African Journal of Agricultural Research

Full Length Research Paper

Productivity impact of growth enhancement support scheme on maize farm households in Kano State, Nigeria

Tiri G. D.[1*], Mlay G. I.[2] and Roselyne A.[2]

[1]Agricultural Economics, Sokoine University of Agriculture, P. O. Box 3007, Morogoro, Tanzania.
[2]Department of Agricultural, Food and Resource Economics, Sokoine University of Agriculture, P. O. Box 3007, Morogoro, Tanzania.

In Nigeria, farmers depend on government support for farm inputs in form of subsidies to improve farmers productivity and food security. In this article, the productivity impact of the Growth Enhancement Support Scheme (GESS) farm input subsidy support program that was implemented in 2011. The study employs a two-stage probability design with stratification was used to collect household survey data from 390 households in Kano State. As an analytical approach, the study employed a propensity score matching and a Two-Stage Least Square (2SLS) regression estimator that corrects for selectivity and endogeneity problems respectively while Hedges "g" was used to estimate the effect size of GESS. Maize yield and total factor productivity index were used as indicators to estimate the productivity impact of GESS program. The result from two-stage least square estimator showed that GESS subsidy increased the yield of participants by 32.3% and the difference was statistically significant (P<0.05) while the result of total factor productivity index, showed that the participants were more productive) and had an average of 14.1% net gain from the cost incurred in production in the 2016 farming season. The size of the estimated treatment effect suggests a moderate improvement in the productivity outcomes of participants. The study found that the results of the study are consistent with similar findings and therefore validate the hypothesis that the GESS subsidy programme improved the productivity of beneficiary households. The scheme obviously has enormous potentials and is also very promising for agricultural input procurement and distribution to resource-poor households in Nigeria. In addition, there is a need for capacity building of the farmers by local extension agents in the form of integrated crop management practices in order to sustain productivity gains. This study concludes that input use alone is not enough to increase maize production, improvement in input use efficiency through integrated crop management practices are also needed.

Key words: Agricultural input subsidy, mobile phone, productivity outcomes, farming households.

INTRODUCTION

In the first decade of the twenty-first century, a number of governments sponsored programs and schemes have

*Corresponding author. E-mail: gtiri@fudutsinma.edu.ng.

been introduced in order to meet the socio-economic development objectives of inclusive growth in SSA. The most prominent among these programmes was the agricultural input subsidy support programmes. In the 1970s and 1980s, farm subsidies were the major drivers of agricultural development and growth. They were implemented as large scale subsidies spanning over a period of 5 to 10 years in Zambia, Malawi, Tanzania, Kenya, Ghana, Zimbabwe, Mali, Nigeria. However, there was a growing concern that the cost of subsidy program generally overweighs their benefits leading to welfare loss (Jayne and Rashid, 2013) and was also characterized by rent-seeking and diversion of the subsidized inputs to unintended beneficiaries. The subsidy programmes were later phased out during the liberalization programs of World Bank and IMF in the 90s on the premise that the private sector can provide farm input more efficiently through market-driven mechanisms (Ricker-Gilbert, 2014) and Tesfamicheal et al., 2017). This move led to a drastic fall in agricultural productivity. The market liberalization programme did not increase input use and crop productivity either. For example, Ammani et al. (2010) observed that the liberalization period led to a decrease in maize yield and other cereals. Hassan et al. (2014) used time-series data between 1971 - 2010 to examine total factor productivity of maize production under various subsidy programs in Nigeria, with results revealing that the 40 years of subsidy programs produced a mean total factor productivity of 1.004, implying that a total factor productivity growth of 0.4% as well as a total factor productivity index of less than 1 shows that farmers are unproductive while fertilizer use stagnated at about 8 kg/ha compared to Sub-Saharan Africa average of 21 kg/ha.

Regional initiatives such as Maputo Declaration 2003 and the First African Fertilizer Summit 2006 led to the re-emergence of large-scale input subsidy programs across the continent (Jayne and Rashid, 2013; Jayne et al., 2013). These subsidies correspond to what is understood as a new model of pro-poor, targeted, and market-friendly smart subsidies (Chirwa and Dorward, 2013). They were said to overcome the challenges of past subsidy programmes by depending on institutions and innovative mechanisms to effectively target resource-poor households with farm inputs. In 2011, the Federal Government of Nigeria launched the called "Growth Enhancement Support Scheme (GESS), designed and implemented with the broad objective of promoting agricultural productivity and food security and poverty reduction through increased use of fertilizer from the current 13 to 50 kg/ha (Adesina, 2012). Under the programme, farmers received messages via their mobile phone which entitled them to buy fertilizer and improved seed from accredited agro-dealers at a subsidized price. The e-voucher further specifies the total quantity of fertilizer and improved seed allocated to the farmer as well as the designated redemption center for collection. A

registered farmer is entitled to 2 bags of 50 kg fertilizer and a 25 or 50 kg bag of improved maize seeds. A major policy stance underpinning the implementation of the scheme was the withdrawal of the federal government from the procurement and distribution of fertilizers, improved seeds and involvement of private agro-dealers in the procurement and distribution of subsidized fertilizer and improved seeds.

Impact evaluations is an important tool for the analysis of public policies and interventions and are increasingly being used by policymakers and practitioners for decision-making. Their main objective is to estimate the overall effect of an intervention or program, that is, to identify whether there is a cause-and-effect relationship between the intervention and the outcome(s) of interest by estimating the change that can be directly attributable to the intervention.

Empirical studies on the impact of targeted farm input subsidies in sub-Saharan Africa (SSA) suggested that subsidies increase production and productivity of beneficiary households. For example Malawian farm subsidy programme achieved the objective of increasing production and productivity (Dorward, et al., 2008). According to Ricker-Gilbert et al. (2011) also found that fertilizer subsidy increased farm level-productivity if rural poor are well targeted to receive fertilizer subsidy.

