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# The Role of Agricultural Extension in Raising the Productivity of Rainfed Sorghum Small-Scale Farmers in Gezira State, Sudan: A Case Study from South Gezira Locality

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**Abstract**

Sorghum is one of the most important crops of Sudan according to its economic and nutritional value. The climate change and use of traditional cultural practices are the major problems of sorghum production in the rainfed sector of Sudan and consequently, the yield of the crop did not exceed two sacs/feddan. The Federal Ministry of Agriculture has designed and financed a special programme for the traditional rainfed sector of the country called the National Integrated Solutions Programme as the main adaptation strategy to solve these problems since 2014 growing season with objective to diversify and increase production and productivity of crops cultivated in traditional rainfed areas in each State of the country such as sorghum, sesame, millet and sunflower. The present study seeks to investigate farmer`s adoption of National Integrated Solutions Programme Package for rainfed sorghum farmers in South Gezira Locality, Gezira State, Sudan. A field survey was used to collect data from 125 rainfed farmers participated in the programme and an equal number from non- participant farmers from the study area were selected for comparison using the simple random sampling technique. A close-ended questionnaire was constructed and the personal interview technique was used to administer the questionnaire. The collected data were coded, fed to the computer and statistically analyzed using (SPSS), discussed interpreted using descriptive statistics and chi-square test. The descriptive analysis showed that the majority of participant farmers were adopted the programme components and their production was increased significantly. Chi-square test result revealed that there was no significant association between participation in the programme and adoption of the programme components as a result of many constraints faced by the farmers during the growing season. From this study, it can be concluded that the National Integrated Solutions Programme for supporting rainfed sorghum small- scale farmers are a very effective agricultural national strategy for the rainfed sector of the country, which in turn will help rainfed farmers to increase their production and consequently their income through the adoption of the programme components. The study recommends that this national programme for supporting rainfed sorghum farmers should continue, the needed inputs should be available, the agricultural extension officers should be trained on the programme components to be able to implement it effectively and further agricultural extension research in this area should be conducted.

**Keywords**: Technical package, Rainfed Sorghum, Small-scale Farmers, Gezira State, Sudan

## 1. Introduction

Sudan relies on agriculture as the main source of food crops for local consumption, food security and export. The majority of Sudanese people live in rural areas and depend on agricultural production as the main source of their

income and food security. The country has two main agricultural subsectors irrigated and rainfed (traditional and mechanized) subsector. The traditional rainfed sector represents 60% of the total cultivated area in the country. Sorghum, sesame and millet are the main cultivated crops in this sector in addition to other crops such as sunflower, groundnut and cotton. The total yields of rainfed sector vary from season to season according to variability of rainfall (Ahmed et al., 2013).

The effect of climate change on African agriculture represents a major challenge to continental agricultural development including food security, nutrition and management. Climate change is one of the major challenges to Sudan agricultural sectors as in other Sub-Saharan African countries (Ifeanyi et al, 2012). Changes in temperature, rainfall, water availability, increased outbreak of pests and diseases, land degradation, soil erosion, shrinking of grazing and cultivable areas, ongoing desertification and the other aspects of climate change have direct significant impact on agricultural production, productivity and cultivated crops of the Sudan (Ahmed et, tal, 2013). The most suitable option to Africa to manage the impact of climate change is adaptation strategies, but the continent's low adaptive capacity serves as a major constraints facing its ability to adapt. These major constraints include limited financial resources and low technical awareness to adapt to climate change (Nyong et al, 2006).

Sorghum is one of the most important crops of Sudan according to its economic and nutritional value. The climate change and use of traditional cultural practices are the major problem of sorghum production in the rainfed sector of country. In Sudan, the yield of rainfed crops is characterized by high variability due to the high variability in seasonal rainfall and production not exceed two sacs/feddan because the rainfed farmers were adopted low-input rainfed agriculture as a risk management option which led to reduce in the yield per unit of land and water (Shamseddin et al., 2011). Shamseddin (2009) reported that the low yield of rainfed crops in Sudan is mainly due to rainwater mismanagement. The soils are characterized by moderate to poor mineral fertility due to low content of nitrogen, available phosphorus, and sometimes potassium. In spite of these deficiencies, rainfed farmers, whether in the traditional or mechanized sector, do not use fertilizers in order to reduce the cost, i.e. rainfed farmers, especially traditional farmers, receive a very low per cent of all formal agricultural credit, besides that they receive few support services such as research and extension (FAO, 2006). Shamseddin, (2009) cited that due to the lack of supporting services such as agricultural extension, rainfed farmers depend entirely on their own acquired knowledge, traditional technology, traditional varieties and cultural practices. In spite of the low adoption rate of rainwater harvesting techniques (RWHT) by rainfed farmers, this adoption differs from a region to another in Sudan, only 0.05% of the farmers were adopted RWHT in Sinnar region. However, the adoption rate at western regions of Central Sudan (Kordofan and Darfur) is relatively high since farmers became more willing to adopt RWHT as a direct result of the witnessed historical drought events in the region. Therefore, there is a high need for conducting solid research on proper sowing dates, increasing formal credit to traditional rainfed farmers and initiation of nation-wide RWHT capacity building programmes (Shamseddin et al., 2009).

