

RESEARCH ARTICLE

Technological Factors Affecting Adoption of Zero Tillage Farming by Agadi Households Farmers- Blue Nile State- Sudan

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ABSTRACT

The Arab Authority for Agricultural Investment and Development (AAID) adopted a program for developing and modernizing rain-fed agriculture in Sudan it by applying Zero tillage cultivation. However, despite the great efforts exerted to promote this technology in Agadi and other areas since 2003, information on the adoption and factors affecting the adoption is relatively scarce.

The main objective of this study was to determine the level of adoption and identify some innovation attributes affecting adoption and dissemination of this technology in Agadi Sector in Blue Nile State of the Sudan. The study used a stratified and systematic random sampling technique to select the research sample which consisted of 300 farming households. The primary data was gathered through direct survey using structured interviews. In addition, field observation and informal group discussions with farmers, extension staff, and key informants was performed during the entire duration of the research. Secondary data was collected from institutional sources, references, reports, and previous studies. Descriptive statistics, tabular analysis (frequency distribution) was used to describe the different variables of the study and the extent of ZT adoption; whereas, significance of the variables was determined using chi-square test. Furthermore, Phi-test or Cramer's V was used to assess the strength of association. The study revealed very low (6.3%) adoption rate of all ZT technology components in the study area. Adoption of ZT was found to be significantly ($P \leq 0.05$) influenced by: Farmers' perceptions of ZT implement availability, herbicide availability, perceived difficulty to understand ZT, and perceived ZT complexity and among them only implements availability and herbicide availability were strongly ($\Phi \geq 0.7$) and highly significantly affecting adoption of ZT technology. Other factors such as perceived ZT yield as compared with CT, perceived ZT profitability, perceived ZT cost, perceived ZT risk, ZT compatible with farmers values and needs, and perceived ZT suitability with farmers circumstance did not significantly ($P \leq 0.05$) affecting adoption of ZT technology. Based on the findings, the study recommends that the government of Sudan should facilitate a conducive environment for ZT adoption through: timely availability of required ZT implements and herbicides at the right time and place through construction of local manufactures, provision of spare part facilities, initial inputs subsidy and improvement of security situation.

Key words: Technological factors, Adoption, Zero Tillage, Agadi Sector

INTRODUCTION

Adoption is a decision-making process in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to

adopt or reject, to implementation of new idea, and to confirmation of the decision (Liberio, 2012). Diffusion of innovation theory indicates that perceived attributes of an innovation strongly affect adoption and diffusion of that practice (Rogers, 2003). With regard to the relationship of technological attributes with farmers' adoption decision, Rogers (1995) identified five

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characteristics of agricultural innovations, which play a significant role in adoption studies.

These include:

- 1) Relative advantage
- 2) Compatibility
- 3) Complexity
- 4) Trialability
- 5) Observability.

Rogers (1995) defines these characteristics as follows:

Relative Advantage: is the degree to which an innovation is perceived as better than the idea it supersedes.

Compatibility: is the degree to which a farmer perceives an innovation to be consistent with his/her cultural values and beliefs, traditional management objectives, the existing level of technology and stages of development.

Complexity: is the degree to which an innovation is perceived to be complex to understand and use by farmers.

Trialability: is the degree to which the innovation could easily be tried by farmer on his/her farm.

Observability: is the degree to which the results of innovation are visible to farmers.

The study of Doss et al. (2003) on adoption of maize and wheat technology in Eastern Africa report that farmers cited several reasons for not adopting improved technologies. The first was simply being not familiar of the technologies or that they could provide benefits; this may include misconceptions about the related costs and benefits. The second reason was that the technologies were not profitable, given the intricate sets of decisions that farmers make about how to allocate land and labor across agricultural and non-agricultural activities. This may be due to the fact that appropriate varieties for farmers' agro ecological conditions were not available or that farmers preferred characteristics found only in local varieties. It may also be due to institutional factors, such as the policy environment, which affects the availability of inputs (land, labor, seeds, and fertilizer) and markets for credit and outputs. These institutional factors also affect input prices. It may also be that use of improved technologies may increase production risks: if crops fail, the financial losses would be higher. Finally, Technologies were not adopted because they were simply not available.

Ehui et al. (2004) explain that a new technology introduced to smallholder farmers by itself alone does not guarantee for wide spread adoption and efficient use. For efficient utilization of the technology, fulfilment of specific economic,

technical and institutional conditions are required. The authors further stated that innovations usually are adopted rapidly when they have a high relative advantage for the farmers; compatible with the farmers' values, experiences and needs; are not complex; can be tried first on small scale and easy to observe the results. There are three factors that farmers do not adopt improved technologies. The first is that they are not aware of them or that they are not aware that the technologies would provide benefits for them. Farmers may also have misconceptions about the costs and benefits of the technologies. The second reason is that the technologies are not accessible, or not available at the times that they would be needed. The third reason is that the technologies are not profitable, given the complex sets of decisions that farmers are making about how to allocate their land and labor across agricultural and non-agricultural activities (Doss, undated).

While current crop production systems have resulted in soil degradation and in extreme cases to desertification, the adoption of the no-tillage technology has led to a reversion of this process. No-tillage/Conservation Agriculture (CA) has developed as a technically viable, sustainable and economical alternative to current crop production practices (Derpsch, 2008). Zero tillage (ZT) technology is one of a set of technologies used in conservation agriculture which aim 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, 2001). 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, 1984).

