ORIGINAL PAPER

A review of Ghana's planting for food and jobs program: implementation, impacts, benefits, and costs

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Abstract

Farm input subsidies are widely used in Sub-Saharan African countries as a response to low adoption of fertilizers and seeds. While subsidy programs traditionally focused on helping farmers access inputs, new generation market smart subsidies additionally emphasize careful targeting, development of input supply systems, and complementary production and marketing support mechanisms. Ghana's Planting for Food and Jobs (PFJ) initiative, launched in 2017, is one example of such an evolved subsidy program; yet, despite its scale and prominence, the current government monitoring and evaluation system is not well equipped to accurately assess its impacts. This paper triangulates evidence from multiple public sources and independent evaluations to develop a simple and effective impact assessment model for PFJ that can easily be adopted by the government. It can also be adapted to other contexts with minimal adjustment. Model results reveal that maize and rice production levels are more than 40 percent higher than they would have been in the absence of PFJ, thus contributing significantly to food and calorie availability in Ghana. However, there is much room for efficiency improvements that would increase the return on investment-currently, program benefits roughly equal public and private costs of the program. In this regard, several recommendations are made relating to beneficiary targeting, crowding out of commercial input sales, input use efficiency, marketing support to farmers, and improvements in the monitoring and evaluation system, all of which have relevance for other countries implementing or considering similar programs.

Keywords Farm input subsidies · Policy impact assessment · Sub-saharan Africa · Ghana

JEL C63 · O13 · Q18

1 Introduction

Farm input subsidies are widely used in countries in Sub-Saharan Africa (SSA) to promote agricultural productivity growth (Jayne et al., 2018). They are justified as a response to low adoption of modern technologies such as chemical fertilizers and hybrid seeds, which is associated with stagnant crop yields that hinder agricultural development (Holden, 2019). Input subsidies have the potential to simultaneously address farmers' resource constraints and supply chain bottlenecks in input markets (Bizikova et al., 2017). They can also lower carbon emissions by promoting intensification over land expansion (Holden, 2019), especially in

SSA where increases in organic and chemical fertilizer use have been insufficient to maintain soil fertility (Binswanger-Mkhize & Savastano, 2017).

Input subsidy programs have evolved over the past five decades. The large-scale subsidy programs that were common in the 1960s and 1970s did not result in the expected agricultural growth, mainly due to ineffective implementation, high fiscal costs, and failure in identifying differentiated production systems and needs (Morris et al., 2007). Subsidy programs also tended to benefit larger farmers who grew fertilizer-intensive crops (Holden, 2019). As a result, subsidy programs were suspended under the Structural Adjustment Programs of the 1980s and 1990s but reintroduced again following the 2008 food and energy price crisis. The new generation of so-called market smart subsidies emphasize carefully targeted packages of inputs, development of private input supply systems, promotion of competition among input suppliers, a clear exit plan for beneficiaries,

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and a more holistic strategy of providing inputs alongside complementary production support to farmers and improving their market opportunities (Dorward & Morrison 2015, Holden, 2019).

Despite initial optimism that the new generation of subsidy programs would overcome challenges of the past, the fiscal freedom offered by debt forgiveness and a reduced focus on conditionality led to subsidy programs once again losing sight of their smart principles and often being used as political tools to buy votes (Holden, 2019; Banful, 2011, Mason et al., 2017). A review of new generation input subsidy programs in SSA further shows that while subsidized inputs raise crop yields of beneficiaries in the year the subsidy is received, the overall production and welfare effects have been disappointing (Jayne et al., 2018). This relates to low soil fertility and poor management practices which cause crop yield responses to fertilizer use to be lower on smallholder-managed fields than on trial plots on which expectations are based. When combined with poor market access, which cause farm input prices to be high and output prices to be low, it makes little economic sense to buy fertilizer, very often at commercial prices, and in some cases even at subsidized prices. Risk is another critical factor, with uncertainty in output markets creating disincentives to grow a marketable surplus, even when inputs are subsidized (Arndt et al., 2016; Radchenko & Corral, 2018). As a result, even new generation subsidy programs have failed to kick-start dynamic growth processes in SSA, as farmers often reduce input use soon after graduating from subsidy programs. This leads Jayne et al. (2018) to lament the fact that subsidy programs place too much emphasis on fertilizer supply and not enough on complementary support measures that would enable farmers to use fertilizer efficiently and profitably.

Despite their apparent design and implementation failures, a substantial share of agricultural budgets in African countries is allocated to subsidy programs (Jayne & Rashid, 2013), and they will likely remain an integral part of agricultural development strategies in years to come. As a result, it is imperative to continually monitor program implementation and evaluate their impacts. Both quasi-experimental methods and general equilibrium economic models are frequently used in the academic literature to evaluate input subsidy program impacts (Hemming et al., 2018). Econometric evaluations require good quality household surveys that differentiate beneficiaries from non-beneficiaries and carefully measure crop yields and their relation to the use of subsidized and commercially procured inputs. Since pre-subsidy baselines are often unavailable, robust program evaluation methods are required to correct for potential selection bias. When subsidy programs are complex and entail multiple interventions that are inconsistently available across the beneficiary population, econometric evaluation becomes particularly onerous. In such instances, ex ante simulation models may be useful for exploring complex program designs or to examine outcomes under different behavioral or performance assumptions. General equilibrium models also measure indirect spillover effects for non-beneficiaries or non-agricultural sectors, consider government financing implications, and can simultaneously measure outcomes across a broad range of outcome indicators. One challenge is that the model counterfactual should represent a state in which the subsidy program is absent. If baseline data is collected from a period when the subsidy program was already in place, some adjustment to the baseline may be required.

Ultimately, both evaluation approaches require good quality data and expertise in data analysis and economic modeling. In countries where these are lacking, or where funding to carry out such evaluations is limited, monitoring and evaluation systems often default to attributing changes in outcome indicators pre- and post-intervention to that intervention, or using other simple attribution methods to infer program impact. This can easily lead to incorrect policy conclusions and, potentially, misallocation of public resources. This is arguably true in Ghana, where the impacts of the Planting for Food and Jobs (PFJ) initiative, a large-scale subsidy program implemented by the Ministry of Food and Agriculture (MoFA), are still not well understood several years after it was launched in 2017. A first objective of this study is to carefully document what we know about PFJ design and implementation and its likely impact by triangulating from official implementation reports, national crop production estimates, government budgets, and independent evaluations.

A second objective is to showcase an impact assessment model that produces what is arguably the most accurate assessment yet of the changes in yields and crop output that are directly attributable to PFJ. Although the model is purpose-built for Ghana, focusing on the maize and rice sectors, it provides a blueprint for also assessing impacts on other crops, or for carrying out evaluations in other countries facing similar data or capacity constraints that hinder them from implementing regular, robust survey-based evaluations or economywide assessments. The proposed model can easily be improved and refined as new information about program implementation or farmers' behavioral effects becomes available. The findings and policy recommendations stemming from this comprehensive assessment of PFJ have relevance for input subsidy programs in other countries, which are highlighted in the conclusion.

