GHANA

IFPRI

STRATEGY SUPPORT PROGRAM | WORKING PAPER 61 DECEMBER 2021

Fertilizer Quality Assessment

Perception versus testing in selected Ghanaian districts

Seth Asante, Andrew M. Simons, Kwaw S. Andam, Felicia Ansah Amprofi, Ernest Osei-Assibey, and Adisatu Iddrisu

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Fertilizer use in Sub-Saharan Africa remains below recommended rates, contributing to low yields, and increasing poverty. Poor quality fertilizer – whether perceived or real – is often cited as a reason for low adoption rates. In Ghana, for example, there are widespread but often unsubstantiated claims of substandard fertilizers. This is a concern for farmers with limited purchasing power and without the means to independently substantiate the quality of agricultural inputs. This paper describes the agricultural input sector in Ghana, compares farmers' perception of fertilizer quality with those of input dealers, and analyses chemical tests of fertilizers performed in a laboratory. The fertilizers were sampled from selected districts participating in the Planting for Food and Jobs initiative, a large-scale farm input subsidy program. We find that input dealers and farmers are somewhat suspicious of the quality of commercially supplied and government subsidized fertilizers. However, the true quality measures based on laboratory testing of fertilizers sold in agricultural input shops were found to largely meet the labeled chemical composition.

1. INTRODUCTION

Despite moderate increases, agricultural productivity in sub-Saharan Africa (SSA) is still growing at approximately half the average rate compared to developed countries (Nin-Pratt 2015). Improving the productivity of the agricultural sector is fundamental to achieving sustainable development, reducing poverty, and enhancing living standards. One key mechanism for improving agricultural productivity is to increase fertilizer adoption and use. Low rates of mineral fertilizer use in sub-Saharan Africa (SSA) have been attributed to high costs of delivering inputs, especially to remote farmers (Minten, Koru and Stifel 2013). Farmer characteristics such as time preference and risk-aversion (Suri 2011) as well their social networks, behavioral constraints and access to information have all been identified to play a role in the uptake of technologies (Maertens, Michelson and Nourani 2021, Conley and Udry 2010).

Fertilizer subsidy programs are a common policy measure for reducing financial constraints to using fertilizers in SSA. Fertilizer subsidy programs have been implemented as an anti-poverty measure to increase the productivity of farmers (Jayne and Shahidur 2013). In Ghana the fertilizer application rate is estimated at 20kg per hectare while average application rates globally are as high as 135 kg per hectare (MoFA 2021, The World Bank 2021). Only around 28 percent of Ghanaian smallholders who cultivate crops use fertilizer (GSS 2019). Low fertilizer adoption is one of the main reasons the government of Ghana launched its Planting for Food and Jobs (PFJ) initiative, a seed and fertilizer subsidy program, in 2017. PFJ is a much-expanded successor program of the Fertilizer Subsidy Program (FSP) that was initiated in 2008. While subsidy programs are designed to make fertilizer more affordable for smallholders, we explore a different potential reason for the underuse of fertilizer, namely perceptions or evidence of poor quality of fertilizer.

Ensuring the delivery of high-quality fertilizer to farmers is critical for achieving the PFJ goals. Claims about substandard fertilizer in Ghana are common. Around the time when PFJ was being formulated, there was anecdotal evidence of counterfeiting. Multiple news outlets have reported on fake fertilizers (Business Ghana, 2017; Ghana Agricultural & Rural Development Journalists Association, 2015; Ghana Broadcasting Corporation, 2017). Irrespective of whether perceptions of fertilizer quality are based on facts or falsehoods, any notion of low quality could have devastating implications for farmers' trust in agricultural support programs and subsequent technology adoption rates. Research has shown that the presence of substandard inputs and farmers' perception of low quality could be a reason for low uptake (Michelson, et al. 2021, Bold, Kaizzi and Yanagizawa-Drott 2017, Mason and Jayne 2013, Fuentes, Bumb and Johnson 2012, Hoel, et al. 2021). It is crucial that the Ministry of Food and Agriculture (MoFA), as the PFJ implementing agency, has information to counter claims about substandard fertilizer with scientific evidence or to respond swiftly if fertilizer is indeed found to be of substandard quality. This work examines (i) the perceptions of fertilizer quality based on a survey of input dealers and farmers, and (ii) the quality of fertilizers sampled from selected districts, to determine the extent to which substandard or low-quality fertilizers are present in the market.

