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REDUCING POVERTY THROUGH FERTILIZER SUBSIDY PROGRAME "EVIDENCE FROM RWANDA"

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ABSTRACT: *Farm input subsidies are assumed to improve agricultural production and productivity for small resource poor farmers in developing countries by promoting the use of improved farm inputs, mainly inorganic fertilizers and hybrid seeds. This is expected to contribute to increased income from produce sales, improved food security at household and national levels, and consequently, contributing to poverty alleviation. However, little insights exist on the impacts of this program. The overall objective of the study was to determine the effect of the fertilizer subsidy program on reducing poverty among small holder farmers in Gatsibo district, Eastern province of Rwanda. Multi stage sampling techniques were employed to select respondents. Structured questionnaires was employed to collect data from 200 smallholders maize farmers including (86 farmers with fertilizer subsidy and 114 without subsidies in the period 2015B, 2016A and 2016B agricultural seasons in the selected sectors of Kabarole, Rwimbogo and Rugarama). Propensity score matching using a "with" and "without" the fertilizer subsidy project evaluation approach was used to estimate the effect of fertilizer subsidy and descriptive statistics using t-test was used compare effects of fertilizer subsidies across respondents. Based on the study objectives, results from propensity score matching indicated an effect on yield between fertilizer subsidy users and non-users.*

KEYWORDS: Agriculture input subsidies, Poverty, Fertilizer Subsidies, Agriculture, Propensity Score Matching.

INTRODUCTION

This chapter focuses on the General background of the study, Statement of the problem, General objective, Specific objectives, Research hypothesis, Justification of the study and, Limitations of the study.

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Background of the study

The global food sufficiency by, many governments introduced fertilizer subsidy schemes in 1960s, fertilizer consumption, increased by about 14% during the same period various advancements in agriculture occurred that helped the region get closer to their food self-sufficiency goal, although the degree of their relative contributions remains unclear in respect to poverty reduction(Druilhe & Barreiro-Hurlé, 2012). Acute hunger crisis repeated in the 2004/05 growing seasons, affected five million people and forced the many governments into a costly exercise of importing emergency food (Dorward & Chirwa, 2011).

Agricultural input subsidies have often been used by national governments in sub-Saharan Africa to achieve the following goals, improve the affordability of agricultural inputs for smallholder farmers; improve the accessibility farmers have to inputs; develop the input-supply distribution system; sensitize farmers to the use of inputs where it may potentially be profitable; provide social protection for vulnerable groups by increasing productivity and access to food; restore soil fertility and improve soil fertility management practices; reduce the social costs arising from rural-urban income disparities with broader goals of raising agricultural production and food security. However poverty in Africa and in the Sub-Saharan Africa (SSA) in particular, has remained constant over the last two decades. For instance, between 1981 and 2005, the poverty rate in the SSA has shown no sustained decline in that it remained at around 50%, in absolute terms, the number nearly doubled from 200 to 380 million people(Prakash, 2011).Recent research has underscored the major effects of changes in food prices on poverty, with the weight of the evidence indicating that rising food prices exacerbate poverty and food insecurity (Ivanic & Martin, 2008).The intended response to liberalization up to at least the mid-1990s appeared disappointing, fertilizer use and agricultural productivity were stagnant in most countries and rural poverty rates remained inflexibly high. The stagnation of African agriculture in the 1980s and early 1990s led many to argue that the liberalization reforms failed and that the reintroduction of direct government participation in markets was necessary(Dorward & Chirwa, 2011).Maize drives fertilizer consumption in East Africa, cereals (maize) also dominate fertilizer consumption, although the pattern and increases trend is more in maize and other cereals which account for the majority of total fertilizer consumption, in most maize-producing African countries, the proportion of maize fertilizer consumption in total consumption by cereals tends to equal or exceed the proportion of maize production. Maize productions consume seventy percent of fertilizer supplied in Sub-Saharan Africa with Tanzania being first, since the mid-1960s, 50 to75 percent of the crop yield increases in non-African developing countries have been attributed from fertilizers use (Thornton, Jones, Alagarswamy, Andresen, & Herrero, 2010).However, though productivity in maize at region-wide have increased but consumption on fertilizer is slowly increased and fertilizer use on cereals crops in general, and on maize in particular, has become relatively more unimportant.
In Rwanda fertilizer use is not expanding quickly enough and that application rates are not high enough. However, Rwanda is characterized by low soil productivity due to nutrient depletion arising from over cultivation, low use of inputs and soil erosion, it is imperative that increased and judicious use of fertilizers is adopted to achieve agricultural intensification. PSTA III targets that fertilizer use of 45Kg/Ha which translates to 55,000MT of fertilizers. This is still below the target as contained in the Abuja Declaration on Fertilizer for an Agricultural Green Revolution of 50Kg/Ha. Fertilizer subsidies have been introduced since 2007 to accelerate the agriculture

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productivity under the program of crop intensification program (CIP), the program has emphasized improving the availability, access and use of fertilizers have increased from 4Kg/Ha in 2006 to 30Kg/Ha in 2013, while fertilizer availability increased from annual quantities of 8,000MT to 35,000MT though PAPSTA3 targets that fertilizer availability increases to 55,000MT per year and fertilizer use increases to 45kg/ha in 2017/18, government subsidies have been reduced from 20-50% of retail prices to 15-35%(Cantore, 2011). Despite these achievements the development of a fertilizer input subsidy program challenges still exist.

