NSUK Journal of Science & Technology, Vol. 6: No. 2. 2016. pp. 154 -159 ISSN: 1597- 5527

ASSESSMENT OF THE RATES OF ADOPTION OF IMPROVED CROP PRODUCTION TECHNOLOGIES IN THE SUDAN SAVANNAH AGRO-ECOLOGICAL ZONE OF NIGERIA (2008-2011)

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ABSTRACT

Some improved crop production technologies were promoted in Kano and Katsina States of Nigeria since 2008 in a series of farmer-managed field trials in four Innovation Platforms (IPs) in the Sudan Savannah Task Force (SSTF) of Kano-Katsina-Maradi Pilot Learning Site (KKM -PLS) of the Sub Saharan African Challenge Programme (SSA-CP). The objective of this paper was to determine the rates and intensities of adoption of these technologies. To achieve this, primary data were collected in 2011 cropping season using questionnaires administered on 300 farming households, consisting of ten households each selected randomly from 30 villages each in the clean, conventional and treatment site. The data were analyzed using adoption level and index. The results showed that, out of the 231 crop farmers that participated or has access to the SSTF improved crop technologies, 59.31% adopted them, while the estimated mean adoption rates for the introduced crop varieties of maize, sorghum, cowpea, millet and groundnut were: 67%, 46%, 54%, 46% and 52%, respectively. The study concludes that the adoption rates for the introduced technologies were satisfactory. It is still necessary to form a strong linkage between farmers and input sources, particularly seed and fertilizer suppliers to improve their timely availability and enhance productivity.

Keywords

Rates, Adoption, Crop, Production, Technologies, Sudan, Savannah, Agro-ecological, Zone

INTRODUCTION

The Sub Saharan Africa Challenge Programme (SSA-CP) was initiated in 2004 following extensive consultations with numerous agricultural stakeholders (researchers, extension and development agents, policy makers, farmers and the private sectors) to diagnose the reasons behind the underperformance of agricultural research in Africa (Ayanwale *et al*., 2009). The consultations established that besides inadequate funding, the main impediment to the contribution of Africans agricultural research to agricultural development lies in the way the research is organized and conducted. Research, technology transfer and technology use have been treated as independent activities whereby research derived knowledge consisting of large prescriptive technology packages flows linearly from researchers to farmers through extension agents (Ayanwale *et al*., 2009). The consultations proposed an alternative approach that aims to appropriately embed agricultural research within a larger system of innovation whereby knowledge from numerous sources (comprising all actors and stakeholders) are integrated and effectively put into use. This approach to agricultural research is termed Integrated Agricultural Research for Development (IAR4D) and has been adopted by the SSA CP (Ayanwale *et al*., 2009).

The Integrated Agricultural Research for Development (IAR4D) aims to improve tremendously the adoption rates of the technologies introduced which is the main focus of this paper. Forum for Agricultural Research in Africa's (FARA) SSA-CP PLS programme aims to embed agricultural research into a broader innovation's system approach where knowledge from various sources is integrated and put into use. The fundamental structure for this is an "Innovation Platform" which comprised of a partnership of researchers, extension workers, farmer representatives, traditional leaders, private firms, Non-Governmental Organizations (NGOs), and government policy makers who interact to support sustainable agricultural development (Ellis-Jones and Kamara, 2010).

The Sub Saharan African Challenge Programme (SSA-CP) operates across three PLS projects[1] of which KKM falls within the West African sub-region and is coordinated by Conference of the Agricultural Research leaders in West and Central Africa (CORAF)/West and Central Africa Council for Agricultural Research and Development (WECARD) and operates across three PLS projects of which KKM falls within the West African sub-region. The KKM PLS comprises three Taskforces, one each in three agro-ecological zones, namely, the Sahel, Sudan Savannah and Northern Guinea Savannah. This study covers the Sudan Savannah Task Force (SSTF)). Each Taskforce aims at improving the productivity of farming systems and ensuring efficient use of resources through technical, administrative, marketing and management improvements (Forum for Agricultural Research in Africa, 2009) in order to improve the living standards of the benefiting communities. The SSTF covers the Sudan Savannah agro-ecological zone of Nigeria.

The rate of adoption of a technology is defined as the relative speed with which members of a social system adopt an innovation. It is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation (Rogers, 1962). The rate of adoption of an innovation is determined by an individual's adoption category. In general, individuals who first adopt an innovation require a shorter adoption period than later adopters.

