution function for u_i. Thus the probability of a farmer adopting improved pearl millet variety is the probability that the utility of not adopting is less than the utility of adopting or the cumulative distribution function evaluated as $B_i X_i$. The exact distribution of F depends on the distribution of the random term u_i. If it follows a logistic distribution then the F is a cumulative logistic function. If u_i is normal then F is a cumulative normal distribution function. Thus the distribution assumption for u_i determines the type of probability model that reflects the farmers' adoption behavior. We used the logit model from the cumulative logistic probability function to transform the dependent variable to predict the probabilities within the bound of 0 and 1. The dependent variable thus becomes the natural logarithm of the odds when a positive choice is made and the model is specified as:

$$\ln [P_x/(1-P_x)] = \sum B_i X_i \quad (3)$$

Where P_x = the probability that farmers adopt improved pearl millet for an observed set of variables X_i as earlier defined and B_i = the regression coefficient to be estimated.

Model specification

We specified a logit model to identify factors that determine the adoption or non-adoption decision of farmers to use improved pearl millet varieties. Thus, the probability (P_i) that a farmer will adopt improved pearl millet variety is a function of an index Z_i which is also the inverse of the standard logistic cumulative function of P_i that is,

$$P_i (Y=1) = F^{-1}(P_i) \quad (4)$$

Then, $Z_i = F^{-1}(P_i)$

The index is a set (X_i, that is farmers' socioeconomic characteristics, while b_i are regression coefficients which indicate the probability effect of farmers' attributes) and is a linear function of the attributes, that is,

$$Z = b_0 + b_1X_1 + b_2X_2 + b_nX_n\ldots \quad (5)$$

The probability of adopting improved pearl millet variety is given by

$$P_i(Y-1) = \frac{1}{1+e^{zi}} \quad (6)$$

While the probability of not adopting improved pearl millet is given by

$$1 - P_i(Y=1) = \frac{1}{1+e^{zi}} \quad (7)$$

and

$$e^{zi} = \frac{P_i(Y=1)}{1-P(Y=1)} \quad (8)$$

The dependent variable, (Y_i, which is farmer's decision to adopt or not to adopt) takes the value 1 if the farmer adopts and 0 if he does not. We used maximum likelihood estimation since the dependent variable is binary thus making ordinary least squares estimation inappropriate (Pindyck and Rubinfield, 1981; Scolt et al., 1997). The probability that a farmer will adopt improved pearl millet variety (Equation 3) can be estimated the average value of Z_i as:

$$zi = In\frac{P_i}{1-P_i} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \quad (9)$$

Where X_1 = Household size (in number), X_2 = Education (in years), X_3 = Age (years), X_4 = Sex (male= 1 and 0 otherwise), X_5 = Farm size (hectares), X_6 = Farming experience (years), X_7 = Member of farmers organization (yes=1 and 0 otherwise), X_8 =Millet maturity period (days),
X_9 = Yield (Kg), X_{10} = Distance of source of improved seeds (Km), X_{11} = Extension contact (yes=1 and 0 otherwise), X_{12} = Access to credit (yes=1 and 0 otherwise).

RESULTS AND DISCUSSION

All the 300-questionnaire schedules distributed were equally retrieved and analyzed. Table 1 shows the socio-economic characteristics of the respondents. About 42% of the respondents were aged 31 to 45 years, indicating that a good number of the respondents belong to the active age group while 90% were males. The low percentage of farm women may be as a result of Islamic religion which tends to restrict women to the households. Sixty percent of the respondents have no formal

Table 1. Socio-economic characteristics of the farmer respondents in the study area.

Variable	Frequency	Percentage
Age		
18 – 30	90	30
31 –45	125	41.7
46 – 55	55	18.3
56 and above	30	10
Total	300	100
Gender		
Males	270	90
Females	30	10
Total	300	100
Education		
No formal education	180	60
Primary	75	25
Secondary	30	10
Tertiary	15	5
Total	300	100
Marital status		
Married	235	78.3
Single	65	21.7
Total	300	100
Household size		
1 – 4	63	20.8
5 – 8	95	31.6
9 and above	142	47.5
Total	300	100
Years of farming exp		
1 – 5	100	33.3
6 – 10	150	50
11 and above	50	16.7
Total	300	100

Source: Survey data, 2009.

education. Illiteracy may positively affect adoption of new technologies. Formal schooling may enhance or at least signify latent managerial ability and greater cognitive capacity in the acquisition of new technology (Barrett et al., 2002). About 80% of the respondents have household sizes of five people and above. This relatively large household size may have implication to adoption of new technologies. This is in consonant with the findings of Kehinde (2011) who posited that large household size increases the farmers' tendency to adopt new technologies. About 67% of the respondents have 6 years and above farming experience indicating that the farmers are not novices.

