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ADOPTION OF SORGHUM NATIONAL INTEGRATED SOLUTIONS TECHNICAL PACKAGE BY RAINFED FARMERS, GEZIRA, SUDAN

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Abstract

The effect of climate change on African agriculture represents a major challenge to continental agricultural development including food security, nutrition and management. In Sudan, the yield of rainfed crops is characterized by high variability in the yield due to the high variability in seasonal rainfall and does 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. The Federal Ministry of Agriculture has designed and financed a special programme for the traditional the rainfed sector of the country called 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 Agricultural Research Corporation (ARC) and the Agricultural Bank of Sudan. Field survey was used to collect data from 50 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

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administer the questionnaire. The collected data were coded, fed to computer and statistically analyzed using (SPSS), discussed interpreted using descriptive statistics and chi-square test. The results showed that the participant farmers adopted the programme components. The majority of chi-square test results revealed no significant association between farmer`s adoption of the programme components and participation in the programme and also no significant association between farmer`s adoption of the programme components and the selected socio-economic characteristics of the respondent farmers. From this study, it can be concluded that the NISP are very effective agricultural extension policy that can be applied in the rainfed sector of the country, which will help rainfed farmers to increase their income through their participation in various activities of the programme. The study recommends that NISP should become the main national policy specially designed for the agricultural rainfed sector of the country, the needed agricultural inputs should be available at a reasonable price, the curriculum of NISP should be updated and developed regularly to solve the constraints that might face the programme, in-service training should be organized for agricultural extension officers on various aspects related to the rainfed sector, various means for conduction the programme should be available, Further agricultural extension research should be conducted**.**

Keywords: *Food Security, Sudan, Rainfed Farmers.*

Introduction

Agriculture is the backbone of Sudan's economy and food security. As in developing countries, 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 (Abdel Rahman *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 (FAO, 2008).

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 (Abdel Rahman *et al.,* 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).

Information, knowledge and skills are important elements in farmer's awareness and practices to adapt to climate change. The capacity of farmers to adapt to climate change can be increased positively by the level of awareness about climate change in their communities (Idrisa *et al.,* 2012).

Agricultural extension organizations therefore, should transfer appropriate adaptation practices and management techniques for farmers such as drought resistant crop varieties in addition to knowledge of cropping and management systems which have resilient to changing climate conditions (Davis, 2009).

Despite this unfavorable situation, there are many adaptation strategies which have been tried in the Sudan, such as good agricultural management systems, drought resistant varieties, crop diversification and efficient water harvesting techniques. Therefore, Administration of Agricultural Extension and Technology Transfer in each State has an important role to play in transferring appropriate adaptation technologies to farmers particularly in the traditional rainfed subsector. Agricultural development requires the shift from traditional methods of production to new and scientific methods of production that include new technological components such as; new varieties, cultural practices, fertilizers, improved seeds, fungicide and so on. For farmers to adopt these new production technologies, they must first learn about them and then learn how to use them correctly in their farming system. This can be achieved by the help of an extension process, which, each step in it requires an educational and/or communication input, and represent the essence of agricultural development. Therefore, the function of agricultural extension regardless of how it is provided must be viewed as an essential component in the agricultural development process (Swanson, 1984).

According to Rogers (2003), "*trial ability* is the degree to which an innovation may be experimented with on a limited basis. Also, trial ability is positively correlated with the rate of adoption. The more an innovation is tried, the faster its adoption is. As discussed in the implementation stage of the innovation-decision process, reinvention may occur during the trial of the innovation. Then, the innovation may be changed or modified by the potential adopter. Increased reinvention may create faster adoption of the innovation. For the adoption of an innovation, another important factor is the vicarious trial, which is especially helpful for later adopters. However, Rogers stated that earlier adopters see the trial ability attribute of innovations as more important than later adopters. Concerning importance of extension Butt (1961) mentioned that extension workouts be undertaken because we now live in a changing World. Extension work (the education of people to help themselves) is thus selected as a means of guiding inevitable change in the right direction. Rogers (1962) stated that perhaps one of the most effective means of