2 Agricultural input subsidies in Ghana

2.1 Rationale

As in many other African states, Ghana's agricultural policy in the 1960s and 1970s was characterized by large-scale

interventions that included input subsidies or fertilizer price support policies (Resnick & Mather, 2016). These subsidy programs were suspended under the Structural Adjustment Programs of the 1980s and 1990s. However, at the time of the 2008 food and energy price crisis, Ghana reintroduced subsidies with the launch of its national Fertilizer Subsidy Program (FSP) (Banful, 2011). This was replaced by the Planting for Food and Jobs (PFJ) initiative in 2017 (MoFA, 2017), which built on the FSP and introduced several additional smart subsidy design principles that were absent from the FSP.

Input subsidies in Ghana are justified for the same reasons as in other countries in SSA. Firstly, adoption of modern inputs is surprisingly low considering Ghana's lower middle-income status. At the time when the Abuja Declaration recommended a fertilizer application rate of 50 kg per hectare in 2006, the average fertilizer use rate in Ghana was only 8 kg (Benin et al., 2013). Since then, fertilizer use rates have increased to around 20 kg per hectare (MoFA, 2020), but remain well below desired levels. Likewise, lower-performing recycled maize seeds continue to be widely used even though yields and profitability of available hybrids are up to 50 percent higher (Van Asselt et al., 2018). High costs, resource constraints, and risks associated with investing in modern inputs when farming under rainfed conditions or when selling in uncertain markets are just some of the demand-side constraints to adoption that the Ghanaian government hopes to address through input subsidies.

Secondly, with respect to fertilizer, Ghanaian farmers have historically had limited choice, with NPK 15-15-15 distributed throughout the country despite significant regional variations in soil fertility and types (Chapoto & Tetteh, 2014). Quality of fertilizer has also been a concern; for example, a government study in 2015 found that less than one-third of fertilizer samples tested conformed to technical requirements (GoG, 2015). The combination of inappropriate fertilizer and poor soil quality reduces the effectiveness and profitability of fertilizer use, which, alongside (perceptions of) substandard fertilizer, may constrain adoption. Concerns about seed quality are also widespread, with factors such as lack of availability of well-performing seeds or distrust in input dealers believed to be selling inauthentic seeds affecting adoption (Van Asselt et al., 2018). Ghana's subsidy programs are justified on the basis that they can strengthen input supply systems and encourage the private sector to supply a more diverse range of quality products. Recent evidence shows over 90 percent of PFJ beneficiaries consider the maize and rice seeds they access through the program as good quality (Asante & Bawakyillenuo, 2021), while laboratory testing shows nutrients contained in PFJ fertilizer deviate less than one percent from labeled values (Asante et al., 2021).

2.2 Fertilizer subsidy program: 2008–2017

The FSP specifically intended to improve production and food security while reducing poverty (Fearon et al., 2015). It also aimed to develop and strengthen fertilizer markets and encourage private sector participation in those markets. Government initially subsidized 50 percent of the commercial cost of fertilizer. The fertilizer price itself was negotiated beforehand with fertilizer importers and fixed for the season (Banful, 2011). Fertilizer was initially disbursed via a voucher system, but logistical challenges and the fact that less than half of the vouchers were redeemed led to the abolishment of the voucher system in favor of a waybill receipt system in 2010 (Houssou et al., 2019). Initially the subsidy was universally targeted, but from 2013 onwards only farmers with two hectares or less could, in principle, access the subsidy.

Some successes were recorded. Jayne et al. (2015) estimate that FSP accounted for 40 percent of national fertilizer use between 2011 and 2013. In addition to an increase in the number of farmers using fertilizer, average fertilizer application rates increased from 8 to 13 kg per hectare over this period (Benin et al., 2013). On the downside, there were reports of late delivery of inputs (Yawson et al., 2010), while lack of storage facilities, poor quality control, and fiscal pressures created implementation challenges; for example, in 2014 FSP was suspended after government failed to settle debts with fertilizer importers. Targeting was another challenge: although subsidized inputs were supposedly targeted at smallholders, many recipients were larger and wealthier farmers (Houssou et al., 2019).

2.3 Planting for food and jobs: 2017–2020

At its inception in 2017, PFJ was implemented alongside FSP, but from 2018 FSP was formally rolled into PFJ. Three features set PFJ apart from its predecessor program. Firstly, PFJ has the elevated status of a presidential flagship program, which has ensured steady growth in funding and widespread knowledge of and visibility of the program (Asante & Bawakyillenuo, 2021). Secondly, whereas FSP occasionally provided subsidized seeds, a seed subsidy component is a permanent, integral, and rapidly expanding component of PFJ. Other support measures, including extension and marketing support, have also been integrated into the program. Thirdly, whereas FSP primarily had food security and poverty reduction objectives, PFJ has adopted a clear employment agenda, aiming to create a substantial number of jobs along priority value chains, both on and off the farm.

As such, PFJ is a more holistic policy support program that incorporates many of the design principles of smart subsidy programs. While farmer support is prioritized, several support measures are designed to also benefit off-farm actors

and strengthen linkages across and along value chains. PFJ further targets a wide variety of crops rather than only fertilizer intensive staples. In the first year, maize, rice, sorghum, soya, and vegetables (onion, tomato, and chili pepper) were targeted, while in 2018 and 2019 groundnut, cowpea, various root crops, and several additional vegetable crops were added. Although the initial implementation phase (2017 to 2020) has now concluded, the program has been extended and continues to be implemented at the time of writing.

The PFJ implementation plan for 2017 to 2020 ambitiously aimed to increase the number of smallholder beneficiary farmers from 200,000 in 2017 to 1.6 million by 2020. The planned budget was 3.3 billion Ghana cedi (GH¢) over four years (approximately US$ 750 million) (MoFA, 2017). By comparison, the entire MoFA budget allocation for 2016 was GH¢ 501 million (MoF, 2015), illustrating just how ambitious the plan was. Budget estimates suggest government spent only GH¢ 2.3 billion (valued in 2017 prices) on the program over four years, or 31 percent below budget (Table 1). This figure includes GH¢ 204.8 million in 2017, which was technically spent on FSP fertilizer.

Official reports show that the number of farmers receiving subsidized inputs consistently exceeded targets. By 2020, 1.74 million farmers out of an estimated 2.6 million agricultural households participated in the program. PFJ also set job creation targets ranging from 863,500 in 2017 to 1,492,000 in 2020. Some reports suggested these targets were achieved in the first year of PFJ, although no official statistics were ever published to verify this. Importantly, the adopted definition for *job creation* refers to the number of workers benefiting from a direct or indirect association with PFJ as opposed to new, full-time jobs.

