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Determinants of farmers' knowledge exchange on drought-tolerant maize technology in Kwara State, Nigeria

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Abstract

Over the years, interpersonal communication among farmers has been identified as a way farmers share agricultural knowledge among themselves. During this process ideas are exchanged. In the face of inadequacy in the number of extension personnel in Nigeria, there is need to document the effectiveness of farmers' knowledge exchange as an alternative channel of disseminating innovations. Hence, this study assessed the determinants of knowledge exchange on drought tolerant maize (DTMA) technology in Kwara State, Nigeria. A three-stage sampling procedure was used to select 391 main plot managers to be respondents for this study. The mean age of the respondents was 47.6 years. Majority (78%) of them were males, 85.3% married and 81.9% had formal education with an average household size of 9 persons and 20.9 years of farming experience. Data were collected through interview schedule and analyzed using both descriptive and inferential statistics such as frequency, percentage, mean, standard deviation and multiple regression analysis. A small proportion (20.1%) of the respondents belonged to the category of very low knowledge exchange of DTMA. Plot neighbor was indicated as the major communication network through which knowledge exchange occurred among the farmers. Comparative benefits of the technology ($\bar{x}$ = 3.55) was identified as the most important motivation influencing farmers' decisions to exchange knowledge among themselves. Age, household size, contact with extension agents, and farming experience had significant contribution to the extent of knowledge exchange among the farmers at 0.05 level of significance. It is recommended that farmer-to-farmer extension should be strengthened since it could bridge the gaps in technology transfer and promote adoption of agricultural technologies.

Keywords - determinants, drought tolerant maize technology, farmers, innovations, knowledge exchange

Introduction

In Nigeria, maize can be regarded as an important food security crop due to the high level of its consumption. Apart from its potential to enhance food security and sustainability of the crop-livestock system, maize has been found to increase annual income of farm households in Nigeria tremendously (Audu & Aye, 2014). It is the predominant crop for small-scale farmers in Nigeria with an increasing demand as food and for industrial usage. Improving maize production is therefore one of the major approaches to solving the problem of food insecurity in Nigeria.

As a crop, maize is particularly prone to drought (Aslam et al., 2015; Epule et al., 2017). Erratic and low rainfall in most parts of Nigeria pose a severe impact on maize production (Butu & Emeribe, 2019). This has led many farmers in Nigeria to resort to irrigation and other management practices which are cost-prohibitive.

Efforts by scientists across the globe have led to the discovery of improved maize varieties that can withstand stress of drought and heat effects, thereby providing succor to farmers cultivating in drought and heat-prone areas. For instance, as part of their effort to boost productivity of maize, scientists from

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the International Maize and Wheat Improvement Centre (CYMMIT), and the International Institute for Tropical Agriculture (IITA) developed and disseminated drought-tolerant maize (DTMA) varieties and recommended agronomic practices for its optimum performance (Aslam et al., 2015).

To benefit from existing and future technology options, awareness of such technology is important (Ogunlade et al., 2010). In Nigeria, dissemination of improved practices from agricultural research institutions and Faculties of Agriculture in Universities to smallholder farmers is carried out mainly by government-owned agricultural extension service departments and occasionally by the private sector. With decreasing project support funds and dwindling state budgets, government extension services have become even less efficient in disseminating new technologies. All these have resulted to widening of extension to farmer ratios, posing further constraints on the delivery of extension messages.

This widened gap has led to the need for alternative channels of disseminating information to farmers. One such channel is through fellow farmers. Farmers have the potential to play notable roles as the intermediary in agricultural innovation system. Farmers are known to exchange information, ideas and experiences within their social system (Olabanji & Ogunlade, 2020). This is the farmer-to-farmer paradigm shift in exchange of agricultural information. Despite the belief that farmers' interaction can serve as an important route through which individuals learn about and become convinced to adopt new technologies, not much effort has been put into assessing the determinants of information disseminated through this channel. In a bid to properly position farmers as knowledge brokers, it is important to evaluate the factors motivating effective knowledge exchange among them. Therefore, this study was designed to assess the extent of knowledge exchange on DTMA technology among the farmers, identify major knowledge exchange channels existing among the farmers, determine the perceived importance of various motivators of knowledge exchange among the farmers, and determine if socioeconomic characteristics have a significant contribution to the effectiveness of farmers' knowledge exchange.