conceptualizing adoption and diffusion behavior is first to view this behavior in its most basic and elementary form, and secondly to develop some of the complex varieties affecting this behavior. At one level of conceptualization, adoption of a new idea by an individual is a type of action. Parsons *et al.* (1952) concluded that an act consists of three basic elements; first an actor, second is orienting, and third is a situation. This conceptualization of human behavior implies:

a) Behavior is oriented towards attaining ends or goals,

b) It takes place is situation.

c) It is normatively regulated.

d) It involves an expenditure of effort or motivation.

1.1 Statement of the Problem

The Federal Ministry of Agriculture has designed and financed a special programme for the traditional rainfed sector of the country called Integrated Solutions Programme as the main adaptation strategy for the 2014/ 2020 growing seasons and spreading the adoption of technologies and technical packages 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.

1.2 Research problem

Sorghum is one of the most important crops of Sudan according to its economic and nutrition value. The climate change and use of traditional cultural practices and Sorghum is considered one of the most important crops in Sudan in terms of its economic and nutritional value. Climate change, use of traditional cultural practices, and farmers' failure to adopt new technologies are major problems for sorghum production in the rain-fed sector of Gezira State. Therefore, the Department of Agricultural Extension and Technology Transfer in the state adopted and implemented the Integrated Solutions Program as the main adaptation strategy to climate change since the 2014 growing season in all rainfed areas in the state, with the aim of diversifying and increasing production and productivity and disseminating new agricultural technologies. Of the crops grown in the traditional rain-fed areas of the state, the most important of which is sorghum and new introduced crops such as sesame and millet. are the major problems of sorghum production in the rainfed sector of Gezira State. Therefore the Administration of Agricultural Extension and Technology Transfer of the State was adopted and implemented the Integrated Solutions Programme as the main adaptation strategy to climate change since 2014 growing season in all rainfed areas of the state with the objective of diversifying and increasing the production and productivity of crops cultivated in the

traditional rainfed areas in the State, mainly sorghum and new introduced crops such as sesame and millet.

1.3 Research objectives

1.3.1 Main objective

The main objective of this study was to assess the farmer`s adoption of national integrated solution package for rainfed sorghum in South Gezira Locality, Gezira State, Sudan.

1.3.2 Specific objectives

The Specific objectives of this study are to:

1- To determine selected socioeconomic characteristics of rainfed farmers in South Gezira Locality, Gezira State, Sudan. (Age, educational level, farm size and land ownership).

2- To assess the application of rainfed sorghum production technical package (Use of water harvesting techniques, use of recommended improved seeds, use of chemical fertilizers, cultivation method and chemical weeding).

3- To measure sorghum production of respondent farmers.

1.4 Research Question

Does the rainfed farmers in South Gezira Locality, Gezira State adopt the national integrated solution package for rainfed sorghum?

1.5 Research hypotheses

1.5.1 Null hypothesis

The rainfed farmers in South Gezira Locality, Gezira State did not adopt the national integrated solution package for rainfed sorghum.

1.5.2 Alternate hypothesis

The rainfed farmers in South Gezira Locality, Gezira State have adopted the national integrated solution package for rainfed sorghum.

1.6 Independent and dependent variables

Table (1): This table shows the independent variables as in column (A) and the dependent variables as in column (B).

Independent variables (A)	Dependent variables (B)
A- Selected socioeconomic characteristics of the respondents: 1- Gender 2- Age. 3- Educational level 4- Farm size 5 - Kind of land ownership	Application of the national integrated solutions package for rainfed sorghum : 1- Land preparation 2- use of recommended rainfed sorghum varieties 3- use of chemical fertilizers 4- Cultivation method 5- Chemical Weeding

1.7 Need for the study

a. The results of this study will help the Administration of Agricultural Extension and Technology Transfer, Gezira State and other States to plan and adopt suitable agricultural extension programme specially designed to increase the adoption rate of rainfed sorghum production technical package.

b. It is anticipated that the increase of adoption rate of rainfed sorghum production technical package by farmers in rainfed sectors in Gezira State and other States may help in increasing their production and income from rainfed sorghum and improving other aspects of their life that will lead to better standards of living in rural areas of the country.

