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FACTORS AFFECTING ADOPTION OF FERTILIZERS BY FARMERS IN KHARTOUM STATE, SUDAN

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ABSTRACT

This study was conducted to assess factors affecting fertilizers adoption in Khartoum State of Sudan. A random sampling procedure was used to select 60 respondents. Data were collected through structured interview schedule. Descriptive analysis, Inter-correlation and multiple regression analysis techniques were adopted. The results emphasized that the adoption of fertilizers depends on availability of information about fertilizers, capital, social participation and farm size. The study proposed set of recommendations that will contribute to raising the awareness of farmers and the adoption of the technical packages of fertilizers in the study area.

INTRODUCTION

Adoption of innovations has been defined as the decision to apply an innovation and to continue to use it (Rogers and Shoemaker, 1971). According to Bohlen and Milton (1969) adoption process is a mental process through which an individual passes from first hearing about a new idea to its final adoption. Different factors determine the adoption of difference agricultural innovations and technologies (Akudugu *et al*., 2012). According to Rogers (1983), the rate of adoption is usually measured by the length of time required for a certain percentage of the members of a system to adopt an innovation". Prokopy *et al*., (2008) claimed that education levels, capital, income, farm size, access to information, positive environmental attitudes, environmental awareness and utilization of social networks are generally positively, associated with the adoption of best management practices. In this regards, Langat *et al*., (2013) commented that farmers with larger farms are more likely to adopt an improved technology compared with those with small farmers since they can afford to allocate part of their farms to try out the improved technology. Focusing on factors outside the farm gate, Fulginiti and Perrin (1993) reported a positive relationship between past output prices and current productivity, while Miller and Tolley (1989) show that market interventions such as price supports can speed up the adoption of new technologies. The characteristics of the technology itself have important influence on farmers' technology adoption and usage decisions (Adesina and Zinnah, 1993). However, as indicated by Batz *et al.* (1999), the relative complexity, risk and investment characteristics of technologies significantly affect their adoption and diffusion. Various studies emphasized that interaction with extension services and peer-group behavior also positively impact farmers' technology adoption decisions (Howley *et al*., (2012). According to Hassan (2006), adoption of agricultural technologies is influenced by a number of interrelated components within the decision environment in which farmers operate. These factors as identified by Feder *et al.* (1985) include lack of credit, limited access to information, aversion to risk, inadequate farm size, insufficient human capital, tenure arrangements, absence of adequate farm equipment, chaoticsupply of complementary inputs and inappropriate transportation infrastructure as key constraints to rapid

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adoption of innovations in less developed countries. Feder *et al.* (1985) also indicated that not all factors are equally important in different areas and for farmers with different socio-economic situations. Socio-economic characteristics of farmers are the most cited factors influencing technology adoption. The variables most commonly included in this category are age, education, household size, landholding size, livestock ownership and other factors that indicate the wealth status of farmers. Farmers with bigger land holding size are assumed to have the ability to purchase improved technologies and the capacity to bear risk if the technology fails. This was confirmed in the case of fertilizer by Nkonya *et al*. (1997) in Tanzania, Hassan *et al*., (1998) in Kenya, Muneer (2008) in Sudan, and Yohannes *et al*. (1990) in Ethiopia; whereas farm size did not matter in Nepal as indicated by Shakaya and Flinn (1998). In the same context Toborn (2011) commented that empirical studies attempt to understand and explain adoption. It is an ex post perspective. Obviously, technology research has to be guided by early analysis of likely adoption of a technology at some stage of development. Such ex ante analysis may include partial farm budgets to show the economic attractiveness of the technology, constraint and risk analysis. Should the innovation be selected for dissemination, the analysis may be repeated when early signs of adoption are available and the trends extrapolated, constraints focused, etc.

Objectives

The main objectives to this study are to:

- Identify individual and farm level factors affecting adoption of fertilizers in Khartoum State.
- Assess the level of awareness about fertilizers and methods of their application among farmers in Khartoum State.
- Determine the extent of adoption of fertilizers by farmers in Khartoum State.
- Develop some policy recommendations that can help in appropriate usage of fertilizers.

Hypotheses

- Adoption of fertilizers is affected positively by farmers' attitude towards fertilizers, knowledge about fertilizers, access to extension information, capital, education level, farm size, family size, social participation, and contact with urban centers and negatively affected by age.
- Farmers attitudes towards fertilizers is affected positively by their knowledge about fertilizers, access to extension information, education level, farm size, family size, social participation, and contact with urban centers and negatively affected by age.
- Farmers' Knowledge about fertilizers is affected positively by access to extension information, education years, farm size, family size, social participation, and contact with urban centers and negatively affected by age.
- Farmers' access to extension information is affected positively by capital, education level, farm size, family size, social participation, and contact with urban center and negatively affected by age.
- Capital is affected positively by education years, farm size, family size, social participation, and contact with urban center and negatively affected by age.