Methodology

Study Area

The study was carried out in Kwara State, Nigeria, where drought-tolerant maize varieties and associated agronomic practices are being promoted by various research organizations especially the IITA. Kwara State covers eight percent of the total land area of Nigeria; that is, an area of 74,256 km^2. The state has a tropical climate, with a total population of 3,192,893 (National Bureau of Statistics, 2018) and a density of 66 people km^{-2}. The state is typically agrarian. Eighty percent of the population reside in rural areas and 90% of the population are farmers (Yusuf et al., 2016). The climate, vegetation pattern and soil make the state suitable for cultivation of a wide variety of food crops of which maize takes the lead. The predominant agricultural system is a combination of mixed cropping and bush fallowing with emphasis on subsistence crop cultivation. The state has 16 Local Government Areas (LGAs). The Agricultural Development project (ADP) classified the 16 LGAs into 4 agricultural zones, 23 blocks and 184 cells in consonance with ecological characteristics and cultural practices (Kwara State Agricultural Development Project, 2011).

Sampling Procedures and Sample Size

Purposive sampling based on the presence of communities where DTMA on-farm trials were conducted to select two from the four agricultural zones (A, B, C and D) in the state. The selected zones were Zones C and D. From each of the two selected zones, 16 communities cutting across 4 LGAs were randomly selected for direct observations. A proportional sampling method was used to select the respondents from a list of farming households in each community. Within the household, the main plot manager was chosen as the respondent of the study. Information on the number of the total households in each village was obtained through the assistance of the village head. Twenty percent of farmers' households in each community were randomly selected. Hence, 391 respondents were sampled, out of which 387 questionnaires were determined to be fit for analysis.

Measurement of Variables

The instrument for the study consisted of four components: the socioeconomic characteristics of the respondents, extent of knowledge exchange on DTMA, knowledge exchange channels and the perceived importance of various knowledge exchange motivations. Each of these components are described below.

The socioeconomic characteristics gathered included sex, marital status, educational attainment, group membership and awareness of DTMA technology, which were measured in a nominal scale. Data were also collected on age, years of farming experience, household size, size of farmland and number of contacts with extension agents, all of which were measured in an interval scale.

The extent of farmers' knowledge exchange on DTMA was assessed through the Knowledge Exchange Assessment Scale developed and validated by Olabanji and Ogunlade (2020). It addressed knowledge exchange on DTMA technology along four domains: clarity, reliability, usefulness, and reciprocity (Table 3). Each question addressing the quality of information shared on the technology was rated '0' for 'not applicable', '1' for 'to a very little extent', '2' for 'to some extent' and '3' for 'to a great extent', '4' for 'to a very great extent'. The questionnaire contained 10 questions across the four domain items (3 each for clarity and reliability, 2 each for usefulness and reciprocity) each of which consisted of 5 subscales (varieties' identification, methods of planting, fertilizer application, weeding and variety's benefits). Hence, the minimum score obtainable was 0 and maximum score was 200 for all the scale items.

For each subscale, the mean was computed. A cut-off point of 3 was used to judge status of the domain components as either good or poor.

The knowledge exchange score was calculated using the formula below.

$$\text{Knowlege exchange score} = \frac{\text{Respondents' total score}}{\text{Total possible score}} \times 100\%$$

The respondents were then categorized based on their Knowledge Exchange scores (KEs) into:

70% and above as very high level of knowledge exchange
60-69% as high level of knowledge exchange
50-59% as low level of Knowledge exchange and
Less than 50% as very low level of knowledge exchange

The major knowledge exchange channels existing among the farmers was identified by asking the respondents to mention the person who told them about DTMA technology and the kind of relationship that existed between them. The relationship status was used to establish farmers' communication network using frequency counts and percentages. The networks were explored to understand how the farmers acquired DTMA knowledge.