RESEARCH METHODOLOGY

2.1 Area of the study:

This study was conducted in South Gezira Locality. The South Gezira Locality as mentioned in the literature is one of eight 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 a considered as the biggest part of Gezira Scheme the largest agricultural Scheme in Sudan, with 70,000 Km long irrigation canals, 210000 feddans, 2000 villages and 500 camps . The majority of the people work in agriculture and animal rearing

2.2 Population and sample size:

The number of participant farmers in the programme (NISP) in the study area for 2019/2020 growing seasons was estimated to be 100 using the full count method. Fifty per

cent of them and an equal number from non- participant farmers (for comparison) were selected using the simple random sampling technique to be used as the study sample.

2.3 Data Collection:

A close ended questionnaire was constructed and the personal interview technique was used to administer the questionnaire. A pretest for the questionnaire was made with 15 farmers. The interview continued from October to November 2019.

3.4 Data analysis:

The data were coded, fed to computer and statistically analyzed using Statistical Packages for Social Sciences (SPSS), discussed interpreted using descriptive statistics (percentage, frequency distribution) and chi-squire test at 0.05 significance level or less.

RESULTS AND DISCCUSSION

In this chapter the collected data were statistically analyzed and interpreted using descriptive statistics (percentage, frequency distribution) and chi-squares test at 0.05 significance level or less. The results are discussed below.

3.1 Descriptive analysis of the data:

3.1.1 Selected socioeconomic characteristics of farmers:

3.1.1.1 Gender:

Table (2): Distribution of the participants and non-participants according to their Sex

Sex	Participants		Non-participants	
	Frequency	%	Frequency	%
Male	41	82	50	100
Female	9	18	0	0
Total	50	100	50	100

Table (2) showed that the majority of the participants (82%) and all the non-participant farmers (100%) were males, while (18%) of the participants were female. This situation has prevailed in Central Sudan only as a result of the values, norms, religion and traditions of rural people in this area, but in the other parts of the country, we find that women farmers form the majority of those employed in the agricultural sector. The result of this study is not in line with results obtained by Saito *et al* (1994) who observed that rural women in some sub-Saharan African countries constitute the majority of smallholder farmers, provide most of the labour, and manage many farms on a daily basis.

3.1.1.2 Age:

Table (3): Distribution of the participants and non-participants according to their age group

Age group	Participants		Non-participants	
	Frequency	%	Frequency	%
15-25	6	12	5	10
26-35	9	18	7	14
36-45	13	26	20	40
46 above a	22	44	18	36
Total	50	100	50	100

The age of participant and non-participants farmers ranged from 15 to 55 years and above as shown in table (3). (12%, 10%) of the participants and non-participants within the age of 15-25 years respectively, (18%, 14%) of them within the age of 26-35 years respectively, (26%, 40%) of them within the middle age of 36-45 years respectively, and (44%, 46%) of them within the age of 46 years and above respectively. Generally, the assumption is that younger people tend to be more productive than that of their older counterparts.

3.1.1.3 Educational level:

Table (4): Distribution of the participants and non-participants according to their educational level

Educational level	Participants		Non-participants	
	Frequency	%	Frequency	%
Illiterate	4	8	3	6
Khalwa	2	4	3	6
Primary	15	30	12	24
Secondary	21	42	16	38
University and above	8	16	13	26
Total	50	100	50	100

In term of educationl level, table (4) revealed that (8%, 6%) of the participants and non-participants farmers were illiterate respectively, (4%, 6%) had acquired Khalwa education respectively, (30%, 24%) had primary education respectively, (42%, 38%) had acquired secondary education respectively, and (16%,26%) of them possessed university education and

above respectively. 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 e*t al.* (2020).