Understanding the impact of the GESS farm subsidy programme remains controversial because most of the studies did not apply rigorous impact evaluation methodology. For instance, farm households who participated in GESS subsidy programmes optimize the use of fertilizer and improved maize seeds and significantly improved their productivity (Liverpool-Tasie, 2013; Oguniyi and Kehinde, 2015; Kemisola et al., 2018; Ibrahim et al., 2018; Nwalieji et al., 2015). Most of these relied on single econometric models and did not properly control for potential differences between participants and non-participants and are therefore subject to serious problems arising from selection bias and endogeneity. Specifically, the studies relied on propensity score matching (PSM) approach which only works if the difference between the two groups can be captured by using only observable variables. If there are unobservable characteristics, which can influence participation decisions and the outcome variable, the result from the PSM is likely to be biased (Ma and Abdulai, 2016).

Tesfamicheal et al. (2017) examined the productivity impact of GESS subsidy programme using a nationally representative household survey data, as well as statistically and econometrics approaches to control selectivity and endogeneity problems thereby establishing a clear causality between GESS subsidy programme and productivity. Under different circumstances, the current study validated the hypothesis and tested the consistency and generalization of findings. When treatment effect is consistent from one study to the other, common effects

can be identified and if there is variation, the reasons for such variation can be identified because decisions about the utility of an intervention cannot be based on a single study (Obayelu, 2016). The study provided useful information that would guide policymakers and development makers to understand if the same subsidy gain can be delivered at the lowest cost. The information generated on the total factor productivity of the households is important for policymakers to know if efficiency should be addressed through research and development or improving the size of the subsidy.

Productivity is essentially focus of the study on because agricultural productivity is a measure of the performance of the agricultural sector and thus provides a guide to the efficiency of the sector (Aloyce et.al 2014; Awotide et.al, 2013; Lameck, 2016).

Kano State is the largest livelihood zone in Northern Nigeria which also represents a more densely populated area in Northwest Nigeria and one of the first states to join the scheme in Nigeria with over two million beneficiaries (Adesina, 2012). An evaluation of the scheme at the state level would provide the government with information relevant for identifying context-specific issues that are relevant to improving the effectiveness of the scheme.

In order to achieve the objectives of this study we intend to provide answers to these pertinent questions: does those access to subsidized inputs lead to higher productivity? How productive are the farmers in the use of these inputs? Meanwhile, from a policy perspective, we noted that answers to these questions are very important in addressing the dwindling agricultural productivity and attaining the objectives of poverty reduction and welfare improvement in Nigeria, particularly among the rural farming households.

MATERIALS AND METHODS

Study area

The study was conducted in Kano State, Northwest, Nigeria in 2017. Kano State is also located in the North-west geopolitical Zone of Nigeria between latitudes 130° N and 110° S and longitudes 80° N and 100° E with a landmass of 20,760 km². It is the largest state in Nigeria with 44 local governments. The state has a projected population of 11,206,688 million in 2012 based on NPC (2006). The average annual rainfall is 700 mm with 350 and 190°C as mean daily maximum and minimum temperature respectively. Major crops cultivated by farmers in the State include rice, maize, millet, cowpea, groundnut, and vegetables.

Sampling procedure

The study employed a two-stage stratified probability sampling design to collect data from 390 farming households in Kano State between July and November 2017. In the first stage, 30 farming villages were selected from 44 local government areas based on probability proportional to size, whereas in the second stage, 400 respondents were randomly selected from a list of maize farmers association in the State. Data from 390 respondents was stratified

into 170 respondents and 220 non-respondents. The survey questionnaire was designed to capture detailed information on socio-economic characteristics of the households, input use, allocation, crop output for maize and other notable cereals and participation in GESS. In addition, village-level data was collected on average district prices of key inputs and farm inputs among others. In terms of participation, relevant data was collected on the level of awareness about the Growth Enhancement Support Scheme (GESS) as well as other decisions to register for the GESS program. The same survey instrument was used to collect data from the same villages to avoid biases.

Sample size determination

Arkin and Coulton (1963) was used to determine the population sample size of the study. It is given by:

$$n = \frac{NZ^2 \, P(1-P)}{Nd^2 + Z^2 \, P(1-P)} \tag{8}$$

Where n = Sample size N = Total number of Households (3850) Z = Confidence level (at 95% level Z = 1.96) P = Estimated population proportion (0.5), this maximizes the sample size) d= error limit of 5% (0.05). Application of the above sample formula with values specified.The estimated population proportion of 50% is the power level that maximizes or increases the statistical power of the sample size , yielded a sample size of 333. Including a reserve of 20%, took the total sample size to 400, however, only 390 was utilized for the analysis due to missing data and non-response cases.

Methods of analysis

The data for this study were analyzed using descriptive statistics, propensity score matching, and instrumental variable approach to analyzed the impact of GESS subsidy program on productivity outcomes. The study adopted maize yield per hectare and total factor productivity index to examine the productivity impact of the subsidy program. The crops were aggregated into maize equivalent. In this study we conceptualize GESS participants as those who actually received subsidize fertilizer and maize seeds in the 2017 farming season and non-participants as those who did not received Subsidized fertilizer and improved seeds in the same farming season.

Impact of GESS on maize productivity

Propensity score matching (PSM)

Household's decision to participate in the GESS subsidy scheme was based on each household's self-selection (non-randomized), hence GESS participants may be systematically different from non-participants. Propensity score matching adjusts for initial differences between the two groups by matching each participant to a non-participant based on similar observable characteristics (Rosenbaum and Rubin, 1983) before determining treatment effect. The first step in PSM is to predict the propensity scores for each observation using a logit model using characteristics that are not affected by the treatment variable. In order to get the most preferred propensity score equation, different model specifications were employed. The variables were selected based on economic theory and previous economic theory. The predicted propensity score indicated the probability of receiving treatment. After predicting the scores, imposing the common support region is the next step in the PSM framework. The common support region is the area within the

minimum and maximum propensity scores of treated (participants) and comparison groups (non-participants). This is followed by the identification of an appropriate matching estimator. Dehejia and Wahba, 2002; Caliendo and Kopeinig (2008) and wooddrige, 2010 listed a number of matching estimators including the Nearest Neighbor (an individual from a comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score), Caliper (where an individual from the comparison group is chosen as a matching partner for a treated individual that lies within a given caliper) and Kernel (a non-parametric matching estimator uses weighted averages of all individuals in the control group to construct the counterfactual outcome). The final step was checking for matching quality whether the matching procedure has balanced the distribution of different variables or not. If the matching quality is satisfied, ATT was specified as the mean difference of maize yield of the participants matched with non-participants who are balanced on the propensity scores and fall within the region of common support (Mendola, 2007).