In a related paper reporting on a survey of input dealers, Asante et al. (2021) found a high level of participation in the fertilizer market by input dealers: 98 percent of agricultural input dealers sell inorganic fertilizers, and 56 percent sell seeds. In this paper we show that the perception of the quality of full price, commercially supplied fertilizers and PFJ subsidized fertilizer varies among input dealers and is more negative than the quality observed from chemical analysis of the samples. When examining farmers, the perceptions are somewhat different. Farmers had more positive perceptions of quality as compared to input dealers. We tested fertilizer samples at a local laboratory and at an international laboratory. According to the results from the international laboratory, samples of compound NPL fertilizers are, on average, within +/- 1 percentage point of the labeled nutrient values for nitrogen (N), phosphate (P), and potassium (K), which in terms of regulations in Ghana characterize the product as “full quality” (Plant Fertilizer Regulations, 2012).

The paper is structured as follows. Section 2 provides details on the study areas, the sampling of input dealers and farmers, and sampling of fertilizer for laboratory analysis. Section 3 presents descriptive results focusing on the characteristics of input shops and farmer characteristics, perceptions of fertilizer quality from farm households, combined with results from analyses of the chemical and physical characteristics of fertilizer samples. Section 4 presents the conclusions of the paper.

Background

Nearly all fertilizers in Ghana are imported in compounds and in bulk to the port. There are eight major importing companies (Yara Ghana, Chemico Limited, Louis Dreyfus Company (formerly Macrofertil Ghana), Omnifert, Agricultural Manufacturing Group (AMG), OCP, ETC Agro and GloFert) and a handful of wholesalers. The small number of firms at the importer-wholesale level suggests that the fertilizer market structure may be oligopolistic (IFDC 2019, Tsiboe, Egyir and Anaman 2021). Six of these firms (Yara Ghana, Chemico Limited, Louis Dreyfus Company, Omnifert, Agricultural Manufacturing Group, and GloFert) have invested in blenders with varying capacities to incorporate micronutrients into fertilizer products to address soil deficiencies. The rest of the fertilizer market is estimated to have about 35 to 50 large distributors with a dense network of more than 3,500 retail shops across the country (IFDC 2019, Iddrisu, et al. 2021). These retail shops, referred to as agro input dealers, usually operate independently of the large companies. However, although they are not formal subsidiaries, some receive stock on credit or negotiate sales agreements with the large companies. Activities of agro input dealers are regulated by the Ghana Agricultural Input Dealers Association (GAIDA).

The Plants and Fertilizer Act, 2010 (Act 803) mandates the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA) to enforce policies and regulations related to fertilizer manufacturing, importation, distribution, adulteration, plant nutrient guarantees and the establishment of the national fertilizer council. Within PPRSD, the Pesticides and Fertilizer Regulatory Division (PFRD) defines the regulatory environment, handles registration of new fertilizer products, and inspects fertilizer for quality. However, a weak regulatory environment and limited product standards enforcement, mainly due to insufficient financial and logistical support for the regulator, makes it difficult for regular market surveillance, especially along the various distribution points in the supply chain once the product has left the port.

Studies in other countries provide some context for our analysis. Bold, Kaizzi and Yanagizawa-Drott (2017), examined inputs from agricultural markets in Uganda and found 30 percent of nitrogen to be missing from urea fertilizer and that hybrid maize seed was less than 50 percent authentic. They used pure inputs and market-purchased inputs to do crop grow-outs at researcher managed plot trials and found that the average returns for smallholder farmers would be 80 percent higher if authentic inputs replaced low-quality products.

Similarly, in Uganda, Ashour, et al. (2019) compared people’s perceptions about herbicide quality against actual quality of products sampled from local markets. They find the average container of glyphosate herbicide to be missing 15 percent of active ingredient, with around 70 percent of sampled containers having. less than the advertised amount of herbicide. However, farmers believed that only 41 percent of glyphosate containers were adulterated or counterfeit. When comparing farmer perceptions to actual quality, farmers knew which geographic areas had lower quality products, but their perceptions did not fully adjust to true levels of quality.

In Tanzania, Michelson et al. (2021) found that farmers believed fertilizers were of low quality, even though chemical tests found fertilizers to be consistent with industry standards. They also found that farmers relied on observable attributes (i.e., lumpiness, discoloration) to incorrectly assess the unobservable nutrient content.

An ECOWAS study conducted in 2010 in Ghana examined the chemical makeup of a wide range of fertilizer products traded in local markets (Sababria, Dimithe and Alognikou 2013). The percentage of samples with deviations in chemical contents hat fell outside of the tolerance range set by ECOWAS varied widely by fertilizer product. For example, among samples of what was a commonly used NPK formulation in Ghana in the past, 15:15:15, between 10 percent (compound product) and 42 percent (blended product) were found to be noncompliant. On the other hand, only 1 percent of what is now a more commonly recommended and used product, NPK 23:10:5 (compound product), were found to be noncompliant. Ghana's PFJ initiative now supplies more than two-thirds of smallholder farmers with improved inputs (MoFA 2020), and subsidized fertilizer supplied under the program accounts for an astounding 83.7 percent of the overall fertilizer market (Pauw 2021). Monitoring the quality of fertilizer supplied to farmers is now more important than ever. This study aims to fill this evidence gap.