The official PFJ targeting criteria (MoFA, 2019) state that, apart from a willingness to participate, beneficiary farmers should be resource-poor smallholders with holdings between 0.4 and 2.0 hectares. As under FSP, this targeting criterium does not exclude wealthy or large farmers in practice, but rather restricts the quantity of subsidized inputs that can be bought by a farmer. Furthermore, 40 percent of beneficiaries should be women, although the gender breakdown is neither reported in official documents nor are women actively targeted. Small-sample survey estimates show that farmers

Table 1 Planting for Food and Jobs program targets and reported achievements

		2017	2018	2019	2020[2]
Budget (*GH¢ millions*)	Projected *(2017 prices)* [1]	189.5	525.3	1,049.3	1,571.0
	Actual (current prices)	*476.4*	*448.4*	*656.3*	*1,143.1*
	Actual (2017 prices)	*476.4*	*408.2*	*547.3*	*867.6*
Beneficiary farmers	Planned[1]	202,860	562,400	1,123,500	1,682,000
	Actual	*202,000*	*677,000*	*1,183,000*	*1,736,510*
Projected job creation [1]		863,500	1,036,200	1,243,440	1,492,128
Seed distribution (*metric tons, mt*) [1, 2]					
Maize	Planned	1,339	9,114	17,753	18,617
	Actual	*2,370*	*4,029*	*9,031*	*13,951*
Rice	Planned	700	6,231	12,377	12,992
	Actual	*1,698*	*2,399*	*6,544*	*10,951*
Soybean	Planned		3,150	6,650	7,000
	Actual	*180*	*339*	*2,729*	*3,860*
Sorghum	Planned		1,185	2,502	2,633
	Actual	*147*	*35*		*300*
Vegetables	Planned	3.6	27.5	54.2	56.9
	Actual	*4.0*	*9.0*	*29.0*	*35.0*
Fertilizer distribution (*metric tons, mt*) [1, 2]					
All fertilizer	Planned	40,763	320,841	632,037	663,157
	Actual	*297,000*[3]	*247,039*	*331,348*	*423,473*

MoFA (2017, 2019, 2020) and MoFA and GHS (2021)

[1] All projected or planned estimates are taken from the original PFJ Implementation Plan (MoFA, 2017), acknowledging that MoFA did revise its annual projections each year thereafter

[2] The quantities of fertilizer and seed reported as "actual" for 2020 are revised planned quantities for 2020 as reported by MoFA (2020). Likewise, the actual budget estimate for 2020 is a projection based on revised planned quantities of inputs

[3] The actual fertilizer quantity for 2017 includes 121,000 metric tons which was technically supplied under FSP. The cost of that fertilizer is included in the budget estimate for 2017

who are better educated, members of farmer organizations, or have larger farms (Abdallah et al., 2021), are younger, or male (Tekuni et al., 2021), or have better access to input or output markets (Ansah et al., 2020) are more likely to participate in PFJ. As with its predecessor program, PFJ started out using a voucher system, but this was replaced by a waybill system in 2018, which limits the possibility of beneficiary targeting that could address participation inequities.

PFJ is designed around five pillars: seed, fertilizer, extension, marketing, and e-agriculture. The goal of the seed pillar is to increase seed use and seeding rates, to strengthen the seed system, and to provide a more diverse range of seed varieties. Whereas there was a heavy reliance on imported seeds in the first years of the program, all PFJ seed except hybrid maize is now sourced from local seed producers (MoFA, 2020). Objectives of the fertilizer pillar include developing private sector fertilizer supply systems, promoting local blending, and ensuring the quality of fertilizer. Under the terms of the program, beneficiaries can acquire fertilizer and seed packs sufficient for up to two hectares at 50 percent of the commercial price. These first two pillars were initially projected to account for 90 percent of the PFJ budget. As shown in Table 1, subsidized seed supplies have been well below target. Only 10 percent of sorghum seed has been distributed, while for the remaining crops, disbursement has ranged from 42 percent for soybean seed and 67 percent for rice seed. The fertilizer disbursement rate was higher at 78 percent of the original target.

The remaining three pillars, while crucial in the context of the PFJ's stated ambition of being a holistic economic support program, are poorly funded. The extension pillar was projected to receive 9 percent of the budget. In practice, this pillar entailed incorporating the existing extension system into PFJ. Since the extension workforce at the time was only around two-thirds the size of what was deemed necessary to provide adequate coverage, the pillar entails aggressive recruitment, training of agents, more frequent farm visits, and better-quality advice.

The marketing pillar encourages more active participation of private actors in agricultural value chains, including farmer-based organizations, traders, food and feed enterprises, and exporters. Interventions include rehabilitation and construction of warehouses and support to private enterprises to undertake processing, packaging, and branding activities. The e-agriculture pillar focuses on dissemination of information (e.g., on input prices or weather) and administrative coordination of PFJ (e.g., through implementation of an e-payment system). These two pillars had an initial projected budget of only 1 percent of the total PFJ budget.

In summary, while PFJ beneficiary targets are being met, the 31 percent expenditure shortfall implies that per capita quantities of subsidized seed and fertilizer have been smaller than originally planned. PFJ expenditure reports do not provide a breakdown by implementation pillar, but indications are that the seed and fertilizer subsidy components made up the bulk of the costs, and probably attracted even more than the 90 percent projected budget share. Resources available for extension services and off-farm investments, especially under the marketing pillar, appear to be very limited.

The imbalance in funding across PFJ pillars is also evident from household survey data. For example, Asante and Bawakyillenuo (2021) finds that 89 percent of PFJ beneficiaries in 2019 received fertilizer, 36 percent received seeds, 45 percent accessed extension, and only 13 percent accessed weather or marketing information. Mabe et al. (2018) report an extension coverage rate of 51 percent among beneficiaries in 2017, which is unchanged from the coverage rate among those same beneficiaries in 2016 before PFJ was implemented. However, PFJ beneficiaries do report an increase in the average number of visits they receive per year, from 2.3 to 3.4 visits. Another study confirms that while most PFJ beneficiaries received fertilizer and seeds, none received marketing support (Quarmine et al., 2020). PFAG (2019) deems this failure to provide effective marketing and value-addition support a critical failure of PFJ. Analysis by Abdallah et al. (2021) reveals that lack of demand for farm output, low or unstable prices, and high transportation costs create significant disincentives to PFJ participants to producing a marketable surplus, to the detriment of the downstream growth and job creation ambitions of PFJ.

3 The farm- and national-level impacts of planting for food and jobs

While MoFA compiles and publishes programmatic data on PFJ expenditures, input supplies, and number of beneficiaries (as reported in Table 1), little is known about the impact of the program at farm-level. Several independent survey-based assessments of PFJ have been conducted in recent years - some of the evidence is cited throughout this section - but they present mostly descriptive estimates and require further analysis to correct for selection bias or control for external factors that may affect farmers' performance.

As far as the national-level impact of PFJ is concerned, official estimates of crop output (and employment) attributed to PFJ are currently based on simplistic models. The objective here is to propose a more advanced simulation tool to assess the likely impacts of PFJ on crop output. This would also allow policymakers to estimate more accurate program benefit-cost ratios, thus enabling them to make evidence-based decisions about value for money and resource allocations.

The proposed model is calibrated with the best available data on subsidized and commercial fertilizer and seed supplies, fertilizer application rates by crop, and input use efficiency rates at farm-level, and can easily be adopted and

modified by MoFA. It also serves as a blueprint for other subsidy program implementing agencies wishing to carry out evaluations of their programs but facing data or capacity constraints that hinder them from conducting more rigorous survey-based evaluations or economywide assessments. Sections 3.1 to 3.3 introduce the data, theoretical concepts, and model parameters needed to calibrate the proposed impact assessment model in a systematic way. The model itself is introduced and showcased in Sect. 3.4.

