A BASELINE ASSESSMENT OF GOVERNMENT OF GHANA FERTILIZER SUBSIDY PROGRAMME IN THE SISSALA WEST AND LAMBUSSIE DISTRICTS

REPORT

SUBMITTED TO

COMMUNITY DEVELOPMENT ALLIANCE (CDA-GHANA)

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JULY, 2018

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Acknowledgements

The consultants acknowledge the invaluable contributions and support of various institutions and persons in the process of this assessment. To begin with is the main implementing agency, Community Development Alliance (CDA), Ghana. We received support from various members of staff of CDA. We would like to express our heartfelt appreciation for the invaluable support in areas of planning the assessment, linking us to the various stakeholders and providing the necessary documents and reports. We appreciate the wonderful relationship and support we received from Mr Salifu Issifu Kanton, the Executive Director of CDA-Ghana.

Funding support for this study was provided by the ACDI/VOCA via its implementing agency, CDA-Ghana. This study was undertaken as part of CDA-Ghana's six-month advocacy project initiative entitled: "Strengthening Transparency and Accountability in Ghana's Fertilizer Subsidy Program Implementation". The consultants wish to thank all the stakeholders (i.e., MoFA officials, local government officials, input dealers, farmers, etc.) who set aside some of their schedules to participate in the surveys and provided valuable information for the analyses leading to this report.

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Abbreviations and Acronyms

ACDI/VOCA	Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance (but now the legal name for entity)
ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect for the Untreated
CDA	Community Development Action
FGD	Focus Group Discussion
FSP	Fertilizer Subsidy Programme
GHS	Ghana Cedi
Ha	Hectare
LA	Lambussie District
METASIP	Medium Term Agriculture Sector Investment Plan
MoFA	Ministry of Food and Agriculture
PSM	Propensity Score Matching
SW	Sissala West District

Executive Summary

The baseline assessment of Government of Ghana Fertilizer Subsidy Programme (FSP) is a project undertaken by Community Development Alliance (CDA)-Ghana, as part of a six-month advocacy project initiative to strengthen transparency and accountability in Ghana's FSP. Funding for the project came from ACDI/VOCA with CDA-Ghana as its implementing agency. Thus this report presents a baseline assessment of government of Ghana Fertilizer Subsidy Programme (FSP). The project aimed at increasing citizens' oversight responsibilities in the tracking of the implementation of Ghana's FSP so as to improve transparency, accountability and to curb smuggling of subsidized inputs. Specifically, the evaluation was to assess the implementation of FSP so as to identify successes, gaps and provide recommendations for improved interventions in the future.

The project was undertaken in the Sissala West and Lambussie Districts of the Upper West Region. The target population was smallholder farmers, Ministry of Food and Agriculture (MoFA) officials, District Assembly officials and local agriculture input dealers. The evaluation combined both qualitative and quantitative methods of data collection and analysis. The main data collection instruments were key informants interviews (KIIs) guide, focus group discussions (FGDs) guide and questionnaires for farmers and input dealers. The analysis of data was based on narratives, descriptive statistics, and multivariate statistical techniques (i.e. probit and PSM).

The analysis of evidence available suggests that the FSP has the potential to achieve its stated objectives and that the 2017 national FSP contributed positively towards achieving those objectives. The following were some positive contributions of FSP as revealed by the findings. First, the programme has made fertilizer affordable to farmers and hence has increased the farm lands under cultivation and that there is the prospect of it ensuring financial security for farm households. Second, evidence from the study indicates that there has been an increase in the use of fertilizer as a result of the programme. Lastly, FSP had boosted the production of food crops as well as farmers' income, as beneficiary farmers obtained higher yields as compared to their non-beneficiary counterparts especially farmers in the Sissala West District. However, the study identifies some challenges and among them are bureaucratic procedures, inadequate storage facilities for fertilizers, over-centralization of subsidized fertilizers, inadequate extension officers and public education, delay in the supply of fertilizer, low recovery rate, smuggling of the subsidized inputs, and politicization of the programme. These challenges if unresolved could affect the programme's effectiveness and efficiency.

To avoid double registration of farmers, it is recommended that MoFA should institute a geographic information system (GIS) to map all farms with beneficiaries. Further, the government should create an electronic registration system or database to track farmers to eradicate multiple registrations. To make inputs readily accessible to farmers, the government should decentralize distribution points. To forestall delays in the supply of subsidized inputs, it is recommended that government starts negotiations with the importers and retailers early so that the inputs would be in stock at the districts before the planting season. This would ensure timely supply of subsidized inputs to farmers. For FSP to achieve its aim of increasing access and the use of affordable fertilizer, it is recommended that government should educate and sensitize farmers, decentralize distribution points and depoliticize the programme.

1 Background of Fertilizer Subsidy Program (FSP)

Fertilizer policy in sub-Saharan Africa was characterized by enormous levels of intervention in the 1960s and 1970s, liberalization of fertilizer markets in the 1980s and 1990s, and moderate interventions in recent years (Dittoh et al., 2013). In the case of Ghana, government interventions in agriculture through direct subsidies that reduced fertilizer prices were a key element in the country's agricultural policy in the 1970s and early 1980s (Resnick & Mather, 2016). Nonetheless, direct fertilizer subsidies did not lead to sustained growth in fertilizer usage mainly due to lack of capacity on the part of the government to implement them effectively, failure to recognize the multiplicity of production systems and varied farmers' needs, and high fiscal and administrative costs (Morris et al., 2007). Hence, many of these programmes were abandoned in the 1990s.

Ghana was an underperformer in terms of fertilizer usage with an average of 7.4 kg per hectare, compared to 35.2 kg per hectare for Côte d'Ivoire (Benin et al., 2013). The country reverted to input subsidy programmes particularly fertilizer subsidy programmes abandoned years back as a move to bridging the fertilizer gap. After nearly twenty (20) years of no government intervention in the fertilizer sub-sector, a national Fertilizer Subsidy Programme (FSP) was re-introduced in 2008, as a temporary response to spikes in domestic food, energy, and fertilizer prices that year (MoFA, 2013). Rather than dismantling the programme after the price crisis, as originally planned, the government of Ghana supported the programme and even scaled it up from US$ 10.8 million in 2008 to US$ 63 million in 2012 (MoFA, 2013). The stated goal and objectives of the subsidy programme were to increase fertilizer use by farmers from 8 kilograms to 20 kilograms per hectare, increase crop production and yields, raise the profitability of farm production, and improve private-sector development (Benin et al., 2013). In recent years, the programme aimed to increase the rate of fertilizer application to at least 50 kilograms per hectare, as recommended under the Medium Term Agriculture Sector Investment Plan (METASIP) and in line with the Abuja Declaration on Fertilizer Use by the African Green Revolution.