Many adaptation strategies have been tried to enable farmers to adapt to climate change particularly in the agricultural rainfed sector in Sudan including good agricultural management systems, drought-resistant varieties, crop diversification and efficient water harvesting techniques. One of these strategies is the National Integrated Solutions Programme for the rainfed sector. To achieve the goal of this strategy , the Administration of Agricultural Extension and Technology Transfer in each State has an important role to play by transferring appropriate adaptation technologies to farmers to be adopted by them that in turn will keep and raise the production of their cultivated crop in this sector (Ahmed et al., 2013).The Sorghum ((Sorghum bicolor L. Moench) is the main food crop for most of the population in Sudan, as it represents 70% of the nutritional needs of the Sudanese and occupies the largest cultivated areas in the country in both irrigated and rainfed sector. It is also a source of concentrated fodder for animals and used in the manufacturing of starch, glucose, alcohol and flour. The surplus is exported to fill the shortage in the neighbouring countries, especially the Arab Gulf states, so it is therefore considered as a pillar of food security and social stability (Alzein et al., (2013).

Programme description:

The Federal Ministry of Agriculture has designed and financed a special programme for the traditional rainfed sector of the country called the National Integrated Solutions Programme as the main adaptation strategy for the 2014/ 2020 growing seasons to diversify and increase production and productivity of crops cultivated in traditional rainfed areas in each State of the country such as sorghum, sesame, millet and sunflower. This programme was implemented by the Administration of Agricultural Extension and Technology Transfer in each State in collaboration with Sudan Agricultural Research Corporation (ARC) and the Agricultural Bank of Sudan.

Technologies recommended:

Water harvesting techniques: Different types of local rainwater harvesting techniques such as ridging and high terracing were recommended to store rainwater in the field after each rainfall throughout the rainy season.

Improved seeds: Climate change has a direct effect on cropping systems; thus adapting food production systems to rapid change in climate conditions is important to local and global food security. In some cases, rainfed farmers need to cultivate new crop varieties as an adaptive method to reduce the losses in yield of existing crops which can result from the variability of climatic conditions. Hence two new sorghum varieties; Arfaa Gadamac and Butana were recommended for the traditional rainfed sector.

Use of chemical fertilizers: Some chemical fertilizers were recommended for the traditional rainfed sector such as urea and DAP.

Cultivation method: Cultivation on furrow was recommended for the traditional rainfed sector which will help in keeping continuous and suitable irrigation for all rainfed crops throughout the rainy season.

Weeding: Manual weeding was recommended for the traditional rainfed sector.

2Extension methods used: The following extension methods were used as the main extension activities in implementing the programme: Method and result demonstrations, field visits, extension meetings such as workshops, seminars, lectures and panel discussions. Field days, and mass communication.

Objective of the study:

The present study seeks to investigate farmer`s application (adoption) of integrated solutions programme package for rainfed sorghum small-scale farmers in South Gezira Locality, Sudan.

## 2. Materials and Methods

### 2.1. Area of the study:

The South Gezira Locality is one of seven Gezira State localities, it is located at South of Wad Medani and North of Sinnar, East to Elmangil and West to the Blue Nile which and considered as the biggest part of Gezira Scheme the largest agricultural Scheme in Sudan, with 70,000 Km long irrigation canals, 210,000 feddans, 2000 villages and 500 camps . The majority of the people work in agriculture and animal rearing.

### 2. 2. Study population:

The total number of rainfed farmers in South Gezira Locality was estimated to be 125 for 2018/2019 growing season using the full count method. This number represents the population size of the study.

### 2.3. Sample size and data collection:

The study was based on primary and secondary data. The primary data were gathered by administering a questionnaire among all rainfed farmers in South Gezira Locality, Sudan. The secondary data were collected from past research studies and reports.