The PSM, which is the probability of assignment to treatment conditional on pre-treatment variables is given by:

$$P(X) = P[Z = 1/X] = [Z/X; F(h/X_i)] \quad (1)$$

F (.) is a logistic cumulative distribution and X is a vector of conditioning variables. Rosenbaum and Rubin (1983) defined the average treatment effect (Z_i) in a counterfactual framework as

$$ATE = Y_{1i} - Y_{0i} \quad (2)$$

where Y_{1i} and Y_{0i} denote productivity outcomes of household i that participated in GESS and the household that did not participate in the program, respectively but either Y_{1i} or Y_{0i} is normally observed, but not both of them for each household.

The average treatment effect on the treated (ATT), that is, the conditional mean effect is only defined within the region of common support. It is estimated as follows.

$$ATT = E[E\{Y_{1i} - Y_{0i}/Z_i = 1, P(X)\}] \quad (3)$$

$$ATT = E[E\{Y_{1i}/Z_i = 1, P(X)\} - \{Y_{0i}/Z_i = 0, P(X)/Z_i = 1\}] \quad (4)$$

PSM only adjust for selection bias that may come from observable factors. However, casual identification requires controlling for both observable and unobservable factors that influence participation in the GESS and productivity outcomes. Hence, the estimates of Equation 5 may give biased estimates of yield due to possible correlation arising from unobservable factors. An appropriate estimation approach was therefore necessary to minimize the bias in the error term, as well as to produce a consistent estimate of the impact of GESS subsidy program on the productivity outcomes of maize-producing households.

To deal with the non-random endogenous error term in Equation 5, the instrumental variable (IV) regression procedure which uses a two-stage least square estimator was used to estimate the impact of the GESS subsidy program on maize productivity. The procedure assumes the existence of a variable, Z_i, an instrument, that predicts participation in the program, but does not predict productivity (Cameron and Trivedi, 2005). Similar techniques have been used by (Nino-Zarazua, 2007; Ricker-Gilbert et al., 2013; Ricker-Gilbert et al., 2011; Tesfamicheal et al., 2017).

The study identified two instruments which correlate with farmer's decision to participate in GESS and had no direct effect on productivity except through its effect on farmers' decisions to participate in the GESS. The variables are the number of years that the household head has lived in the village and membership of the ruling party as instruments for GESS participation. Years of residence in the village is a measure of household political power

that could influence GESS participation (Ricker-Gilbert et al., 2011). Membership of ruling political measures a farmers' participation in social network and could also influence GESS participation. Jansen-Hargan test of over-identification was performed to verify the hypothesis that the instruments are exogenous and valid. The Wu-Hausman – F-test and Durbin-wu-Hausman –chi-square test was performed to test the hypothesis that GESS participation is exogenous. The study found that instruments were valid and GESS participation was endogenous hence instrumental variable estimator was found to be a consistent estimate of treatment effect.

In the first stage, GESS participation is treated as endogenous and is regressed on the identified instruments (years of residence in the village and membership of ruling party) other controls that can affect GESS participation were included; meanwhile, in the second stage the yield equation was specified in a log-linear functional form and predicted values of the residual were included along with other controls in the outcome equations. Given the IV model in a linear functional form as:

$$Y_{1ij} = \beta_0 + \beta_1 y_2 + \beta_2 z_1 + \beta_3 z_2 + \beta_i X_{ij} + \mu_i \quad (5)$$

Where y_2 represents the endogenous variable (GESS participation), Y_1 is the outcome (maize yield), Zs are the instrumental variables (years of residence in the village and membership of ruling party), X_{ij} variables that influence both treatment and outcome, μ_i is the error that is assumed to correlate with μ_i and X_i. Assuming that the equation is over-identified with two instruments, the reduced form equation in the first stage would be

$$y_{2ij} = \pi_0 + \pi_1 z_1 + \pi_2 z_2 + \beta_i X_{ij} + v_i \quad (6)$$

In the second stage

$$Y_{1ij} = \pi_0 + \pi_1 y_2 + \pi_2 z_1 + \pi_2 z_2 + \beta_i X_{ij} + \gamma_i s_{ij} + \gamma_i C_{ij} + \delta_i w_{ij} + \vartheta \hat{v} \quad (7)$$

Where Y_{ij} rrepresents the outcome (maize yield in kg/ha), y_1 is the endogenous variable (GESS participation), X_i is the household demographic characteristics such as age, years of education, farming experience, gender, household size) which influence GESS participation, s_i represents membership of commodity and cooperative association, w_i represents household landholding and number of working population, C_i represents community characteristic such as distance to redemption center, farm and access to credit while z represents the instruments (number of years household have lived in the village and, membership of ruling party). γ_1, π_1 and δ_i are population parameters, β_i are a vector of the X_i variables. ϑ is tested if its significantly different from Zero if Cov $(\mu_i, v_i) = 0$.

Estimation of total factor productivity of the households

The total factor productivity analysis was used to estimate the total productivity of inputs used in maize productivity.

$$TFP = \frac{Y}{TVC} \quad (8)$$

Where TFP is the total factor productivity, Y, the yield of maize realized in Kg/ha (maize equivalent) and TVC is the total variable cost in Naira. Equation 2 can further be stated as

$$TFP = \frac{Y}{\sum_{i=1}^{n} P_{X_i} X_I} \quad (9)$$

Where Xs are the inputs is the P_{X_i} is the price of the ith input.
We also calculated the Hedges g (sample size correction)

standardized mean difference. For studies using parallel-group or matching strategies, g and its standard error (Borenstein et al., 2009) are computed as:

$$g=\frac{\bar{y}_t-\bar{y}_c}{sp} * [1-\frac{3}{4*(nt+nc-2)-1}] \qquad (10)$$

$$SEg=\sqrt{[\frac{nt+nc}{nc+nt}+\frac{g^2}{2*(nc+nt)}]} \qquad (11)$$

Where $\bar{y}_t$ is the mean outcome in the treatment group, $\bar{y}_c$ the mean outcome in the comparison group, nt and nc are the sample sizes of the treatment and comparison groups respectively, Sp is the pooled standard deviation and Sc and St are the standard deviations in treatment and comparison groups.