The perceived importance of various motivators enhancing the decision to exchange knowledge on the technology was assessed using a five-point Likert Scale (1=not important; 2=somewhat important, 3=important; 4=very important and 5=extremely important) and subjected to frequency counts. The frequency values on the Likert-type scale were added to obtain 15 and a mean score of 3; hence variables with mean scores of 3 or above were regarded as important while mean scores below 3 were considered as not important.

The hypothesis was tested using multiple regression analysis. The model was specified implicitly thus: $Y = f(X_1, X_2, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9)_U$...................... where

Y = Knowledge exchange score (in percentages)
X_1 = sex of respondents (1 for male and 0 otherwise)
X_2 = age of respondents (in years)
X_3 = marital status (1 for married and 0 otherwise)
X_4 = educational status (in years)
X_5 = farming experience (in years)
X_6 = household size (in numbers)
X_7 = size of farmland (in hectares)
X_8 = group membership (Yes =1, No =0)
X_9 = contact with extension agents (in numbers)
U= error term

The basic assumption in this study was that for knowledge exchange to occur, a proper knowledge exchange channel must be established and farmers must be motivated to exchange information among themselves. The knowledge exchange assessment establishes the extent to which the knowledge exchange occurred.

Results and Discussion

Socioeconomic Characteristics of the Respondents

Table 1 shows the socioeconomic characteristics of the plot managers who were the respondents of this study. More than two-thirds of the respondents (302 or 78%) were male, revealing the dominance of the male gender in farming activities in the study area. This could be attributed to the vigorousness attached to farming, causing many females to seek other activities other than farming. Oyakhilomen (2013) reported that most farm activities are energy demanding; hence men tend to be more involved in the production aspect while women often carry the responsibility of marketing and processing of food crops. On average, the respondents were aged 47.6 years with majority of the age distribution ranging from 41-50 years. This is in line with the findings of Mgbada (2010) who posited that the mean age of Nigerian farmers was between 45 and 50 years. It could be inferred from this finding that majority of the farmers interviewed were in the active age group. Below the age of 50, farmers still have the capacity to engage in energy demanding activities and most often have the capacity to seek and use information.

According to Ebewore et al. (2013), marital status is a crucial factor in shaping social participation and acceptance in rural communities. The study revealed 85.3% of the respondents were married; only 9.3% were single. With regards to educational attainment, only 70 (18.1%) of the respondents had no formal education. A reasonably good percentage (81.9%) of the respondents had some form of formal education. Educated farmers can easily access information from various sources, and can generate knowledge out of those sources (Estruk & Oren, 2014). The mean number of years of farming experience was 20.9 years. This means the farmers are quite experienced and can relate new knowledge with their existing practices. The mean household size was 9 persons. Koskei et al. (2013) asserted that an increase in household size increases the probability of access to information. The average farm size was 3.8 hectares. This implies that majority of the farmers were small-scale farmers. Furthermore, it was revealed that most of the farmers (63.7%) were members of a farmers' group. Membership in an association is assumed to assist farmers to have more access to information. The average time the farmers had contact (interaction) with extension workers was about 5 times per year. This is below the Food and Agricultural Organization (FAO) recommendation that farmers are expected to be visited at least once in every two weeks, or a minimum of 15 extension contacts in a farming season (Idrisa & Ogunbameru, 2012). A significant number of the respondents (83.7%) indicated that they were aware of the DTMA technology.

Knowledge Exchange among Farmers

The knowledge exchange categorization of the 324 respondents who had knowledge exchange on DTMA technology are shown on Table 2. A small proportion of the respondents (20.1%) were categorized to have very low knowledge exchange. This implies that the farmers had good interactions on the technology. Pratiwi and Suzuki (2017) reported that farmers easily share their experiences with each other hence improving their production.