The Fertilizer Subsidy Programme is within the national development agenda with a view to promoting the agriculture sector to contribute significantly to the structural transformation of the national economy. Besides, it is expected to maximize the benefits of the accelerated growth of the country and raise the average income of Ghanaians, especially peasant farmers. Apart from the year 2014, the programme has been progressively pursued to meet national

aspiration and it is the opinion of many stakeholders especially those in the agriculture sector that the introduction of the subsidy has been a major contributory factor towards increased food production in the country.

In an attempt to reach more farmers and increase fertilizer usage in the country, the government in 2010 introduced the waybill system. This was a policy shift toward blanket subsidies. The previous modalities for distribution of fertilizer used the redeemable vouchers which targeted poor smallholder farmers. Under the waybill system, farmers purchased subsidized fertilizers directly from agro-dealers without vouchers. The waybill system was used in the 2017 subsidy programme. Here, the fertilizer companies were required to issue waybills on all consignments issued to distributors. Distributors were required to send copies of all waybills covering fertilizers sold under the subsidy programme to the office of the Regional Department of Agriculture. Retailers were required to sell subsidized inorganic/organic fertilizers to farmers with passbook. Payment was made on the quantities of fertilizers sold to farmers and which were duly recorded on the relevant fertilizer forms submitted to MoFA for verification.

Ghana's subsidy programme is in twofold, namely *National Fertilizer Subsidy Programme* and *Planting for Food and Jobs*. In the 2017 farming season, the government of Ghana under the National Fertilizer Subsidy Programme slashed fertilizer prices by 50%. This was the first time in the history of the subsidy programme that the government decided to take off 50% of the cost of various types of fertilizers. According to the government, this was to motivate farmers to increase crop yields and also pave way for more exports. For the 2017 subsidy programme, eleven (11) fertilizer companies were selected to participate in the programme. These companies which took part in the bidding process are AMG limited, Chemico Limited, Afcott Ghana limited, Yara Ghana Limited, Omni Energy Ghana Limited, Iddisal Company Limited, Louis Dreyfus Commodities Limited, ETC Ghana Limited, Centroid Supplies & Logistics Limited, RMG Ghana Limited and Ganorma Agro-Chemicals Limited.

The subsidy programme had achieved some successes including increased average yields of some major crops (such as maize, rice and soybean), decreased expenditure on food imports, increased sales and turnover to the fertilizer companies and increased employment along the fertilizer supply chain - porters, transporters, sales agents. In spite of the achievements and prospects, Ghana's fertilizer subsidy programme is bedevilled with a number of challenges such as absence of comprehensive farmer database, smuggling of fertilizers to neighbouring

countries, late payment of subsidies to the supplying companies, weak monitoring at all levels due to unavailability of funds and delays in getting fertilizer forms from regional offices.[1]

2 Objectives of the Project

Based on the terms of reference, the project aimed at increasing citizens' oversight in the tracking of the implementation of Ghana's Fertilizer Subsidy Programme so as to improve transparency, accountability and to curb smuggling of subsidized inputs. The specific objectives of the project are to:

i. Assess the first year of implementation of the fertilizer subsidy programme so as to identify successes, gaps and recommendations for improved implementation;

ii. Increase access to and use of subsidized fertilizer/inputs by smallholder farmers to boost food crop production in the Sissala West and Lambussie Districts of the Upper West Region through advocacy and awareness raising; and

iii. Reduce the smuggling of subsidized fertilizer from Sissala West and Lambussie Districts into neighbouring Burkina Faso through increased citizens' awareness and oversight in the management and sale of the subsidized fertilizers.

Based on the project objectives the current study aimed at: first, to assess the implementation of government fertilizer subsidy programme so as to identify successes, challenges and as well make recommendations; second, to determine whether the government fertilizer subsidy programme has increased access, use of subsidized fertilizer/inputs and as well boosted production of food crops by smallholder farmers in the Sissala West and Lambussie Districts of the Upper West Region; and finally to find out whether the perceived smuggling of subsidized fertilizer into neighbouring Burkina Faso is a reality in the study area.

3 Methodology

The project was undertaken in the Sissala West and Lambussie Districts of the Upper West Region. The target population for this study was primarily smallholder farmers, Ministry of Food and Agriculture, and local agriculture input dealers in these districts. These farmers and

[1] Council for Scientific and Industrial Research. (n.d.). Status and impact of Ghana's fertilizer subsidy programme available at: http://www.csir-stepri.org/wysiwyg/plugins/source/pdf/mofa/MOFA%203%20full.pdf

other stakeholders were in the position to provide critical information regarding the Fertilizer Subsidy Programme being implemented by the government as well as provide the needed information necessary to achieve the objectives of this study.

Our sample size calculation yielded 162, but we decided to err on the side of caution by oversampling by 15% of this figure to arrive at 190 for both districts. Given the differences in households that engaged in agricultural activities in the two districts, proportionate sizes were used - 93 farm households for Lambussie and 97 for Sissala West districts. These farm households which included beneficiaries and non-beneficiaries of FSP were randomly selected.

A field survey was undertaken to collect data from these respondents using five enumerators who were carefully trained to gather quality data for analysis. Six days (within 20th and 28th March, 2018) were used for the data collection. Two enumerators were stationed at Lambussie while three were stationed at Gwollu.

The main data collection instruments were key informants interviews (KIIs) guide, focus group discussions (FGDs) guide, and questionnaires for input dealers and farmers (refer to Appendices B, C, D and E)[2]. Specifically, KIIs were conducted with district assemblies particularly the District Chief Executives while FGDs were conducted for MoFA officials to elicit information on FSP. Interviews were conducted using questionnaires to elicit data from our primary target (that is farmers), as well as input dealers. Data collected were entered and managed using SPSS and Stata. Data were analysed using narratives, descriptive statistics and multivariate statistical techniques [i.e., probit and propensity score matching (PSM)]. PSM modelling technique is designed to help in comparing experimental outcomes between treated and untreated groups. More explicitly, for this study, the approach is used to compare the observed output, productivity and income of FSP participants to that of counterfactual non-participants based on the predicted propensity scores of participating in the FSP (Rosenbaum and Rubin, 1983; Heckman et al., 1998; Smith and Todd, 2005). The PSM estimation of outcomes was done using nearest neighbour matching (NNM) and kernel-based matching (KBM) algorithms in Stata.[3]

[2] If hard copy of the report is used then the instruments are available from the CDA-Ghana Office, Wa.
[3] For more details, reader can consult Issahaku et al. (2018) and Iddrisu et al. (2018) [see references].

4 Demographic Characteristics of Farmers

Table 1 gives highlights of the descriptive statistics about demographic characteristics of our primary respondents (that is farmers).