RESULTS AND DISCUSSION

The results in Table 1 have shown the differences between participants and non-participants and have centered on mean differences in the outcome variable and farm and farmer characteristics. The results concerning the outcome variables suggest that GESS participation may have a role in improving farm productivity, but because participation is endogenous, a simple comparison of the productivity indicators of participants and non-participants has no causal interpretation. The above difference may not be the result of GESS participation but instead may be due to other factors, such as differences in household characteristics and farm characteristics as mentioned above so the outcome effect on individuals who participated in GESS might have been achieved even without participation, that is, the counterfactual effect. There is, therefore the need to further investigate these outcome effects by applying other rigorous analysis to test the impact of GESS participation on farmers' productivity. In consequence, we apply propensity score matching methods that control these observable characteristics to isolate the intrinsic impact of GESS and also an instrumental variable approach to a correct possible correlation between participation and unobservable characteristics.

Descriptive statistics of the respondents

A chi-square test of independence on some categorical variables of interest between participants and non-participants is reported in Table 2. The data showed that GESS participant owns more land by inheritance, have more access to off-farm income, belong to ruling political party, own more phones, had more registered members, more risk advertised, was more informed of GESS and also use more fertilizer in the last farming season than non-participants. These are the variables that affect the household's decision to participate in the GESS program. The variable risk-aversion is measured by farmer's willingness to try new agricultural practices such as improved seed. We consider farmers as risk-averse if

they are unwilling to ever try new improved varieties. The two groups did not differ in participation in terms of gender, access to credit and membership of commodity associations (Table 2). The difference in GESS participation between men and women reflects the fact that men in the area are more informed about agricultural technology than women. Doss (2001) also finds that male-headed farmers adopt new agricultural technologies faster than women farmers due to access to complementary inputs such as access to credit and access to extension services. Women often lack capacity (mobility and funds), education, self-confidence, and more limited opportunities to join in groups and organizations due to cultural and ethnoreligious differences, which often serve as platforms and avenues for consultations and information-sharing with other actors including policymakers, researchers, and technical experts. According to Aboh et al. (2006), access to and use of fertilizer tend to reflect a gender dimension reflecting the element of traditional roles in agriculture. While women constitute 60% of agricultural producers in Nigeria, they have less than commensurate access productive resources and inputs including fertilizers. Gender roles and power relations,therefore, have a critical influence on fertilizer access and use, just like fertilizer subsidy tend to impact differently.

With regards to productive variables, the result in Table 3 showed that the sampled average landholding is 3.5 ha, but landholding among participants was 3.6 ha and is not statistically different from non-participants. According to international standard judgment on farm sizes, farm size of fewer than 10 ha is considered as a small scale (Ozowa, 2005), which implies that most of the participants under the program were smallholders suggesting that access to farmland was not a constraint to maize production in the study area. Data also showed that GESS participants cultivated more plots for maize production during the farming season under consideration but there was no difference in the number of seeds used. The difference in yield was found to be 1660.92 kg/ha and statistically significant. Results in Table 3 also indicated a significant amount of heterogeneity in demand in the subsidy program seems to be associated with fertilizer used, with participants using an average of 197.53 kg/ha against 173 kg/ha for non-participant and the difference is statistically significant. Abdoulaye et al. (2018) also found a statistically significant difference in fertilizer used among subsidy beneficiaries in Senegal, Liverpool-Tasie et al. (2017) found that maize farmers in the main cereal producing areas of Nigeria used about 211 kg/ha . It is likely that a reduction in the price of inputs as a result of subsidy would have encouraged farmers to purchase more fertilizer. However, this is subject to verification. From Table 3, data also reveals that both groups do not differ in total labour used and the total number of persons in the working population. The mean total factor productivity was found to be 0.87,

Table 1. Socio-economic characteristics of respondents by participation status.

Characteristics	Participants		Non–participants		Mean cliff	t- values	p- value	Total sample (N= 390)	
	Mean	Standard deviation	Mean	Standard deviation				Mean	Standard deviation
Age of household head	45.764	9.445	45.156	9.7024	0.3853	0.3934	0.6942	45.982	9.581
Household years of education	13.635	3.4533	12.895	3.6879	0.7398	2.6195	0.0441**	13.2179	3.60179
Distance to nearest redemption centre	2.5647	1.5020	3.4522	0.9234	0.8875	7.1834	0.000***	3.66566	1.2863
Household size	13.3411	0.2814	17.03118	6.075	3.6906	0.5931	0.5535	15.42308	6.8893
Extension visits per month	2.21	1.146	12.58	11.520	0.371	2.656	0.008**	1.8128	1.4045
Number of off–farm livelihood activities	1.6	0.6996	1.53	0.4986	0.0500	0.8233	0.4109	1.5718	0.5945
Number of year of residence	40	11.6051	37.350	9.9198	2.9323	2.6871	0.0075***	38.6282	1.0972
Years of farming experience	26.541	8.8646	27.000	9.8602	0.4588	0.4760	0.6343	26.8	9.4300
Number of years in commodity association	10.711	6.112	9.899	5.127	0.961	0.3661	0.562	11.120	6.900

The T-test was used to test for difference in socio-economic demographic characteristics between participants and non–participants; *, **, *** : Significant at 10, 5 and 1%, respectively.

Table 2. Mean difference in categorical variables between GESS participants variable and non – participants.