MATERIALS AND METHODS

This study was conducted in six villages purposively selected from three localities in Khartoum State of Sudan; namely Khartoum, Omdurman and Khartoum North (two from each). The targeted group was the Vegetables farmers. A random sampling procedure was adopted to select 60 respondents from lists of 1446 farmers, obtained from the Technology Transfer and Extension Administration, of the State. The primary data were collected in the face-to-face interviews using a pretested questionnaire. Descriptive statistics, Inter-correlation and multiple regression analysis Techniques were adopted, using the Statistical Package for the Social Sciences (SPSS).The conceptual model employed in this study to measure and identifies factors affecting the adoption of fertilizers among farmers in the study area. The model was focused on 11 variables, 6 exogenous variables namely age, education years, farm size, social participation, family size and contact with Urban Centers. The remaining 5 variables constitute endogenous variables.

RSULTS AND DISCUSSION

Table 1 shows that the mean age of the respondents is 47.5000 years, the minimum age is 22.00 and the maximum age 75.00, the mean of farm size is 10.3 feddans. It also showed that the respondents' mean of contact with urban center is 30.00. The table also showed that the mean of formal education is 6.1667 years, and maximum is 18.00 and minimum is 0.00.The mean of the social participation of the respondents is 2.80, the maximum is 7.00 and the minimum is 0.00.

Result of Correlation Analysis shown in Table 2 indicates the whole sets of inter-correlation of the variables in the conceptual model. The sequence of the variables in the model is based on the hypothesized causal ordering of the variables. The significant predictors for each of the variables in the model are different. It is reflected that adoption of fertilizers by farmers is positively and significantly associated with their access to fertilizers information ($r = .440$), social participation ($r = .457$) and farm size ($r = .347$). This was confirmed in the case of fertilizer by Nkonya *et al* (1997) in Tanzania, Hassan *et al*. (1998) in Kenya, Muneer (2008) in Sudan and Yohannes *et al*. (1990) in Ethiopia. As indicated by Hassan *et al*, (1998) the convention approach to adoption study considers age to be negatively related to adoption based on the assumption that with age farmers become more conservative and less acceptable to new ideas. On the other hand, it is also argued that with age farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to use new technologies more efficiently. In this regards Howley *et al*. (2012) argued that age was negatively and significantly related to adoption of innovations suggesting that old farmers are more conservative in relation to the uptake of new management practices.

Table 1. Distribution of respondents according to age, farm size, contact with urban centers, family size and social participation

Descriptive	Min	Max	Mean	St. D
Age	22.00	75.00	47.5000	12.82146
Farm size	2.00	87.00	10.2583	12.85364
Contact with urban centers	0.00	30.00	8.1167	10.28590
Formal education	0.00	18.00	6.1667	5.34621
Family size	0.00	14.00	6.2500	2.92636
Social participation	0.00	7.00	2.8000	1.78316

Table 2. Multiple regression of amount of farm yard manure used by farmers

Variables	B	SEB	Beta	T	Sig.
X1	.167	1.232	.023	.135	.893
X2	.339	1.059	.046	.320	.751
X3	1.466	1.444	.160	1.016	.314
X4	-4.568	3.006	-.259	-1.520	.135
X5	-8.238	4.631	-.256	-1.779	.081
X6	-3.039	8.387	-.058	-.362	.719
Constant	97.477	63.328		1.539	.130

Key: X1 = Age X2 = Farm size X3 = Contact with urban centers X4 = Formal education,X5 = Family size X6 = Social participation.R square = .093 (F = 0.91; P = 0.497).

Table 3. Multiple regression of amount of chicken manure used by farmers

Summary of the regression					
Regression		.809a			
R square		.654			
Adjust R square		.614			
Standard error of the estimate		425.85419			
		d f	Sum of square		Mean square
Regression		6	18143452		3023908.686
Residual		53	9611644.9		181351.790
F = 16.674		Sig. = .000			
Variables included in the equation					
Variables	B	SEB	Beta	T	Sig.
X1	-2.976	5.547	-.056	-.536	.594
X2	41.213	4.787	.772	8.645	.000
X3	-9.087	6.498	-.136	-1.398	.168
X4	-6.795	13.530	.053	-.502	.618
X5	14.391	20.846	.061	.690	.493
X6	30.009	37.752	.078	.795	.430
Constant	-238.413	285.062		-.836	.407

Key:X1 =Age, X2 = Farm size, X3 = Contact with urban centers, X4 = Formal education,X5 = Family size, X6 = Social participation.