Table 1: Descriptive statistics of farmers

	Lambussie District		Sissala West District	
Variable	Frequency	Percent (%)	Frequency	Percent (%)
Gender				
Male	90	95.7	76	85.4
Female	4	4.3	13	14.6
Age				
18-29	12	12.8	23	25.8
30-44	59	62.8	40	44.9
45-59	19	20.2	21	23.7
60≥	4	4.2	5	5.6
Marital Status				
Married	88	93.6	79	88.8
Widowed	1	1.1	1	1.1
Never Married	5	5.3	9	10.1
Literacy				
Literate	44	46.8	29	32.6
Non-Literate	50	53.2	60	67.4
Educational Level				
No Formal	43	45.7	57	64
Primary	11	11.7	7	7.9
JHS/JSS	17	18.1	8	9
Secondary	10	10.6	15	16.9
Post-Secondary	7	7.5	1	1.1
Tertiary	6	6.4	1	1.1
Religion				
Christian	52	54.3	2	2.2
Islam	37	39.4	87	97.8
Traditional	5	5.3	0	0

With regard to gender, 95.7% and 85.4% of the farmers were males in the Lambussie (LA) and Sissala West (SW) districts respectively. For respondents' age, 62.8% and 44.9% were between the ages of 30-44 years in the LA and SW Districts respectively. This means that the majority of farmers in the study area are relatively youthful. This is a positive development as the youth are now taking farming as an occupation. With respect to marital status, 93.6% and 88.8% of farmers were married couples in the LA and SW Districts respectively. For the educational

level of respondent farmers, 45.7% and 64.0% had no formal education in the LA and SW Districts respectively. Lastly, on religious affiliations, 54.3% of the respondents in the LA District exercise the Christian faith while 97.8% of the respondents in the SW Districts exercise Islamic faith.

5 Accessibility and Utilization of Subsidized Fertilizer

The accessibility and utilization of subsidized fertilizer is a prerequisite for guaranteeing the effectiveness of any fertilizer subsidy programme. This section addresses these issues using information from the farm household survey. The study assessed these on the basis of four domains as follows: awareness, the source of information and registration, mode of selection of beneficiary, accessibility and delivery of subsidized fertilizer, and affordability of subsidized fertilizer.

5.1 Awareness, source of information and registration

On the awareness level of farmers on the government fertilizer subsidy programme, the results revealed that 95.7% and 94.4% of farmers were aware of the programme in the Lambussie (LA) and Sissala West (SW) districts respectively (see Table 2). This implies that majority of the farmers were aware of the government fertilizer subsidy programme.

Table 2: Awareness of the government FSP

	LA District		SW District	
	Frequency	Percent (%)	Frequency	Percent (%)
Aware	90	95.7	84	94.4
Not Aware	4	4.3	5	5.6
Total	94	100	89	100

For where farmers obtained information about the programme, 12.8%, 28.7%, 28.7%, and 56.4% got it from MoFA, local radio station, input dealers, and fellow farmers respectively in the LA district. For SW, 43.8%, 52.8%, 18%, 23.6%, and 4.5% got information about the programme from MoFA, local radio station, input dealers, fellow farmers and other respectively (see Table 3). These results show that majority of farmers got information about the government subsidy programme from either fellow farmers or local radio station in the LA and SW districts respectively. With respect to the registration of farmers, 73.4% and 61.8% registered under the government fertilizer subsidy programme in the LA and SW districts

respectively. All the farmers who registered for the subsidized fertilizer actually benefited from the programme in both districts.

Table 3: Source of information about FSP

		LA District		SW District	
Information source	Response	Frequency	Percent (%)	Frequency	Percent (%)
MoFA	YES	12	12.8	39	43.8
	NO	82	87.2	50	56.2
Radio Station	YES	27	28.7	47	52.8
	NO	67	71.3	42	47.2
Fertilizer Dealers	YES	27	28.7	16	18.0
	NO	67	71.3	73	82.0
Fellow Farmers	YES	53	56.4	21	23.6
	NO	41	43.6	68	76.4

5.2 Mode of selection of beneficiaries

With regard to how farmers became beneficiaries of the programme, 10.1%, 85.6%, 1.4% and 2.9% indicated they benefitted through agricultural extension agents, local input dealers, self-volunteered, and subsidy programme officials respectively in the LA district.

Table 4: Mode of selection of beneficiaries

	LA District		SW District	
Mode of selection	Frequency	Percent (%)	Frequency	Percent (%)
Agricultural extension agents	7	10.1	34	61.8
Local input leaders	59	85.6	6	10.9
Self-volunteered	1	1.4	8	14.5
Subsidy programme officials	2	2.9	4	7.3
Others	0	0	3	5.5

In the case of SW district, 61.8%, 10.9%, 14.5%, 5.5% got their subsidized fertilizer through agricultural extension agents, local input dealers, self-volunteered, subsidy programme officials, and other sources respectively (see Table 4). Here, one could observe some differences. For LA district, the majority of farmers became beneficiary through local input leaders while for SW district it was through agricultural extension agents.

On the rating of farmers' level of satisfaction on the mode of selection of beneficiaries, 15.9% were very satisfied while 84.1% were fairly satisfied with the mode of selection of beneficiary in the LA District. In the SW District, 36.4%, 34.5%, 20.0% and 9.1% were extremely satisfied, very satisfied, fairly satisfied, less satisfied with the mode of selection of beneficiaries respectively.

5.3 Accessibility and delivery of subsidized fertilizer

For a national programme that aimed to increase access and the use of fertilizer, farmers need to get the quantity they required. In the LA and SW districts, 91.3% and 83.6% respectively of beneficiaries obtained the quantity of fertilizer they required.

In responding to the question of how accessible subsidized fertilizer was to them, 1.4% and 23.5% of beneficiaries indicated extremely accessible, 11.6% and 65.5% indicated very accessible and 87.0% and 5.5% indicated fairly accessible in the LA and SW Districts respectively (see Table 5). Only 5.5% of farmers who benefitted in SW District were of the view that the programme was not accessible. These findings show that subsidized fertilizer was more accessible in SW District than in the LA District.

Table 5: Accessibility of FSP

	LA District		SW District	
How accessible	Frequency	Percent (%)	Frequency	Percent (%)
Extremely accessible	1	1.4	13	23.5
Very accessible	8	11.6	36	65.5
Fairly accessible	60	87.0	3	5.5
Not accessible	0	0	3	5.5

For responses on the rating of timely delivery of subsidized fertilizer, 5.8%, 92.8% and 1.4% rated very timely, fairly timely, not timely respectively in the LA District whereas in the SW District, 27.3%, 27.3%, 36.4%, and 9.0% rated extremely timely, very timely, fairly timely, and not timely, respectively.

