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EFFECTS OF SASAKAWA GLOBAL-2000 IMPROVED MAIZE PRODUCTION TECHNOLOGY ON FARMERS' PRODUCTIVITY IN KADUNA STATE, NIGERIA

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ABSTRACT
The effect of Non-Governmental Organisations (NGOs) on maize farmers' productivity cannot be over emphasised in Nigeria. The study analysed the effects of *Sasakawa* Global 2000 (SG-2000) improved maize production technologies on farmers' productivity in Kaduna State, Nigeria. A total of 263 respondents were selected through a multi-stage sampling technique. Data were collected through structured questionnaire administered to the sampled respondents and complemented with interview schedule. Analysis of the data collected was done using descriptive statistics, total factor productivity index, ordinary least square regression model and chow test analysis. Results showed that the mean age of adopters and non-adopters of SG-2000 improved maize production technology were 45 years and 49 years, respectively. Most of the respondents had one form of formal education or the other. The mean farm size for adopters and non-adopters were 2.26ha and 1.75ha, respectively. The farming experience of adopters and non-adopters were 15 and 24 years with household size of 8 and 6 persons, respectively. The productivity index, ordinary least square and the chow test analysis revealed that SG-2000 improved maize production technologies had significant positive effect on the productivity of the farmers. The severe production constraints faced by the farmers were high cost of acquiring credit facilities, poor road access, inadequate market information, high cost of farm inputs among others. The study recommended that there is the need to strengthen existing farmers' cooperatives in the study area for easy access to credit, farm inputs and markets.

Keywords: Adopters, Cooperatives, Productivity index, *Sasakawa,* Technology.

INTRODUCTION

Maize (*Zea mays* **L.**) is one of the main cereal crops of West Africa. It is the fourth most consumed cereal during the past two decades after sorghum, millet and rice in Nigeria (FAO, 2012). Nigeria is the eleventh largest producer of maize in the world, and the second largest producer in Africa after South Africa (FAO, 2012). An estimated 5.85 million hectares were harvested in 2014 with an average yield of 1.8t ha^{-1} giving a national production of about 11 million metric tons (FAOSTAT, 2014). Ibrahim *et al.* (2014) stated that maize provides food for more than 1.2 billion people in the world in addition to other uses. International Maize and Wheat Improvement Centre (CIMMYT) and International Institute for Tropical Agriculture [IITA] (2011) stated that maize is one of the most important food crops in developing countries, hence addressing the challenges facing the productivity of this crop is vital to the future of hundreds of millions of people. In 2010 Nigeria produced 7.7 million tons of maize representing 0.9% of the world production and the highest contribution from the sub-Sahara Africa region (FAOSTAT 2013).

Nigerian government and non-governmental organizations have initiated several agricultural programmes in order to boost agricultural production and alleviate poverty, such as *Sasakawa* Global 2000 (SG-2000) a non-Governmental organization established to develop programmes for agricultural technology demonstration in various African countries, have made efforts as part of their objectives to diffuse improved agricultural technologies to farm households in order to increase output. One of these efforts is the introduction of improved maize production technologies in some States in Northern Nigeria. *Sasakawa* Global 2000 have worked mainly with and through the Agricultural Development Projects (ADPs) established in participating States (Sasakawa Global, 2010).

Since inception the number of participants in rural communities that were involved in the adoption and use of the technologies has grown from 100 farmer-managed demonstration plots in two States in 1992 to 6,673 in six States by 1996 and more than 2,000 extension agents and 1 million smallholder farmers in eight States of the north. Thousands of demonstration plots (then called Management Training Plots) were established with participating farmers in the diffusion of improved maize, wheat, rice, cowpea, soybean, groundnut, millet, sorghum, sesame and cassava technologies (SG 2000, 2010).

Broadly, the SG 2000 uses a technological package of agronomic practices which include appropriate planting date, good quality improved seed, proper row-to-row and plant-to-plant spacing resulting in correct plant population per unit area, appropriate seed planting depth, timely application and method of fertilizer application at the correct rate among others (Jamilu *et al*. 2014). The project objective is to assist small holders farmers achieve sustainable growth in agricultural production and productivity and thus contribute to reduction of food insecurity, poverty and improve household income and welfare.