3.1.1.4 Farm size:

Table (5): Distribution of the participants and non-participants according to their farm size

Farm size/fed	Participants		Non-participant	
	Frequency	%	Frequency	%
1 – 5	16	32	17	34
6 – 10	10	20	8	16
11 and above	24	48	25	50
Total	50	100	50	100

Table (5) indicates that (32%, 34%) of the participants and non-participants their farm size was 1-5/fed respectively, (20%, 16%) of them their farm size was 6-10/fed respectively, and (48%, 50%) of them their farm size was 11/fed and above respectively. Generally, the assumption is that farmers with large farm size tend to adopt recommended agricultural practices than other farmers with small farm size.

3.1.1.5 Kind of land ownership:

Table (6): Distribution of the participants and non-participants according to their kind of land ownership

Kind of land ownership	Participants		Non-participants	
	Frequency	%	Frequency	%
Personal ownership	22	44	30	60
Renting from farmers	15	30	12	24
Partnership	13	26	8	16
Total	50	100	50	100

Table (6) showed that (44%, 60%) of the participants and non-participants possessed personal land ownership respectively, (30%, 24%) of the participants and non-participants renting the land from other farmers respectively. (26%, 16%) of the participants and non-participants cultivate the land in partnership with other farmers respectively. It is generally hypothesized that land ownership encourages agricultural technology adoption, while the lack of land ownership discourages it.

3.1.2.1 Types of agricultural equipment used in land preparation:

Table (7): Distribution of the participants and non-participants according to types of agricultural equipment used in land preparation

Types of agricultural equipment used	Participants		Non-participants	
	Frequency	%	Frequency	%
Disc harrow only	7	14	15	30
Disc plow only	10	20	11	22
Disc harrow & Disc plow	33	66	23	46
Did not use	0	0	1	2
Total	50	100	50	100

Table (7) shows the type of agricultural equipment used in land preparation as rainwater harvesting technique. (14%, 30%) of the participants and non-participants used disc harrow only for land preparation respectively, (20%, 22%) of them used disc plow only respectively, (66%, 46%) of them used disc plow and disc harrow respectively, and (2%) of the non-participants used other equipment for land preparation. In Sudan different types of local rain water harvesting techniques such as, ridging and high terracing were recommended to store rain water in the field after each rainfall throughout the rainy season. The result of this study is not in line with results obtained by Akpoikpe *et al.* (2010) who cited that the majority of respondent farmers in Sudanian areas (North Benin, Togo and Ghana with southern Burkina and Niger) did not adopt the use of plowing as soil water management adaptation technology.

3.1.2.2 Recommended rainfed sorghum varieties used:

Table (8): Distribution of the participants and non-participants according to recommended rainfed sorghum varieties used

Recommended rainfed sorghum varieties used	Participants		Non-participants	
	Frequency	%	Frequency	%
Arfa gadamak	39	78	24	48
Butana	4	8	8	16
Gishaish	7	14	10	20
Others	0	0	8	16
Total	50	100	50	100

Table (8) revealed that (78%, 48%) of the participants and non-participants used Arfa gadamak variety (Early maturing variety) as recommended by ARC respectively, (8%, 16%) of

them used Butana variety (Early maturing variety) as recommended by ARC respectively, (14%, 20%) of them used Gishaish variety respectively, and (16%) of non-participants used other varieties. Rainfed farmers will need to cultivate early maturing crop varieties or drought resistant crop varieties as adaptive methods to avoid the variability of rainfall. Similar results were reported by Ahmed (2016) who found that (62%) of the respondents adopted the use of improved rainfed sorghum varieties in Umalgura Locality rainfed area, Gezira State, Sudan. The result of this study also agreed with the results obtained by Anyoha *et al.* (2013) who mentioned that the majority of crop farmers in Umuahia South Area of Abia State, Nigeria is adopting the cultivation of early maturing varieties.