3.1 Commercial and subsidized fertilizer supplies

Figure 1 plots agricultural fertilizer supplies for 2014 to 2019 and projected estimates for 2020 (Africa Fertilizer, 2020). These are split into subsidized and commercial sales. Following the suspension of FSP in 2014, fertilizer supplies increased rapidly during 2015 to 2020. However, over this same period, the share of commercial supplies declined from 68 to around 20 percent. A linear trend model suggests that for every 100 kg by which subsidized fertilizer increases, commercial supplies decline by 16.4 kg. With an implied commercial fertilizer displacement rate of 16.4 percent, and subsidized fertilizer supplies projected to reach 423,000 tons in 2020 (MoFA, 2020), commercial sales will likely shrink to 82,000 tons in 2020, or 16 percent of total supplies.

While in the short-term, fertilizer importers are likely indifferent whether they sell direct to consumers or through a subsidy program, the sustainability of recent fertilizer sales growth is a concern. Another concern is the crowding out of commercial fertilizer sales. Crowding out is a major reason why production impacts of subsidy programs tend to be lower than expected (Jayne et al., 2018). Crowding out

occurs when subsidy programs target farmers who would have likely purchased fertilizer also in the absence of the program. As more subsidized fertilizer is supplied, less commercial fertilizer is bought, and the net injection of fertilizer into the farming system is less than the quantity of subsidized fertilizer supplied. Quarmine et al. (2020) report that only five percent of PFJ beneficiaries were first-time fertilizer users, which may explain the large crowding-out effects seen in Ghana's fertilizer market.

On the positive side, two changes in the composition of fertilizer imports under PFJ are notable. Firstly, there has been an increase in the share of NPK fertilizer with a high nitrogen content under PFJ, which is consistent with basal fertilizer use recommendations for cereals shifting from medium-nitrogen NPK (e.g., 15-15-15) to high-nitrogen NPK (e.g., 23-10-5). Secondly, there has been an increase in the use of urea (46 percent nitrogen) and a decline in sulphate of ammonia (23 percent nitrogen) as top-dressing. The combined effect of these changes has led to an increase in the average nitrogen content per unit of fertilizer typically applied to cereals from 21.5 before PFJ to 25.1 percent during PFJ. Nitrogen availability is positively associated with leaf growth and crop yields.

3.2 Fertilizer use by crop and fertilizer use efficiency

There is a dearth of information on fertilizer use by crop in Ghana. Although household surveys include fertilizer use information, the prevalence of intercropping makes it difficult to accurately estimate fertilizer allocations across
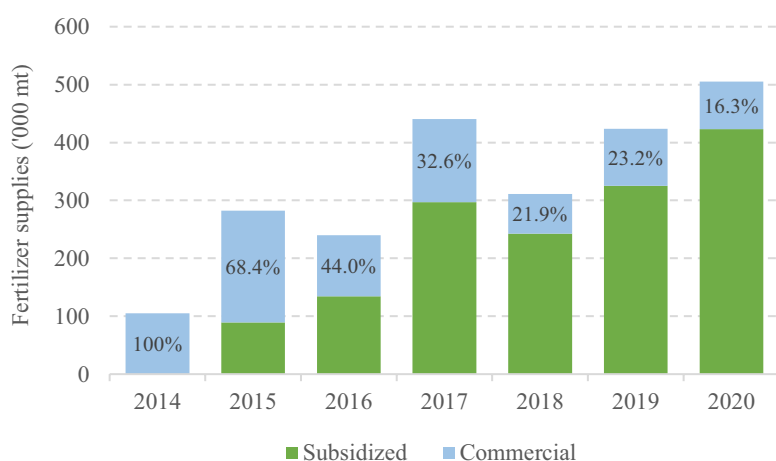
Source: Africa Fertilizer (2020) and MoFA (2019, 2020).
Note: The labels show the share of fertilizer supplies sold in the commercial market. Commercial sales for 2020 are estimated based on projected subsidized fertilizer supplies (see Table 1) for 2020 and a commercial fertilizer displacement rate of 16.4 percent.

Fig. 1 Subsidized and commercial fertilizer supplies in Ghana, 2014–2020

crops planted on the same plot. As a solution to this challenge, IFDC (2019) combines fertilizer import data and fertilizer recommendations to impute fertilizer use by crop (see Table 2). They estimate that 54 percent of fertilizer is applied to cereals (of which we estimate 34 percent is applied to maize and 8 percent to rice), 21 percent to vegetables, and 15 percent to cocoa. Fertilizer allocations to remaining crops are relatively small.

Fertilizer use by crop data are important for estimating the potential impacts of fertilizer subsidies on crop output. Although PFJ prioritizes certain crops, it does not prescribe, control, or monitor how subsidized fertilizer is applied across crops. Prioritization in this context relates mostly to seed supplies. Therefore, the most logical assumption is to assume subsidized fertilizer is allocated across crops in the same proportions as in the table above. Acquiring better fertilizer use by crop data on PFJ beneficiary farms will improve model results.

The fertilizer use efficiency (FUE) rate expresses the marginal crop output per unit of fertilizer and is measured (in the case of grain) as the additional kilograms of grain per additional kilogram of nitrogen applied (per hectare) (Jayne et al., 2015). A related indicator is the value-cost ratio (VCR), which is the ratio of the value of marginal output to the marginal cost of fertilizer. The VCR expresses whether it is profitable to acquire additional fertilizer. Although a value greater than one indicates profitability, studies have shown that VCRs of two or more are typically required for smallholders to demand fertilizer on a sustained basis (Jayne et al., 2015). The VCR is a potentially useful indicator of the likelihood of participation in subsidy programs at different

subsidy rates. It also serves as an indicator of the return on an investment in fertilizer subsidies, as we demonstrate later.

A literature survey by Jayne and Rashid (2013) reveals a wide range FUEs for maize across Africa, from around 8 to 24 kg. This reflects variations in soil, rainfall, and market conditions. They also point at a concentration of estimates at the lower end, arguing that a range of 8 to 15 kg may be a reasonable average for smallholders in Africa. In Ghana, FUEs from small-scale surveys of maize (Chapoto & Ragasa, 2017) and rice (Ragasa & Chapoto, 2017) farmers have been estimated at 22 and 27 kg of grain per kilogram nitrogen, respectively, which is well above the 15 kg considered by Jayne and Rashid (2013) as a reasonable upper-bound estimate. To our knowledge, no other estimates of FUEs are available for Ghana.

3.3 Subsidized seed supplies

As was the case with fertilizer supplies, subsidized seed supplies, although remaining below the initial annual targets (Table 1), increased rapidly under PFJ. Figure 2 compares domestic production of maize, rice and soya seed against seed quantities supplied under PFJ. In the first year of the program, government relied on imported seed for about 80 percent of PFJ seed supplies. This was presumably due to procurement and logistical reasons, as domestic production could have theoretically satisfied around 60 percent of PFJ seed demands. The following year saw a dramatic increase in domestic seed production, to the extent that supply outweighed demand from PFJ. By 2019 the situation was reversed again, with PFJ seed demand outstripping domestic supply. However, by 2020, all seed for PFJ was reportedly sourced domestically, the only exception being hybrid maize seed, which is still being imported (MoFA, 2020).