Table 6: Rating of timely delivery of subsidized fertilizer to farmers

	LA District		SW District	
Ratings	Frequency	Percent (%)	Frequency	Percent (%)
Extremely timely	0	0	15	27.3
Very timely	4	5.8	15	27.3
Fairly timely	64	92.8	20	36.4
Not timely	1	1.4	5	9.0

5.4 Affordability of subsidized fertilizer

To ascertain whether the price of subsidized fertilizer was within reach, farmers were asked to rate the price of 2017 subsidized fertilizer. In the LA District, 10.1% said the price was high while almost 90% said the price was moderate. In the SW District, 5.5%, 30.9%, 38.2%, and 25.5% rate the price as extremely high, high, moderate and low respectively (see Table 7). This implies that most farmers perceived the price quoted under subsidy programme as moderate. This is a good indicator of affordability of subsidized fertilizer and is very encouraging.

Table 7: Affordability of FSP

	LA District		SW District	
Ratings	Frequency	Percent (%)	Frequency	Percent (%)
Extremely high	0	0	3	5.5
High	7	10.1	17	30.9
Moderate	62	89.9	21	38.2
Low	0	0	14	25.5

6 Effects of FSP on Fertilizer Application, Productivity and Income

This part of the report gives both qualitative and quantitative description of the effect of FSP on adoption and use of fertilizer, productivity and income. In responding to the question 'has the FSP enhanced adoption and use of fertilizer', all beneficiary farmers in the LA district answered in the affirmative and believed the programme had increased productivity. However, 94.5% of beneficiary farmers in the SW district agreed that the subsidized fertilizer programme has enhanced their adoption and use of fertilizer and also increased their productivity. Additionally, beneficiary farmers in both districts unanimously agreed that the programme has increased the use and application of fertilizer among them.

To verify this claim, quantitative evidence was sought to assess the effect of FSP on the application of fertilizer. In this discussion, two types of fertilizer were considered namely NPK (15-15-15) and ammonium sulphate. The results from Table 8 shows that on average, beneficiary farmers use 6.75 kg per hectare of NPK fertilizer compared to 4.82 kg per hectare by non-beneficiaries in the LA District.

Table 8: FSP and fertilizer application (NPK 15-15-15)

	LA District			SW District		
Detail	N	Mean	T-statistic	N	Mean	T-statistic
Beneficiaries	69	6.75		41	17.39	
		(0.93)			(3.56)	
Non-beneficiaries	22	4.82		33	7.00	
		(0.95)			(1.30)	
Combined	91	6.29		74	12.76	
		(0.74)			(2.13)	
Difference		1.94	1.12		10.39***	2.51
		(1.73)			(4.15)	

Note: Standard errors in parenthesis; *** denotes statistical significance at 1%.

In the use of ammonium sulphate, beneficiaries utilize 3.61 kg per hectare while non-beneficiaries use 2.18 kg per hectare (see Table 9) in the LA District. These results reveal that there are no statistically significant differences among beneficiary farmers and non-beneficiaries on the application of NPK fertilizer and ammonium sulphate in the LA District. The reverse is true in the case of SW District. In the SW District, on the average beneficiaries use 17.39 kg per hectare of NPK fertilizer compared to 7 kg per hectare by non-beneficiaries. This indicates a statistically significant difference of 10.39 kg per hectare and thus implies that beneficiaries apply 10.39 kg per hectare more than their non-beneficiary counterparts.

For ammonium sulphate in the LA District, beneficiary farmers use 14.75 kg per hectare compared to 2.15 kg per hectare by non-beneficiaries (Table 9). This shows a statistically significant difference of 12.60 kg per hectare and thus suggests that beneficiaries apply more ammonium sulphate than non-beneficiaries counterparts.

Table 9: FSP and fertilizer application (ammonium sulphate)

	LA District			SW District		
Detail	N	Mean	T-statistic	N	Mean	T-statistic

Beneficiaries	61	3.61		32	14.75	
		(0.60)			(3.67)	
Non-beneficiaries	17	2.18		13	2.15	
		(0.29)			(0.52)	
Combined	78	3.29		45	11.11	
		(0.48)			(2.74)	
Difference		1.43	1.2402		12.60***	2.17
		(1.15)			(5.81)	

Note: Standard errors in parenthesis; *** denotes statistical significance at 1%.

To further assess the effect of FSP on fertilizer application, a composite variable was created where we added NPK (15-15-15) and ammonium sulphate. The results are shown in Table 10.

Table 10: FSP and fertilizer application (NPK 15-15-15 and ammonium sulphate)

	LA District			SW District		
Detail	N	Mean	T-statistic	N	Mean	T-statistic
Beneficiaries	69	7.637681		41	17.92683	
		(0.924292)			(3.564286)	
Non-beneficiaries	21	5.761905		31	7. 612903	
		(0.940883)			(1.342984)	
Combined	90	7.2		72	13.48611	
		(0.744258)			(2.18429)	
Difference		1.875776	1.0668		10.31393***	2.4164
		(1.75831)			(4.268279)	

Note: Standard errors in parenthesis; *** denotes statistical significance at 1%.

These results are similar to previous findings. The results reveal that there are no statistically significant differences among beneficiary farmers and non-beneficiaries on the application of both NPK fertilizer and ammonium sulphate in the LA District. The opposite is the case for SW District. In the SW District, on the average beneficiaries use 17.93 kg per hectare of NPK fertilizer compared to 7.6 kg per hectare by non-beneficiaries. This shows a statistically significant difference of 10.31 kg per hectare and thus implies that beneficiaries apply on the average 10.31 kg per hectare more than non-beneficiary. The average of 17.93 kg/ha is still less than the 20 kg/ha the FSP aims to achieve. Indeed it falls far below the new target of 50 kg/ha recommended under the Medium Term Agriculture Sector Investment Plan (METASIP) and the Abuja Declaration on Fertilizer Use by the African Green Revolution (AU, 2006).

To find out whether the 2017 FSP has boosted food crop production, farmers' opinion was sought. Of the beneficiary farmers in the LA and SW districts, 98.6% and 92.7% respectively responded that the application of the subsidized fertilizer has actually brought an increase in crop yields. Quantitative evidence was also sought on the effect of FSP on productivity. Here, productivity is measured as output per hectare (i.e., output/farm size) and done for only maize. This is shown in Table 11. The results revealed that on average, beneficiary farmers producing maize in LA District achieved 332.64 kg/ha while non-beneficiaries achieved 282.58 kg/ha in the 2017 farming season. This means that on average beneficiaries achieved 50.06 kg/ha more than non-beneficiaries, although not statistically significant. In the SW District, beneficiaries producing maize achieved 2,192.81 kg/ha while non-beneficiaries achieved 587.50 kg/ha. This indicates a statistically significant difference in maize productivity of 1,605.31 kg/ha. This implies that on average beneficiaries produce more than non-beneficiaries.