3.1.2.3 Kind of recommended fertilizers used:

Table (9): Distribution of the participants and non-participants according to kind of recommended fertilizers used

Kind of fertilizers used	Participants		Non- participants	
	Frequency	%	Frequency	%
DAP only	9	18	26	52
Urea Only	30	60	18	36
NPK	11	22	3	6
Did not use	0	0	3	6
Total	50	100	50	100

Table (9) shows that (18%, 52%) of the participants and non-participants used DAP only respectively, (60%, 36%) of them used urea only respectively, (22%, 6%) of them used NPK only respectively, and (6%) of non-participants did not use any fertilizer. All mentioned kind of fertilizers were recommended by ARC. According to Abu-Sara *et al.* (2002) in recent years sorghum yield in both irrigated schemes and rainfed sector, has been declining, accordingly research with multi-nutrient fertilizer has been conducted, in which a NPK complex fertilizers such as ASN and AS were compared to urea at Gezira and New Halfa , therefore increase in yield was observed for the higher dose of the NPK treatments in both locations, in comparison to that of the standard fertilization practice using AS fertilizer or urea.

3.1.2.4 Dose of recommended fertilizers used:

Table (10): Distribution of the participants and non-participants according to recommended dose of recommended fertilizers used

Dose used/feddan	Participants		Non- participants	
	Frequency	%	Frequency	%
¼ sack	7	14	4	8
½ sack	16	32	8	16
one sack	26	52	32	64
Did not use	1	2	6	12
Total	50	100	50	100

From table (10) it can be seen that (14%, 8%) of the participants and non- participants respectively used only ¼ sack from one of the recommended fertilizers, (32%, 16%) of them used only ½ sack from one of the recommended fertilizers respectively, (52%, 64%) of them used one sack from one of the recommended fertilizers respectively, and (2%.12%) of them did not use any fertilizer respectively. All mentioned doses were recommended by ARC as boosting doses.

3.1.2.5 Cultivation method used:

Table (11): Distribution of the participants and non-participants according to cultivation method used

Cultivation method used	Participants		Non- participants	
	Frequency	%	Frequency	%
Bottom of the ridge	16	32	26	52
Top of the ridge	13	26	23	46
Did not use	21	42	1	2
Total	50	100	50	100

Table (11) showed that (32%, 52%) of the participants and non-participants cultivated their crop on the bottom of the ridges (Furrow) as recommended by ARC respectively, (26%, 46%) of them cultivated their crop on the top of the ridges respectively, and (42%, 2%) of them did not use the ridges in cultivating their crop respectively.

3.1.2.6 Type of weeding used:

Table (12): Distribution of the participants and non-participants according to type of weeding used

Type of weeding used	Participants		Non- participants	
	Frequency	%	Frequency	%
Manually	9	18	37	84
Using herbicides	41	82	13	26
Total	50	100	50	100

As shown in table (12) (82%, 26%) of the participants and non-participants used herbicides as weeds control method respectively, (18%, 84%) of them used the manual weeding as weeds control method as recommended by ARC respectively.

3.1.2.7 Kind of herbicides used:

Table (13): Distribution of the participants and non-participants according to kind of recommended herbicides used

Kind of herbicides used	Participants		Non- participants	
	Frequency	%	Frequency	%
Vardo prime	19	38	3	6
Clinic	9	18	5	10
Stomp	13	26	6	12
Did not use	9	18	36	72
Total	50	100	50	100

Table (13) revealed that (38%, 6%) of participants and non-participants used Vardo prime herbicide as recommended by ARC respectively, (18%, 10%) of them used Clinic herbicide as recommended by ARC respectively, (26%, 12%) of them used Stomp herbicide as recommended by ARC respectively and (18%, 72%) did not use any herbicides as recommended by ARC respectively.