While the shift to domestic supplies is encouraging and was always a policy goal, it also appears that the commercial market for seed has been crowded out entirely by PFJ. As is the case with fertilizer, the question is whether farmers will continue to buy modern seeds should PFJ be scaled back or suspended. In the event of a suspension, investments made by seed sector actors in response to PFJ may be lost. Clearly, more needs to be done to strengthen the commercial arm of the Ghanaian seed market.

3.4 Crop production

Table A1 (supplementary material) reports output, area, and yields for key crops grown in Ghana between 2016 and 2019, compiled from MoFA (2020) and FAO (2020). Official estimates for 2020 were not yet available for all crops at the time of writing. Among the PFJ priority crops, maize (18.9 percent per annum), rice (10.2 percent), sorghum (14.7 percent), and soya bean (10.5 percent) all grew at more than

Table 2 Fertilizer use by crop and land allocation in Ghana

	Fertilizer use by crop	Land allocation (2019)
All cereals	54%	26%
Maize	34%	17%
Rice	8%	4%
Other	11%	5%
Vegetables	21%	1%
Cocoa	15%	26%
Other crops	10%	47%
Cassava	2%	15%
Soya bean	1%	2%
Other	7%	30%

Authors estimates based on IFDC (2019) and FAO (2020)

All fertilizer use estimates are from IFDC (2019), which the exception of the breakdown of fertilizer use for cereals (54 percent) into maize, rice, and other cereals, which is imputed based on FAO (2020) land areas

Fig. 2 Subsidized maize, rice, and soybean seed supplies and domestic production, 2017–2019
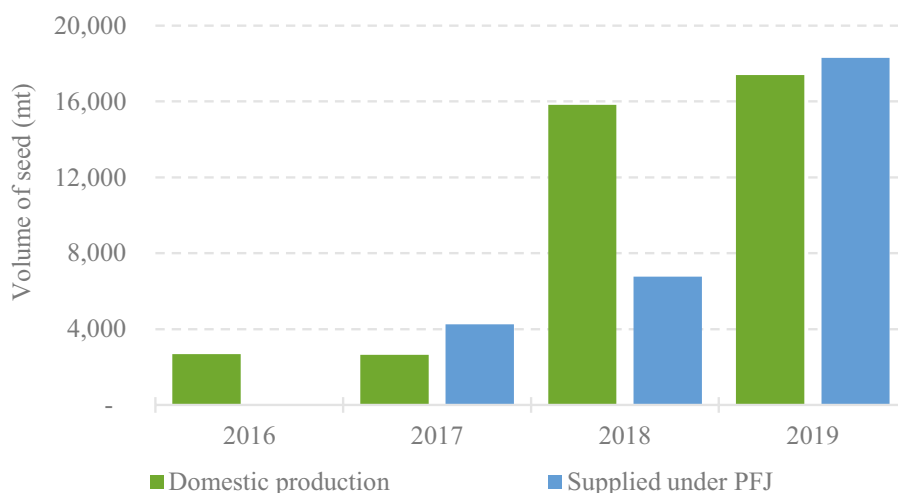
Source: MoFA (2020)

10 percent per year. Except for sorghum, yield growth for these field crops contributed less to output growth than land expansion (e.g., the share of yield growth in total output growth was 44.8 percent for maize and 38.7 percent for rice), suggesting continued dominance of extensive land practices in Ghana.

In contrast to field crops, output growth for PFJ vegetable crops was disappointing: tomatoes grew 3.8 percent, onions 2.8 percent, and chilies 3.2 percent per annum. As with field crops, growth in vegetable yields generally contributed less than half of the output growth. The remaining PFJ crops performed somewhat better than vegetables. This includes groundnut (9.4 percent) and cassava (7.5 percent), which were added to PFJ in 2018, as well as cowpea (6.2 percent), yam (5.6 percent), and plantain (6.9 percent), which were added in 2019.

Overall, Ghana's crop performance was impressive, even though much of it was driven by land expansion rather than productivity growth. The relatively stronger performance of maize and rice likely reflects the fact that the bulk of PFJ resources are allocated to these crops, either explicitly (in terms of seed quantities) or implicitly (in terms of fertilizer allocation choices). Some descriptive statistics of the likely effects of PFJ in raising yields is offered in the literature. Mabe et al. (2018) report a 3.7 percent year-on-year increase in maize yields for farmers who joined PFJ when it was first launched in 2017; a report by PFAG (2019) notes that maize yields on beneficiary farms exceeded national average yields reported by MoFA by 25 percent; and Asante and Bawakyillenuo (2021) estimate that average maize and rice yields in 2019 were respectively 25 and 18 percent higher for PFJ beneficiaries than for non-beneficiaries. While these studies provide useful insights, they do not control for external factors that may have affected yields over time, localized

factors that may explain yield differences across space, or biases in estimates associated with selection into the sample of PFJ beneficiaries. Further analysis of these farm surveys is strongly encouraged.

3.5 Assessing the national-level impact of Planting for Food and Jobs

3.5.1 Simple attribution model

MoFA (2019) uses a simple framework - perhaps best described as an attribution model - to estimate the share of the national crop output that is attributed to the quantities of subsidized seed supplied under PFJ. The method entails first dividing seed supplies by recommended seeding rates to estimate the land area planted to PFJ seeds. Land area is then multiplied by the expected crop yields of beneficiary farmers to estimate output, which is expressed as a share of national crop output. MoFA used this approach to estimate attribution rates in 2017 and 2018. As shown in the Table 3, seeding rates were inconsistent over the two years and deviated from recommended rates. Nevertheless, their results suggested that 24.1 and 27.6 percent of national maize output in 2017 and 2018 could be attributed to PFJ, while for rice the attribution shares were 24.8 and 54.1 percent, respectively.

We apply the same method to calculate attribution rates for 2019 and 2020 as these were never officially released. For maize, assuming a seeding rate of 22.5 kg per hectare (MoFA's recommended rate for open-pollinated varieties) and a yield of 3.0 tons per hectare, we estimate that PFJ contributed 38.1 and 55.5 percent to the national maize crop in 2019 and 2020. Similarly, with a seeding rate of 40.0 kg per hectare (the approximate rate used in 2017) and a yield of

Table 3 Attributing output to subsidized inputs provided, 2017 to 2020

	Maize				Rice			
	MoFA (2019)		Author's estimates		MoFA (2019)		Author's estimates	
	2017	2018	2019	2020	2017	2018	2019	2020
PFJ seed supplied, mt ('000)	2,370	4,029	9,031	13,951	1,698	2,399	6,544	10,951
Seeding rate, kg/ha	14.7	18.4	22.5	22.5	37.9	23.1	40.0	40.0
PFJ land area, ha ('000)	161	219	401	620	45	104	164	274
PFJ farmer yields, mt/ha	3.0	2.9	3.0	3.0	4.0	4.0	4.0	4.0
PFJ output, mt ('000)	484	637	1,204	1,860	179	415	654	1,095
National crop, mt ('000)	2,011	2,306	2,912	3,071	722	769	925	973
PFJ attribution share, %	*24.0*	*27.6*	*41.4*	*60.6*	*24.8*	*54.0*	*70.8*	*112.5*

MoFA (2019, 2020) and MoFA and GHS (2021)

No explanation is provided for the variations in seeding rates or maize yields in the 2017 and 2018 estimates

4.0 tons per hectare, the rice attribution rate is 70.8 percent in 2019 and 112.5 percent in 2020.