Variable	Participant	Non-Participant	Mean difference	Chi-square
Gender (male=1)	0.800	0.850	0.050	1.300
Own phone (yes=1)	0.847	0641	0.206	4.55***
Membership of community association (yes=1)	0.541	0.586	0.0452	0.890
Access to credit (yes=1)	0.600	0.641	0.4091	0.830
Land ownership (yes=1)	0.9471	0.759	0.1879	5.034***
Access to Off-Farm Income (yes=1)	0.971	0.759	0.1879	5.03***
Risk Aversion (yes=1)	0.7176	0.6591	0.0585	1.33
Use of fertilizer in last farming season (yes=1)	0.859	0.555	0.304	6.43***
Register for GESS (yes=1)	0.918	0.523	0.3949	8.40***
Member of ruling party (yes=1)	0.659	0.464	0.1952	3.84***
Keep livestock (yes=1)	0.6627	0.596	0.0672	1.36
N=	170		220	

The T-test was used to test for difference in socio-economic demographic characteristics between participants and non-participants; *, **, *** : Significant at 10, 5 and 1%, respectively.

meaning that if any of the sampled farmers are picked at random with equal probability, the expected TFP will be a factor of 0.87 meaning with about 13% increase in input the farmers would attend the production frontier. Results of the distribution of the propensity scores showed that propensity scores of participants range from 0.04 to 0.9 while among non-participants, the propensity scores range from 0.04 to 0.81. The probability of all households participating in GESS was 0.43 which means that the probability that households selected at random will

Table 3. Mean difference in productivity variables by participation status.

Productivity variable	Participants		Non-participants		Mean cliff	t-value	p-value	Whole sample	
	Mean	Standard deviation	Mean	Standard deviation				Mean	Standard deviation
Total landholding (ha)	4.60	1.26	3.52	1.12	0.14558	1.20	0.2292	3.59	1.18
Area cultivated to maize	4.32	1.64	3.12	1.25	1.2113	7.77	0.000***	3.64	1.7
Quantity of fertilizer used (kg/ha)	56.3	6.63	40.51	4.58	15.861	5.56	0.000***	48.60	4.02
Total factor productivity index	0.14	0.13	0.62	0.46	0.8558	8.34	0.000***	0.87	0.72
Maize yield (kg/ha)	860.90	103	643.30	130	217.6.	6.97	0.000***	890.11	112.90
N		170		220					

The T-test was used to test for difference in productivity outcomes between participants and non-participants; *, **, *** : Significant at 10, 5 and 1%, respectively.

participate in the scheme with respect to propensity scores is 43.5% (Table 5). The common support region lies between 0.04 and 0.81. In other words, households whose estimated propensity scores are less than 0.04 and larger than 0.81 are not considered for the matching exercise. As a result of this restriction, 36 participants were discarded from the analysis, (Dehejia and Wahba, 2002) noted that when the proportion of lost individuals is small, this poses a few problems. However, if the number is too large, there may be concerns about whether the estimated effect on the remaining individuals can be viewed as representative. Accordingly, the proportion of individuals lost in this case is very small and therefore there is no violation of the assumption of common support.

The common support condition was imposed and the balancing property was satisfied in the estimated regression model. The distribution of the propensity scores and the region of common support before and after matching are shown in Figure 2. The density distribution of the propensity scores shows a good overlap between GESS participants and non-participants (Figure 2).

The selection of matching techniques is based on three independent criteria; standardize mean biased a t-test (Rosenbaum and Rubin, 1985) and joint significance of covariates and pseudo R^2 (Sianesi, 2004). Our estimation results suggest that all the matching methods produce similar results but kernel matching was the best algorithm. Kernel matching estimator with a bandwidth of 0.01 satisfied the selection criterion and so was used to estimate average treatment effect (ATE), average treatment effect on the treated (ATET) and average treatment effect on the untreated (ATU).

The reliability of PSM results depends on the quality of matching. This can be seen from the overall covariate balanced and common support as presented in Figure 1 and Table 7 respectively. Table 7 shows the overall covariates' balanced test before and after matching. The result reveals that the standardized mean difference for all covariates used in the PSM is reduced from 28.9% before matching to 6.1% after matching. This result shows that matching reduced bias by 78.8%; in addition, the chi-square test of the joint significance of variables after matching (P-value=0.784) while the chi-square test for the joint significance of covariates was not rejected before matching (P-value=0.000). Moreover, the pseudo-R^2 declined from 20.3 to 2.3% after matching. As indicated in Table 5, the mean bias in the covariates X after matching lies below the 30%

level of bias reduction suggested by Rosenbaum and Rubin. Therefore, the high total reduction, the insignificant p-value of the likelihood ratio test low pseudo-R^2 and significant reduction in standardized mean bias after matching are indicative of successful balancing of the distribution of between participants and non-participants of GESS, hence we fail to reject the hypothesis that both groups have the same distribution in covariates after matching. The visual inspections of the distribution of the estimates of propensity scores reveal a substantial and sufficient overlap in density distribution of the estimated propensity scores between participants and non-participants suggesting that the common support condition was satisfied. Selection bias in GESS participation due to observed covariates have been eliminated. We can now attribute any change in maize yield and total factor productivity to GESS participation.