3.1.2.8 Dose of recommended herbicides used:

Table (14): Distribution of the participants and non-participants according to recommended dose used of recommended herbicides used

Dose used	Participants		Non- participants	
	Frequency	%	Frequency	%
1 liter per feddan	36	72	9	18
1 ½ liter per feddan	5	10	1	2
Did not use	9	18	40	80
Total	50	100	50	100

Table (14) indicates that (72%, 18%) of the participants and non- participants used 1 liter/feddan respectively, (10%, 2%) of them used 1 ½ liter/ feddan respectively and (18%, 80%) of them did not use any dose respectively.

3.1.2.9 Production of the crop:

Table (15): Distribution of the participants and non-participants according to their crop production

Production Sac/feddan	Participants		Non-participants	
	Frequency	%	Frequency	%
1-2	1	2	40	80
3-3½	9	18	7	14
4-5	15	30	3	6
6 and above	25	50	0	0
Total	50	100	50	100

1 sac = 100kg

Table (15) showed that (50%) of the participants reported that their production ranges between 6 and above sac/fed compared to (00%) of non-participants. (30%, 6%) of participants and non-participants reported that their production ranges between 4-5 sacs/fed respectively. (18%, 14 %) of the participants and non-participants reported that their production ranges between 3-4 sacs/fed respectively. (2%, 80%) of the participants and non-participants reported that their production ranges between 1-2 sacs/fed respectively. The results clearly showed that the sorghum crop yield obtained by the participants differed significantly in comparison to the yield obtained by non-participants. Similarly, according to 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.

3.2 The results of chi-squares test:

Chi-squares test was used here to test the association between participation in NISPP, selected personal characteristics of the respondents and adoption of National Integrated Solution programme Package for Rainfed Sorghum.

3.2.1 Association between number of participation in NISPP activities and type of agricultural equipment used in land preparation:

Table (16): Chi-squire test for association between number of participation in NISPP activities and type of agricultural equipment used in land preparation

Number of participation in NISPP /season	**Type of agricultural equipment used in land preparation**				**Total**	**Sig.**
	Disc harrow only	**Disc plow only**	**Disk harrow and Disk plow**	**others**		**0.377**
Did not participate	**15**	**11**	**23**	**1**	**50**	
Three seasons	**0**	**1**	**4**	**0**	**5**	
Four seasons and above	**7**	**9**	**29**	**0**	**45**	
Total	**22**	**21**	**56**	**1**	**100**	

Significance level 0.05.

The result showed in table (16) revealed that there was no significant association between number of participation in NISPP activities and adoption of type of agricultural equipment used in land preparation. This may due to unavailability of the tractors with their machines at the right or suitable time as reported by farmers.

3.2.2 Association between number of participation in NISPP activities and recommended rainfed sorghum varieties used:

Table (17): Chi-squire test for association between number of participation in NISPP activities and recommended rainfed sorghum varieties used.

Number of participation in NISPP /season	Recommended rainfed sorghum varieties used				Total	Sig.
	Arfa gadamak	Butanta	Gishaish	others		0.022
Did not participate	24	8	10	8	50	
Three seasons	5	0	0	0	5	
Four seasons and above	34	4	7	0	45	
Total	63	12	17	8	100	

Significance Level 0.05.

Table (17) revealed that there was no significant association between number of participation in NISPP activities and adoption of recommended rainfed sorghum varieties used. This may due to unavailability of the recommended rainfed sorghum varieties as reported by farmers.

3.2.3 Association between number of participation in NISPP activities and kind of recommended fertilizers used:

Table (18): Chi-squire test for association between number of participation in NISPP activities and kind of recommended fertilizers used.

Number of participation in NISPP /season	kind of recommended fertilizers used				Total	Sig.
	DAP Only	Urea Only	NPK	Did not use		
Did not participate	26	18	3	3	50	0.002
Three seasons	0	3	2	0	5	
Four seasons and above	9	27	9	0	45	
Total	35	48	14	3	100	

Significance level 0.05 or less.