Many researches such as those of Durba (2008) and Jamilu *et al*. (2014) were on the adoption of Sasakawa Global 2000 improved maize technologies; but not much has been done on the effect of these technologies on farmers' productivity unlike other development programmes in the study areas. This study intends to bridge that gap as it assesses the effect of the improved maize technologies by SG 2000 on the productivity of farm households. Against this backdrop, this study determined the productivity level of adopters and adopters of improved maize production technologies; the effect of the SG 2000 improved maize technology on the productivity of the adopters and identifies the production constraints encountered by adopters and non-adopters. The study further hypothesized that there is no significant effect of the SG 2000 improved maize technology on the farmers' productivity in the study area.

MATERIALS AND METHODS

The Study Area

The study was conducted in Kaduna State. The State is located in the northern part of Nigeria and is located between latitudes 10°21'N to 10°33'N and longitudes 7°45'E to 7°75'E. It shares common borders with Abuja in the south east and six other States namely: Katsina, Kano, Zamfara in the North, Nasarawa and Plateau in the North East, and Niger in the North West. March is the warmest month at 30.4°C, January is the coldest month of the year at 12.7°C, Rainfall is heaviest in the south and decreases northwards with an annual mean rainfall varying between 942mm and 1000mm which last from April-October (NAERLS, 2012). The people of the State are predominantly farmers. The main crops which are grown in the State include maize, sorghum, soya bean, millet, rice, groundnut, yam and sugarcane.

Sampling Procedure

A multi-stage sampling technique was adopted for the study. At the first stage, a purposive sampling technique was used to select one maize technology transfer adopting and non-adopting zone that is, Lere and Samaru zones, respectively. The second stage involved a random sampling of two LGAs from each of the selected zones. This gave a total of four LGAs for the study. The third stage involved a random selection of three (3) communities from each of the selected LGAs. This gave a total of twelve communities for the study. At the last stage, following Nwadike (2016) and Adewumi (2017), 10% of the adopters and non-adopters of the improved maize technologies in each of the selected communities were sampled.

Method of Data Collection

Primary data were used for the study. The data were collected with the use structured questionnaire which was complemented with interview schedule. Also, extension agents and trained enumerators were engaged to assist during the period of data collection. The data collected was for the 2015/2016 cropping season.

Method of Data Analysis

Data collected were analysed using descriptive and quantitative techniques. Descriptive statistics such as frequency distribution tables and percentages were used to analyse the socio-economic characteristics of SG 2000 adopters and non-adopters. The quantitative techniques used are as described as follows:

The total factor productivity index used by Mohammad (2017) was adopted to determine the productivity level of the maize farmers. The total factor productivity formula is expressed as:

$$\text{Total Factor Productivity (TFP)} = \frac{VOP}{VIE} \quad \ldots(1)$$

where;
VOP = Value of Output (₦)
VIE = Value of Inputs Employed (₦)

Ordinary Least Squares (OLS) regression model was used to estimate the residual sum of squares for chow test to determine the effect of improved maize technology on the farmers' productivity. Since it is a productivity analysis, the Cobb-Douglas functional form was adopted. The modelwas implicitly specified as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, \ldots X_n) \quad \ldots(2)$$

The explicit form of the model was given as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \ldots.. + \beta_n \ln X_n + \mu \ldots\ldots(9)$$

where;
Y = Total factor productivity index
X_1 = Farm size (ha)
X_2 = Labour (man-day)
X_3 = Fertilizer (kg)
X_4 = Herbicide (litres)
X_5 = Seed (kg)
X_6 = Capital input (₦)
X_7 = Improved maize technology adoption status (adopter = 1, non-adopter = 0)
X_8 = Age of farmer (years)
X_9 = Sex (male = 1, female = 0)
X_{10} = Household size (number)
X_{11} = Education level (years of schooling)
X_{12} = Marital status (married = 1, otherwise = 0)
X_{13} = Farming experience (years)
X_{14} = Credit (₦)