Table 11: FSP and productivity

	LA District			SW District		
Detail	N	Mean	T-statistic	N	Mean	T-statistic
Beneficiaries	69	332.64		55	2192.81	
		(54.6629)			(353.5226)	
Non-beneficiaries	25	282.58		34	587.50	
		(45.5005)			(94.2075)	
Combined	94	319.33		89	1579.55	
		(41.84601)			(235.7506)	
Difference		50.05768	0.5265		1605.31***	3.5156
		(95.0784)			(456.6239)	

Note: Standard errors in parenthesis; *** denotes statistical significance at 1%.

On the issue of whether FSP has reduced the credit needs of farmers, all beneficiary farmers in the LA district agreed while 92.7% of the beneficiary in the SW district were of the view that the programme has helped reduce the credit needs of farmers. This implies that the programme meets the farmer's credit needs and this is necessary to aid agricultural development.

Table 12 gives test results for quantitative evidence about the effect of FSP on household income per capita. It must be noted that in this study, household expenditure is used as a proxy for income. The results show that on average, monthly income per capita of beneficiaries is GHS 64.43, whereas that of non-beneficiaries is GHS 41.79 per capita in the LA district. This implies that on average beneficiaries earned GHS 22.64 per capita more than their non-

beneficiary counterparts though the difference is not statistically significant. In the SW District, beneficiaries earned GHS 199.02 while non-beneficiaries earned GHS 109.65. This gives a statistically significant income difference of GHS 89.37. This implies that on average beneficiaries earned GHS 89.37 per capita more than non-beneficiaries. This means that the programme increased incomes per capita more in the SW District than in the LA district.

Table 12: FSP and household income

Detail	LA District			SW District		
	N	Mean	T-statistic	N	Mean	T-statistic
Beneficiaries	69	64.43		55	199.02	
		(21.036)			(29.316)	
Non-beneficiaries	25	41.79		34	109.65	
		(7.6821)			(18.7883)	
Combined	94	58.41		89	164.88	
		(15.5764)			(19.9472)	
Difference		22.64	0.6401		89.37 ***	2.2252
		(35.3659)			(40.1919)	

Note: Standard errors in parenthesis; *** denotes statistical significance at 1%.

For a national programme that aimed at increasing crop production, it should be accompanied by other complementary services such as extension services, improved seed, among others. Of the beneficiary farmers in the LA and SW districts 89.9% and 43.6% respectively said that they enjoyed complimentary services in addition to the subsidy programme. These results revealed that fewer farmers in the SW district got additional services.

On the general assessment of the 2017 FSP, farmers in the LA District rated 1.4%, 17.4% and 81.2% as extremely good, very good and average respectively. In the SW District, farmers' ratings were as follows: 10.9%, 50.9%, 25.5% and 12.7% as extremely good, very good, average, and poor.

7 Assessing Impact of FSP

In an attempt to provide a more comprehensive understanding of how the subsidized fertilizer was distributed, a multivariate statistical technique was used to identify more precisely the attributes of a beneficiary.

7.1 Factors influencing farmers' decision to participate in FSP

A logit model was used to estimate the determinants of participation in FSP by farmers in both districts, and the results are reported in Table 13. The significant likelihood ratio ($p<0.00$) and the correctly classified counts of 71.04% showed the adequate explanatory power of the independent variables in relation to FSP participation. Variables that significantly influence farmers' decision to participate in FSP include education, marital status and amount of fertilizer use. All these variables show expected signs.

Table 13: Logit result on determinants of participation in FSP

	Coefficient estimates		Marginal effects	
Variable	Estimate	SE	Estimate	SE
Gender	0.6815	0.5626	0.1574	0.1371
Age	-0.0035	0.0170	-0.0001	0.0036
Education	0.1775**	0.0897	0.0378**	0.0188
Marital status	1.0880*	0.6250	0.2568*	0.1519
Household size	-0.0024	0.0277	-0.0005	0.0059
Location	0.0191	0.3692	0.0041	0.0785
Amount of fertilizer	0.6207**	0.3009	0.1320**	0.0638
Constant	-3.0542	1.0235		

Notes: Model diagnostics

Number of observations =183; likelihood ratio χ^2=15.82; Prob(χ^2)=0.0268; Pseudo R^2=0.0688; log likelihood =−107.13483; per cent correctly classified=71.04%.

Notes: **p<0.05; ***p<0.01

Farmers who had higher education tend to have access to information which is important to production and marketing decisions. The results show that farmers with higher education have a higher probability of participation in the FSP. The marginal effect of education suggests that the probability of participating in the FSP would increase by 3.8 percent for every additional year of education of the farmer.

Marital status has a positive coefficient and implies that married farmers are more likely to participate in the FSP. A plausible reason for this finding is that married farmers have quite some family responsibilities which include more mouths to be fed and hence, they would like to increase their output through the use of subsidized fertilizer.

The study found that farmers who used a larger amount of fertilizer have a higher probability to participate in the programme. Any additional kg per hectare of fertilizer used increases the probability of participation by 13.2 percent.

To assess the effects of FSP on outcomes variables that is output, productivity (yield) and income, the study employed the PSM analyses. The PSM estimation of outcomes was done using nearest neighbour matching (NNM) and kernel-based matching (KBM) algorithms. This was done to check for the robustness of the estimates and these results are presented in Table 14.

Table 14: Treatment effect of FSP on output, productivity and income

Model/outcome	**NNM**		**KBM**		**RA**	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Maize output						
ATE	744.02**	220.30	793.98***	178.27	813.05***	187.29
ATT	666.52***	240.01	798.47***	202.72	423.06***	57.44
ATU	921.17***	415.54	783.71***	210.19	–	–
Productivity						
ATE	374.22***	123.00	406.67***	116.46	394.72***	96.85
ATT	347.64***	114.14	381.46***	109.14	214.89***	31.16
ATU	434.04**	198.13	399.79***	124.55	–	–
Income per capita						
ATE	65.27**	25.51	55.56***	21.18	52.61***	19.42
ATT	53.60**	21.30703	53.19**	25.98	77.30***	9.21
ATU	91.03**	38.80254	60.79**	27.18	–	–

Notes: ***p<0.01; **p<0.05.

The overall effect of FSP on the productivity of the sample farmers is indicated by the average treatment effect (ATE). All calculations were based on one-to-one matching pairs, and were all significant at least at the 1 percent level. The ATE of maize output from the FSP with NNM and KBM were 744.02 and 793.98 kg, respectively. Hence, in terms of maize output, FSP beneficiaries significantly do better than their non-beneficiary counterparts. For the beneficiary farmers alone, the impact of FSP, measured by the average treatment effect on the treated (ATT) parameter are 666.52 and 798.47kg for the NNM and KBM algorithms respectively. These significant values mean that, based on output, the FSP impacted positively on beneficiary farmers. Given that the potential output of the non-beneficiary farmers represented by average

treatment effect for the untreated (ATU) is statistically significant also means that if these farmers had actually participated in the government subsidy programme, their potential output from maize would have been increased by 921.17 and 783.71kg for the NNM and KBM respectively. These results, therefore, attest to the fact that the FSP has actually increased the output of farmers.