Table (18) showed that there was significant association between number of participation in NISPP activities and adoption of recommended kind of fertilizers used.

3.2.4 Association between number of participation in NISPP activities and recommended dose used of recommended kind of fertilizers used:

Table (19): Chi-squire test for association between number of participation in NISPP activities and recommended dose used of recommended kind of fertilizers used

Number of participation in NISPP/season	Recommended dose used				Total	Sig.
	¼ sack per feddan	½ sack per feddan	One sack per feddan	Did not use		
Did not participate	4	8	32	6	50	0.179
Three seasons	0	2	3	0	5	
Four seasons and above	7	14	23	1	45	
Total	11	24	58	7	100	

Significance level 0.05 or less.

Table (19) indicates that there was no significant association between number of participation in NISPP activities and adoption of recommended dose used of recommended kind of fertilizers used. This may due to believe that the amount of recommend dose is small for each fertilizer as farmers think.

3.2.5 Association between numbers of participation in NISPP activities and recommended cultivation method used:

Table (20): Chi-squire test for association between number of participation in NISPP activities and recommended cultivation method used

Number of participation in NISPP /season	Recommended cultivation method used			Total	Sig.
	Bottom of the ridge	Top of the ridge Top of the ridge	Did not use		
Did not participate	26	23	1	50	0.000
Three seasons	0	1	4	5	
Four seasons and above	16	12	17	45	
Total	42	36	22	100	

Significance level 0.05 or less.

Table (20) showed that there was significant association between number of participation in NISPP activities and adoption of recommended cultivation method used.

3.2.6 Association between numbers of participation in NISPP activities and recommended type of weeding used:

Table (21): Chi-squire test for association between number of participation in NISPP activities and recommended type of weeding used

Number of participation in NISPP /season	Recommended kind of weeding used		Total	Sig.
	Manually	Using Herbicides		
Did not Participate	37	13	50	0.000
Three seasons	1	4	5	
Four seasons and above	8	37	45	
Total	46	54	100	

Significance Level 0-05 or less

Table (21) revealed that there was significant association between number of participation in NISPP activities and adoption of recommended type of weeding used.

3.2.7 Association between number of participation in NISPP activities and kind of recommended herbicides used:

Table (22): Chi-squire test for associations between number of participation in NISPP activities and recommended kind of herbicides used

Number of participation in NISPP /season	Recommended kind of herbicides used				Total	Sig.
	Vardo prime	Clinic	Stomp	Did not use		
Did not Participate	3	5	6	36	50	0.000
Three seasons	1	3	0	1	5	
Four seasons and above	18	6	13	8	45	
Total	22	14	19	45	100	

Significance level 0.05 or less.

Table (22) indicates that there was significant association between number of participation in NISPP activities and adoption of recommended kind of herbicides used.

3.2.8 Association between number of participation in NISPP activities and recommended dose used of recommended kind of herbicides used:

Table (23): Chi-squire test for associations between number of participation in NISPP activities and recommended dose used of recommended kind of herbicides used.

Number of participation in NISPP/season	Recommended Dose used			Total	Sig.
	1 litter per feddan	½ litter per feddan	Did not use		
Did not Participate	9	1	40	50	0.000
Three seasons	4	0	1	5	
Four seasons and above	32	5	8	45	
Total	45	6	49	100	

Significance level 0-05 or less.

Table (23) revealed that there was significant association between number of participation in NISPP activities and adoption of recommended dose used of recommended kind of herbicides used.

SUMMARY, CONCLUSION AND ECOMMENDATIONS

The main objective of this study was to assess the farmer`s adoption of national integrated solution package for rainfed sorghum, South Gezira Locality, Gezira State, Sudan. The number of rainefed farmers in the study area was estimated to be 100 small-scale farmers. Fifty percent of the population were interviewed using personal interview technique. The collected data were coded, fed to computer and statistically analyzed using the Statistical Packages for Social Sciences (SPSS), discussed interpreted using descriptive statistics (percentage, frequency distribution) and chi-squire test.