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X_{15} = Extension contact (number of contacts)
X_{16} = Membership of farmers' association (member =1, non-member = 0)
μ = Random error term
β_0 = Constant
β_1-β_n = Regression coefficients
X_1 –X_n = Independent variables
Ln= Natural Logarithm

The chow test model was used to confirm the effect of of the SG 2000 improved maize production technologies on the farmers' productivity. The Chow test is the application of the F-distribution test (Gujarati, 2014); it requires the sum of squared errors from the three regressions, one from each sample group and one for the pooled data. If F-Chow is greater than the F-table, it indicates that there is significant difference between the productivity of adopters and non-adopters and then there was SG-2000 effect on adopters' productivity, otherwise no effect. The Chow test formula was specified as:

$$F = \frac{RSS - RSS_1 + RSS_2 / K}{RSS_1 + RSS_2 / n_1 + n_2 - 2K} \quad \ldots(3)$$

where;
RSS = Residual Sum of Square for pooled sample.
RSS_1 = Residual Sum of Square for adopters.
RSS_2 = Residual Sum of Square for non-adopters
n_1 = Numbers of adopters sampled
n_2 = Total number of non-adopters sampled
K = Number of parameters.

RESULTS AND DISCUSSION

The socio-economic characteristics of respondents are as presented in Table 1. The results showed that the mean age of adopters and non-adopters were 45 and 49, respectively. This indicates that adopters were younger than non-adopters. This result corroborates that of Adewumi (2017) that younger farmers at the middle and economically active age are likely to adopt new innovations more than those in older farmers. The level of education of the maize farmers in the study area is presented in Table 1. The results in the table showed that majority of the sampled farmers; at least 80% for the adopters and 60% for the non-adopters had one form of formal education or the other. The adopters however, had more educated people particularly at secondary and tertiary level than the non-adopters. The farmers' level of education is very important in agricultural productivity as it enhances farmers' access to information and agricultural technology adoption. The result in Table 1 also showed that adopters and non-adopter of SG-2000 had farming experience of about 15 years and 24 years, respectively. The number of years a farmer has spent farming is an indication of the length of the practical knowledge and skills acquired by the respondents in maize production and are germane to increased productivity.

Table 1: Socio-Economic Characteristics of the Respondents

Variables	Adopters (n =146)	Non-adopters (n =117)	Pooled data (n = 263)
Age (years)			
21-30	11 (7.53)	16 (13.68)	27 (10.27)
31-40	47 (32.19)	20 (17.10)	67 (25.48)
41-50	51 (34.94)	39 (33.33)	90 (34.22)
51-60	25 (17.12)	27 (23.08)	52 (19.77)
Above 60	12 (8.22)	15 (12.82)	27 (10.27)
Mean	45.00	49.00	47.00
Level of Education			
Tertiary	35 (23.98)	14 (11.97)	49 (18.64)
Secondary	48 (32.88)	12 (10.26)	60 (22.81)
Primary	25 (17.12)	46 (39.32)	71 (27.00)
Adult education	13 (8.90)	7 (5.98)	20 (7.60)
Non-formal education	25 (17.12)	38 (32.47)	63 (23.95)
Farming experience (year)			
1 – 10	47 (32.19)	1 (0.85)	48 (18.25)
11 – 20	71 (48.63)	64 (54.70)	135 (51.33)
21 – 30	26 (17.81)	24 (20.51)	50 (19.01)
Above 30	2 (1.37)	28 (23.94)	30 (11.41)
Mean	15.00	24	19.00
Household size			
1 – 5	45 (30.82)	60 (51.28)	105 (39.92)
6 – 10	71 (48.63)	27 (23.08)	98 (37.26)
11 – 15	29 (19.86)	19 (16.24)	48 (18.25)
Above 15	1 (0.68)	11 (9.40)	12 (4.56)
Mean	8.00	6.00	7.00
Farm size			
0.01 – 1.00	8 (5.48)	15 (12.82)	23 (8.75)
1.01 – 2.00	55 (37.67)	69 (58.97)	124 (47.15)
2.01 – 3.00	54 (36.99)	31 (26.50)	85 (32.32)
3.01 – 4.00	29 (18.86)	2 (1.71)	31 (11.78)
Mean	2.26	1.74	2.04
Annual income (₦)			
1 – 100,000	1 (0.68)	11 (9.40)	12 (4.56))
100,001 – 200,000	10 (6.85)	41 (35.04)	51 (19.39)
200,001 – 300,000	28 (19.18)	6 (5.13)	34 (12.93)
300,001 – 400,000	20 (13.70)	11 (9.40)	22 (8.37)
400,001 – 500,000	56 (38.36)	35 (29.91)	70 (26.62)
Above 500,000	31 (21.23)	13 (11.11)	74 (28.14)
Mean	442,606.69	296,026.12	377,397.85