2. STUDY AREA, SAMPLING, AND DATA

Sampling of agro input dealers

Data on agro input dealers is from a survey conducted jointly by IFPRI's Ghana Strategy Support Program (GSSP) and PPRSD in 2019 (Asante, et al. 2021). A multi-stage sampling technique was adopted. The first stage involved the purposive selection of 8 districts, while the second stage entailed the random selection from a comprehensive list of registered input dealers compiled by PPRSD as of July 2019. The list of input dealers obtained from PPRSD captured information on: (i) name of company, (ii) location, (iii) region and district, (iv) contact person, and (v) telephone numbers. However, the list did not include so-called "tabletop" input suppliers who move from market to market within or across districts. A random sample of up to 40 input dealers were selected from each district. In districts with fewer than 40 input dealers, all input dealers were surveyed. In instances where a chain of input dealer outlets with the same owner existed in a district, only one of the outlets within the district were included in the survey.

Districts were selected from across two of Ghana's main agroecological zones, both of which are important maize growing areas. These include the transitional zone, which stretches across the middle of the country, and the Savanna zone in the north of the country. These zones have distinct rainfall patterns. The bimodal rainfall pattern in the transitional zone allows for two cropping seasons, while unimodal pattern in Savanna zone allows for only a single growing season under rain-fed farming. Within zones, districts were purposively selected based on maize production levels, potential for increased production, and proximity to major markets. The final sample included 207 input dealers, selected from Ejura Sekyeredumase, Kintampo North, Nkoranza North, and Techiman Municipal (all in the transition zone), and Savelugu, Sissala East, Tamale Municipal, and Tolon (Savanna zone) (Table 1).

Table 1. Study area and sample sizes

Zone	District	Agro input dealers (1)	Smallholder farmers (2)
Transition	Ejura Sekyeredumase	40	100
Transition	Kintampo North	22	103
Transition	Nkoranza North	17	100
Transition	Techiman Municipal	23	100
Savanna	Savelugu	31	100
Savanna	Sissala East	25	105
Savanna	Tamale Municipal	18	-
Savanna	Tolon	31	99
N		207	707

Source: (1) Asante et al. (2021) and (2) Asante and Bawakyillenuo (2021).

Data on farm households are from a parallel study on the farm-level impacts of PFJ, which involved a nationally representative household survey that included a purpose-built module on farmers' perceptions of fertilizer quality in Ghana (Asante and Bawakyillenuo 2021). This household survey sampled households from across 21 districts in Ghana, including, by design, 7 of the 8 districts from which input dealers were sampled (i.e., excluding Tamale Municipal). This provided a sample of 707 households whose responses could be compared with those of input dealers in their own districts.

Sampling of fertilizers

Field teams consisting of PPRSD regional officers collected fertilizer samples. Prior to the fieldwork, PPRSD trained the sampling teams on the qualitative evaluation of the fertilizer physical attributes such as segregation, caking, and determining the level of impurities. The training included instructions on drawing fertilizer samples using a probe as well as physical inspection and analysis of samples.

At each agricultural input dealers' shop or warehouse, the PPRSD personnel sampled, inspected, and labelled all NPK and urea brands of PFJ and non-PFJ fertilizer following standard PPRSD procedures (PPRSD 2012). Officers also noted the physical characteristics of the samples and recorded details such as the location of the input shop, name of shop, date, licensee or company, type of product (PFJ or non-PFJ), product registration number, price of non-PFJ fertilizers, level in the supply chain (importer, distributor, retailer), fertilizer type, grade of NPK, and NPK formulation (compound or blended). Note, neither the input dealer survey nor the household survey inspected samples of fertilizer on smallholder farms.

A total of 318 samples were collected. Of these, 61 samples of (mostly) sulphate of ammonia (SOA) fertilizer were removed, leaving only NPK and urea samples, which are distributed under PFJ. This reduced the sample size to 257. There were very few samples of non-PFJ fertilizers available at the time of our visits (n = 26); hence our analysis focuses only on the PFJ samples of urea (n = 66) and NPK (n = 165). Out of the NPK samples, 59 were randomly selected for testing at a PPRSD approved laboratory in Ghana, and a further 15 of these were selected for confirmatory tests at a laboratory in Canada.

Chemical analysis of fertilizers

The objective of chemical analysis of fertilizer samples is to determine whether the product contains the primary plant nutrient content as labeled: total nitrogen (N), available phosphorus (P_2O_2) and soluble potassium (K_2O). The nutrient content analysis focused on NPK samples. The analytical methods employed by the laboratory are described in the Ghana Fertilizer Analytical

Manual (PPRSD 2012), which are adapted from the ECOWAS fertilizer analysis manual and consistent with those of the Association of Official Analytical Chemists (AOAC) and the International Organization for Standardization (ISO), the global standard for fertilizer authorities and scientists.