To get a deeper insight into the extent of knowledge exchange among the farmers, specific domain-wise analyses of various aspects of DTMA are presented in Table 3. The knowledge exchange grand mean for the DTMA components shows that knowledge exchange on identification of varieties and benefits of DTMA having weighted mean scores of 2.45 and 2.96, respectively were lower than the threshold of 3; meaning the interactions on these aspects of the technology was poor. This may be due to the complexities attached to seed nomenclature and shortfall in experts' dissemination of a simplified way of identifying varieties and their associated benefits. However, knowledge exchange grand mean method of planting, fertilizer application and weed control with weighted mean scores of 3.62, 3.33 and 3.27, respectively exceeded the 3.00 threshold. These imply that the farmers had good interactions on the more practical aspects of the technology. This could be because these practices were comparable to the existing and conventional practices of the farmers. According to Olabanji and Ogunlade (2020) and Thomas et al., (2020), farmers freely interact on concepts they are familiar with or similar to what they have experienced.

Major Knowledge Exchange Channels Existing among the Farmers

The channel of knowledge exchange identified by the 324 respondents with knowledge of DTMA technology are shown in Table 4. Plot neighbor was the channel through which the largest proportion of the farmers had exchange of knowledge (35.2%). This may be because DTMA is an innovation that requires on-the-field assessments. The more that farmers see the innovation on fellow farmers' farm, the more they tend to make an inquiry. Next to plot neighbor, the channels most frequently used were agro-input dealers (17.6%), extension

Table 1. Distribution of socioeconomic characteristics of the respondents

Variables	Frequency (N = 387)	Percentage	Mean
Sex			
Male	302	78.0	
Female	85	22.0	
Age			
Less than 20	5	1.3	
21-30	57	14.7	
31-40	72	18.6	47.6 years
41-50	117	30.2	
51-60	82	21.2	
61 and above	54	14.0	
Marital status			
Single	36	9.3	
Married	330	85.3	
Divorced	1	0.3	
Separated	8	2.1	
Widowed	12	3.0	
Educational attainment			
No formal education	70	18.1	
Primary School Education	266	68.7	
Secondary School education	45	11.6	
Above Secondary School	6	1.6	
Years of farming experience			
Less than 10	57	14.7	
10-19	134	34.6	20.9 years
20-29	121	31.3	
30 and above	75	19.4	
Size of household			
Less than 5	21	5.4	
5-10	199	51.4	9 persons
11 and above	167	43.2	
Size of farmland			
1-5 ha	174	45.0	
6-10 ha	201	51.9	3.8 ha
Above 10 ha	12	3.1	
Group Membership			
Yes	334	86.3	
No	53	13.7	
Number of contacts with extension officers (in last 2 agricultural seasons)			
No contact	37	9.6	
Less than 5 times	165	42.6	
6-10 times	113	29.2	
More than 10 times	72	18.6	

Table 1. (Continued)

Variables	Frequency (N=387)	Percentage	Mean
Awareness of DTMA Technology			
Aware	324	83.7	
Not Aware	63	16.3	

Table 2. Categorization of the farmers based on the extent of knowledge exchange on DTMA

Extent of knowledge exchange exchange on DTMA	Frequency (N = 324)	Percentage (%)
Very high knowledge exchange (70-100%)	91	28.1
High knowledge exchange (60-69%)	117	36.1
Low knowledge exchange (50-59%)	51	15.7
Very low knowledge exchange (0-49%)	65	20.1

Table 3. Distribution of farmers' knowledge exchange based on DTMA components

	Knowledge exchange item	Varieties identification Mean score	Method of planting Mean score	Fertilizer application Mean score	Weed control Mean score	Benefit of DTMA Mean score
Clarity	The knowledge shared was brief and clear.	2.81	3.81	3.44	3.32	3.11
	The knowledge shared was decisive.	2.19	3.80	3.53	3.41	2.89
	The knowledge shared had specific examples.	2.31	3.98	3.14	3.07	2.61
Reliability	The knowledge shared was consistent with that received from other sources.	2.10	3.26	3.11	3.02	2.53
	The information was available when needed.	3.12	3.33	3.09	3.19	3.10
	The knowledge shared was easily translated to action.	2.03	3.54	3.30	3.52	3.03
Usefulness	The interaction contributed to my knowledge.	2.58	3.68	3.35	3.37	3.24
	The knowledge acquired was applicable.	2.01	3.69	3.68	3.29	3.19
Reciprocity	The interaction allowed me to share what I know.	2.49	3.38	3.00	2.98	2.86
	The interaction made me confirm with others what I know.	2.83	3.76	3.66	3.50	3.02
	Grand Mean	2.45	3.62	3.33	3.27	2.96