Source: Field survey, 2017

The mean household size was 8 and 6 for the adopters and non-adopters. Larger households are likely to have a higher level of productivity due to increased availability of family and cheap labour. Household size is expected to play a vital role in the adoption of improved technologies among farmers (Jamilu, 2014). Table 1 further showed, that adopters and non-adopters in the study area cultivated 2.26 ha and 1.75 ha of land respectively. This is an indication that respondents were small-scale farmers and the implication is that small farm holdings results in small farm production and may consequently results to low farm productivity. This finding is similar to that of Shalma (2014) who reported that SG-2000 soybean farmers in Kaduna State were small-scale farmers. The result in Table1 showed that on an average adopters and non-adopters earns ₦442,606.69 and ₦296,026.12 annually in the study area. It is glaring that the adopters had higher income than the non-adopters. This could be attributed to the adoption of SG-2000 maize production technologies by the adopters.

Productivity of Maize Farmers

The Total Factor Productivity (TFP) index was computed for the farmers to determine their level of productivity. The result presented in Table 3 revealed that the productivity index for the adopters of SG-200 maize production technologies was 3.34 with the least and highest values estimated as 1.34 and 12.95 respectively. The productivity level for the non-adopters which was estimated to be 2.61 was found to be lower than that of the adopters. This lower productivity value for the non-adopters could be attributed to their non-adopting of the SG-2000 improved maize production technologies. From the pooled data, the TP index was estimated to be 3.07. This implies that the maize farmers in Kaduna State were productive given that the TP index was greater than one.

Table 2: Productivity Analysis of Maize Farmers

Variable	Mean	Standard Deviation	Minimum	Maximum
Adopters productivity	3.34	2.18	1.34	12.95
Non-adopters productivity	2.61	1.50	1.17	7.36
Pooled data productivity	3.07	2.02	1.17	12.95

Source: Field survey, 2017

Effect of SG-2000 Improved Maize Production Technology on the Adopters

The result presented in Table 3 showed the OLS estimates of factors influencing the maize farmers' productivity in the study area. It further indicated R-Squared values of 0.6867, 0.5218 and 0.5294, respectively, for the adopters, non-adopters and the pooled data. This implies that 68.67%, 52.18% and 52.94 % variations in the productivity level of the respondents were explained by the explanatory variables in the model.

For the adopters, farm size, seed, fertilizer, capital input, farming experience, credit amount, extension contact, and membership of farmers' association were positively significant in influencing the productivity of the farmers. This implies that productivity of the adopters will increase with increase in these variables. Conversely, age was negative and significant at $p<0.05$ probability level. This means that the farmers' productivity will reduce as the farmers get older. This implies that as farmers gain more experience in farming the tendency to adopt new practices decreases. This could be due to the fact that farmers become adapted to certain ways of doing things and the tendency to adopt a new innovation might become difficult.

The result of the non-adopters further revealed that farm size, seed, fertilizer, marital status and farming experience were positive and significant in influencing the productivity of maize farmers. The implication is that, the farmers' productivity will increase with increase in these variables, this result collaborated with that of Opaluwa *et al.* (2014) in which they found out that small scale maize farmers with more than six (6) years of farming experience, increased farm size, seed, fertilizer and labor were significantly and positively related to maize output in Kogi State.