4.1 Summary of the findings

4.1.1 Descriptive analysis of the data

1- The majority of the participants (82%) and all non- participant farmers (100%) were male, while (18%) of participants were female.

2- (44%, 46%) of the participants and non – participants within the age of 46 years and above respectively.

3- All the participants and non-participants (100%) in the study area obtained the basic education required for better understanding and ability to embrace the adoption of farm technologies.

4- (48%, 50%) of the participants and non-participants their farm size within 11/fed and above respectively.

5- (44%, 60%) of the participants and non-participants possessed personal land ownership respectively.

6- (90%) of the participants participated in the programme activities for two seasons and all of them (100%) participated in the programme activities for three seasons and above.

7- (66%, 46%) of the of participants and non-participants used disc plow and disc harrow respectively in land preparation for water harvesting.

8- (78%, 48%) of the participants and non-participants used Arfa gadamak variety (Early maturing variety) as recommendedv by ARC respectively.

9- All the participants (100%) and (94%) of the non-participants used the chemical fertilizers as recommended by ARC.

10- (52%, 64%) of the participants and non-participants used one sack from one of the recommended fertilizers respectively.

11- (32%, 52%) of the participants and non-participants cultivated their crop on the bottom of the ridges as recommended by ARC respectively.

12- (82%, 26%) of the participants and non-participants used herbicides as weeds control method respectively.

13- (18%, 72%) of the participants and non-participants did not use any herbicides as recommended by ARC respectively.

14- (18%, 80%) of the participants and non-participants did not use any dose of recommended herbicides respectively.

4.1.2 Test of significance using chi-square test

9- There was no significant association between number of participation in NISPP activities and adoption of type of agricultural equipment used in land preparation.

10- There was no significant association between number of participation in NISPP activities and adoption of recommended rainfed sorghum varieties used.

11- There was significant association between number of participation in NISPP activities and adoption of recommended kind of fertilizers used.

12- There was no significant association between number of participation in NISPP activities and adoption of recommended dose used of recommended kind of fertilizers used.

13- There was significant association between number of participation in NISPP activities and adoption of recommended cultivation method used.

14- There was significant association between number of participation in NISPP activities and adoption of recommended type of weeding used.

15- There was significant association between number of participation in NISPP activities and adoption of recommended kind of herbicides used.

16- There was significant association between number of participation in NISPP activities and adoption of recommended dose used of recommended kind of herbicides used.

4.2 Conclusion:

From this study it can be concluded that the NISPP are very effective agricultural extension policy that can be applied in the rainfed sector of the country, which will help rainfed farmers to increase their income through their participation in various activities of the programme.

4.3 Recommendations:

Based on the results of this study and to improve the efficiency of NISPP, the study recommends the followings:

1- NISPP should become the main national policy specially designed for the agricultural rainfed sector of the country.

2- The needed agricultural inputs should be available at a reasonable price.

3- The curriculum of NISPP should be updated and developed regularly to solve the constraints that might face the programme.

4- In-service training should be organized for agricultural extension officers on various aspects related to the rainfed sector.

5- Various means for conducting the programme should be available.

6- Further agricultural extension research should be conducted.

REFERENCES

A basic and necessary section, and any research without documenting the information with references and sources is worthless research. The most important point is that the references themselves must be from reliable sources, such as international publishing houses or magazines

Prestigious scientific. References must also be as recent as possible, preferably from scientific papers and books published in recent years, up to the year the research itself was published.

After completing writing the research, and before officially sending it to the scientific journal.

It must be reviewed several times, and to ensure that it is free of any errors, whether scientific or linguistic. It is also preferable to seek the help of colleagues and friends to obtain evaluations that contribute to making the scientific paper for research in the best possible form and form.

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