Earlier studies (Seyoum *et al*., 1998; Obwoma, 2000; and Ajibefun, 2006) found that the low rate of adoption of improved agricultural technologies among farmers could be due to low expected benefits from the use of such technologies, or it could be due to farmers' socio-economic characteristics or factors specific to the technology which may not encourage the adoption of such technologies by farmers.

Adoption rate and adoption intensity measures yield equivalent results when farm sizes are roughly the same and/ or the rate of adoption is constant across farm sizes, which often is not the case (Morris *et al*., 1999). Adoption rate differs with farm size. This means a particular innovation is taken up more by the large-scale farmers than the small scale farmers. Under these circumstances, Morris *et al*. (1999) argued that the proportion of farmers adopting the innovation can differ significantly from the proportion of the total cultivated areas affected by the innovation. In the study area, information on rates of adoption of promoted agricultural technologies is not readily available to guide agricultural extension work, policy and further scientific work on such technologies. Thus, this study is more of evaluating the impact of the promoted agricultural innovations by the SSTF in terms of the adoption success of promoted technologies.

The objectives of this study were to; (i) examine the socio-economic characteristics of crop farmers that participated in the technologies dissemination (ii) determine the adoption rates of the different crop production technologies and, (iii) examine the rates of adoption of the components of the different crop production technologies.

MATERIALS AND METHODS

The data for the study were obtained from surveys of the farming households in the project villages using structured questionnaire administered on the selected households by trained enumerators. The data covered four local government areas each in Katsina and Kano States. About 300 farming households, consisting of ten households each selected from 30 villages each in the clean, conventional and treatment sites using the random sampling method. Out of the total 300 farming households sampled for the study, 231 farming households adopted the introduced technology. The sampling frame was provided by the SSTF Office in Kano.

Four improved crop technologies including new improved crop varieties, burying of inorganic fertilizer application method, use of on the row plant spacing and the application of pesticides were covered. These technologies were applied as component technologies in the production of Maize, Sorghum, Cowpea, Millet and Groundnut which were the major crops of farmers in the SSTF.

The data collected include socio-economic characteristics of crop farmers like age (years), farm size (hectare), crop farming experience (number of years engaged in crop farming), educational level (number of years spent in school), household size, marital status and total area of land cultivated to the crop and actual land area cultivated to the improved variety of the crop as well as the components of the improved crop technology adopted.

The tools of analysis used were descriptive statistics using simple frequencies, percentages and means to achieve objective (i) while adoption rates and adoption intensity were used to achieve objectives (ii) and (iii).

Over the years, two methods of determining adoption rate have been established in literature; the first method is based on expressing the number of farmers adopting a particular technology as a percentage of the total number of farmers under study (Floyed *et al*., 1999) while the second method, expresses the land area put under a particular technology as a percentage of the total land area grown to the crop (Akino and Hayami, 1975, Ahmed and Sanders, 1991, and Philips *et al*., 2000). While the former is said to be subjective in the sense that adequate consideration is not given to variation in sizes of farm holdings between adopters and non-adopters (Philip *et al*., 2000), the latter is more applicable to crop production with an additional advantage of providing for easy determination of the contribution of the technology to the production of the particular crop within in the study area.

The adoption index and adoption rate were the tools used to estimate the rate of adoption of improved crop production technologies and their components.

Adoption index model was specified as:

$$B_v = \frac{\sum_i^n R_{vi}}{\sum_i^n R_T} \cdots\cdots \quad (i)$$

Where:

B_v = the adoption index for the crop variety v.

R_{vi} = land area grown to crop variety v by farmer *i* (*i* = 1, 2, ---, n)

R_T = total land area cropped by farmer *i*.

n = total number of farmers in the sample

Adoption rate is given by

$$B = \frac{x}{y}100 \;\ldots\ldots\text{(ii)}$$

Where;

B = Adoption rate of the technology expressed as a percentage

X = Number of people using the technology at the time of study

Y = Total number of people who have access to the technology

RESULTS AND DISCUSSION

Socio-economic characteristics of the crop farmers

Basic socio-economic characteristics of crop farmers like age, farm size, crop farming experience, educational level, household size, and marital status were discussed. These characteristics are imperative to the understanding of the crop farmers, as they have effects on the farmers' behaviour and adoption of the SSTF improved crop production practices extended to them.