The estimates from the regression adjustment (RA), which accounts for systematic differences in baseline characteristics between treated and untreated subjects also led to the same conclusions. The reason for estimating the RA is to verify whether the propensity score model has been adequately specified (Linden & Adams, 2012). Further, RA reduces bias resulting from residual differences in observed baseline covariates between treatment groups. As shown in Table 14, the RA result for ATE and ATT are 813.05 and 423.06 kg respectively, and both are statistically significant at 1 percent.

For productivity, the results provide statistical evidence suggesting that the FSP increases yield significantly. Beneficiary farmers generated yields that were considerably higher than non-beneficiary. Both the ATE (374.22 and 406.67 kg/ha) and ATT (347.64 and 381.46 kg/ha) values based on the NNM and KBM respectively demonstrate the important contribution of FSP to overall maize productivity.

These results mean that beneficiary farmers generated a monthly income per capita of GH¢53.60 which was significantly higher than their non-beneficiary counterparts. This finding goes contrary to a study by Martey et al. (2015) where participation of smallholder farmers in support project did not significantly translate into higher farm incomes.

General observations based on PSM methods revealed that estimate of ATT values are higher than ATE values. The implication of these findings is that farmers with a greater likelihood of becoming beneficiaries of government subsidy programme achieve higher output, productivity and income as compared to farmers with a low probability of becoming beneficiaries.

7.2 Robustness tests of PSM-based treatment effects estimates

A critique of PSM approach is its inability to fully control for unobservable characteristics (Tagel & Anne, 2015), hence the need to test for hidden bias. The covariate balancing indicators for before and after matching as well as sensitivity analysis, which judges the quality of matching and shows robustness of the estimates, are presented in Table 15. It could be observed

that before matching, the pseudo R-square and the likelihood ratio Chi-square for both the NNM and the KM are high in all cases.

Table 15: Covariate Balancing Tests and Sensitivity Analysis

Matching algorithm	Matching status	Pseudo R^2	LR Chi^2	LR p-value	Mean bias	% bias reduction	Critical level of gamma
Output							
NNM	Before	0.070	15.27	0.033	23.9	63.60	1.3− 1.4
	After	0.013	4.12	0.765	8.7		
KM	Before	0.144	31.20	0.000	25.7	52.53	1.3−1.4
	After	0.025	7.63	0.470	12.2		
Productivity							
NNM	Before	0.075	15.81	0.027	23.5	40.78	1.2− 1.3
	After	0.009	2.55	0.932	7.1		
KM	Before	0.075	15.81	0.027	23.5	73.19	1.0−1.1
	After	0.007	2.03	0.958	6.3		
Income per capita							
NNM	Before	0.068	15.76	0.027	21.7	61.29	1.3−1.4
	After	0.025	8.23	0.313	8.4		
KM	Before	0.068	15.76	0.027	21.7	48.74	1.0
	After	0.004	1.43	0.985	4.8		

However, these parameters become relatively very low after matching. This shows that matching has significantly reduced the level of bias across the characteristics of the beneficiaries and non-beneficiaries and able to balance the characteristics across the two groups. For instance, the reduction in the pseudo R-square means that after matching, the covariates have low explanatory power for assignment into treatment.

The results further revealed that the percentage reduction in bias for all cases is at least greater than 40%. These results are in agreement with Rosenbaum and Rubin (1983) assertion that a reduction in bias greater than 20% is a sufficiently large enough reduction. Hence, these estimates are reliable. For example, the mean bias for output model before matching is 23.9 and 25.7% for NNM and KM and the mean bias after matching is 8.7 and 12.2% respectively showing a percentage reduction of 63.60 and 52.53% respectively.

On sensitivity analysis for hidden bias, the gamma estimates show the critical levels at which the estimates of the treatment effects are questionable. By definition, the gamma level is the odd ratio of differential treatment assignments due to an unobserved covariate (Wainaina et al., 2012). For instance, gamma is 1.3−1.4 for both NNM and KM, for the output model. These estimates mean that an unobserved factor would have to increase the odds ratio of FSP beneficiary by 30–40% before the estimates become questionable or negate the estimated effect for both NNM and the KM (see Table 15). This implies that the estimated treatment effects are robust and insensitive to hidden biases, as only sufficiently large unobserved heterogeneity would render the estimates unreliable. This supports the conditional independence assumption (CIA) requirement of PSM and it further shows that the results are reliable. However, gamma 1.0−1.1 for KM in the productivity model shows that the results are highly responsive to unobserved factors and hence unreliable.

In order to observe heterogeneous effects, analyses were done for each district. These results are shown in appendix E (note that gender variable was omitted because of collinearity).

8 Perceived Strengths of the FSP

Input dealers perceived that FSP has made fertilizer affordable, and it has helped to increase crop yield and reduce poverty. Key informants in the districts were of the view that the current approach being used under the "Planting for Food and Jobs" programme, to a large extent would encourage investment in fertilizer and other agro-inputs as the demand for agro-inputs had increased as a result of the policy. Moreover, they see the fertilizer subsidy programme as very significant as it helps make fertilizer readily accessible to farmers. For instance, under the "Planting for Food and Jobs" programme farmers are not required to make full payment before getting the inputs. This helps a lot particularly those farmers who could not afford to make full payment. A key informant in the Lambussie District was of the opinion that the programme has increased farm lands brought under cultivation by farmers and thus the prospect to improve the financial security of households. Lastly, key informants and discussants in the FGDs in both districts were of the opinion that the programme has helped increase fertilizer use among farmers. And that this has increased the productivity of farmers compared to the previous year and hence, has the tendency to reduce poverty.

9 Smuggling of Subsidized Fertilizer

This section focuses on a major irregularity (i.e. smuggling) that is associated with government fertilizer subsidy programme in terms of awareness, alleged perpetrators, and suggestions to curb the menace. On the perceived smuggling of subsidized fertilizer into neighbouring Burkina Faso, almost all participants in this study unanimously agreed to the existence of smuggling activities in the area. However, government officials such as the District Chief Executives and MoFA officials perceived the smuggling activities not to be widespread.

