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Informational and Institutional Factors Affecting Adoption of Zero Tillage Farming by Agadi Households Farmers, Sudan

Anwar M ELHassan[1]*, Mohammed Abdalla Teabin[2], Mulik Abbaker Ibrahim Yousif[3]

[1]*Department of Agricultural Extension, Faculty of Agriculture, University of Zalingei, Sudan*

[2]*Department of Agricultural Economic, Faculty of Agriculture, University of Zalingei Sudan*

[3]*Department of Forest Sciences, Faculty of Forestry Science, University of Zalingei, Zalingei, Sudan*

***Corresponding author:** Anwar M ELHassan, Department of Agricultural Extension, Faculty of Agriculture, University of Zalingei, Sudan

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ABSTRACT

This study was conducted in Agadi Sector in Blue Nile State of the Sudan to identify the informational and institutional factors affecting adoption of Zero Tillage (ZT) system. Field survey was conducted during the year 2015 to collect the primary data using structured interviews. Secondary data were collected from references, reports, and previous studies. Three hundred households were selected using stratified and systematic random sampling techniques. Semi-structured interviews and group discussions were applied to collect the data and information from extension staff, farmers' leaders, and other key informants. In addition, field observations were also used to check the information gathered by other techniques. Descriptive statistics and tabular analysis were used to analyze the study variables and to determine the extent of Zero tillage adoption. On the other hand, Chi-square test was applied to determine the level of association between the variables. Additionally, Phi-test was used to assess the strength of associations. The study revealed that the adoption rate of the complete package was very low (6.3%).

The adoption of the system was found to be influenced significantly ($P \leq 0.05$) and strongly ($Phi \geq 0.7$) by participation in training, credit availability, and availability of subsidy. In addition, adoption was influenced significantly ($P \leq 0.05$) and either moderately or weekly ($Phi < 0.7$) by involvement in farmers organizations, availability of agricultural information, sources of information, and extension contact. The result also showed that only availability of profitable market variable was not significantly ($P \leq 0.05$) associated with the adoption of ZT technology. The findings suggest that, to increase the adoption rate of a complete package of ZT, attention should be given to develop rural soft infrastructure (such as credit, markets, input subsidy, and extension services). In addition, access to formal training, provision of agricultural information, and farmers' organizations should be taken in consideration.

Keywords: Informational, Institutional, Factors, Adoption, Zero Tillage, Agadi Sector.

Introduction

Agriculture dominates the economies of most African countries, being the key employer and major source of income and exports. Yet, yields in developing countries have lagged far behind those in developed countries for decades. One potential mechanism for increasing yields is the use of improved technologies such as

fertilizers, improved seeds and cropping techniques (Aker [1]). The use of improved technologies has remained the major strategy used by governments to increase agricultural productivity and promote food and livelihood security. Numerous studies have attempted to identify the determinants of technology adoption and the potential barriers to it (Feder, Just and Zilberman [2]). While the specific determinants of technology adoption depend upon the setting and the technology type, some common factors identified in the theoretical and empirical literature include education, wealth, tastes, risk preferences, complementary inputs and access to information and learning. Of these, the role of asymmetric and costly information has not received particular attention. To compete and to maintain production in a sometimes-hostile environment, producers need information about new technologies, most often developed by researchers at universities, research institutes, and private companies. In recognition of huge agricultural potential of the rain fed sector in Sudan, The Arab Authority for Agricultural Investment and Development (AAAID) introduced Zero tillage technology to address the problems of traditional farming system such as low productivity, high cost of production, and consequently high financial losses.

Zero tillage (ZT) technology is one of a set of technologies used in conservation agriculture which aims to enhance and sustain farm productivity by conserving and improving soil, water, and biological resources as it essentially maintains a permanent or semi–permanent organic soil (FAO [3]). Zero tillage also defined as the introduction of seed into unplowed soil in narrow slots, trenches or bands of sufficient width and depth for seed coverage and soil contact (Phillips & Phillips [4]). According to the World Bank [5], no-till farming practices encompass four intertwined soil and crop management techniques:

- Minimal soil disturbance, restricted to planting/drilling, i.e., no plowing, disking or other forms of soil cultivation;
- Permanent vegetative soil cover, crop, cover crop, and weed residues are maintained on the surface and none are burned;
- Direct-sowing, specialized equipment inserts seeds and fertilizer (chemical, organic) through/across/below residues, lime and non-nitrogen fertilizer mostly applied on the surface; and
- Sound crop rotation, combining different plant families (e.g., cereals and legumes), generating adequate biomass, and continuously using cropland.

Coutts and Smith [6] declared that Zero tillage improves soil moisture picture on a field by trapping snow and reducing run-off of both snow and rainwater. Better infiltration of surface water and reduction of surface evaporation also contribute to soil moisture availability. Moreover, zero tillage reduces the amount of time and labor required to get the crop in the ground by reducing the number of passes across the field. Phillips and Phillips [4] revealed that zero tillage reduced fuel consumption, which result from land preparation operations, with harvest, processing and transportation remaining about equal with the various cultural systems in use. According to Boame [7] despite the environmental and financial advantages of zero tillage practice, several factors currently discourage its use. According to Adams (1982) adoption of new technologies was found to be dependent on the interaction of several factors. The organized delivery of inputs and outputs, provision of technical advice, stable price and credit for participating farmers are all important determinants of farmers' adoption of innovation. The farmers should be adequately informed in this connection and trained in innovation and be provided with the modern equipment and tools to enhance adoption and as a result, increase production and productivity.