Statement of the problem

Agricultural input subsidies have often been used by national governments in sub-Saharan Africa mainly aimed at reducing the cost of acquiring predetermined quantity of farm inputs and targeted at sub-groups of farmers to reduce food shortage experienced in most developing countries (Minde, Jayne, Crawford, Ariga, & Govereh, 2008). Despite, the gains associated with the reforms in fertilizer subsidy programs in SSA including Rwanda the average agricultural yield still remains low (insert citation).The low agricultural output could be attributed to very low levels of fertilizer use in SSA of between 8 to 10kg per hectare, which is too low compared to 78kg in Latin America and 101kg in South Asia.

Moreover, in spite of the rigorous subsidy programs in SSA including Rwanda, price of fertilizer is still very high; consequently, its use leads to a reduction in the gross margins per unit of fertilizer applied and eventually, a decline in the overall farm profits(Dorward & Chirwa, 2011). The latter poses a big challenge to the small holder farmers in Rwanda. While, a number of studies in the use and effects of costs of farm inputs including fertilizers very limited information is available on the effect of subsidies on fertilizers under Rwandan context. Scarcity of information on the effect of agricultural subsidies presents a research opportunity to bridge the knowledge gap (T. G. Chirwa, 2010).

Research objectives

Primary objective

The primary objective of this research is to analyze the effect of fertilizer input subsidies in reducing poverty among small holder maize producers in Gatsibo district.

Secondary Objectives

1. To determine the effect of fertilizer subsidies on yield between fertilizer subsidy users and non-users in Gatsibo district.
2. To assess the effects of fertilizer subsidies on income between fertilizers subsidy users and non-users in Gatsibo district.
3. To determine effect of fertilizer subsidies on quantity of fertilizer applied per hectare between fertilizer subsidy users and non-users in Gatsibo district.
4. To evaluate the effect of fertilizer subsidies on price purchased between fertilizer subsidy users and non-users in Gatsibo district.

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Research Hypothesis

$Ho_{1:}$ Fertilizer input subsidies does not have effect on maize yield of fertilizer users in Gatsibo District.

$Ho_{2:}$ Fertilizer input subsidies does not have effect on income of farmers using fertilizer in Gatsibo District.

$Ho_{3:}$ The use of Fertilizer input subsidies does not affect quantity of fertilizer applied per ha among fertilizer users on in Gatsibo District.

Ho_4: Fertilizer input subsidy users pay less to fertilizer inputs compared to non- fertilizer subsidy users in Gatsibo District.

THEORETICAL FRAME WORK

The economic Development and Poverty Reduction Strategies of Rwanda aims at increasing economic growth by investing in and modernizing agriculture, recognizes that food crops constitute a major component of agriculture and national GDP and clarifies that the slackening in GDP growth is due to limited increments in farm outputs. Thus farm input subsidy program aims to increase the production of food crops especially staple crops such as maize which is constrained by several factors such as land use patterns, soil quality and supply of technology and infrastructures in rural areas. FISP particularly targets to improve the agricultural productivity and increase the profitability of small farm holds. Survey results suggest that Rwandan farmers identify fertilizer, insecticide and improved seeds as top priorities for improving agriculture (NISR,.2015). Agriculture Input subsidy program was proven to encourage increased participation of the private sector in transfer of technology to farmers, after the initial transfer by the public sector. EDPRS intends to encourage surplus production of farm produces by subsidizing the acquisition of key inputs by farmers.

Given the scale of operations in diverse parts of the country, subsidy program faces several operational and administrative challenges. The operational challenges involve identifying the required inputs for distribution in collaboration with service providers and planning for the seasons. Timely delivery of inputs is often hindered by limitations in human and administrative capacities at administrative levels (Cantore, 2011). For instance, the distribution of vouchers was discontinued in 2009 owing to the difficulties in printing and issuing to farmers on time. The pitfalls in conception of land use consolidation amongst farmers exposes the limitations in proximity extension services. The issues, concerns and confusions on land ownership need to be addressed by the extension service providers to improve adoption rates. In addition to the constraints involved in human and other implementation capacities that were documented, coordination, monitoring and evaluation of seasonal fertilizer also poses serious challenges. The technical challenges associated with raising productivity in smallholder farms increasingly revolve around management of other natural resources such as soil and water. Such approaches will not only improve the efficiency of the use of inputs distributed under subsidy program, but also increase the economic profitability of smallholder farmers on a sustainable basis.

Therefore more emphasis needs to be laid on increasing productivity. When the productivity levels are assumed to have doubled by 2017 with moderate expansion in area under cultivation, the production of maize, wheat and rice could exceed the demand and enable export of these commodities to the region. To produce surplus quantities of cassava, Irish potato and beans, the productivity levels require to be doubled by 2017. These challenges require renewed focus on the sustainability and further acceleration of the current intensification process over the next 7 years.

RESEARCH METHODOLOGY

The methodology includes theoretical frame work, the general approach of the study (research design), study area, the population of interest, the sample size, data collection instruments and the data analysis technique that will be employed in order to measure the effect of agricultural of subsidized fertilizer on poverty reduction in Rwanda.