Farmers view government officials, political party members, local residents/community members, and input dealers as those behind smuggling of fertilizers. Again, input dealers perceived the following persons as those behind the smuggling activity: fellow input dealers, community members, and political leaders. For key informants in the districts, they have no opinion as to those involved in the smuggling activities. Discussants in the FGDs observed that smuggling of subsidized fertilizer is mostly done by community members. They further revealed that this is done on a small scale, as smugglers cart their booty using tricycles and donkeys through the many unapproved routes. This is a clear case of a blame game.

The following were respondents' suggested solutions to the smuggling activity. Input dealers suggested the following: stringent measures such as punishment of the culprits, strict supervision and monitoring, and avoidance of political influence. A key informant and discussants in the FGDs in the Lambussie District suggested the need for local residents/community members to be vigilant and be willing to track the distribution of the inputs and report any suspicious acts of smuggling to the appropriate quarters for actions to be taken. A key informant in the Sissala West District suggested de-politicization of the programme, effective system of verifying and tracking beneficiaries to their actual farm sizes, mounting of surveillance on MoFA staff (because they keep stock of the subsidized inputs under the "Planting for Food and Jobs"), proper book keeping, arrest and prosecution of offenders, stiffer punishment for culprits to serve as deterrent and empowerment of security officials to do their job without fear.

Some quotes from the FGDs and key informants about smuggling of subsidized fertilizer in the study area are provided below:

> "Smuggling of subsidized fertilizer is free for all in this district. It looks like fertilizer has a diplomatic passport because we see it being smuggled out of the country and no one stops it. It is a big business here. People bought cars just by

engaging in this business last year. Those who have the power to stop it are complicit in this business. There was a day, following several complaints of massive smuggling that the DCE together with the district anti-smuggling task force carried out an operation at some border communities. Three trucks fully loaded with subsidized fertilizers were impounded. The trucks were instructed to return the fertilizers back to Gwollu, the District Capital. Later, the trucks were seen crossing the borders into Burkina Faso when we tried stopping them, they told us that the DCE has permitted them to go" [A Key Informant and a Public Servant].

"The fertilizer smuggling is a big business in this district. … I see it happening and I also received several complaints daily about this smuggling activity. I got complaints that some type of subsidy fertilizers which are mostly preferred by farmers under the "Planting for Food and Jobs" program were not being distributed to farmers but instead was being smuggled and sold in Burkina Faso markets. When I got these complaints, I went to the warehouse in Gwollu to confirm the allegations. When I got there with some beneficiary farmers from my electoral area, we requested to be served with that particular fertilizer brand that was alleged to be fast selling in Burkina Faso. To our surprise, the MoFA staff told us that they were instructed not to distribute that brand again to farmers. Meanwhile, we saw a KIA truck in the warehouse loading only that brand of fertilizer but the farmers were denied it. The KIA truck that was seen loading subsidized inputs in the warehouse was clearly bound for Burkina Faso since there was no other distribution point in the district" [A Key Informant]

"I don't think we can stop fertilizer smuggling as it is just impossible. Currently, under the Planting for Food and Jobs subsidy program, we do not have any system to even map out the actual farm sizes and locations of farms before distributing the inputs. Many of the young men living in the villages near the borders just use their motor kings to smuggle the inputs. Tell me how anyone can stop this when the borders are open while the smuggling business is highly profitable." [A Key Informant]

"This fertilizer smuggling business is largely driven by political 'party boys'. They say that their party brought the program back after NDC cancelled it, so they must enjoy. They even say that why should the farmers complain because there is enough fertilizer for farmers to buy for their farms" [A Key Informant−SW District]

10 Challenges of the Fertilizer Subsidy Programme

In this section of the report, we highlight the major challenges facing the fertilizer subsidy programme in the two study districts of Sissala West and Lambussie.

Bureaucratic procedure: Most retailers or input dealers interviewed held that the waybill system is cumbersome. This is because relevant fertilizer forms had to be submitted to MoFA for verification before payment is made and this sometimes takes time. Also, some farmers see the procedure for acquiring the subsidized fertilizer as tedious, as payments could only be done at the bank. For instance, for farmers to acquire subsidized input including fertilizer under the "Planting for Food and Jobs" programme, first they have to register with MoFA, go to the bank to make an initial deposit and submit payment slip to the MoFA stores to be served.

Inadequate storage facilities for fertilizers: In the focus group discussions with MoFA officials particularly in the Lambussie District, they revealed that there are inadequate and uneven distribution of storage facilities for inputs supplied under the "Planting for Food and Jobs" programme. Hence, some farmers had to travel long distances to get the subsidized inputs. Further, under the National Fertilizer Subsidy Programme, input dealers mentioned inadequate fertilizer as a challenge. MoFA officials bemoan the deplorable state of the only district storage facility. Some farmers in the SW District complain of delay in the distribution of the inputs at the warehouse as long queues were formed before they could receive their inputs.

Centralization of subsidized fertilizers: Discussants in the FGDs in both districts revealed that major problem farmers' face in accessing the subsidized fertilizer is the over-centralization of the distribution of the input at the district capitals mainly Lambussie and Gwollu. Therefore, most farmers have to travel from far places to pick the fertilizer at the district capitals, as a result of which farmers reported of high transportation costs. This challenge is dire for farmers in the remote communities as most of the roads are inaccessible.

Inadequate extension officers and public education: Input dealers opined that some farmers were ignorant about the subsidy programme. This is because there was little or no sensitization programme embarked upon in the various farming communities. Admittedly, this may be due to the acute shortage of agricultural extension officers in the region. For instance, the District Director of MoFA in Lambussie district reiterates that the whole Upper West Region has only two extension officers. This affected the department's work of sensitizing, monitoring (i.e. matching inputs with farm size) and supervising under the programme.

Delay in the supply of fertilizer: Farmers reported on the late delivery of inputs. Input dealers and MoFA officials also lament that there was a delay in the supply of subsidized fertilizer. This delay affects the timely distribution of inputs. With regard to the adequacy of fertilizer,

farmers and input dealers were of the view that there is room for improvement as some farmers report of limited quantities of inputs. Some farmers lament that they did not receive the specific type of fertilizer they wanted.

Low recovery rate: Key informants and discussants in the FGDs in both districts were concerned about the low recovery rate of funds resulting from non-payment. The majority of the farmers who benefitted from the "Planting for Food and Jobs" failed to pay their remaining debts/balance after harvesting. This will likely hamper the success of the programme and may affect its sustainability.

Smuggling of the subsidized inputs: Most farmers, input dealers, key informants and discussants in the FGDs in both districts admit the alleged smuggling of the fertilizer into neighbouring Burkina Faso. Even though, key informants and discussants in the FGDs were of the opinion that smuggling activities in the district were minimal, these activities if unchecked could derail government efforts at increasing access and use of subsidized fertilizer by smallholder farmers so as to boost crop production.