### 3.4. Data Analysis:

The collected data were statistically analyzed and interpreted using percentage and frequency distribution and chi-square test. The chi-square test was used (at significance level 0.05 or less) to test the association between education, work experience of sales personnel and the safety measure of pesticide. Chi- square is given by:

$$\chi 2 = \sum_{r=1}^{R}\sum_{c=1}^{C}(Orc - Erc)^2 / Erc$$

With degrees of freedom (v) given by (R-1) (C-1), where:

R: Rows of the contingency table

C: Columns of the contingency table

Orc: Observed frequency in row (r) and column (c)

Erc: Expected frequency in row (r) and column (c)

## 3. Results and Discussion

### 3.1 Selected socio-economic profile of farmers:

The socioeconomic characteristics investigated in the study cover: education level, age, and gender .In term of education level, 36.8% of farmers were illiterate, 23.2% had acquired primary education, and 36% had secondary education. Only 4% of farmers possessed University and above. This indicates that the farmers in the study area obtained the basic education required for better understanding and ability to embrace the adoption of farm technologies.it is generally thought that the level of education enhances the ability to comprehend and adopt relevant agricultural information, which is in conformity to Sennuga et al., (2020).

The age of farmers ranged from 20 to 51 years and above. 04.8% of them fell within the age of 20-30 years, 12.8% of them fell within the age of 31-40 years, and 14.4% of the fell within the middle age of 41-50 years, and 68% of them fell within the age of 51years and above. Generally, the assumption is that younger people tend to be more

productive than that of their older counterparts. . In term of gender, 52% of farmers were female and 48 of them were male.

Table 1. Distribution of farmers according to their selected socioeconomic profile

| Selected socioeconomic characteristics of farmers | Frequency | % |
|---|---|---|
| Educational level | | |
| Illiterate | 46 | 36.8 |
| Primary schools | 29 | 23.2 |
| Secondary schools | 45 | 36 |
| University and above | 05 | 04 |
| Age group | | |
| 20-30 | 06 | 4.8 |
| 31-40 | 16 | 12.8 |
| 41-50 | 18 | 14.4 |
| 51 and above | 85 | 68 |
| Gender | | |
| Male | 60 | 48 |
| Female | 65 | 52 |

**3.2 Farmer`s participation in the programme:**

As indicated in the table (2) only 20% of farmers participated in the programme activities for 2015/2016 agricultural growing season, 32% of them participated in the programme activities for 2016/2017 agricultural growing season and 48% of them participated in the programme activities for 2018/2019 agricultural growing season. The agricultural extension participatory approach assumes that effective agricultural extension cannot be achieved without the active participation of farmers as well as of research and related services, that there is a reinforcing effect in group learning and group action and that agricultural extension efficiency is gained by focusing on important points based on expressed needs of farmers and by reaching more small scale farmers through their groups/organizations instead of through individualized approach.

Table 2.Distribution of farmers according to their participation in the programme/growing season

| Growing season | Frequency | % |
|---|---|---|
| 2014/2015 | 25 | 20 |
| 2016/2017 | 40 | 32 |
| 2018/2019 | 60 | 48 |
| Total | 125 | 100 |

**3.3 Farmer`s adoption of programme components:**

As presented in table (3) 80 %of farmers used disc harrow & disc plough for land preparation, 76% of them used recommended rainfed sorghum varieties, 84% of them recommended cultivation method, 72% of them used of recommended fertilizers and dose,76% of them used recommended type of weeding and 72% of them used recommended kind of herbicides and dose. Similarly, Harbi et al., (1998) reported that wide level disc harrow (WLD) is the most common implement in the rainfed sector of Sudan. WLD is a dual-purpose machine throughout the rainfed agricultural of Sudan. It is used for land preparation as well as seeding of the crop. The result of this study is not in line with results obtained by Abdel Rahman et al., (2013) who found that the majority of rainfed farmers (86%) in Um Alqora Locality, Gezira State, Sudan did not cultivate new crop varieties and the majority of them (90%) did not use any chemical fertilizers or pesticides. The result of this study is in line with a similar result obtained by Azhari et al., (2021) who found that the majority of participant farmers (66%, 78) used disc plow and disc harrow for land preparation , used recommended rainfed sorghum varieties respectively in addition to the use of all recommended fertilizers, herbicides and their doses in South Gezira Locality, Gezira State, Sudan. Also, this result is in the agreement with those reported by Elsheikh et al, (2018) who cited that the improved varieties of sorghum are one of the most influential factors that significantly lead to the adoption of the improved varieties of sorghum in North Kordofan State, Sudan.