Attribution rates exceeding 100 percent are, of course, implausible, which highlights a shortcoming of the model. The model is also highly sensitive to assumptions. For example, in the case of rice, a seeding rate of 25.0 kg per hectare (comparable to the rate used in 2018) and a yield of 4.5 tons per hectare- a recent crop - cutting exercise by MoFA (2020) suggests some rice farmers are achieving that - generates an attribution rate of 204.4 percent. The model further only considers seed inputs and does not explicitly account for the yield effect of increased use of subsidized fertilizer, which is arguably the most significant component of PFJ. While the effect of increased fertilizer could be captured by adjusting the yield exogenously, a more systematic approach would be to endogenize yields based on fertilizer and seed quantities, as well as the efficiency with which these inputs are used on farms.

Another concern about the simple attribution model relates to the choice of model counterfactual. Usually, the impact of an intervention is best assessed by comparing the observed or simulated outcome against a baseline that represents the outcome in the absence of that intervention. Even in the absence of a subsidy program, some output growth will likely occur because of the intrinsic growth in land area as populations grow or yields as farming technologies evolve. The displacement of commercial seed and fertilizer is also not factored into the attribution model.

3.5.2 Improved impact assessment model

Our proposed impact assessment tool improves on the attribution model by projecting the national maize and rice output based on supply of subsidized and commercial seed and fertilizer, and then decomposing those crop outputs by beneficiary and non-beneficiary farmers. The tool factors in the displacement effect on commercial fertilizer, endogenizes crop yields under different assumptions about the efficiency of fertilizer and seed use, and uses consistent methods to estimate a without-subsidy baseline against which simulation results can be compared. Our analysis period starts in 2014 when input subsidies were suspended (a useful benchmark year) and runs through 2020, thus incorporating effects under both FSP and PFJ.

We start with cropped areas as a reference point in the model (see Table A 1), meaning total land availability by crop is assumed given or exogenous. A first-stage model then determines what shares of land are farmed by subsidy program beneficiaries. Beneficiaries receive a combination of fertilizer and/or seed. The remaining land is farmed by non-beneficiaries, who continue to follow traditional farming practices. The first-stage model thus extrapolates from estimates of fertilizer use by crop, subsidy program design elements, and recommended input use rates to allocate inputs and cropland to different maize and rice farm typologies, namely: FSP beneficiaries receiving fertilizer; PFJ beneficiaries receiving seed and fertilizer, seed only, or fertilizer only; and non-beneficiaries. Details of the input allocation model are provided in Table A2 (supplementary material). Results from the model show that around 42 percent of fertilizer imported into Ghana between 2015 and 2020 was supplied to maize and rice farmers through FSP or PFJ, while a further 13 percent was purchased by maize and rice farmers (the rest was applied to other crops). At recommended input application rates, the implication is that about one-third of all maize and rice land cultivated over this period benefited from subsidized inputs.

An important assumption of the model is that all subsidized fertilizer (as reported by input subsidy program documents) and commercially available fertilizer (as derived from import statistics) are applied on farmer fields in the year it is imported. This may not always be the case if, for

example, subsidized fertilizer is delivered late to the farmer. Smuggling of subsidized fertilizer to neighboring Burkina Faso is also thought to be endemic in Ghana's northern regions (Nkegbe, 2018), which would imply not all subsidized fertilizer is used domestically. Evidence in this regard is mostly anecdotal and is not currently factored into the model, although it would be easy to make the necessary adjustments to fertilizer availabilities in the model if such evidence does become available.

Once input supplies and land areas are estimated, the marginal effects of changes in input use on maize and rice yields are calculated for all farm typologies. Yield gains are produced for lower- and upper-bound fertilizer use efficiency (FUE) rates of 8 to 15 kg of grain per kilogram of nitrogen. The model also accounts for the increase in the nitrogen content of fertilizer used on cereal plots in Ghana (i.e., from 21.5 to 25.1 percent). In addition to the yield response from fertilizer, we conservatively assume that farmers using subsidized maize or rice seed in combination with fertilizer obtain a yield advantage of 200 kg per hectare compared to those who only receive fertilizer, while those who only receive seed obtain a yield advantage of 100 kg per hectare. Seed use efficiency rates are difficult to estimate; for example, Ragasa and Chapoto (2017) find that the contribution of certified rice seed to yield improvements ranges between 80 and 830 kg per hectare. However, since most of the yield gain in our model is associated with increased fertilizer use, the overall results are insensitive to the seed use efficiency rate.

An important feature of the improved model is its ability to generate a without-subsidy baseline using methods consistent with those used to generate outcomes under the subsidy program. The baseline serves as a counterfactual against which outputs under the subsidy scenarios can be compared. Our baseline scenario assumes that land expands by 2.5 percent per annum, roughly Ghana's population growth rate and comparable to growth rates seen prior to the launch of PFJ. This is substantially lower than the almost 10 percent expansion rate for maize and rice seen during PFJ. The baseline scenario assumes farmers have the same fertilizer use rates as those estimated for non-beneficiary farmers in the subsidy scenarios. Baselines estimates are also produced for lower- and upper-bound FUE rates.

Table 4 shows the model results, starting in 2014 when no subsidized inputs were provided. Beneficiaries are either FSP beneficiaries (2015 to 2017) or PFJ beneficiaries (2017 to 2020). The same results are depicted visually in Figure A1 (supplementary material). The maize model projects that output will reach between 2,730 and 3,108 thousand tons by 2020 under the lower- and upper-bound FUE values. Coincidentally, the upper-bound production trend is relatively close to official crop estimates, which implies that if national crop estimates were deemed accurate then an FUE value of 15 kg may be plausible for maize. Yields on beneficiary farms reach 3.2 tons per hectare in the upper-bound scenario, relative to non-beneficiary yields of around 1.7 tons per hectare. In the without-subsidy baseline, maize output would have likely reached between 2,120 and 2,180 thousand tons by 2020. Thus, in the upper-bound scenario (FUE = 15), the marginal contribution of PFJ is 928 thousand tons or 42.6 percent.