The result of the logit estimate of the determinants of farmers' decision to adopt improved pearl millet (Table 2) showed that household size, farm size, farming experience, maturity period of millet, yield of millet, and access to credit were positively significant in predicting the farmers' probability of adopting improved pearl millet variety. On the other hand, distance to source of technology (improved pearl millet seeds) negatively influenced the probability of adoption. The Log likelihood statistics of 192.95 confirms the significance of the variables in the model while a chi square statistic of 49.05; which is also significant, justifies the goodness of fit of the regression line.

Table 2. Logit estimates of factors influencing the respondents' likelihood of adoption of improved pearl millet variety.

Likelihood of adoption coefficient		Std. Error	Z	P> |z|
Household size	0.0023	0.0011	2.090**	0.005
Education	0.0299189	0.0700357	0.49	0.669
Age -	0.0108678	0.0091023	-1.19	0.232
Sex	0.4067453	0.2688421	1.51	0.130
Farm size	1.2729231	0.642212	1.98	0.022**
Farming experience	0.2033259	0.1127525	1.80	0.071**
Memfarmersorg'	0.1346071	0.4127561	0.33	0.744
Maturity period	1.504736	0.694134	2.168	0.015**
Yield	1.000661	.00016	4.13	0.000***
Dist of technology	-0.0005517	0.00017	-3.25	0.001**
Extension contact	0.4753018	0.3217224	1.40	0.140
Access to credit	0.7806627	0.3682025	2.12	0.034**
Constant	0.8819395	0.3605838	2.45	0.014**
Log likelihood ratio	192.95			
Chi square	49.05			
Significance	0.0000			

Note: *** **, refer to significance at 1 and 5% significant levels. Source: Computation by the authors from the data.

Specifically, the result revealed a positive and significant relationship between yield of improved pearl millet and the probability of adoption. The result was significant at 1% level of probability. This finding corroborates the findings of Adesina and Zinnah (1993); Shiyani et al. (2002); Kristjanson et al. (2005) and Kehinde (2011). Crop varieties that yield significantly higher stand a better chance of being adopted as well as being used intensively by farmers. The higher the yield from a crop variety, the higher will be the marginal returns to investment in the crop enterprise, and hence higher income. This will be a good incentive for either expanding land area under the improved variety or cropping intensification of the existing land area.

Access to credit was also found to be important in influencing the likelihood of adoption of improved pearl millet variety by farmers in the study area. The variable was found to be statistically significant ($\rho \leq 0.01$) and positively related with the likelihood of adoption. This finding is also in accordance with the findings of De Castro and Teixera (2006); Ouma et al. (2006); Omolehin et al. (2007) and Idrisa et al. (2012). Farmers need credit to acquire new technology. In the case of improved pearl millet, farmers need credit during the planting season to purchase the improved seeds that are usually more expensive than the local seeds. The consequence is that farmers will usually save part of their harvests to be used as planting material in the next planting season.

Results in Table 2 also revealed that distance to source of technology (where the improved seeds are purchased) had a negative and significant influence on the adoption of improved pearl millet variety by farmers ($\rho \leq 0.05$). The negative sign of the coefficient implies that farmers who live closer to the source of technology are more likely to adopt the technology compared to farmers who live farther away from the source of technology. This trend is expected considering the fact that most of these farmers are rural farmers who can hardly travel to distant centres where the technologies are available (Idrisa et al., 2012).

CONCLUSION AND RECOMMENDATION

The study area has the potential to supply the millet need of Nigeria and beyond for human and more importantly for livestock production. This will inevitably reduce the pressure on maize, which is the major source of carbohydrates for man and animals currently. Results showed that household size, farm size, years of farming experience, maturity period of millet, yield of millet and access to credit were positively significant in predicting the farmers' decision to adopt improved pearl millet. On the other hand, distance to source of improved seeds negatively influenced adoption decision of the farmers.

We therefore strongly recommend the establishment of farm service and seed supply centers in strategic places in the study area with a view to making the seeds of improved pearl millet and other farm inputs readily accessible to farmers. We also recommend that pragmatic efforts be made by policy makers to see that the Bank of Agriculture be strengthened to enable them finance farmers since it is only farmers who have access to finance and have the tendency to adopt the technology.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Adesina AA, Zinnah MM (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agric. Econ. 9:297-311.

Barrett CB, Place F, Aboud AA (Eds), (2002). Natural Resource Management in African Agriculture: Understanding and Improving Current Practices. CABI Publishing, Oxford.