Age of the crop farmers

Age is a very important variable that determines the degree of active involvement of an individual in crop production. This is particularly true of the traditional agricultural system of the developing countries where most of the farm operations are performed manually using crude and simple farm implements. Table 1 shows the age distribution of the farmers. The study showed that 51% of the crop farmers were within the active age bracket, which ranged between 20 and 49 years. However, only about 3% were more than 69 years old. The mean age of the farmers was 49.83 years. This age can positively influence the adoption of SSTF improved crop production practices, which invariably could influence the level of crop production. Loren (1984) stated that the middle aged farmers appear to be the most productive. Thus, with the farmers falling into the active age, it was expected that the rates of adoption would be high.

Farm size

The farm size of the crop farmers in the study area ranges between 0.7 hectares to 12.3 hectares, with 2.8 hectares as the mean. Sampled crop farmers were grouped into six farm holdings categories as shown in Table 2. From the table, 88% of the farmers had farm land ranging from less than 1 hectare to 3 hectares, 42% had between 2.1 hectares to 4.0 hectares, and 15% had between 4.1 hectares and 6.0 hectares, while 10% had between 6.1 to 10 hectares. The above findings showed that crop production in the study area was largely practiced by small-scale farmers as 98.34% cultivated lands within the range of less than or equal to 1 hectare to 5.0 hectares, the size considered to be small scale holding in Nigeria.

Years of crop production experience

Experience in agricultural production and processing can raise productivity (Johnson, 1990).The process of learning by doing makes farmers acquire knowledge and skills in their production. This is called gained experience. It measures the duration an individual farmer was involved in crop production and thus interpreted as the more the number of years of crop production by a farmer, the greater the experience gained. This automatically influences individual's understanding and adoption of the improved technologies. The mean years of experience among the sampled crop farmers in the study area was over 27 years. The farming experience of the farmers is shown in Table 3. The result indicated that over 65% of the farmers have been producing crop for over 22 years. On the other hand, only 4% had crop production experience of less than 12 years.

Educational level

Among the major constraints that militate against the awareness and adoption of improved technology in the agricultural sector is illiteracy (Umar, 2005; Saka and Lawal, 2009). One of the most important farmer level factor that can influence the adoption of improved technology and hence productivity of crops is the level of education of farmers. The educational level of farmers is reported in Table 4. From the result, 37% of the crop farmers had Arabic/Quranic education, an educational level that makes farmers only able to read in Arabic, whereas, most literatures on farm technologies are written in English. This is due to the fact that the study area is a predominantly Muslim community where Islamic knowledge is given a high priority. Over 23% and 3% of the farmers had primary education and post-secondary education respectively while 21% had some level of adult education, which also may not be very useful especially when farm technology information are written in technical forms. However, this moderate level of literacy in the study area implies that the farmers may be ready to accept and adopt innovations brought to them.

Household size

A household is defined in this research as the number of persons living together and eating from the same pot. The household size determines the available human labour force that can be employed in carrying out crop production activities. The major source of human labour supply in traditional agricultural production, which is labour intensive, is family labour. The household size distribution of crop farmers is shown in Table 5. Among the farmers, 53% were having the range of 11 and 20 persons in their households, while only about 4% had more than 25 persons in their households. The mean household size was 13 persons, implying that this could be a source of cheap family labour among the farmers household.

The rate of adoption of SSTF improved crop production technologies

The estimated adoption rates of the promoted crop production technologies are shown in Table 6. The result shows that about 24% of respondents adopted the improved crop varieties. However, the adoption index ranges from 2 to 100% on individual farmer basis while the mean adoption index among the farmers was 51%. Farmers in the SSTF have, most of the times, used their own seeds which may not be improved or used improved seeds that have been in use for upward of three years without renewal and this can lead to low adoption rate.

For the use of inorganic fertilizers application method, about 29% of the crop farmers adopted the burying method with a mean adoption index of 56%. The practice among most non project farmers in the SSTF is spreading fertilizers on the surface near the base of the crop which makes nutrient uptake to be low. In these days of high cost of fertilizers due to the almost completely removed subsidy by government, farmers have learnt to be more prudent in the use of fertilizers; hence about 30% of them adopted this practice.