To achieve optimum production in agricultural activities, farmers can be benefit from tailored training. Farmers are often unfamiliar with modern agricultural practices or new technologies. Information plays a key role in strengthening farmers' daily decision-making related to agricultural activities by enhancing their knowledge about new technology, inputs, and markets (Mittal, Gandhi, and Tripathi in Mittal and Mehar, 2016). Without information about likely markets and prices, the producer cannot make decisions about what crops to grow and when to buy and sell. Without information about the location and size of a crop or the quality of produce, the processor cannot plan how much finished product to supply to consumers. To compete and to maintain production in a sometimes-hostile environment, producers need information about new technologies developed by researchers at universities, research institutes, and private companies. It is not possible, or even desirable, for individuals in one part of the knowledge system to maintain direct contact with all others in the system who may need information they can provide (Mundy [8]).

The Arab Authority for Agricultural Investment and Development (AAAID) adopted a program for developing rain-fed agriculture in Sudan by applying Zero tillage system. Despite the great efforts exerted to promote the system since 2003, information on the adoption and factors affecting it is relatively scarce. Recent evaluations suggest an incremental uptake of the various components of the ZT technology in Sudan (ELtaib [9]). However, there is a need to better understand why some farmers adopt the complete package and others only partly adopt ZT. It is critical to understand both informational and institutional factors that are likely to affect the level of adoption of this technology. In fact, few if any studies have been undertaken in Sudan to assess the key factors that influence the uptake of ZT farming.

Methodology

Sample Selection Procedures

This study was undertaken in Agadi sector which is in Blue Nile State about 35 kilometers west of AL- Damazine town, the capital of the state. The Agadi population is expected to be about 49,402 consisting of about 8,262 households residing in 17 blocks (5th Sudan Census [10]). This study used stratified and systematic random sampling techniques to choose the research sample. The first stage involved the random selection of six villages out of the 17 villages. A list of all villages in Agadi area was prepared and 6 villages were selected randomly. While the last stage involved the selection of farming households from each selected village. A list of all household heads in each village was obtained from stakeholder, key informant, and villages' popular committee. Representative households were taken from each village using probability proportional to size. The number of households located within each village determined the measure of size of the village. Hence, a total of 300 farming households were selected randomly for interviews as shown in Table 1.

Table 1: Distribution of sample respondent per each sample block.

Name of sample villages	Total No. of household heads	Percent	No. of Sample household heads
ALhela Algadida	80	9.9	30
ALdoma	160	19.9	60
Kenana	70	8.8	26
Jabel Moot	207	25.7	77
ALlaouta	74	9.2	28
ALgonobi	213	26.5	79
Total	804	100	300

Source: field survey (2015)

Data Collection

The primary data for this study was collected through direct survey using questionnaire and personal interviews. A questionnaire was designed and used to collect data for this study using the structured interview method. Field observations were also used in cross checking the information gathered by the questionnaires. Informal groups' discussions with farmers, extension staff, and key informants were performed during the entire duration of the research. While secondary data was collected from institutional sources, references, reports, and previous studies. A pilot survey was conducted to acquaint the researcher with the study area, examine the suitability of data collection methods and to assess the duration of the main survey.

Data Analysis

The collected data was organized, summarized, coded, and fed in software. Data analysis was carried out using the computerized Statistical Package for Social Science (SPSS) version 16. Descriptive statistic and tabular analysis (frequency distribution) was used to describe the different variables in this study. Chi-square test was used to determine the degree of association between variables. Phi-test or Cramer's V was used to measure the strength of association between the study variables. Phi test was used in case of 2 by 2 tables and otherwise Cramer's V test was used. If Phi or Cramer's V = 0.7 --- 1 it denotes strong relation, Phi = 0.3—0.69 it denotes moderate relation, and if Phi = 0.00 – 0.29 it denote none or weak relation.

Results and Discussions

The level of Adoption of ZT Technology:

Table 2: Respondents' distribution according to adoption of ZT components.

Adoption of ZT component	Frequency	Percent
Adopted	19	6.3
Not adopted	266	88.7
Discontinuance	15	5.0
Total	300	100.0

Source: Household field survey (2015).

The Table 2 indicates that 88.7% of respondents did not practice ZT technology in any of the growing seasons. The interviewed respondents explained that they did not adopt ZT because they did not afford to buy ZT equipment due to high cost of machinery. Nonetheless, 5% of respondents clarified that they did practice ZT in the past but has resumed conventional farming in the 2015 growing season. According to them, the factors that led them to abandon ZT practices included:

1. Security situations
2. Credits problems
3. Lack of herbicides & machines
4. Lack of spare part facilities

These findings were like the findings of ELtaib [9] who found that 96.1% did not adopt ZT, and only 3.9% of farmers adopted ZT technology in the White Nile State.