Table 4. Multiple regression of amount of urea fertilizer used by farmers

Summary of the regression					
Regression		.748a			
R square		.560			
Adjust R square		.510			
Standard error of the estimate		28.56064			
		d f	Sum of square		Mean square
Regression		6	55010.676		9168.446
Residual		53	43232.637		815.710
F = 11.240		Sig. = .000			
Variables included in the equation					
Variables	B	SEB	Beta	T	Sig.
X1	-.656	.372	-.206	-1.762	.084
X2	2.351	.320	.740	7.352	.000
X3	-.342	.436	-.086	-.785	.436
X4	-1.358	.907	-.178	-1.497	.140
X5	1.746	1.398	.125	1.249	.217
X6	-1.618	2.532	-.071	-.639	.526
Constant	29.923	19.118		1.565	.123

Key: X1 = Age X2 = Farm size X3 = Contact with urban centers X4 = Formal education, X5 = Family size X6 = Social participation.

Table 5. Multiple regression of amount of Tri Super Phosphate fertilizer used by farmers

Summary of the regression					
Regression		.806a			
R square		.650			
Adjust R square		.611			
Standard error of the estimate		17.04327			
		d f	Sum of square		Mean square
Regression		6	28628.082		4771.347
Residual		53	15395.064		290.473
F = 16.426		Sig. = .000			
Variables included in the equation					
Variables	B	SEB	Beta	T	Sig.
X1	-6.255E-02	.222	-.029	-.282	.779
X2	1.629	.191	.767	8.538	.000
X3	-.490	.260	-.185	-1.885	.065
X4	-.111	.541	-.022	-.204	.839
X5	.674	.834	.072	.808	.423
X6	1.001	1.511	.065	.662	.511
Constant	-11.804	11.409		-1.035	.306

Key: X1 = Age X2 = Farm size X3 = Contact with urban centers, X4 = Formal education,X5 = Family size X6 = Social participation.

Table 6. Result of the causal models of adoption of fertilizers by farmers in Khartoum state as a model for amount of fertilizers used by farmers

Dependent variable	Determinants	Direct effect	Indirect effect	Correlation
X7	X5	- 0.256	0.395	0.139
X8	X2	0.772	- 0.668	0.104
X9	X2	0.740	- 0.771	- 0.031
	X1	- 0.206	0.267	0.061
X10	X2	0.767	- 0.759	0.008
	X3	- 0.185	0.234	0.049

X1 = Age, X2 = Farm size, X3 = Contact with urban centers, X4 = Formal education, X5 = Family size X6 = Social participation

The table also shows the association of adoption of fertilizers by farmers with positive attitude towards fertilizers, knowledge about fertilizers, family size, education years, and age was revealed to be not significant at the 0.05 level of significance. Data in the table revealed that attitude towards fertilizers is positively and significantly associated with knowledge about fertilizers ($r = .655$) and age($r = .284$). This is also in line with Hassan (2006), who cited that education was found to be positively affecting adoption of improved maize varieties in West Shoa of Ethiopia and Tanzania. According to Voh (1982); Shakya and Flinn (1985), the effect of family size on adoption can be ambiguous. It can hinder the adoption of technologies in areas where farmers are very poor and the financial resources are used for other family commitments with little left for purchase of farm inputs. On the other hand, as indicated by Yonannes *et al*, (1989) it can also be an incentive for adoption of new technologies as more agricultural output is required to meet the family food consumption needs or if more family labor is required for adoption of labor intensive technologies.