The result for the pooled data revealed that farm size, seed, capital input, adoption status, marital status, credit amount, extension contact and membership of farmers' association were all positive and significant in influencing the productivity of the farmers. This implies that an increase in these variables holding others constant will lead to increase in the productivity of the farmers.

Table 3: Factors Affecting Maize Productivity in the Study Area

Variable	Adopters		Non-adopters		Pooled data	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	-2.4268	-2.85***	-0.4067	-0.27	-1.4310	-1.74
Farm size	0.1567	3.39***	0.3667	3.94***	0.2346	2.3***
Labour	0.0501	0.63	0.1253	0.47	-0.0104	-0.12
Seed	0.1074	1.93*	0.1591	2.18**	0.0906	1.69*
Fertilizer	0.0235	3.27***	0.0364	1.73*	0.0077	1.17
Herbicide	0.0105	0.37	-0.0110	-0.25	-0.0535	-1.08
Capital input	0.6826	7.13***	0.1660	0.86	0.4945	5.36***
Adoption status					0.0568	4.54***
Age	-0.4692	-2.47**	0.1614	0.48	-0.2073	-1.15
Sex	-0.0339	-1.59	-0.0300	-0.74	-0.0238	-1.13
Household size	0.0606	1.05	0.0480	0.68	0.0108	1.23
Years of schooling	-0.0258	-1.59	-0.0270	-1.07	0.0221	1.47
Marital status	0.0193	1.02	0.0603	2.4**	0.0401	2.47**
Farming experience	0.3098	3.92***	0.2408	1.69*	0.0880	1.19
Credit amount	0.0115	2.12**	0.0127	1.61	0.0154	3.14***
Extension contact	0.0513	2.79***	0.0195	1.58	0.0400	3.56***
Farm association member	0.0850	4.45***	0.0093	0.62	0.0506	3.96***
R-Squared	0.6867		0.5218		0.5294	
Adjusted R-Squared	0.6505		0.4508		0.4988	
F-Ratio	18.99***		7.35***		17.30***	

Note: ***p<0.01; **p<0.05 and *p<0.10 probability level
Source: Field survey, 2017

Chow Test Analysis

The result presented in Table 4 showed that the estimated chow (F) value was significant at p<0.01. This implies that the SG-2000 improved maize production technologies had a positive effect on the productivity of the adopters. This was also indicated by the significance of adoption status at p<0.01 in the OLS regression analysis of the pooled data. This implies that SG-2000 maize improved production technologies had positively and significantly improved the productivity of the maize farmers in the Kaduna State. This is a confirmation that the production technologies have a positive effect on productivity in the study area.

Table 4: Chow Test Analysis of Respondents' Productivity

Parameters	Residual Sum of Squares	Chow (F) value
Adopters	52.6491623	2.6036***
Non-adopters	36.7714317	
Pooled data	106.7039763	

Source: Field survey, 2017

Constraints Faced by the Maize Farmers

The result of analysis on the constraints faced by the maize farmers in Kaduna State is presented in Table 5. The result shows that high cost of acquiring credit facilities with a mean score of 3.49 ranked highest among the major several production constraints faced by the farmers. Credit facilities serves a great purpose of enabling farmers gain access to required inputs towards improved productivity and standard of living. However, when farmers are not able to access adequate credit, they tend to get discouraged and reduce cultivable acreage to a sizeable level. This inhibits their productivity as well as their livelihood. This finding is similar to those of Pelemo (2016) and Adewumi (2017) who reported high cost of credit facilities as a problem faced by farmers in Kogi and Kwara States, respectively. The poor road and transport facility was found to be the second severe constraints faced by the maize farmers with a mean score of 3.14. Poor access road and transport facilities can hinder the smooth movement of farm produce to the market. The implication of this is that, farmers are not able to sell their produce in good time. This may lead to farmers suffering post-harvest losses which will reduce their farm income.

Inadequate market information was also a severe constraint faced by the maize farmers. Market information is important to enable the smallholder farmers to make proper decisions about prices for their produce. Farmers explained that they do not receive market information from agriculture extension officers. This implies that middlemen tend to dominate and maximize profit because farmers are always ignorant about current prices as opined by Varathan *et al.* (2012) and Mohanasundaram (2015). Also, high cost of farm inputs was a major constraint faced by the farmers which poses a barrier to farmers' timely access to adequate resources required for improved maize productivity.