Estimating treatment effect of GESS on productivity outcomes

The results of the treatment effects (ATE, ATT, and ATU) is presented in Table 9. The average treatment effect on the treated (ATT) maize yield
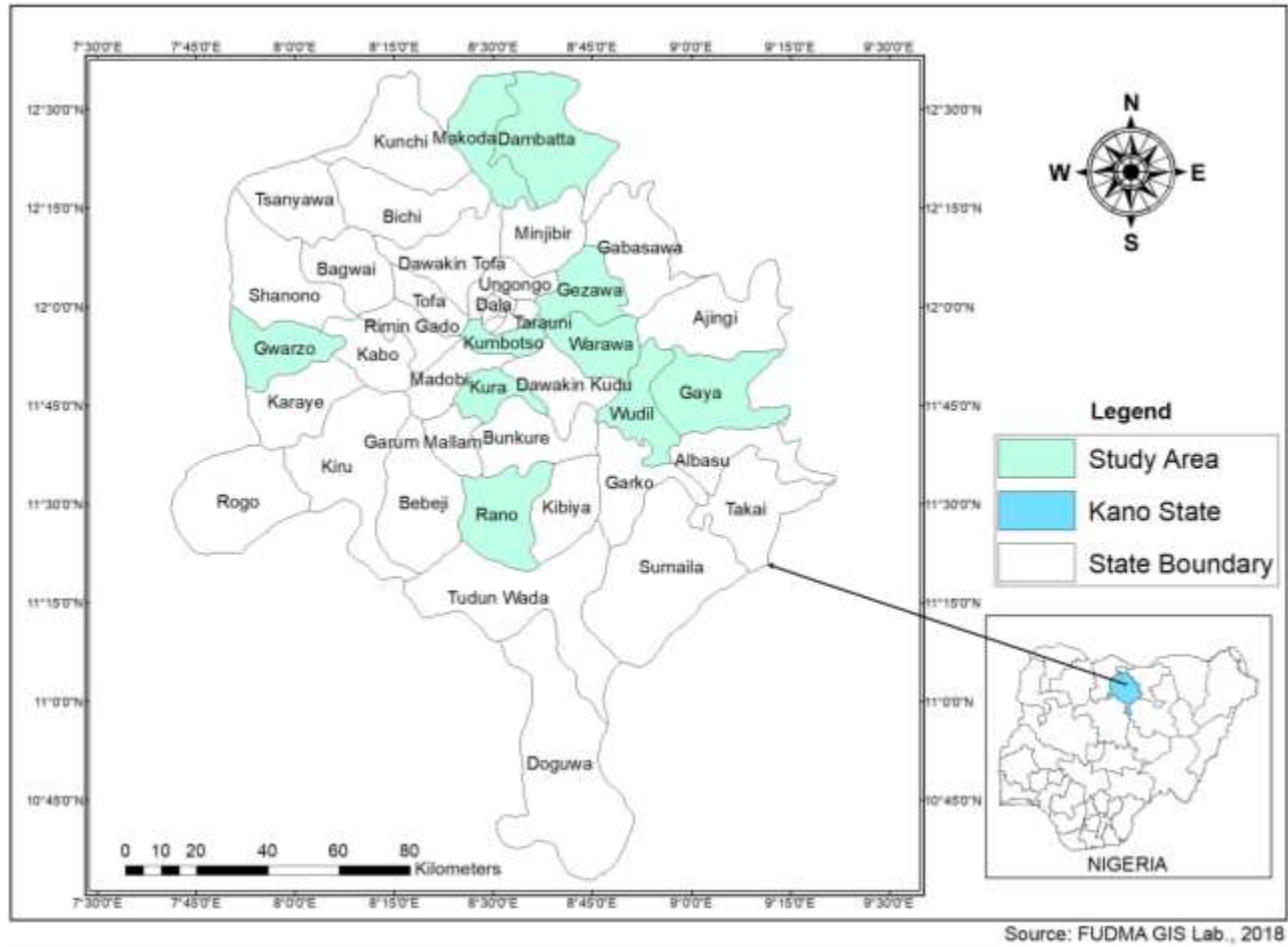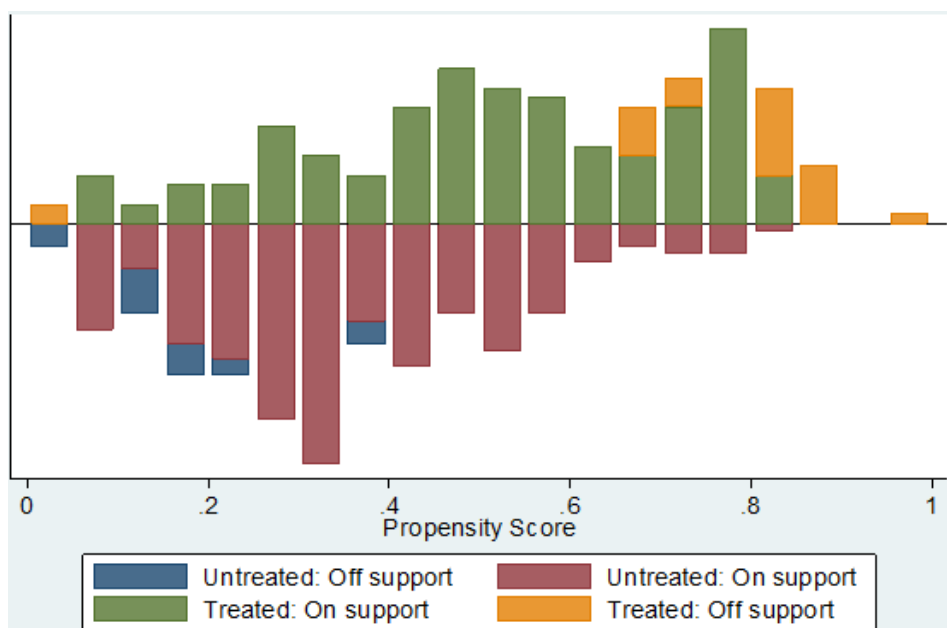
Figure 1. Sampled local government areas.

Figure 2. Propensity score distribution and common support for propensity score.

Table 4. Distribution of sampled households by estimated propensity scores and access to subsidized farm inputs.

Group	Observation	Mean	Standard deviation	Minimum	Maximum
Total household	390	0.43	0.22	0.04	0.97
Treatment household	170	0.53	0.22	0.03	0.99
Control household	220	0.34	17	0.04	0.81

Table 5. Chi-square test for the joint significance of variables of propensity scores.

Sample	Ps R^2	LR chi^2	$p>chi^2$	Mean bias	Med bias	B	R	%Var
Unmatched	0.203	108.56	0.000	28.9	13.2	117.5*	1.42	38
Matched	0.023	8.88	0.782	6.1	6.0	35.6*	0.59	25

Table 6. GESS participation effect on maize yield and total factor productivity.

Participation	Productivity indicators	Kernel matching ATE, ATT, ATU
If a household is a participant	Maize yield (kg/ha)	197.8. 212.6*** 200.6
	Total factor productivity	0.85 0.81*** 0.89
N		390

*** P<0.01, ** P<0.05, *P<0.1.

on the entire population was 32.3% (P<0.001). The average effect of treatment (ATE) for a household drawn from the entire population at random was lower compared to the treated category. The ATU is the counterfactual outcome of the treated indicating how much they would have lost if they were not treated. The results of the treatment effects on TFP was also indicated. The average treatment effect on the treated (ATT) was 0.87 (P<0.01). This means that if any of the participating farmers is picked at random with equal probability, the expected growth rate of TFP will be 0.8133; on the other hand, the average treatment effect (ATE) for a household drawn from overall population at random is somewhat greater with value of 0.86 compared to the treated category.