Regarding, knowledge about fertilizer, as indicated by Wozniak (1984) introduction of new technologies creates demand for information that is useful in making decisions. In this regards Hassan (1998) commented that agricultural extension organizations supply useful information about new agricultural technologies. Access to such sources of information can be crucial for adoption of improved varieties. Table 3 shows the association of access to fertilizers information, capital, social participation, family size, education years, and contact with urban centers and farm size was revealed to be not significant at the 0.05level of significance. Knowledge about fertilizers is positively and significantly associated with access to fertilizers information ($r = .279$). Table 3 also shows the association of knowledge about fertilizers with capital, social participation, family size, education years, and contact with urban center, farm size and age revealed to be not significant at the 0.05 level of significance. Access to fertilizers information is positively and significantly associated with social participation ($r = .344$) and contact with urban centers ($r = .280$). Regarding the family size this result is in line with Adesina (1996), who indicated that larger farms are more likely to adopt innovations than smaller farms due either to economies of scale effects (which would not be expected for fertilizer) or to preferential access to inputs and credit. Table 4 indicates the association of capital, family size, education years, farm size and age were revealed to be not significant at the 0.05 level of significance. Capital is positively and significantly associated with social participation ($r = .312$) and farm size ($r = .732$). On contrary, Langat *et al*., (2013) commented that farmers with larger farms are more likely to adopt an improved technology compared with those with small farmers since they can afford to allocate part of their farms to try out the improved technology.

This fact was also indicated by Lin (1991) who stated that farm size was postulated to be positively related to the adoption of the technology; however Filho (1997) concluded that adoption was negatively related to farm size. Data in table 5 shows the association of family size, education years and contact with urban centers and age, revealed to be not significant at the 0.05 level of significance. Social participation is positively and significantly associated with

contact with urban centers ($r = .337$) and farm size ($r = .485$). Table 6 shows the association of family size, education years and age, to be not significant at the 0.05 level of significance. Family size is positively and significantly associated with education years ($r = .289$) and age ($r = .481$). Table 6 shows the association of contact with urban centers and farm size, to be not significant at the 0.05 level of significance. Education years and participation is positively and significantly associated with contact with urban centers ($r = .479$) and age ($r = .445$). Table 6 shows the association of education years with farm size, to be not significant at the 0.05 level of significance. Table 6 also shows that contact with urban centers; farm size and age were not significant at the 0.05 level of significance. Farm size with age was revealed to be not significant at the 0.05level of significance.

Results of Multiple Regression Analysis

Multiple regression analysis was conducted to estimate the direct effects on the endogenous variables of the model. The variables were used in standard for generating beta weights, which are used for comparing the relative strength of the effects of casual variables on each of the endogenous variables. The value of beta coefficients determines the relative strength of the relationships between the dependent variable and the causal independent variables. The testing of the hypothesis on determinants of farmyard manure (Table 2) used by farmer, involved regression of this variable on age, farm size, and contact with urban centers, formal education, family size and social participation. The results of stepwise regression analysis in table 6 indicate that one variable affected farm yard manure, namely family size ($Beta = .256$). The testing of the hypothesis on determinants of chicken manure used by farmer, involved regression of this variable on age, farm size, contact with urban centers, formal education, family size and social participation (Table 3). The results of stepwise regression analysis in table 6 indicate that one variable affected chicken manure, namely farm size ($Beta = .772$). The testing of the hypothesis on determinants of urea fertilizer used by farmer, involved regression of this variable on age, farm size, and contact with urban centers, formal education, family size and social participation (Table 4). The results of stepwise regression analysis in table 6 indicate that two variables affected urea fertilizer, namely farm size ($Beta = .740$) and age ($Beta = .206$). The testing of the hypothesis on determinants of Tri Super Phosphate fertilizer used by farmer (Table 5), involved regression of this variable on age, farm size, contact with urban centers, formal education, family size and social participation. The results of stepwise regression analysis in table 6 indicate that two variables affected Tri Super Phosphate fertilizer namely farm size ($Beta = .767$) and contact with urban centers ($Beta = .185$)

Results of casual model of factors affecting adoption of fertilizers among farmers in Khartoum state

According to table 6 the beta coefficients showed the variable that most significantly affected farmyard manure are family size (direct effect = -.256). The table also shows that the variable that most significantly affected chicken manure is farm size (direct effect .772). The variable that most significantly affected the Urea fertilizer from farm size (direct effect = .740) and age (direct effect = -.206). The variable that most significantly affected Tri super phosphate fertilizer is farm size (direct effect = .767) and contact with urban centers (direct effect = -.185).

Conclusion and Recommendations

The study identified the socioeconomic factors affecting positively and/negatively adoption of fertilizers in the study area. Accordingly, the study recommended relevant interventions of concerned government authorities, Non-governmental Organizations, UNs agencies, Community Based Organizations and the private sector organizations involved in agriculture need to: 1- Intensify efforts to make agricultural extension services more functional so that farmers can get useful information to enhance adoption of organic farming practices, 2- Strengthening linkage between agricultural extension units and research centers to provide farmers by new innovations and techniques, and 3- Set of clear strategy for importing fertilizers to control the prices of fertilizers to be available for farmers to apply the technical package.

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