De Castro ER, Teixera BC (2006). Agricultural Credit Interest Equalization Policy: A growth subsidy? Paper presented at the International Association of Agricultural Economists' Conference, Gold Cost, Australia, August 12th -18th

ICRISAT/FAO, (1996). The World Sorghum and Millet Economies, Facts, Trends and Outlook a Joint study of FAO/ICRISAT. Kano, Nigeria pp. 5-27.

Idrisa YL, Ogunbameru BO, Madukwe, MC (2012). Logit and Tobit Analyses of the determinants of likelihood of adoption and extent of adoption of improved soybean seed in Borno State, Nigeria. Green. J. Agric. Sci. 2(2):037-045.

Feder,G. Just, RE, Zilberman D (1985) Adoption of Agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural Change. 33:255-298. http://dx.doi.org/10.1086/451461

Jamnick SF, Klindt TH (1985). An analysis of 'no-tillage' practice decisions. Department of Agricultural Economics and Rural Sociology, University of Tennessee, USA.

Kehinde AL (2011). Factors determining tractor use among arable crop farmers of the Osun State Government Tractor Hiring Scheme, Nigeria. Nig. J. Agric. Econ. 2(1):17-27.

Kristjason P, Okike I, Tarawali S, Singh BB, Manyong VM (2005). Farmers' perceptions of benefits and factors affecting the adoption of improved dual purpose cowl pea in the dry savannas of Nigeria. Agric. Econ. 32: 195-210.

Kumar K, Anand M (1993). Pearl Millet in West Africa: Millet and Sorghum commodity and Research Environment. Patancharu, A. P. India: ICRISAT pp. 1-16.

Mijindadi MC, Ikwelle AB, Anaso M, Aminu K (1998). Pearl Millet in Nigerian Agriculture Research Priorities. LCRI pp. 77–79.

National Council on Agriculture (N.C.A) (2002). Progress Report on the Community Seed Development Programme. FDA pp. 10-25.

National Bureau of Statistics (2013). Annual Abstract of Statistics for 2011. www.nigeriastat.gov.ng

Okoh PN, Nwasike CC, Ikediobi C (1985). Studies on seed protein of millet: Amino acid Composition of protein fractions of early and late maturing varieties. J. Agric. Food Chem. 33:55-57.

Omolehin RA, Ogunfiditimi TO, Adeniji OB (2007). Factors influencing the adoption of chemical pest control in cowpea production among rural farmers in Makarfi Local Government area of Kaduna State, Nig. J. Agric. Exten. 10:81-91.

Ouma JO, De Groot H, Owuor G. (2006). Determinants of improved maize seed and fertilizer use in Kenya: Policy implication. Paper presented at the International Association of Agricultural Economists' Conference, Gold Cost, Australia, August 12-18.

Pindyck RS, Rubinfield DL (1981). Econometric models and economic Forecast. 2nd Edition, London, McGraw-Hill.

Rahm MR, Hufman WE (1984). The adoption of reduced tillage: The role of human capital and other variables. Am. J. Agric. Econ. 66:405-413.

Rai KN, Kumar S (1994). Feeding preference of the Sahelian Grasshopper (*Oedaleus senegalensis*). Nig. J. Plant Protect. 15:52-63.

Rooney IW, McDonough CM (1987). "Food quality and consumer Acceptance of Pearl Millet". Proceedings of the International Crop Research Institute for the Semi-arid Tropics Center, Patancheru AP, India. ICRISAT pp. 43-59.

Scolt LC, Smith L, Rungeelling B (1997). Labour force participation in southern labour markets. Am. J. Agric. Econ. 59(2):266-274.

Sheikh, AD, Rehman T, Yates CM (2003). Logit models for identifying the factors that Influence the uptake of new 'no-tillage' technologies by farmers in the rice-wheat and the cotton-wheat farming systems of Pakistan Punjab. Agric. Syst. 75:79-95.

Shiyania RL, Joshi PK, Asokan M, Bantilan MCS (2002). Adoption of improved chickpea varieties: Krishak Bharati cooperative (KARIBHCO) Experience in tribal region of Gjarati, India. Agric. Econ. 27: 33-39.

Singh BB, Emecheme AM (1998). Millet diseases and their control in Nigeria. Paper Presented at the 2nd National Millet, Sorghum Workshop held at Zaria, 17 – 19th April.

Syngenta foundation (2003). Twenty top most Millet producers. Available at http://www.syngenntafoundation.com/pdf/mille_top_20_producers accessed 19th November, 2013

Wikipedia (2013). Yobe State". Available online at http.//www.sen.wikipedia.org/wiki/yobe_state accessed 19th November, 2013

Yobe State Printing Press (1998). Yobe State Executive Diary pp. 1-5.

Yobe State Agricultural Development Programme (2002). Farmers Assessment of Extension Delivery System YOSADP pp. 1-19.