Table 5: Production Constraints faced by the Maize Farmers

Constraints	Very severe	Severe	Undecided	Not severe	Weighted sum	Weighted mean	Remark
High cost of acquiring credit facilities	130 (49.43)	133 (50.57)	0 (0.00)	0 (0.00)	919	3.49	Severe
Poor road access and transport facilities	82 (31.18)	159 (60.46)	0 (0.00)	22 (8.37)	827	3.14	Severe
Inadequate market information	75 (28.52)	153 (58.17)	2 (0.76)	33 (12.55)	796	3.03	Severe
High cost of farm inputs	67 (25.48)	164 (62.36)	2 (0.76)	30 (11.41)	794	3.02	Severe
Inadequate storage facilities	88 (33.46)	90 (34.22)	8 (3.04)	77 (29.28)	715	2.72	Severe
Inadequate extension and farm advisory services	52 (19.77)	130(49.43)	10 (3.80)	71 (27.00)	689	2.62	Severe
High incidence of pests and diseases	54 (20.53)	96 (36.50)	7 (2.66)	106(40.30)	624	2.37	Not severe
Pilfering/theft	41 (15.59)	98 (37.26)	10 (3.80)	114(43.35)	592	2.25	Not severe
Limited farm land	48 (18.25)	75 (28.52)	19 (7.22)	121(46.01)	557	2.12	Not severe
Insufficient rainfall	30 (11.41)	80 (30.42)	38 (14.45)	115(43.73)	551	2.09	Not severe
No co-operative or farm association	16 (6.08)	99 (37.64)	22 (8.37)	126(47.91)	531	2.02	Not severe

Note: Figures in parenthesis are percentages
Source: Field survey data, 2017

Inadequate storage facility was ranked fifth constraint with a mean score of 2.72. It revealed that that the maize farmers have inadequate storage facilities to keep their bumper harvest and produce in wait for higher prices. This could lead to persistent poor prices during harvesting period and selling the output at cheaper prices as argued by Varathan *et al.* (2012).

Furthermore, the farmers are faced with the problem of inadequate extension and farm advisory services. This could be that extension agents were not enough in terms of number and perhaps are not also well equipped with extension facilities that will foster appropriate service delivery to their clients. This lends credence to the report of Eze *et al.* (2010) that, inadequate transfer of information to farmers by extension agents due to bottlenecks such as negative attitudes of extension agents to their work could lead to poor service delivery.

Hypothesis of the Study

The OLS result presented in Table 3 show that estimated t-value of 4.54 from the adoption status of farmers was positive and statistically significant at $p<0.01$ this implies that the adoption of SG-2000 improved maize technology had significant effect on the farmers' productivity. Therefore, the null hypothesis (Ho_1) that there is no significant effect of SG-2000 improved maize technology of the farmers' productivity is hereby rejected.

CONCLUSION AND RECOMMENDATIONS

The study concluded that *Sasakawa* improved maize technology had significant and positive effect on the productivity of maize farmers in Kaduna State. The adopters were more productive than the non-adopters. Based on the outcome of this study, the following recommendations were made:

1. There is the need for SG-2000 to extend their programme and activities to other maize farmers in Nigeria.
2. The existing farmers' cooperative societies need to be strengthening for easy access to credit, more so, an institutional factor such as access to extension services was found to also significantly influence farmers' productivity. Timely and adequate extension service delivery should be fostered in the study area.
3. Farmers should be encouraged by SG 2000 project to join existing associations and participate fully in their activities. This will enhance farmers' accessibility to interventions provided by the SG 2000 project as well as other stakeholders and enable them pull more resources together in order to improve their financial base as group and hence, grant credits to individual members as well as purchase farm machines and equipment needed for renting and hiring to members, this will assist to reduce the incidence of high cost of acquiring credit facilities as constraints to farmers' productivity and profitability.

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