Research Design

The study was conducted through propensity score matching approach and descriptive survey design; information on the effect of fertilizer subsidies was presented as received from the respondent. Descriptive survey is a process of collecting data in order to answer questions concerning the current status of the subject in the study (Moti, Masinde, Mugenda, & Sindani, 2012). The rationale behind the selection of the designs was that it helped the researcher to analyze effect of fertilizer subsidies in the study area.

Target population

A population refers to the aggregate of all cases that conform to some designated set of specifications it is the entire set of relevant units of analysis or data (Kothari, 2008). The study targeted small holder farmers who accessed Maize fertilizer subsidy and those who did not have access to subsidy in three sectors of Gatsibo district with the size of population of 421.

Sampling Design

A sample is a group in a research study on which information is obtained. Sampling therefore refers to the process of selecting individuals in the sample. Sampling is necessary because population interest could be large, diverse and scattered over a large geographic area (Kothari et al., 2008). Stratified sampling was used to divide the sample size in the selected sectors where maize are highly cultivated into strata of fertilizer users and non-users, the stratum approach was used to determine sample size to be selected in each sector of Gatsibo district.

Purposive sampling was used because every sector in Gatsibo district had defined farmers who had more information than others among them include lead farmers. Finally, Simple random sampling was used to obtain sub samples from each stratum. The use of Simple Random Sampling gave each individual in the population theoretically an equal chance of being selected for the sample of 200 individuals.

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Table 1: Simple random sampling

Sectors	Total number of maize farmers	Number of sample selected		Sample size selected
		Fertilizer users	Non-users	
Kabarole	125	18	32	50
Rwimbogo	146	30	36	66
Rugarama	150	38	46	84
Total	421	86	114	200

The simple random sampling technique was used to select members in three sectors of Kabarore, Rwimbogo and Rugarama.

Sample size determination

Sample size is the number of representative elements selected from a population on which an investigation was conducted.The sample size was determined by using the following formula of (Sloven et al., 2004).

The sample size will be determined based on farmers benefiting from fertilizer subsidies using Sloven's formula:

$$n = \frac{N}{1+N*e^2}$$

$$n = \frac{421}{1+421*0.05^2}=200$$

Where n: stands for desired sample size, N: is the total sample size (population) and e: acceptable margin error equal to 5%.

Data collection instruments

Primary data was collected through the use of self-administered questionnaires. A questionnaire consisted of a number of questions printed or typed in a definite order on a form or set of forms. This method of data collection had the advantage of low cost, it was also proven to be free from bias of the interviewer, it also gave the correspondence adequate time to give well thought answers and since large samples could be made use of, the results were more dependable and reliable (Kothari, 2008).The questionnaire contained both structured and semi-structured questions.

Semi-structured interviews involved a total of 200 household units. The data collected using the semi-structured questionnaires included household demographic data which include household membership by age and sex, school attendance, marital status; household land type and area cultivated; household income by source; household assets; crop type and its production, split into amounts consumed, sold and given out as gifts and household participation in social programs, yield, quantity of fertilizer applied, price of fertilizer.

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Estimation models

Following previous impact assessment studies and objectives this study adopts the semi-parametric PSM approach Rosenbaum and Rubin (1983)to assess the effect of fertilizer subsidy programs, this technique aims at minimizing the potential bias resulting from the selection problem using non-experimental data.

Therefore, for a farmer *i*, (where *i*=1…*I*, and *I* denotes the population of farmers), the major task of impact evaluation study is to separate the impact of fertilizer subsidy (*Di=1*) on a certain outcome *Yi* (*Di*) from what is happening to the farmers without fertilizer subsidy programme (*Di=0*), the so called counterfactual scenario. The equation (1) differentiates the observed outcome for a adopter farmer *I* and the counterfactual potential outcome without/fertilizer.

$$\prod_i Y_i(1) - Y_i(0) \qquad (1)$$

The impact πi cannot be observed, since in an *ex post* setting, a farmer is either a user or non-user, but not both. This situation will shift attention to the average population effect. This consists of estimating the average treatment effect on the treated (ATT) defined as follows:

$$\prod_{ATT} = E\left[\prod \middle| D=1\right] = E\left[Y(1) \middle| D=1\right] - E\left[Y(0) \middle| D=1\right] \qquad (2)$$

Where *E* represents the average (or expected value)

E (*Y*0 | *D* =1) is the average outcome that the treated individuals would have obtained in absence of treatment, which is not observed.

However, we do observe the term *E*(*Y*0 | *D* = 0) that is, the value of *Y0* for the untreated individuals. Since E [Y0/D=1] is unobservable, the technique consists of subtracting the unobserved effect of the adopting group in respect to those who did not adopt *E*(*Y*0 | *D* = 0)

$$E\left[Y(1) \middle| D=1\right] - E\left[Y(0) \middle| D=0\right] = \prod_{ATT} + E\left[Y(0) \middle| D=1\right] - E\left[Y(0) \middle| D=0\right] \qquad (3)$$

The right-hand side of the equation represents the impact under investigation, while the two last terms on the right-hand side stand for the selection bias. Hence, the identification of the true impact on

$$E[Y(0) | D = 1] - E[Y(0) | D = 0] = 0 \qquad (4)$$

Three assumptions underlie the PSM method (Rosenbaum & Rubin, 1983). First, the balancing assumption in equation (5) ensures that farmers with similar propensity score will share similar unobservable characteristics, irrespective of their adoption outcome.