Chi-squares test revealed that there was no significant association between participation in the programme and adoption of programme components**.** The farmers cited that there are many factors that hindered their adoption of the programme components, the most important of which include unavailability of the tractors with their machines at the

right or suitable time, unavailability of the recommended rainfed sorghum varieties, unavailability of the recommended fertilizers and unavailability of the recommended herbicides. Similarly, Kinfe (2018) reported that based on the farm level adoption of new sorghum varieties at different corners of Ethiopia, a large number of influential farmers among the adopters pointed out unequal access of farmers to extension information, and nearly half of the non-adopters reported that they were not aware of the existence of the improved sorghum such as Striga-resistant.

Table 3. Distribution of farmers according to their application of programme components

| Programme components | Application of programme components | | Participation in the programme/season | | |
|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Sig. |
| Use of Disc harrow & Disc plow | 100 | 80 | 25 | 20 | .213 |
| Use of recommended rainfed sorghum varieties | 95 | 76 | 40 | 32 | |
| Use of recommended cultivation method | 105 | 84 | 60 | 48 | |
| Use of recommended fertilizers and dose | 90 | 72 | 125 | 100 | |
| Use of recommended type of weeding | 93 | 76 | | | |
| Use of recommended Kind of herbicides and dose | 90 | 72 | | | |

**3.4 Farmer`s production before/after their participation in the programme:**

Table (4) shows the production /sac/fed before and after the participation of farmers in the programme. Before the programme 31.2% of farmers their production ranged between 1 to 1.5 sacs/fed only, 34.4 % of them their production ranged between and 34.4 % of them their production ranged between 3 to 3.5 sacs/fed. After the programme, 20% of farmers their production ranged between 5-15 sacs/fed, 40% of them their production ranged between 16-25 sacs/fed, and 24 % of them their production more than 25 sacs/fed. Similarly, according to the Ministry of Agriculture and Natural Resources, Gezira State report (2017) .The rainfed farmer`s average yield in the State before the programme implementation is 1.5 -2/ sac/feddan and the after programme implementation is 5 sac/feddan. Also, a similar result was obtained by Ahmed *et al.*, (2016) who found that rainfed farmers in Umalgura Locality, Gezira State, Sudan achieved a yield of 6-9 sack/feddan when growing improved varieties.

Table 4. Distribution of farmers according to their production before/after their participation in the programme

| Production/sac/fed | Before the programme | | After the programme | |
|---|---|---|---|---|
| | Frequency | % | Frequency | % |
| 1- 1.5 | 39 | 31.2 | 00 | 00 |
| 2-2.5 | 43 | 34.4 | 00 | 00 |
| 3-3.5 | 43 | 34.4 | 00 | 00 |
| 5-15 | 00 | 00 | 25 | 20 |
| 16-25 | 00 | 00 | 50 | 40 |
| More than 25 | 00 | 00 | 50 | 40 |
| Total | 125 | 100 | 125 | 100 |

1 ton = 10 sac, 1 hectare = 2. 38 feddan

**3.5 Source of information and correct application of programme components:**

It is revealed from the table (2) that (67.2%) of farmers reported that their source of information and correct application of programme components are the agricultural extension officers, (20%) of farmers reported that their source of information and correct application of programme components are neighbours, rainfed farmers, while (12.8%) of them reported that their source of information and correct application of programme components are their friends who cultivating rainfed sorghum. This result also is not in line with the results reported by Ahmed (2016) who

found that the proportion of rainfed farmers who have face to face contact with extension personnel is only a quarter of the study population in Umalgura Locality, Gezira State, Sudan.

Table 5. Distribution of farmers according to their source of information and correct application of programme components

| The Source | Frequency | % |
|---|---|---|
| Agricultural extension | 84 | 67.2 |
| Friends | 16 | 12.8 |
| Neighbours | 25 | 20 |
| Total | 125 | 100 |

**4. Conclusion and Recommendations**

From this study, it can be concluded that the national programme for supporting rainfed sorghum small-scale farmers are a very effective agricultural national strategy for the rainfed sector of the country , which in turn will help rainfed farmers to increase their production and consequently their income through the application (adoption )of the programme components.

The study recommends that this national programme for supporting rainfed sorghum small-scale farmers should continue, the agricultural inputs should be available, the agricultural extension officers should be trained on the programme components to be able to implement the programme effectively and further agricultural extension research in this area should be conducted.

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