Table 4. Distribution of the farmers based on their channels of knowledge exchange

Knowledge channels	Frequency (N = 324)	Percentage (%)
Plot neighbor	114	35.2
Agro-input dealers	57	17.6
Extension agents/researchers	53	16.4
Residential neighbor	45	13.9
Group contact	28	8.6
Family and friends	27	8.3

agents/researchers (16.4%), residential neighbors (13.9%), and group contact (8.6%). Findings of this study are in line with what have been reported previously by Lwoga et al. (2011) who stressed that interpersonal sources such as neighborhood and group membership are consistently the main providers of the agriculture information due to their credibility, reliability and most of all, the trust in them by rural community. Ramirez (2013) explained that farmers' communication networks have influence in the decision to accept or reject a technology. Ogunlade et al. (2012) posited that the role of agro-input dealers in agricultural development go beyond input distributions as they also impart knowledge to farmers, bridging the insufficiency of extension agents to provide technical information on the use of input for optimum production.

Perceived Importance of Various Motivators Enhancing Knowledge Exchange

Motivation is a drive that pushes an individual to act and perform specific tasks and actions. Mohammad et al. (2018) noted that motivation is vital for an individual to act in a positive manner. Table 5 shows the respondents' perceived motivations for their decision to exchange knowledge on DTMA technology. The most important motivators related to the technology is on the comparative benefits of the technology ($\bar{x}$ = 3.55, SD = 1.30). Another important motivator is on what they witnessed ("what I see, I ask to know more") ($\bar{x}$ = 3.44, SD = 1.21), and adequate exposure to the technology ($\bar{x}$ = 3.43, SD = 1.27). The ability to make new relationships with other farmers ($\bar{x}$ = 2.60, SD = 1.15; 16th) and on-farm trials ($\bar{x}$ = 2.91, SD = 1.16) were not seen as important motivators. The results indicate that the primary motivation for knowledge exchange were based on how additional knowledge and exposure to the technology can benefit the farmers. It is based on extrinsic motivation that is represented by reciprocity and external rewards (Hung et al., 2011). It was also shown that the standard deviations of most of the items were greater than 1.0 indicating that the respondents' individual scores as regards their responses on the perceived importance are spread apart.

Contribution of Socio-economic Characteristics to Farmers' Knowledge Exchange

Table 6 shows there is a significant relationship between the farmers' socioeconomic characteristics and their knowledge exchange (F = 57.298, R^2 = 0.582, p < 0.05). To check whether the model, in which all the constructs were added, is successful in predicting knowledge exchange, the Model Summary was assessed. The coefficient of determination (R^2 = 0.582) indicated that the socioeconomic characteristics (sex, age, farming experience, household size, size of farmland, and contact with extension agents) accountable for 58.2% changes in extent of knowledge exchange. In order to test the variability in the multiple regression model, ANOVA was used to check whether all the independent variables have regression coefficients equal with zero, or in other words if the explained variance is not due to a chance (Table 7). Since p < 0.05, the null hypothesis was rejected, meaning that not all the regression coefficients are equal to zero. The implication is that there is a significant relationship between selected socioeconomic characteristics and the extent of knowledge exchange among the farmers. The variables that have significant relationship with the knowledge exchange on DTMA technology in the study area are age of the farmers, farming experience, household size, size of farm land and extension contact. Age of the farmers (β =0.462; p =0.000), farming experience (β =-0.175; p =0.000), household size (β =0.302; p =0.000), size of farmland (β =-0.099; p =0.041) and extension contact (β =0.173; p =0.000) were significant at 5% level of significance. The standardized beta-value accounts for the unique contribution of the independent variables in explaining the dependent variable. Judging from the beta coefficient, age of the farmers has the strongest positive contribution to explaining the extent of knowledge exchange, while size of farmland has the largest negative contribution. This means that older farmers will more likely engage in conversations leading to exchange of knowledge. In Nigeria, older people are often regarded as custodians of knowledge due to experiences they have acquired over time (Olabanji & Ogunlade, 2020). Similarly, larger households will have more tendencies to engage in meaningful knowledge exchange. Likewise, the more the contact with extension agents, the better the farmers' exposure to technology, leading to improved knowledge and motivation to adapt the technology. Improve their knowledge and motivate discussion of such technology. In the same vein, farmers with higher farming experience have better capacity to exchange knowledge of what they know and have practiced. In addition, large farm size will give farmers the opportunity to compare existing knowledge with new ones. Teklewold et al. (2013) asserted that variations in socioeconomic characteristics have a way of influencing knowledge intensive process.