$$D \perp X \middle| \Pr(X) \qquad (5)$$

Second, assuming that adoption of fertilizer use is not confounded, the conditional independence assumption (CIA) in equation (6) implies that after controlling for farmers' characteristics (X), use of fertilizer subsidy is as good as random.

$$Y(0), Y(1) \perp D \middle| X, \quad \forall X \qquad (6)$$

Third, the common support assumption in equation (7) ensure that the probability of using fertilizer subsidy for each value of vector X is strictly within the unit interval so that there is sufficient overlap in the characteristics of user and non-user farmers to find adequate matches.

$$0 < \left[\Pr(X) = \Pr(D = 1 \middle| X\right] < 1 \qquad (7)$$

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With the CIA assumption, the resulting PSM estimator for ATT can be generalized as follows:

$$\prod_{ATT}^{psm} = \Pr(X)|D=1\{E[Y(1)|D=1,\Pr(X)]-E[Y(0)|D=0,\Pr(X)]\} \quad (8)$$

Empirical estimation

The probit regression model was used to estimate the propensity score Pr (*X*) □Pr (*D*□ 1 /*X* for assessing the impact, the study adopted a Probit model (Wooldridge, 2005). This model estimates the probability that a farmer *I* with particular characteristics *Xi* will fall under a user group as follows

$$P(Di)=1/xi) = \phi(Xi, \beta) \quad (9)$$

Where ф denotes the cumulative distribution function of the standard normal distribution

Matching methods

To address the second, third and fourth objective which is to assess the impact of fertilizer subsidy propensity score matching was used. Baker (2000) gives the steps involved in applying propensity score matching. In this study nearest neighbor matching (NNM), radius matching (RM) and kernel based matching (KBM) methods were used. Basically, these methods numerically search for neighbors" that have a propensity score for non-treated individuals that is very close to the propensity score of treated individuals.

NNM method is the most straight forward matching method. It involves finding, for each individual in the treatment sample, the observation in the non-participant sample that has the closest propensity score, as measured by the absolute difference in scores Baker (2000).To match user and non-user based on the propensity scores, the study used different algorithms and compares their results. For a user farmer *I* and non-user farmer *j*, the nearest neighbour matching algorithm calculates the absolute difference between propensity scores as follows.

$$|\Pr_i - \Pr_j| = \min_{K\varepsilon L=0}\{\Pr_i - \Pr_k\} \quad (10)$$

The KBM method is also a non-parametric matching method that uses the weighted average of the outcome variable for all individuals in the group of non-users to construct the counterfactual outcome, giving more importance to those observations that provide a better match. This weighted average is then compared with the outcome for the group of participants.

The difference between the two terms provides an estimate of the treatment effect for the treated case, placing higher weights to non-users with propensity scores closer to that of the user. Under this technique, for a user farmer *i*, the associated matching outcome is given by (Deschamps-Laporte, 2013).

$$\frac{\breve{Y}i = \sum_{j\varepsilon I=0}^{n} K[Pri - Prj]/h]yi}{\breve{Y}i = \sum_{j\varepsilon I=0}^{n} K[Pri - Prj]/h]yi}$$

Where *k* is a kernel function and h is a bandwidth parameter

Radius matching (RM) is a variant of caliper matching suggested by Dehejia and Wahba (2002)applying caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper ('propensity range') and is closest in terms of propensity score (Caliendo & Kopeinig, 2008).The basic idea of RM as a variant of caliper matching is to use not only the nearest neighbour within each caliper but all of the comparison members within the caliper. A benefit of this approach is that it uses only as many comparison units as are available within the caliper and therefore allows for usage of extra (fewer) units when good matches are (not) available.

In the third stage overlap condition or common support condition is identified. The common support or the overlap condition is an important condition while applying PSM. The common support is the area where the balancing score has positive density for both treatment and comparison units. No matches can be made to estimate the average treatment effects on the ATT parameter when there is no overlap between the treatment and non-treatment groups.

In the fourth stage the treatment effect is estimated based on the matching estimator selected on the common support region.

RESULTS AND DISCUSSION

Gender of respondents

Table 4.2.1the results of the study found that majority of the respondents were males that presented (78 %) and females presented 22% this means that fertilizer application was done more by men than women equally, it can therefore be stated that men are more involved in fertilizer application than women the results of study are suported byOdendo, Obare, and Salasya (2010)who found that men adopt technologies more easily than men.

Table 2. Categorization of respondents by Gender

Sex	Frequency	Percent
Male	156	78
Female	44	22
Total	200	100

Categorization of respondents according to marital status

Table 4.2.2the results of the study found that majority of the respondents that were married which presented 94.9 %and the respondents that were single represented 5.1%, this could be attributed to the fact of cooperative performance and the benefits of being married in this study showed that those people were steadier and faithful in loan request from the banks for planning their business and easily repayment than the single and those persons have the ability to run away from the area without paying. It was also found that because some MFIs focus on women, the husbands encourage their women to get the loan to start a business, or pay school fees or purchase household items and they in turn assist in the loan repayment the results of the study are supported by reportNtamazeze (2014) that found that married house hold enjoy more benefits related to accessibility to loans.