According to FAO (2001), zero tillage helps farmers to increase productivity and conserve their natural resources by spending less time on land preparation, and it provides a higher yield at less cost and also saves on fuel use and tractor wear and tears. Due to the successful adoption of Zero tillage Agriculture (ZT) in the Americas, international organizations and research institutions are now promoting the ZT adoption in Africa. However, local constraints have influenced the uptake of ZT in most of the African countries. Moreover the empirical evidence of ZT adoption in Africa has not clearly shown whether ZT practices are highly adopted or not and the ways of accelerating ZT adoption by farmers in Africa. Therefore the aim of this research was to assess Zero tillage Agricultural adoption as

practiced in Agadi area, addressing its attributes constraints.

Purpose and Objectives

The purpose of this study was to determine which aspects of ZT technology package were responsible for the variations in the adoption behavior of farmers in Agadi Sector. The specific objectives were to:

1. Determine the level of adoption of the ZT technologies disseminated to the farmers
2. Identify technology-related factors influencing the use (adoption) of a complete package of ZT technology.

METHODOLOGY

Sample selection procedures

This study was undertaken in Agadi sector which is located in Blue Nile State about 35 kilometres west of AL- Damazine town, the capital of the state. The Agadi population is estimated to be approximately about 49,402 consisting of about 8,262 households residing in 17 blocks (5th Sudan Census, 2008).

This study used stratified and systematic random sampling techniques to choose the research sample. The first stage involved the random selection of six blocks out of the 17 blocks. A list of all blocks in Agadi area was prepared and 6 blocks were selected randomly. While the last stage involved the selection of farming household heads from each selected block. A list of all household heads in each village was obtained from stakeholder, key informant and blocks' popular committee. Representative household heads were selected from each block using probability proportional to size. The number of households located within each block determined the measure of size of the block. Hence, a total of 300 farming household heads were selected randomly for interviews as shown in table (1).

Table (1): Distribution of sample respondent per each sample block

Name of sample bocks	Total No of household heads	Percent	No of Sample household heads
ALhelaalgadida	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: Household field survey (2014)

Data collection

The primary data for this study was collected through direct survey using a questionnaire and personal interviews. A questionnaire was developed and used to collect data for this study

using the structured interview method. A semi-structured questionnaire was developed for extension agents working in Agadi area; 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. Moreover, secondary data were collected from institutional sources, references, reports, and previous studies.

Data analysis

The collected data were 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, tabular analysis (frequency distribution), cross tabulation was referred to describe the different variables in this study. Chi-square test was used to determine the degree of association between variables. In addition, 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 2by 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 denotes none or weak relation (consistent with Nadia, 2004).

RESULTS AND DISCUSSIONS

The level of Adoption of ZT technology:

The table (2) indicates that 88.7% of respondents did not practice ZT technology in any of the growing seasons. They explained that was caused by non-affordability of ZT equipment and 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.

Depending 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 similar to the findings of ELtaib (2010) who found that 96.1% did not adopt ZT, and only 3.9% of farmers adopted ZT technology in the White Nile State.

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)

Some Attributes of the Innovation influencing Farmers’ Adoption Decision of ZT:

The results of Chi-square test (table 3) show that out of all attributes of ZT technology only ZT implements availability, herbicide availability, perceived difficulty to understand ZT, and perceived ZT complexity were significantly (at $P \leq 0.05$) associated with adoption of ZT technology and among them only implement availability and herbicide availability was strongly ($\Phi/\text{Cramer’s } V \geq 0.7$) and highly significantly affecting adoption of ZT technology. This result confirmed the finding of Derpsch et al. (2010) who mentioned that adoption of No-till need availability of machines and herbicides; also Derpsch and Friedrich (2009) found that the main barriers to ZT adoption continued to be, knowledge on how to do it, inadequate policies as commodity based subsidies, availability of adequate machines and **availability of suitable herbicides** to facilitate weeds management.

Other factors such as perceived ZT yield, perceived ZT profitability, perceived ZT cost, perceived ZT risk, ZT compatibility with farmers values and needs, and perceived ZT suitability with farmers circumstance did not significantly (at $P \leq 0.05$) affecting adoption of ZT technology. During the group discussion, the respondents indicated that irrespective of ZT technology characteristics they did not adopt it because ZT need high initial cost they did not afford it and ZT inputs (planters and herbicide) were not available to them. This finding is inconsistent with many previous studies such as Rogers (1995), Hoffman (2011), and Sunding and Zilberman (1985), but in the line of Abera(2008), Awada (2012) and Boame (2005).

Table 3: Summary of Chi –square test for the association between technological factors and adoption of ZT

variables	X ²	df	P	Phi/Cramer’s V
ZT yield compared to CT	1.056	4	.901	.042
ZT economic returns	1.738	4	.784	.054
ZT cost compared to CT	2.097	4	.718	.084
ZT risk compared to CT	5.757	4	.218	.098
ZT compatibility with values	1.947	2	.373	.081
ZT compatibility with needs	2.466	2	.264	.094
ZT suitability with farmers circumstance	.422	2	.810	.038
ZT Implements availability	2.83	4	.000***	.690
Herbicides availability	1.523	4	.000***	.504
ZT complexity to use	17.152	4	.002**	.169

ZT complexity to understand	14.631	2	.000***	.221
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Source: Household field survey (2014)

CONCLUSIONS

This study analyzed adoption of ZT technologies. Low levels of adoption (6.3%) were found with ZT technologies. Results indicate that farmers’ perceptions of ZT implements availability, herbicide availability, perceived difficulty to understand ZT and perceived ZT complexity was associated with increased adoption of ZT practices and among them only implement availability and herbicide availability were strongly ($\Phi \geq 0.7$) and highly significantly affecting adoption of ZT technology. Perceived ZT yield, perceived ZT profitability, perceived ZT cost, perceived ZT risk, ZT compatibility with farmers values and needs, and perceived ZT suitability with farmers circumstance did not significantly (at $P \leq 0.05$) affecting adoption of ZT technology.

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