The rice model predicts output will reach 1,062 to 1,242 thousand tons by 2020. In this case, the lower-bound production trend closely tracks official crop estimates, suggesting perhaps that an FUE value of 8 kg may be plausible for rice. The rice model predicts a substantial increase in output in 2020, which is consistent with the large increase in subsidized rice seed supplied that year (see Table 1). An estimated 91.8 percent of rice land was planted to PFJ inputs in 2020. Rice yields on beneficiary farms gradually increase to 3.6 tons per hectare under the lower-bound scenario, compared to around 3.0 tons per hectare for non-beneficiaries. In the absence of subsidies, rice output would have likely reached 736 to 767 thousand tons by 2020, which implies a marginal gain in output of 326 thousand in 2020 or 44.3 percent due to PFJ in the lower-bound scenario (FUE = 8).

3.5.3 Food security implications

The simulated marginal increases in maize and rice output translate into significant improvements in food security as measured by per capita calorie availability We assume one kilogram of maize grain or milled rice has a food energy content of 3,600 kilocalories. For values of FUE = 15 for maize and FUE = 8 for rice, maize output increased 928 thousand tons and milled rice 212 thousand tons (an industry standard conversion factor of 0.65 is applied to convert paddy to milled rice quantities). Based on trade data (UN Comtrade, 2022) and assuming net imports would have increased by 1 percent per year in the absence of PFJ to maintain per capita food availability (domestic output grew by about 3.5 percent per year in our baseline while the population growth rate is 2.5 percent), we estimate that 110 thousand tons of maize imports and 44 thousand tons of rice imports were substituted with domestic production under PFJ. The combined net increase in maize and rice is therefore 986 thousand tons, which for a population of 31.1 million in 2020 translates into increased availability of 313 kilocalories per capita per day. This equates to 12.5 percent of the daily recommended intake of 2,500 kilocalories for a moderately active adult female (Willett et al., 2019).

Although the model cannot infer on food access and availability at the individual household level, other available evidence supports this finding of significant improvement in

Table 4 Assessing marginal impact of subsidized inputs provided, 2014 to 2020

	2014	2015	2016	2017	2018	2019	2020
Maize							
Land available, ha ('000)	1,025	880	865	985	1,021	1,149	1,263
Share with subsidized inputs (%)		*9.7*	*14.9*	*34.1*	*30.1*	*35.0*	*49.1*
Projected output with subsidies							
FUE = 8, mt ('000)	1,769	1,629	1,589	1,990	1,998	2,353	2,730
Non-beneficiary yield, mt/ha	*1.7*	*1.8*	*1.7*	*1.8*	*1.7*	*1.7*	*1.7*
Beneficiary yield, mt/ha		*2.4*	*2.4*	*2.5*	*2.5*	*2.6*	*2.6*
FUE = 15, mt ('000)	1,769	1,725	1,673	2,225	2,174	2,606	3,108
Non-beneficiary yield, mt/ha	*1.7*	*1.9*	*1.8*	*1.9*	*1.7*	*1.8*	*1.8*
Beneficiary yield, mt/ha		*2.9*	*2.9*	*3.0*	*3.1*	*3.2*	*3.2*
Compare official crop output, mt ('000)	1,769	1,692	1,722	2,011	2,306	2,912	3,071
Projected output w/o subsidy							
FUE = 8, mt ('000)	1,769	1,820	1,875	1,932	1,991	2,054	2,120
FUE = 15, mt ('000)	1,769	1,827	1,889	1,955	2,025	2,100	2,180
Rice							
Land available, ha ('000)	224	233	236	241	260	281	298
Share with subsidized inputs (%)		*9.1*	*14.0*	*39.6*	*34.8*	*58.2*	*91.8*
Projected output with subsidies							
FUE = 8, mt ('000)	604	657	661	736	776	917	1,062
Non-beneficiary yield, mt/ha	*2.7*	*2.8*	*2.7*	*2.8*	*2.7*	*2.8*	*2.9*
Beneficiary yield, mt/ha		*3.4*	*3.4*	*3.5*	*3.5*	*3.6*	*3.6*
FUE = 15, mt ('000)	604	682	684	806	832	1,029	1,242
Non-beneficiary yield, mt/ha	*2.7*	*2.8*	*2.7*	*2.8*	*2.7*	*2.8*	*3.0*
Beneficiary yield, mt/ha		*3.9*	*4.0*	*4.1*	*4.2*	*4.3*	*4.3*
Compare official crop output, mt ('000)	604	642	688	722	769	925	973
Projected output w/o subsidy							
FUE = 8, mt ('000)	604	622	642	663	685	709	736
FUE = 15, mt ('000)	604	625	648	673	701	732	767

Modeled estimates

FUE fertilizer use efficiency rate, measured in kilograms of grain produced per additional kilogram of nitrogen applied

food security. For example, 46.4 percent of non-beneficiary farmers report experiencing food shortages during the calendar year, compared to only 39.1 percent among beneficiaries (Asante & Bawakyillenuo, 2021), while a seasonal market price analysis confirms significant price declines associated with PFJ-induced food supply increases, (Amewu et al., 2021), which improves food access for net-consumers.

3.5.4 Program value-cost ratios

Recall that the value (or benefit) cost ratio (VCR) of PFJ is defined as the marginal value of crop output divided by the marginal cost of inputs. Marginal output values are obtained by multiplying marginal output (Table 4) by farmgate prices obtained from FAO (2020). Input costs can be calculated either from the perspective of farmers alone or for both farmers and government. The marginal cost to farmers is the unsubsidized portion (50 percent) of fertilizer and seed

accessed through the program minus the input costs they would have incurred in the absence of the subsidy program. The total program cost includes the operational costs of the program and the subsidized portion of inputs supplied (Table 1). All benefits and costs are expressed in local currency. Table A3 (supplementary material) presents detailed VCR calculations for each of the implementation years, while Fig. 3 shows the average estimates over the four years. We focus the discussion below on results for FUE = 15 for maize and FUE = 8 for rice.

The farmers' VCRs average 2.6 for maize and 2.5 for rice. Given that VCRs of two or more generally encourage sustained demand for inputs (Jayne et al., 2015), the subsidy program clearly creates significant incentives for farmers to participate. Once government costs are factored in, the program VCRs decline to around one for both maize and rice, suggesting the value of marginal output roughly equals the private and public cost of the subsidy program.
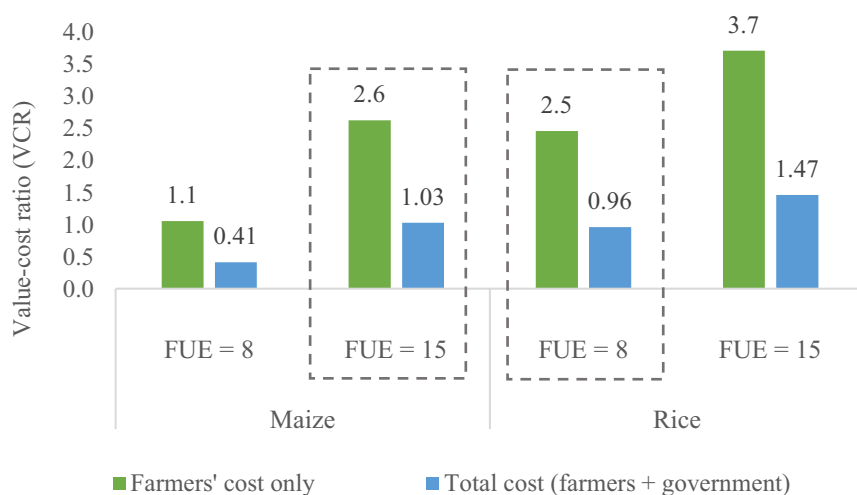
Source: Author
Note: FUE = fertilizer use efficiency rate, measured in kilograms of grain produced per additional kilogram of nitrogen applied.