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Table 3. Categorization of respondents according to marital status

Sex	Frequency	Percent
Married	188	94.9
Single	12	5.1
Total	200	100

Categorization of respondents according by education

As illustrated by the table shown below, the respondents attended school were non formal 8.5, primary 68, secondary 22.5 and University 1 %,this number of those attended school can contribute to the development of study area which is Gatsibo District as the case of interest, the results of the study are supported by report Ntamazeze (2014)that found that school attendance in the population has increased by 6% since2005/06, with about 83% of the population aged 6 years or more having ever attended school, according toAbdulai and Huffman (2005), educated farmers would use their acquired skills and adopt the more profitable production systems.

Table 4. Categorization of respondents according by education

Education	Frequency	Percent
Non formal	19	8.5
Primary	110	68
Secondary	69	22.5
University	2	1
Total	200	100

Categorization of respondents according by occupation

From the table indicated below, respondents were also asked to state the main activities and results revealed that 87% were engaged in agriculture activities where as 13 % were engaged in non-farm activities, the results of the study are in line with findings ofNtamazeze (2014)that found agricultural occupations dominate Rwandan workforce.

Table 5.Categorization of respondents according by occupation

Occupation	Frequency	Percent
Famer	174	87
Non farmer	26	13
Total	200	100

From the table indicated below, respondents were also asked to state the main crop grown and results revealed that 97.5% cultivate maize as their primary crop and 2.5 % grow other crops as

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their primary crops, the results of the study are in line with findings of(Cantore, 2011); that found maize crop is the main recommended crop under crop intensification program which is mainly active in eastern province where Gatsibo district is found and according to EICV3, Maize crop production is ranked the first priority crop grown at 49.2% of total land area.

Table 6. Categorization of respondents by maize cultivation

Maize as main crop	Frequency	Percent
Yes	174	87
No	26	13
Total	200	100

Land ownership of maize growers in Gatsibo District

The table under below concerns the farm size situation of maize growers in Gatsibo District and the results from the field survey are summarized as follows by those farmers who are having the land varying from 0.03 to 1ha were 98%, 1.1 to 13 ha represented 2% generally all most the entire population had land size less than one hectare the results of the study are consistent with the current country situation where average farm size for a farmer is 0.7 ha.

Table 7. Categorization of respondents according to land size

Area in ha	Frequency	Percent
0.03 to 1	196	98
1.1 to 13	4	2
Total	200	100

Comparison of social economic characteristics of respondents

The socioeconomic characteristics, such as age, education, household size and farm size of a population were expressed statistically. In terms of age, the average age mean difference between fertilizer subsidy users and non-users was 0.7 with p-value equal (0.3) indicating that respondents in terms of age were different and might have affected the use of fertilizer subsidy in the study area. On education, it is slightly different across respondents the mean difference 0.2 with p-value equal (0.38) indicating difference in levels of education as there was no statistical significance at 5% level of significance. The household size is different between fertilizer subsidy users and non-users as the mean difference was 0.1 with p-value (0.33) that was not statistically significant meaning that maize crop is not labour intensive crop that would help give the households a good labor support, the findings of the study contradict with Mengistu (2010), who found availability of household labor positively affecting adoption of agriculture technology.

The farm size between fertilizers was different and means difference was 0.4 with p-value of (0.08) and there was no statistical significance at 5 % indicating that farm size has no influence on use of fertilizers subsidy.

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Table 8. Comparison of social economic characteristics of respondents

Variable	Users		Non users		Diff	P-value
	Mean	Obs	Mean	Obs	Mean	
Age	43.2	114	43.9	86	0.7	0.30
Education	5.7	114	5.9	86	0.2	0.38
HH size	6.2	114	6.3	86	0.1	0.33
Farm size	1.8	114	1.4	86	0.4	0.08

*Significant at 5 % percent level of significance

Comparison of respondent's income by source

The study analyzed whether fertilizer subsidy use has a positive effect on participation in off farm income by comparing the mean of characteristics of fertilizer subsidy users and non-users using a t-test, the results shows that fertilizer subsidy user and non-fertilizer subsidy users differ significantly the income got from livestock sales is 38660.2 with p-value (0.12), crop production 16456.1 with p-value (0.21), off farm income 21897.1with p-value (0.037).

Table 9. Comparison of respondents by income by source

Variable	Users	Non users	Diff	P-value
	Mean	Mean	Mean	
Livestock	39823.0	1162.7	38660.2	0.12
Crop prod	95990.9	79534.8	16456.1	0.21
Off farm	23873.9	1976.7	21897.1	0.037

*Significant at 5 % percent level of significance

Comparison of respondents by access to extension services

As the results from the field survey revealed that availability of trainings and sensitization are among the key factors that influenced use of fertilizer subsidy with p –values (0.01 and 0.08) respectively, the results reflect reality since farmers in cooperatives in study area are provided more incentives compared to farmers outside.

Table 10. Comparison of respondents by access to extension services

Variable	Users	Non users	Diff	P-value
	Mean	Mean	Mean	
Trainings	0.5	0.31	0.2	0.08
Contacts	0.9	0.2	0.7	0.01
Credits	67526.1	29830.9	37695.2	0.006

Significant at 5 % percent level of significance

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Descriptive results on challenges affecting FISP

Respondents were also asked to state the challenges that affected them most in FISP most of the respondents indicated that the programme was strongly affected by lack of markets which accounts 92.5% lack of knowledge on use inputs which accounts 90.0%, delay of inputs with 80.5 % and insufficient farm inputs. This indicates a lot of gap to cover by fertilizer subsidy policy in order to address the challenges.