The total factor productivity of less than one means productivity is low though statistically significant. The low TFP could mean that there are some inefficiency factors in maize production. However, these differences in the value of production and total factor productivity cannot simply be attributed to GESS by looking at the mean differences between GESS participants and non-participants. In particular, these mean differences are only indicative of correlations and cannot be used to make causal inferences regarding the impacts of the GESS on maize yields and total factor productivity without controlling for another confounding factor.

The result from PSM is presented in Table 6. The result showed that ATT on maize yield was 212.6 kg/ha

(P<0.001) and TFP was 0.81 (P<0.01). This result is robust and consistent with both models. However unobserved heterogeneity among smallholders could have caused potential endogeneity resulting in possible of the error term with the productivity outcomes.

To verify the claim that participation in GESS may be endogenous, we perform a post estimation test using "estat endogenous" to test the hypothesis that GESS participation is exogenous. The results of the test are as follows; Durbin (score) Chi^2 (1) = 4.41177 (P=0.02230); the robust regression-based test of Wu-Hausman F-statistics (1696) =4.7823 (P=0.03115) and χ2 and F-statistic (53.5). Besides, we fail to accept the null hypothesis and conclude that GESS participation is endogenous at 5% significant level and therefore OLS estimation might be considered inconsistent estimate of treatment effect. The result supports the choice of instrumental variable method of estimating the treatment effect. We tested the validity of instruments using the stata command 'estat first'. We found that the minimum eigenvalue (53.2) is greater than the value of the nominal 5%, wald test at 5% bias tolerance and the joint significant test (F= 53.2, P=0.000) show that instruments are strong. Hansen–J test confirms that the model is correctly specified, thus, we fail to accept the null hypothesis that the instruments are weak and conclude that the instruments are valid and strong.

The result of the IV-2SLS in Table 7 show that GESS participants got an average net gain of 14.1% from the

Table 7. IV-2SLS estimation of treatment effect on productivity outcomes.

Variable	IV-2SLS	
	Yield	Total factor productivity
GESS	0.323(0.058)***	0.141(0.0033)**
Phone ownership(1=yes)	-0.461 (0.336)	0.346(0.240)
Marital status (1=married)	-0.154(0.131)	0.029(0.0094)**
Gender(male headed=1)	0.186(0.147)	-0.092(0.105)
Membership of commodity(1=yes)	0.124(0.130)	0.0205(0.0928)
Household access to credit (1=yes)	0.0300(0.0701)	0.1904(0.0501)
Number of extension visits	0.0757(0.068)	-0.205(0.049)
Distance to redemption centre(km)	-0.648(0.0250)**	-0.291(0.193)
Number of years of education of household head	-0.302(0.0203)**	0.0667(0.146)
Household landholding	0.307(0.0258)***	0.297(0.184)
Years of farming experience	-0.098(0.096)	0.251(0.231)
Household size	0.0838(0.0118)*	-0.141(0.125)
Age of household head	0.187(0.0341)**	0.154(0.153)
Joint significant all regression F- test	3.68***	4.25***
R^2	0.09133	0.01288

Observation: Durbin score chi^2= 3.41177 (P = 0.02230); Wu- HausmanF(1,379) = 4.40057 (0.0021); Waldchi^2 (9) = 58.97; Prob>chi^2 = 0.000; R-squared= 0.2888. *, **, *** : Significant at 10, 5 and 1%, respectively. Numbers in bracket are standard errors.

Table 8. Results of effect size on productivity outcomes base on mean comparison.

Participants outcome	Hedges's		
	Mean diff	Effect size	Decision
Maize yield (kg/ha)	212.6	0.72	Moderate effect
Total factor productivity	0.87	0.75	Moderate effect

Source: Authors Calculation (2018).

cost incurred in maize production while maize yield increased by 32.3%. We also found that the age of household head, years of education of the household head while total landholding significantly improve yield per hectare while total factor productivity is influenced by gender of the household head, with male-headed households tending to be more productive. However, distance to redemption centres, a number of years of formal education negatively influenced yield per hectare and total factor productivity. The result of this study is consistent with the findings of Jayne et al. (2010) who found that increased maize production was positively associated with fertilizer subsidy in Malawi. World Bank (2010) also found 89% of the growth in output as a result of the subsidy program in Zambia. Tesfamicheal et al. (2017) also found that maize yield of GESS participants in Nigeria is increased by 26.1%. The findings of this study have shown that farmers who used subsidized maize seeds improved their productivity but contrary to Cesar et al. (2017) who found that input donation in Mexico did not improve the value of maize production.

Our study supports the argument that suggests that farm subsidy provides incentives for farmers to use inputs to improve farm-level productivity.

The Hedges "g" test in Table 8 also suggested moderate improvement in productivity outcomes . These results may be key ingredients in the renewed interest of subsidizing farm inputs across the continent.

Conclusion

The impact of GESS subsidy program on maize of productivity farming households in Kano State, Nigeria was investigated to stimulate policymakers' commitment to the provision of assistance to farmers in the form of input subsidy. The study used propensity score matching analysis and IV-two stage least square method and Hedges 'g' effect size estimation. The matching method made a comparison between those who participated in the program and those who did not and drew conclusions based only on those that participated in GESS farm

subsidy programs. From the instrumental variable approach, we found that the yield per hectare of participants was (32.3%, P<0.01) and the TFP of participants was (14.1%, P<0.05). The result from hedges 'g' effect size of the estimation suggests a moderate improvement in productivity outcomes, meaning that there is considerable hope if the government can build on achievements to substantially raise program effectiveness, efficiency, and benefits to the farmers. We conclude that input use alone is not enough to increase maize production; improvement in input use efficiency through integrated crop management practices is also needed.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abdoulaye T, Wossen T, Awotide B (2018). Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. Food Security 10(2):369-379..

Adesina A (2012). Agricultural transformation agenda: Repositioning agriculture to drive Nigeria's economy. https://queenscompany.weebly.com/uploads/3/8/2/5/38251671/agric_nigeria.pdf

Aloyce GM, Gabagambi DM, Hella JP (2014). National Agricultural Input Voucher Scheme Impact on Productivity and Food Security of Smallholder Farmers in Tanzania. Journal of Economics and Sustainable Development 5(21):1-13.

Ammani AA, Alamu JF, Kudi YM (2010). Effect of fertilizer liberalization on maize production in Nigeria. Journal of Development and Agricultural Economics 2:401-405.