Pesticide use among farmers generally is herbicides for weeding and insecticides for insect control on cowpeas and vegetables. In the SSTF, the use of this technology was adopted by about 26% of the farmers with the mean adoption index of 61%. The high adoption rate among the farmers is attributed to the fact most of the farmers cultivate cowpeas which mandatorily need insecticide treatment if any meaningful yield was to be obtained.

Crop spacing is another technology promoted among farmers in SSTF. This was because farmers' practice in cultivation of crops like cereals is to use a wide spacing of up to 100cm between plants on same row whereas, the recommendations, for example, Maize is 25and 40cm for single plant and two plants per hole respectively. Indeed in the study, only about 21% of the farmers followed the recommended crop spacing with mean adoption index of 51%.

The overall adoption rate for SSTF improved crop production technologies in the study area ranges from 12% to 97% with a mean adoption index of 55%. This imply that adoption rate for the promoted improved crop practices was above average and with a mean of about 3 hectares of land devoted to adoption of such technologies.

For the promoted improved crop varieties, the estimated mean adoption index for maize, sorghum, cowpea, millet and groundnut technology as a package in the study area were 67%, 46%, 54%, 46% and 52% respectively (Table 7). However as can be seen in table 7, the adoption of the components of the technology packages varies from crop to crop with farmers adopting: improved crop varieties, inorganic fertilizers application method, the recommended row spacing and pesticide applications differently.

The estimated mean adoption index of 67% for the introduced new maize varieties agrees closely with Phillip *et al*. (2000) who, in their study found maize adoption rate in Kano state to be 52.98% while in Katsina state, it was 48.94% in the 1997 cropping season. In both states, the adoption rate of maize crop package was 49.46%. This is also similar to the findings of Saka and Lawal (2009) in which the adoption rate of improved rice varieties was estimated to be 69%. In this study, about 34% of the farmers adopted new maize varieties, about 31% of the farmers adopted new sorghum varieties, about 27% of the farmers adopted new cowpea varieties, about 22% of the farmers adopted new millet varieties while about 27% of the farmers adopted the new groundnut varieties. This result shows the preference of farmers' adoption of improved production package maize, cowpea, groundnut, sorghum and millet in that order. It is probably an indication of the level of breeding works going on in these crops in the country, as more new varieties of these have been released to farmers in this order. Besides, millet and sorghum are regarded as traditional staple food crops in these areas and because farmers have also found other uses for these crops such as for fencing, livestock feeds and fuel wood, they tend to depend more on their traditional systems for producing them.

The average land area put into the cultivation of maize and sorghum was 3 hectares each, cowpea and millet was one hectare each while groundnut was 2hectares. This result contradicts the work of Ofor *et al*. (2009), which states that in spite of the importance of maize and sorghum as sources of food for human consumption, their production was concentrated in the hands of peasant farmers, whose average farm size was very small (approximately 0.5-1.0 hectare). With the increase in the land cultivated to improved crop varieties and following the adoption of other improved packages, the productivity of farmers and their incomes are increased tremendously, thereby enhancing their food security status.

In conclusion, this study has shown that there were appreciable levels of adoption of improved crop production technologies and in particular, variety adoption in the SSTF of KKM –PLS, which can be attributed to SSA-CP efforts to enhance African farmers' productivity and income. Such knowledge is necessary to facilitate policy on extension for improved agricultural crop production technologies and for the breeders' awareness on the performance on their released varieties in terms of meeting farmers' socio-economic objectives. It was therefore recommended that there should be a strong linkage between farmers and input sources, particularly seeds and fertilizer suppliers inform of out-grower schemes or linkage to farmer cooperatives to improve their access to the promoted improved crop production technologies for affordability and timely availability.

Declaration of conflict of interest

In undertaking this study, there is no financial or other interest that might have influenced the results presented here.

Table 1: Distribution of crop farmers based on age

Age (years)	Frequency	Percentage
20 – 29	24	8.00
30 – 39	32	10.67
40 – 49	97	32.33
50 – 59	116	38.67
60 – 69	23	7.67
≥ 70	8	2.67
Total	300	100

Mean: 49.83 years

Table 2: Distribution of the crop farmers according to farm size

Farm Size (Hectare)	Frequency	Percentage
≤ 1.0	47	15.67
1.1 – 2.0	68	22.67
2.1 – 3.0	148	49.33
3.1 - 4.0	23	7.67
4.1 – 5.0	9	3.00
≥ 5.1	5	1.67
Total	300	100