Table 11. Descriptive results on challenges affecting FISP

	Strongly affected		Affected		Not affected	
Challenges	Frequency	%	Frequency	%	Frequency	%
Delay of inputs	161	80.5	36	18	3	1.5
Insufficient farm inputs	131	65.5	60	30	9	4.5
Lack of enough knowledge on use of fertilizers	180	90.0	12	7.5	8	4
Corruption	2	1	18	9	180	90.0
Lack of markets	185	92.5	11	5.5	4	2

Objective 1: Effect of fertilizer subsidies on yield (ATT)

The results indicate that, fertilizer subsidy use has a positive and slightly significant effect on yield of the farmers at the 5 percent level the mean difference between fertilizer subsidy users and non-users across all seasons (2015B, 2016 B and 2106A) based on nearest neighbour, kernel and radius matching, the results of the study revealed the mean difference ranged from 82.2to 377.5,ranged from 27.1 to 369.6 and ranged from 27.1 to 371.2kg per ha respectively which are significant at 1 and 5 percent level confidence interval. It can therefore be concluded fertilizer use has effect on increasing maize yield for the farmers who accessed fertilizer subsidies across all three seasons. This finding suggests that getting smallholder commercial farmers to use fertilizers subsidies can help improve their welfare through increasing their yield consequently reduced poverty through increased yield, in Rwandan case the results are as expected due to the fact that farmers in cooperatives are not only with the incentives to get subsidized fertilizer but are also more advantaged to production systems through availability of extension services and post-harvest technologies with effective policy strategies in distribution of inputs like zero corruption, the results of the study are supported by findings of Viyas (1983) who found that 50 to75 percent of the crop yield increases in African developing countries have been attributed from fertilizers use. Hence the hypothesis that fertilizer input subsidy does not increase yield rejected.

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Table 12: Effect of FISP on yield (ATT)

Season	Matching estimator	Fertilizer subsidy users	Non-users	Difference	S.E	T-stat
2015 B	NN	1567.9	1485.7	82.2	266.8	0.31
2015 B	KM	1567.9	1540.7	27.2	240.1	0.1
2015 B	RM	1567.9	1540.8	27.1	240.2	0.1
2016 A	NN	1655.5	1277.9	377.6	249.4	1.5
2016 A	KM	1655.5	1285.9	369.6	235.6	1.6
2016 A	RM	1655.5	1284.2	371.3	235.6	1.6
2016 B	NN	398.7	250	148.7	100.4	1.5
2016 B	KM	398.7	269.1	129.6	99.5	1.3
2016 B	RM	398.7	267	131.7	99.4	1.3

**Significant at 5 % percent level of significance
*Significant at 1 % percent level of significance

Objective 2: Effect of fertilizer subsidies on income (ATT)

The results indicate that, fertilizer subsidy use has a positive and slightly significant effect on income of the farmers which are significant at 1 percent level of significance the mean difference income measured in Rwandan francs between fertilizer subsidy users and non-users per season in 2015 B based on Nearest neighbour, kernel and radius matching the results of the study revealed the mean difference that ranged from 620.7 to 2666.7,and 113.9 to 2373.9, and 115.7 to 3150.2 in local currency (Rwandan francs) respectively. Though the findings reveal that the income of fertilizer subsidy farmers is positive compared to non-fertilizer subsidy famers but it is still low which justify the reason for no significance. This means, the effect of fertilizer subsidy program on farmer's income is small and can be attributed to lack of information related to the types of fertilizer subsidized and the targeted crops which cause low fertilizer used by farmers, less adoption of extension services as well as subsistence agricultural techniques, which result to insignificant yield, thus income increase at a low pace. This implies that effective sensitization strategies should be designed to improve for the program to benefit the users, in Rwandan case it can be interpreted by NISR data for the year 2016 where Agriculture operators that used inorganic fertilizer were counted to 22% (NISR, 2016) and famers do need improvements in understanding the benefits of fertilizer application, rates and the perception farmers have on the program still requires a lot of efforts by extension agents on the program, the findings of the study are relevant to Dorward and Chirwa (2011) who found that fertilizer subsides improve income of small holder farmers through increased yields. The hypothesis that fertilizer input subsidy does not increase income of small holder farmers rejected.

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Table 13: Effect of fertilizer subsidies on income (ATT)

Season	Matching estimator	Fertilizer subsidy users	Non-users	Difference	S.E	T-stat
2015 B	NN	182535.7	171556.7	10979	48665.6	1.2
2015 B	KM	183156.4	182535.7	620.7	43697.9	1.1
2015 B	RM	185685.9	182535.7	3150.2	43446.1	1.1
2016 A	NN	253089.3	250422.6	2666.7	54522.8	1.1
2016 A	KM	253089.3	250715.3	2374	50720.5	1.1
2016 A	RM	253089.3	250019.6	3069.7	50573.6	1.1
2016 B	NN	1329	1294.4	34.6	273	1.3
2016 B	KM	1442.9	1329	113.9	246.5	1.5
2016 B	RM	1444.7	1329	115.7	245.3	1.5

**Significant at 5 % percent level of significance
*Significant at 1 % percent level of significance

Objective 3: Effect of fertilizer subsidies on quantity of fertilizer applied per ha (ATT)