Arkin H, Colton RR (1963). Tables for statisticians, New York: Barnes and Noble Books, 2nd Edition, contributed by the National Library of Australia 124 p.

Awotide BA, Karimov A, Diagne A, Nakelse T (2013). The impact of seed vouchers on poverty reduction among smallholder rice farmers in Nigeria. Agricultural Economics 44(6):647-658.

Caliendo M, Kopeinig S (2008). Some Practical Guidance for the Implementation of Propensity Score Matching. Journal of Economic Surveys 22(1):31–72.

Cameron AC, Trivedi PK (2005). Multinomial models. Microeconometrics, Methods and Applications pp. 113-146.

Cesar AL, Lina S, Carmine PS (2017). Agricultural Input Subsidies and Productivity: The Case of Paraguayan Farmers. Inter-American Development Bank. Environment, Rural Development, and Disaster Risk Management Division.

Chirwa E, Dorward A (2013). Agricultural Input Subsidies.The Recent Malawi Experience.Oxford University Press, Oxford, UK.

Dehejia R, Wahba S (2002). Propensity score matching methods for non-experimental causal studies.Review of Economics and Statistics 84:151-161.

Dorward A, Chirwa E, Slater R, Jayne TS, Boughton D, Valerie K (2008). Evaluation of 2006/2007 Agricultural input subsidy programme in Malawi. Final Report. Ministry of Agriculture and food security. Lilongwe, Malawi.

Hassan Y, Abdullah AM, Ismail MM, Mohamed ZA (2014). Factors influencing the total factor productivity growth of maize production in Nigeria. IOSR Journal of Agriculture and Veterinary Science 7(4):34-43.

Ibrahim HYI, Ale-ojo HAI, Wahab MJ (2018). Impact of the Growth Enhancement Support Scheme (GESS) on Maize Farmers in Dutsinma Local Government Area of Katsina State, Nigeria FUDMA.

Journal of Sciences 2:143-148.

Jayne TS, Sitko NJ, Ricker-Gilbert J, Mangisoni JH (2010). Malawi's maize marketing system (No. 1093-2016-88020)

Jayne TS, Rashid S (2013). Input Subsidy Programs in Sub-Saharan Africa: A Synthesis of Recent Evidence. Agricultural Economics 44(6):547-562.

Jayne TS, Mather D, Mason N, Ricker-Gilbert J (2013). How do fertilizer subsidy programs affect total fertilizer use in sub-Saharan Africa? Crowding out, diversion, and benefit/cost assessments. Agricultural Economics 44(6):687-703.

Kemisola O, Adenegan F, Fagbemi O, Osanyinlusi I (2018). University of Ibadan, Nigeria Abiodun Olusola Omotayo: Impact of the 'Growth enhancement support scheme (GESS)' on farmers' income in Oyo state, Nigeria. The Journal of Developing Areas 52:1.

Lameck C (2016). Impact of agricultural subsidies to smallholder maize farmers of Mbeya district council in Tanzania. Thesis Presented in Partial Fulfillment of the Requirements for the Degree Master of Science in the Graduate School of the Ohio State University. https://etd.ohiolink.edu/!etd.send_file?accession=osu1469112342&disposition=inline

Liverpool-Tasie S (2013). Targeted Subsidies and Private Market Participation: An Assessment of Fertilizer Demand in Nigeria. IFPRI Discussion Paper 01194.International Food Policy Research Institute, Washington, D.C., USA. [https://www.semanticscholar.org/paper/Targeted-Subsidies-and-Private-Market-An-Assessment-Liverpool-Tasie/5a0ddad09226c0488ed73e6c29cee30d20980333] sited visited on 10/06/2017.

Ma W, Abdulai A (2016). Does Cooperative Membership Improve Household Welfare? Evidence from Apple Farmers in China. Food Policy 58:94-102.

Mendola M (2007). Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. Food Policy 32(3):372-393.

Nwalieji HU, Chukwuemeka OO, Uzuegbunam CO (2015). An Assessment of Growth Enhancement Support Scheme among Rice Farmers in Anambra State, Nigeria. Journal of Agricultural Extension 19(2):71-81.

Nino-Zarazua M (2007). The impact of credit on income poverty in urban Mexico. Sheffield Economic Research Paper (SERP) No. 2007005. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=977759

Obayelu AE (2016). Cross-Country Comparison of Voucher-Based Input Schemes in Sub-Sahara Africa Agricultural Transformation: Lessons Learned and Policy Implications. Agriculture Conspectus Scientificus 81(4):251-267.

Oguniyi A, Kehinde O (2015). Impact of Agricultural Innovation on Improved Livelihood and Productivity Outcomes among Smallholder Farmers in Rural Nigeria. A paper prepared for presentation at the 5th MSM 5th Annual Research Conference Managing African Agriculture: Markets, Linkages and Rural Economic Development. MSM, Maastricht, The Netherlands. 4 September 2015

Ricker-Gilbert J, Jayne TS, Shively G (2011). Addressing the 'Wicked Problem' of Evaluating the Impacts of Input Subsidy Programs in Africa: A Review. Paper prepared for the 2012 meeting of the Agricultural and Applied Economics Association, Seattle, Washington, 14 August 2012.

Ricker-Gilbert J, Mason NM, Darko FA, Tembo ST (2013). What are the effects of input subsidy programs on maize prices? Evidence from Malawi and Zambia.Agricultural Economics 44(6):671-686.

Ricker-Gilbert J (2014). Wage and employment effects of Malawi's fertilizer subsidy programme. Agricultural Economics 45(3):337-353.

Rosenbaum PR, Rubin DB (1983). The central role of the propensity score in observational studies for causal effects. Biometrika 70:41-55.

Rosenbaum PR, Rubin D (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. The American Statistician 39:33-38

Tesfamicheal W, Tahirou AA, Alene S, Feleke J, Ricker-Gilbert VM, Bola AA (2017). Productivity and Welfare Effects of Nigeria's e-Voucher-Based Input Subsidy Program. World Development 97:251-265.

World Bank (2010). Zambia Impact Assessment of the Fertilizer Support
    Program, Analysis of Effectiveness and Efficiency. Report No. 54864,
    World Bank, Africa Region P 16.