Double registration: Input dealers and discussants in the FGDs complained about farmers moving from one district to another to collect subsidized fertilizer as there are no mechanisms to prevent double registrations. Some farmers said that inputs were distributed to persons who are not even farmers.

Politicization of the programme: Discussants in the FGDs in the Sissala West district revealed that most farmers thought the fertilizer was for only the ruling political party members. This actually discouraged non-party members to participate in the programme. In one instance, a farmer said: "I was turned down because I did not have voters ID". Some farmers even alleged nepotism as officials serve their relatives first as well as bribery and corruption in the distribution of the inputs.

The non-beneficiary farmers were asked to give factors or reasons that prevented them from participating in the FSP. They gave the following reasons: that the initial down payment was too costly; time spent in registration and payment at the bank was too much; they have been farming without fertilizer; and lastly, late information about the FSP.

11 Conclusions

Based on the findings of the study, the following conclusions are drawn:

- Farmers and input dealers were of the view that FSP has made fertilizer affordable and hence has increased the number of farm lands cultivated by farmers and has the prospect of ensuring financial security for farm households.
- The evidence from the study indicates that there has been an increase in the use of fertilizer as a result of government Fertilizer Subsidy Programme, and that beneficiary farmers obtained higher yields and incomes than non-beneficiary farmers particularly those in the Sissala West District.
- On accessibility and timely delivery of subsidized fertilizer, the study revealed that both farmers and input dealers were quite not satisfied with the current state of affairs.
- On the issue of smuggling of subsidized fertilizer into neighbouring Burkina Faso, the study revealed that the activity is endemic in the study area.

12 Recommendations

Based on the findings the following recommendations are made:

- To avoid double registration of farmers the Ministry of Food and Agriculture should institute a GIS system to map all farms with beneficiaries. For instance, under "Planting for Food and Jobs" officials of MoFA should monitor and verify the acreage cultivated before issuing subsidized inputs. Added to this, the government should create an electronic registration system or database to track farmers to eradicate multiple registrations.
- For the programme to achieve its aims of increasing access and the use of affordable fertilizer, the government should decentralize distribution points. For example, at least increasing the number of distribution channels or points to area council or zonal levels would make inputs readily accessible to farmers.
- To maximize the use of fertilizer, the government through its agents should embark on early registration and supply of subsidized fertilizer.
- To further improve distribution and use of fertilizers, government should educate and sensitize farmers on the fertilizer subsidy programme.
- The national fertilizer subsidy programme cannot realise its full potentials without other complementary services such as extension services. It is for this reason that it is

recommended that the government should improve extension services via the engagement of additional personnel.

- To get all farmers involved, conscious efforts should be made at depoliticizing the programme.
- To curb the smuggling of subsidized fertilizer into neighbouring Burkina Faso, there should be an effective system of verifying and tracking beneficiaries of inputs to farms through the use of GIS system and also proper bookkeeping. Moreover, the government should mount surveillance on MoFA staffs, arrest and prosecute offenders, and mete out stiffer punishment to culprits to serve as a deterrent.

References

African Union, (2006). Abuja Declaration on Fertilizer for the African Green Revolution available at: http://www.africafertilizersummit.org/Abuja%20Fertilizer%20Declaration%20in%20English.pdf

Benin, S., Jonhson, M., Abokyi, E., Ahorbo, G., Jimah, K., Nasser, G., Owusu, V., Taabazuing, J. & Tenga, A. (2013). Revisiting Agricultural Input and Farm Support Subsidies in Africa: The Case of Ghana's Mechanisation, Fertiliser, Block Farms and Marketing Programmes. Discussion Paper 01300, International Food Policy Research Institute.

Council for Scientific and Industrial Research. (n.d.). Status and Impact of Ghana's Fertilizer Subsidy Programme available at: http://www.csir-stepri.org/wysiwyg/plugins/source/pdf/mofa/MOFA%203%20full.pdf

Dittoh, S., Omotosho, O. A., Belemvire, A., Akurib, M. & Haider, K. T. (2013). *Improving the Effectiveness, Efficiency and Sustainability of Fertilizer Use in Sub-Saharan Africa*. GDN Working Paper 062. New Delhi: Global Development Network.

Heckman, J., Ichimura, H., Smith, J. & Todd, P. (1998). Characterization of selection bias using experimental data. *Econometrica*, Vol. 66 No. 5, pp.1017-1098.

Iddrisu, A., Ansah, I. G. K. & Nkegbe, P. K. (2018). Effect of input credit on smallholder farmers' output and income: evidence from Northern Ghana. *Agricultural Finance Review*, Vol. 78 No. 1, pp.98-115

Issahaku, H., Abu, B. M. & Nkegbe, P. K. (2018). Does the use of mobile phones by smallholder maize farmers affect productivity in Ghana? *Journal of African Business*, Vol. 19 No. 3, pp.302-322. DOI: 10.1080/15228916.2017.1416215

Linden, A. & Adams, J. L. (2012), "Combining the regression discontinuity design and propensity score-based weighting to improve causal inference in program evaluation". *Journal of Evaluation in Clinical Practice*, Vol. 18 No. 2, pp. 317-325.

MoFA, (2013), Agriculture in Ghana–Facts and Figures, available at: http://mofa.gov.gh/site/?page_id=6032

Morris, M., Kelly, V. A., Kopicki, R. J. & Byerlee, D. (2007). *Fertilizer Use in African Agriculture: Lessons Learned and Good Practice Guidelines*. Directions in Development. Washington, DC: World Bank.

Resnick, D., & Mather, D. (2016). *Agricultural Inputs Policy under Macroeconomic Uncertainty: Applying the Kaleidoscope Model to Ghana's Fertilizer Subsidy Programme (2008–2015)*. IFPRI Discussion Paper 01551, Washington DC: International Food Policy Research Institute.

Rosenbaum, P. & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. Biometrika, 70(1), 4155. doi:10.1093/biomet/70.1.41.

Smith, J. A. & Todd, P. E. (2005). "Does matching overcome LaLonde's critique of non-experimental estimators?", *Journal of Econometrics,* Vol. 125 No. 1, pp. 305-353.

Tagel, G. & Anne, V. (2015), "Estimating the impact of a food security program by propensity score matching", *Journal of Development and Agricultural Economics*, Vol. 7 No. 1, pp. 38-47.

Wainaina, P. W., Okello, J. J., & Nzuma, J. (2012, August 18–24). Impact of contract farming on smallholder poultry farmers' income in Kenya. Selected Paper for Presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do lguagu, Brazil.

Appendices

Appendix A

Checklist for KII_DCEs.docx

Appendix B

Checklist for FGD_MoFA.docx

Appendix C

Questionnaire_Distributors_CDA_Ghana.c

Appendix D

Questionnaire_Farmers_CDA_Ghana.doc

Appendix E

Appendix E.docx