The results indicate that, fertilizer subsidies has a positive and significant effect on quantity of fertilizer applied per ha at the 5 percent level of significance the mean difference between fertilizer subsidy users and non-users per season based on Nearest neighbour ranged40.9 to 44.9kg per ha, Kernel matching is 47.2 to 51.3 kg per ha and Radius matching algorithms ranged from 43.1 to58.9 kg per ha respectively which are significant at 5 percent level confidence interval. In Rwandan context the significance can be explained by the efforts made by the government in providing fertilizer subsides, however more efforts is required on trainings on recommended fertilizer application rates and soil testing. The results of the study are supported by findings of Brabet et al. (2013),which indicates that use of fertilizers have increased from 4Kg/Ha in 2006 to 30Kg/Ha in 2013, while fertilizer availability increased from annual quantities of 8,000MT to 35,000MT, fertilizer availability increases to 55,000MT per year and fertilizer use is targeted to increase to 45kg/ha in 2017/18.Hence the hypothesis that fertilizer input subsidy does not increase quantity of fertilizer applied per ha rejected.

Table 14: Effect of fertilizer subsidies on quantity of fertilizer applied per ha (ATT).

Season	Matching estimator	Fertilizer subsidy users	Non-users	Difference	S.E	T-stat
2015 B	NN	91.6	48.5	43.1	17	2.5**
2015 B	KM	91.6	48.4	43.2	17.1	2.5**
2015 B	RM	91.6	48.4	43.2	17	2.6**
2016 A	NN	123.5	82.6	40.9	53.2	2.9**
2016 A	KM	129.8	82.6	47.2	47.1	2.97**
2016 A	RM	141.5	82.6	58.9	46	2.3**
2016 B	NN	129.6	78.6	51	64.3	2.9**
2016 B	KM	129.9	78.6	51.3	55.5	2.9**
2016 B	RM	129.9	78.6	51.3	55.5	2.99**

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**Significant at 5 % percent level of significance
*Significant at 1 % percent level of significance

Objective 4: Effect of fertilizer subsidies on price paid on fertilizer (ATT).

The results on price paid to purchase fertilizer between fertilizer subsidy users indicate that, the mean difference across three seasons using all three matching logarithms was, Nearest neighbour match range from 15.1 to 32.2Frws, Kernel matching, 19.1 to 27.7 Frws and Radius matching algorithm range from 19.1 to 27.7 Frws, which are not statistically significant at both 1 and 5% level of confidence interval across all matching logarithms. This findings found that farmers using subsidies were paying slightly low prices compared non-subsidy users. In Rwandan context the results reflect reality due to the fact that famers accessing subsidies pay marginally less price compared to non-fertilizer subsidy users and the reason is that government have initiated the subsidy roll out of the program through reducing the subsidy share from 35-50% to 15-35% of initial price of fertilizer. The results of the study contradict with findings of Ricker-Gilbert and Jayne (2009),who found that smallholder farmers find fertilizer use unprofitable the FISP contributed to household food expenditure. Hence the hypothesis that fertilizer input subsidy reduces the price paid by fertilizer users rejected.

Table 15: Effect of fertilizer subsidies on price paid on fertilizer (ATT).

Season	Matching estimator	Fertilizer subsidy users	Non-users	Difference	S.E	T-stat
2015 B	NN	427.5	412.4	15.1	12.1	2.2**
2015 B	KM	431.5	412.4	19.1	10.4	1.84
2015 B	RM	431.5	412	19.5	10.4	1.84
2016 A	NN	429	414.5	14.5	12.4	2.35
2016 A	KM	434.4	414.1	20.3	10.7	1.85
2016 A	RM	434.4	414.5	19.9	10.7	1.85
2016 B	NN	462.1	429.9	32.2	48.2	1.7
2016 B	KM	462.2	434.4	27.8	47.8	1.5
2016 B	RM	462.1	434.4	27.7	47.7	1.5

**Significant at 5 % percent level of significance
*Significant at 1 % percent level of significance

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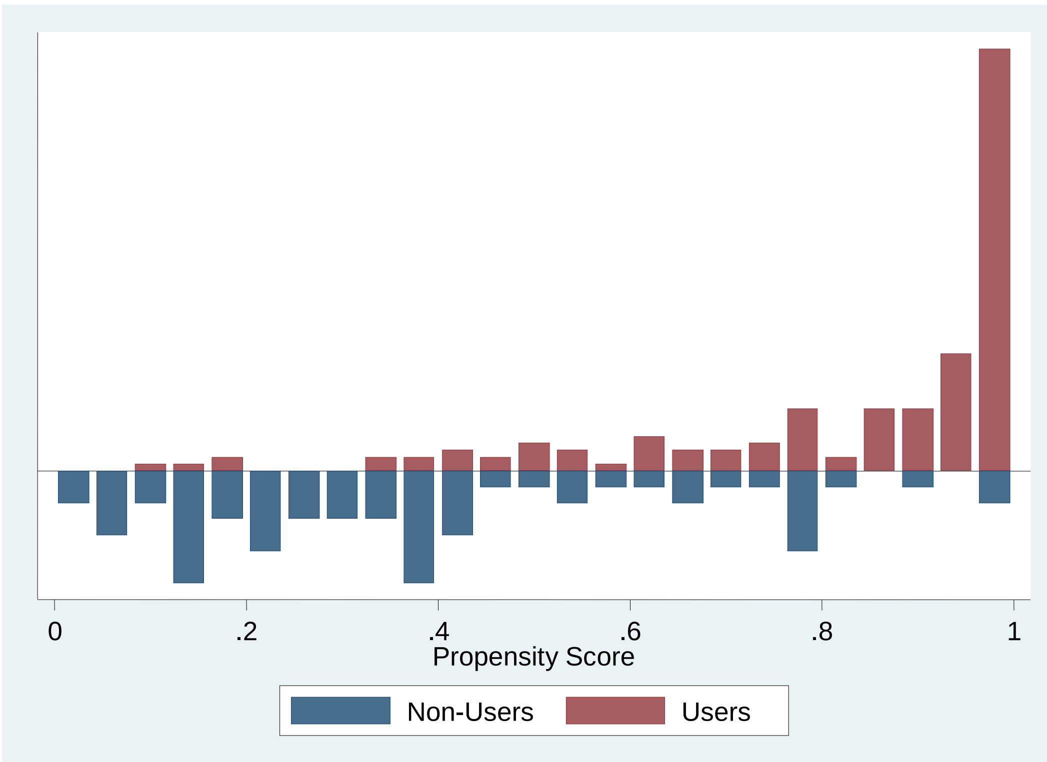
Propensity score histogram