Fig. 3 PFJ value-cost ratios

While this latter result may seem somewhat discouraging, it should be noted that these are production-based VCRs. As demonstrated by Arndt et al. (2016), the value of marginal crop output understates the economywide benefits of large subsidy programs with significant economic spillover effects. Their analysis for Malawi shows that the economywide benefit-cost ratio is up to 60 percent higher than the equivalent production-based VCR.

4 Conclusions

Farm input subsidies are widely used in Sub-Saharan African countries as a response to low adoption of fertilizers and seeds (Jayne et al., 2018). While subsidy programs traditionally focused on helping farmers access inputs, new generation market smart subsidies implemented since the mid-2000 additionally emphasize careful targeting, development of input supply systems, and complementary production and marketing support to farmers or other value chain actors (Holden, 2019; Morris et al., 2007). Despite implementation challenges, poor performance linked to low returns to fertilizer use, and frequent neglect of the smart subsidy principles, input subsidies will likely remain prominent components of agricultural development strategies. Subsidy programs are also costly given the size of rural populations and political pressure to expand their scope. Continued monitoring and evaluation of subsidy program impacts is therefore important to ensure effective and efficient delivery.

Unfortunately, many implementing agencies lack the expertise or funding to conduct regular, rigorous survey-based evaluations or economywide assessments. Using Ghana as case study, this paper triangulates evidence from official implementation reports, crop production estimates, government budgets, and independent evaluations to develop a simple yet effective impact assessment model that can easily be adopted by implementing agencies to measure crop impacts attributable to subsidy programs. Although the model is purpose-built to assess impacts in the maize and rice sectors in Ghana under the Fertilizer Subsidy Program (FSP) and Planting for Food and Jobs (PFJ) initiatives, it provides a easily adaptable blueprint for assessing subsidy program impacts in other sectors or countries.

Model results show that Ghana's subsidy programs, particularly PFJ, have contributed substantially to crop output. For example, by 2020, PFJ contributed 42.6 percent to maize output and 44.3 percent to rice output relative to a hypothetical without-PFJ baseline. This has likely resulted in improved food security, with a net addition of 313 kilocalories from maize and rice available per person per day, or 12.5 percent of daily calorie needs. Results also reveal that the value of marginal crop output associated with PFJ roughly equals the public and private costs of PFJ, which indicates the program essentially breaks even. Critical observers may argue that other public investments with larger returns should be considered instead, but subsidy programs have been shown to have significant spillover effects in non-agricultural sectors, which raises the economywide returns to investments (Arndt et al., 2016). Complementary economywide analysis will reveal the extent to which this is true for Ghana. The partial model developed here already provides many of the input parameters needed for such an analysis.

From the results and the comprehensive review of PFJ, several programmatic design improvements can be highlighted, all of which have relevance for other countries implementing or considering similar programs. The first concerns **targeting** of subsidy programs. Although PFJ intends to target resource-poor smallholders and prioritize women, better educated, wealthier, male farmers are more likely to participate. This is unsurprising since PFJ is universally accessible, but even in countries with deliberate targeting mechanisms in place, marginalized and poor farmers face barriers to entry (Jayne & Rashid, 2013). Because of trade-offs, targeting may differ depending on whether efficiency, poverty reduction, national food security, or private sector growth is being pursued. The absence of targeting principles that are aligned to clear PFJ policy objectives creates uncertainty among stakeholders as to how the program's performance should be assessed.

The second concerns **crowding out** of commercial input sales. Evidence suggests that both commercial fertilizer and seed sales are being crowded out at a disturbing pace in Ghana. This problem is not unique to Ghana; crowding out is widely considered an important reason why production impacts of subsidy programs are below expectation in SSA (Jayne et al., 2018). Crowding out usually reflects the targeting of farmers who would have purchased commercial fertilizer in the absence of the subsidy. As these farmers switch from commercial to subsidized fertilizer, the net injection of fertilizer into the system declines, resulting in reduced marginal output gains without lowering the cost of the program. Governments can reduce crowding out and strengthen commercial input markets by actively targeting farmers who do not frequently use modern inputs and by adopting exit plans that support beneficiaries to continue using inputs once they graduate.

The third concerns **input use efficiency**. Although fertilizer use efficiency (FUE) estimates are available for many countries (Jayne & Rashid, 2013), there is a dearth of evidence in West Africa and Ghana in particular. FUE estimates are crucial to our understanding of the returns to investment in subsidy programs such as PFJ. More generally, low FUEs associated with poor soil quality and inappropriate use of fertilizers contributes to poor performance of subsidy programs across SSA; as noted by Jayne et al. (2018), subsidy programs give too much attention to supplying fertilizer and not enough to enabling farmers to use it efficiently and profitably. Findings presented here suggest that only half of PFJ beneficiaries have access to extension services. Broader coverage alongside sound advice about appropriate fertilizer application regimes and soil fertility management will help increase FUEs in Ghana.

The fourth concerns **marketing** support. It is widely understood that without a reliable market, farmers lack incentives to produce a marketable surplus (Radchenko & Corral, 2018). This also holds for subsidy program participants, including in Ghana, as evidenced in this paper. This, in turn, has repercussions for agribusinesses that, without reliable input supplies or a conducive business environment, fail to be competitive in global markets (Gelb et al., 2014). Very few - if any - PFJ beneficiaries report having received any form of marketing support through the marketing pillar. PFAG (2019) deems this a critical failure of PFJ, arguing that cycles of glut and low prices create production disincentives and reduce profits. The authors argue that linking PFJ farmers to markets is critical to the success of PFJ, that value chain actors should be given incentives to source from smallholders, and that value addition and processing - all of which is highlighted in PFJ documents but seemingly ignored in its implementation - should be prioritized.

The final point concerns **monitoring and evaluation systems**, which specifically relates to the Ministry of Food and Agriculture (MoFA) in Ghana, but has relevance for implementing agencies in other countries. It is crucial that MoFA goes beyond providing only supply-side information on beneficiary numbers, subsidized input quantities, and the program budget. The more nuanced impact assessment tool such as the one proposed in this paper could easily be adopted as an immediate reform. A medium-term goal should be the implementation of a comprehensive monitoring and evaluation system. Key aspects of the system should include completion of a farmer registry and adoption of a clear targeting strategy; improved, ex-post monitoring of farm-level changes in input use and yields of beneficiaries and non-beneficiaries; continued monitoring of input quality along the supply chain; and tracking of farmers' input receipts, reconciled with supply-side data, to ensure that the intended beneficiaries are reached. The estimated cost of such a monitoring exercise is a small fraction of the overall program budget, but the increased transparency it brings will likely encourage private sector and development partners to support PFJ implementation.

Declarations

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