Mean : 2.8 hectares

Table 3: Distribution of crop farmers based on years of crop production experience

Farming Experience	Frequency	Percentage
≤ 11	12	4.00
12 – 16	35	11.67
17 – 21	57	19.00
22 – 26	62	20.67
27 – 35	110	36.67
≥ 32	24	8.00
Total	300	100

Mean : 27 years

Table 4: Distribution of the crop farmers according to their educational level

Education Level	Frequency	Percentage
Arabic/Quranic education	111	37.00
Adult education	63	21.00
Primary school education	70	23.33
Secondary school education	46	15.33
Post secondary school education	10	3.33
Total	300	100

Table 5: Distribution of crop farmers based on their household size

Household Size	**Frequency**	**Percentage**
1 – 5	36	10.00
6 – 10	76	25.33
11 – 15	127	42.33
16 – 20	32	10.67
21 – 25	24	8.00
≥ 26	11	3.67
Total	**300**	**100**

Mean : 13 persons

Table 6: Adoption rates and adoption index of SSTF promoted improved crop production technologies in the study area

Adoption rate			Average land Area used	Adoption index		
Technology Adopted	Frequency	%	(ha)	Mean	Min	Max
New crop varieties	56	24.24	2.71	0.51	0.02	1.00
Burying of fertilizer	68	29.44	3.57	0.56	0.11	1.00
Plant row spacing	48	20.78	1.71	0.51	0.01	1.00
Pesticide application	59	25.54	2.69	0.61	0.34	0.88
Total	231*	100	2.67	0.55	0.12	0.97

Note: * multiple responses allowed

Table 7: The adoption rates and adoption indices of SSTF promoted improved crop production technologies and its components in the study area

Technology Adopted	Adoption Rate Frequency	%	Average Land area use (ha)	Adoption index		
				Mean	Min	Max
Maize						
New maize variety	56	33.94	2.78	0.67	0.33	1.00
Burying of fertilizer	61	36.97	5.06	0.62	0.24	1.00
Plant row spacing	48	29.09	1.53	0.39	0.11	0.66
Total	**165***	**100**	**3.11**	**0.56**	**0.23**	**0.89**
Sorghum						
New sorghum variety	47	30.52	3.17	0.46	0.02	0.89
Burying of fertilizer	68	44.16	5.66	0.49	0.22	0.75
Plant row spacing	39	25.33	2.10	0.32	0.01	0.62
Total	**154***	**100**	**3.63**	**0.43**	**0.08**	**0.76**
Cowpea						
New cowpea variety	43	27.22	1.43	0.54	0.20	0.88
Burying of fertilizer	32	20.25	1.21	0.18	0.11	0.25
Plant row spacing	24	15.19	1.01	0.45	0.05	0.84
Pesticide application	59	37.34	2.69	0.61	0.34	0.88
Total	**158***	**100**	**1.59**	**0.45**	**0.18**	**0.71**
Millet						
New millet variety	28	21.71	1.22	0.46	0.03	0.89
Burying of fertilizer	66	51.16	1.01	0.56	0.40	0.74
Plant row spacing	35	27.13	1.11	0.37	0.06	0.66
Total	**129***	**100**	**1.11**	**0.46**	**0.16**	**0.76**
Groundnut						
New groundnut variety	39	27.08	2.23	0.52	0.03	1.00
Burying of fertilizer	68	47.22	1.34	0.56	0.22	0.89
Plant row spacing	37	25.69	1.09	0.67	0.34	1.00
Total	144*	100	1.55	0.59	0.20	0.96

Note: * multiple responses allowed

ACKNOWLEDGEMENTS

We hereby acknowledge the financial support of FARA to the SSTF of the KKM-PLS and the cooperation of staff of Katsina State Agricultural and Rural Development Authority (KTARDA) and Kano State Agricultural and Rural Development Authority (KNARDA) that are in charge of the Innovation Platforms where we worked. We also appreciate the dedication and cooperation of the farmers and other stakeholders we worked with in the taskforce.

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Abbreviations

FARA	Forum for Agricultural Research in Africa
IPs	Innovation Platforms
KNARDA	Kano State Agricultural and Rural Development Authority
KTARDA	Katsina State Agricultural and Rural Development Authority
KKM –PLS	Kano-Katsina-Maradi Pilot Learning Site
SSA-CP	Sub Saharan African Challenge Programme
SSTF	Sudan Savannah Task Force