The graph shows that no treated individuals were off support indicating that all the individuals that used fertilizers (treated) found a suitable match among those who did not use fertilizers (control), for all the covariates, the matched sample means are almost similar for both the treatment and the control; hence the assumption of common support was attained.



CONCLUSION

The results indicate that, fertilizer subsidy use has a positive effect on yield across all seasons (2015B, 2016 B and 2106A) based on nearest neighbour, kernel and radius matching the results of the study revealed the mean difference ranged from 82.2 to 377.5, kernel matching 27.1 to 369.6 and radius matching ranged from 27.1 to 371.2kg per ha respectively.

The results on second specific objective of the study, on effect of fertilizer subsidy on income of the farmers, found the mean difference income measured in Rwandan francs between fertilizer subsidy users and non-users per season based on Nearest neighbour ranged from 620.7to 266Frws, Kernel matching was 113.9 to 2373.9 frws and Radius matching algorithms was115.7 to 3150.2 in local currency(Rwandan Francs).The results of the study were not statistically significant at 1 and 5% level of significance.

The third specific objective of the study, the results indicated that, fertilizer subsidies have a positive and significant effect on quantity of fertilizer applied per ha and was significant at 5 percent level of significance, the mean difference between fertilizer subsidy users and non-

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fertilizers subsidy users per season based on Nearest neighbour40.9 to 44.9 kg per ha, Kernel matching is 47.2 to 51.3 kg per ha and Radius matching algorithms ranged from 43.1 to 58 kg per ha. It can therefore be concluded fertilizer subsidy use has effect on quantity of fertilizer applied per ha for the farmers who accessed fertilizer subsidy. This reject the third hypothesis that fertilizer subsidy users do not increase quantity fertilizer per ha.

The results on fourth specific objective of the study on price paid to purchase fertilizer between fertilizer subsidy users and non-users indicate that, the mean difference across three seasons using all three matching logarithms was, Nearest neighbour match range from15.1 to 32.2Frws, Kernel matching, 19.1 to 27.7 Frws and Radius matching algorithm range from 19.1 to 27.7 Frws respectively which are not statistically significant at 5 percent level confidence interval. This rejects the fourth hypothesis that fertilizes subsidy users pay less price compared to non-fertilizers subsidy famers.

RECOMMENDATIONS

Given the potential benefits of fertilizer subsidy, and based on the findings of the study, the study encourages the farmers to join cooperatives to adopt use of fertilizers because it was found that farmers in cooperative have more information related to fertilizer use and sources of fertilizes compared to non-fertilizer users and access other benefits that accrue from cooperatives.The study further recommends that efficient policy strategies like distribution channels ,timely distribution of inputs, better lending terms for farm inputs provided on credit to farmers particularly to encourage adoption on use of fertilizer, improve the affordability of agricultural inputs for smallholder farmers; develop the input-supply distribution system; sensitize farmers to the use of inputs where it may potentially be profitable, allocating public resources to agricultural input subsidies to encourage more use fertilizers by small holder farmers and also pause to phase out the program in Rwanda, strengthen research and extension on fertilizers, promote private sector in to intervene in the subsidy program and provide credits to farmers where applicable, this can help small holder farmers to maximize their live hood potentials.

Strengthen the extension systems to increase their awareness about better production systems and a strong extension service is important. This study indicates that effect of the program is small strengthening the extension service can help to easily disseminate the required knowledge to increase productivity. In this regard, improving the extension requires, designing and providing specific training on production systems as well as strict follow-up system by the government.
The Rwanda fertilizer subsidy program was designed to benefit those households that were before then using insufficient or no fertilizer for their production. However, though there is a positive association from our analysis, there is a need to design more sophisticated policy strategies and enhance the subsidy program implementation to achieve its objectives.

FURTHER RESEARCH

The study also recommends that, in future, research could be undertaken to evaluate the transaction cost points, conduct a cost-benefit analysis, to verify if fertilizer subsidies are a cost effective way

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of assisting the poor which this study was not able to accomplish due to limitations of time and funding.

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