Chi-Square Test for the Association between Informational and Institutional Variables and Adoption of ZT: The results of Chi-square test (Table 3) shows that involvement in farmers organizations, availability of agricultural information, sources of information, extension contact, participation in training, credit availability, and availability of subsidy were significantly (at P≤0.05) associated with adoption of ZT technology. Among these variables, only participation in training, credits availability, and availability of subsidy were strongly (Phi / Cramer's V≤0.7) and highly significantly affected adoption of ZT technology. This implies that the increase in these variables will lead to increased adoption of ZT.

The significance of involvement in farmers' organizations suggested that farmers who involved in farmers organization are more likely to use ZT. This result might be because farmers within a group learn from each other and benefit from the services provided by the organization. Similarly, Petros [11], Kabwe, et al. [12], Bonabana-Wabi [13], Doss, et al. [14], and Mohammed [15] supported this argument. The effect of availability of agricultural information has been variously found to be positive as Derpsch and Friedrich [16] found that the main barriers to ZT adoption is to knowledge on how to do; similarly, Rahm and Huffman [17] revealed that it is expected that the gathering of information improves resource allocation skills and also increases the efficiency of adoption decisions irrespective of the technology used, and Derpsch, et al. [18] said that one of the main barriers to ZT adoption in many developing countries was lack of enough information available in this field.

Table 3: Summary of Chi–square test for the association between institutional / informational factors and adoption of ZT.

Variables	X2	df	P	Phi
Involvement in farmers' organizations	89.395	2	.000***	.546
Availability of agricultural information	30.278	2	.000***	.318
Sources of agricultural information	56.210	12	.000***	.433
Extension contact	1.314	6	.000***	.662
Participation in training	2.903	2	.000***	.984
Credits availability	1.738	4	.000***	.761
Availability of profitable market	.733	2	.693	.049
Availability of subsidy	1.809	2	.000***	.777

Legend: ** *P< 0.001; ** P< 0.01; * P< 0.05.

Farmers who have frequent contacts with agricultural agents were more likely to adopt ZT than those with other sources of information; it seems that the majority of non-adopter depended on personal skills as a source of information. This result confirmed with Baradi [19]. Diverging from this, Bonabana-Wabi [12] revealed that none of the informal sources of information like friend, neighbor, and others had a positive effect on IPM technology adoption. Most of the studies analyzing extension contact variable in the context of agricultural technology showed a strong positive influence on adoption as confirmed by Mohammed (2001), Petros [11], and Baradi [19]. Training equips farmers with new knowledge and skills that help them to perform new practices properly. This result is in harmony with the Baradi [19] who found that those farmers with greater familiarity with / or participate in existing conservation programs were more likely to adopt more conservation tillage systems, and Salim, et al. [20] who found that there was a significant association between attendance of training and adoption of Melon Bug Hand Picking in West Bara Locality North Kordofan State,

Sudan. The association between credit availability and adoption of ZT is seen to be positive. The result of this study is in agreement with the findings of many previous studies, such as: Feder, Just and Zilberman [2], Doss [21], and Baradi [19]. Nevertheless, this study disagreed with Onyenweaku, et al. [22] and Nguthi [23] who found that the accessibility of credit was not significantly associated with growing tissue-cultured banana.

The study revealed strong positive (Phi = 0.777) and highly significant (P = 0.000) relationship between having subsidy for input and adoption of ZT technology. This means that respondents who had a subsidy for his inputs adopted ZT more than those who did not have a subsidy. This is since subsidy helped the farmer to purchase inputs. This finding is in line with Mazvimavi & Twomlow [24] who found that a farmer who received continuous support tended to intensify adoption of different Conservation Farming (CF) components. Similarly, Bisangwa [25] found that subsidized fertilizer provided by NGOs was correlated with the probability of adoption. The result of Chi-square test (Table 3) also showed that only availability of profitable market variable was not significantly associated with the adoption of ZT technology. This mean that adoption of ZT was not depending on the availability of profitable market, because this technology needs special equipment that were not available in the study area, so adoption depends on availability of these equipment rather than availability of profitable market. This result confirmed the findings of Onyenweaku, et al. [22], World Bank [5], and Miller and Toylley cited in Howley, et al. [26]. But disagreed with Sunding and Zilberman [27] who argued that the introduction of guaranteed markets for Punjabi food grain production by the government procurement policy (which was in essence a price support policy) enhanced the adoption of high-yield wheat and rice varieties in the region.

Conclusion

This study showed that the adoption of the system was found to be significantly ($P \leq 0.05$) and strongly (Phi ≥ 0.7) influenced by participation in training, credit availability, and availability of subsidy. In addition, adoption was significantly ($P \leq 0.05$) and either moderately or weekly (Phi < 0.7) influenced by involvement in farmers organizations, availability of agricultural information, sources of information, and extension contact. The result also showed that only availability of profitable market was not significantly associated with the adoption of ZT technology.

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