Conclusions and Recommendation

Effective agricultural knowledge exchange is important for increased access to agricultural knowledge. Learning about new innovations is an activity that cannot be left to extension personnel alone. Leveraging on farmers' knowledge exchange

Table 5. Perceived importance of various motivators of knowledge exchange

Items	Mean	Standard Deviation
Comparative benefits of the technology	3.55	1.30
What I see, I ask to know more	3.44	1.21
Adequate exposure to the technology	3.43	1.27
Ease of technically discussing the technology without becoming confused	3.35	1.23
Interpersonal trust within the community	3.33	1.28
Gain of recognition, hype in status, more networks	3.27	1.23
Availability of free time for discussion	3.28	1.22
The language of communication with a fellow farmer makes the message easy to comprehend	3.19	1.22
Regular conversation with fellow farmers	3.11	1.30
Lack of alternative information sources	3.09	1.09
Attendance of farmers' meetings	3.06	1.28
Reliability of knowledge shared	2.97	1.14
Proximity of individuals with information	2.94	0.98
Participation in on-farm trials	2.91	1.16
Community cultures on free flow of interaction	2.77	1.26
Ability to make new relationships with other farmers	2.60	1.15

Table 6. Multiple regression results of the relationship between farmers' socioeconomic characteristics and their knowledge exchange

Model One $Y = \alpha_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + e$	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*
	β	Std. Error	*β*		
(Constant)	42.535	4.687		9.075	0.000
Sex	–1.521	1.354	–0.040	–1.123	0.262
Age	0.495	0.055	0.462	8.966	0.000
Farming experience	–0.265	0.063	–0.175	–4.216	0.000
Household size	1.275	0.213	0.302	5.974	0.000
Size of farmland	–0.591	0.288	–0.099	–2.054	0.041
Contact with extension agents	–0.652	0.151	–0.173	–4.301	0.000

a. Dependent variable: Knowledge exchange

b. R = 0.763 R^2= 0.582 F = 57.298

Table 7. Variation Analysis (ANOVA[a])

	Sum of Squares	df	Mean Square	*F*	*p*
Regression	40096.846	6	6682.808	57.298	0.000[b]
Residual	36972.792	317	116.633		
Total	77069.639	323			

[a]Dependent Variable: Extent of knowledge exchange

[b]Predictors: (Constant), Contact with extension agents, Sex, Age, Size of farmland, Farming experience, Size of household

potentials can play notable intermediary roles in an agricultural innovation system. The study pointed out that only a small proportion of the respondents were categorized to have very low knowledge exchange. The plot neighbor channel was identified as the major network through which most of the farmers had exchange of knowledge. Also, understanding the comparative benefits of the technology was noted as the most important motivation for knowledge exchange. It was concluded that farmers can effectively exchange knowledge among themselves when they have the right motivation to do so. Hence, the study recommends that farmers should adequately be furnished with benefits of new innovations. Network-smart extension can be promoted for easier information dissemination. In this case, the farmers' communication networks could be used to connect farmers with questions to those with answers.

Disclosure Statement

No potential conflict of interest was declared by the authors.

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