The in-country laboratory lab tested the selected 59 samples for nitrogen using the Kjeldahl method (GFAM-N1), phosphorus using the Spectrophotometric Molybdovanado-phosphate method (GFAM-P8), and potassium using the Atomic Emission Method (GFAM-K3). The 15 samples tested in the international laboratory employed the Combustion AOAC 993.13 in testing for nitrogen content, while phosphorus was tested using the AFPC XI-3C (total phosphorus) and AOAC 993.31.d.3 (available phosphorus) methods and potassium oxide was tested using the SPPA method.

3. RESULTS

In this section we first present the characteristics of the agricultural input dealers and farmers within the selected districts. We then describe the perceptions of fertilizer quality among input dealers and farmers. Finally, we present an objective assessment of fertilizer quality based on laboratory tests of fertilizer samples.

Characteristics of agro input dealers and farmers

Panel 1 in Table 2 shows the characteristics of agro input dealers within the selected districts. Consistent with the findings of Krausova and Banful (2010), shopkeeper or owners of agro input shops are predominantly male (72 percent) The most frequently reported level of education is Senior High School (37.7 percent), followed by Junior High School (21.3 percent). The average years of experience in the sale of agricultural inputs is about 7 years. Eleven percent of respondents report earning nearly all their income from the sale of agricultural inputs; however, 92 percent are also involved in other income-generating activities. The vast majority (96 percent) of agro input shops are classified as micro-organizations (five employees or less). The majority (88 percent) also have a sole proprietorship ownership structure. Inorganic fertilizers are sold at 98 percent of shops, seeds are sold at 57 percent of shops, and organic fertilizers are sold at 22 percent of shops. Agricultural inputs are not sold year-round, and the average shop has no sales for about five months of the year.

Panel 2 in Table 2 summarizes results from the survey of farmers conducted in the same districts. Farmers in the sample are male dominated (94 percent), are 45 years old, on average, and have a mean household size of 5.87. On average, 47 percent of farmers have completed some form of education and have about 12 years of experience as farmers. Land ownership averages 8.88 acres with a range of 0.5 to 175 acres. Only 10 percent of farmers own the title to their lands.

Table 2: Agro-dealer and farmer descriptive statistics

	Mean (SD)	Min.	Max.
Panel 1: Agro-input dealers *(n = 207)*			
Male (share)	0.72		
Education (share)	0.91		
Years of experience	6.99 (6.53)	0.5	31
Share of all income from ag input sales	0.11		
Size of input shop (share):			
Micro (1-5 persons engaged)	0.96		
Small (6-30 persons engaged)	0.04		
Business Ownership (share):			
Sole proprietorship	0.88		
Partnership	0.12		
Inputs sold (share):			
Inorganic fertilizer	0.98		
Organic fertilizer	0.22		
Seed	0.57		
Number of months with no input sales	5.16 (2.38)	1	9
Panel 2: Farmers *(n = 707)*			
Male (household head share)	0.94		
Education (share)	0.47		
Household size	5.87 (2.61)	1	17
Age (household head years)	45.37 (13.20)	20	90
Experience in farming	12.09 (12.49)	1	60
Land owned (acres)	8.88 (11.18)	0.5	175
Tenure status of plot (share of titled plots)	0.10		
Fertilizer application on plots (share)	0.82		

Source: GSSP-IFPRI Survey 2019 and ISSER PFJ Survey 2020

Perceptions about fertilizer quality

Ensuring delivery of high-quality fertilizer to farmers under PFJ is of critical importance for achieving the program's goals. As discussed, concerns about fertilizer quality, whether based on facts or falsehoods, could damage trust in fertilizer subsidy programs and negatively affect modern input adoption. We first look at the common complaints received about fertilizers by agro input dealers, and then consider the perceptions of farmers. Responses were collected separately for PFJ and full price commercial fertilizers.

Common complaints received about fertilizer

Common complaints about fertilizer quality heard by agro input dealers are presented in Table 3. While 29.5 percent of dealers received no complaints, among the rest, fertilizer quality issues rank as the most frequently received complaint reported by 47.3 percent of input dealers, while 41.6 percent received complaints about the unavailability of a type of fertilizer needed by customers, and 25.1 received complaints about the price of fertilizer (note, respondents could select more than one type of complaint). Many others (22.7 percent) listed "other" complaints, including registration difficulties during the initial implementation of the PFJ program; limited quantities of subsidized fertilizer that are available; the removal of PFJ labels from bags then sold as commercial fertilizer; and perceptions that fertilizers have limited impacts on crop yields or soil quality.

Table 3: Common complaints heard by input shop owners/attendants about fertilizer

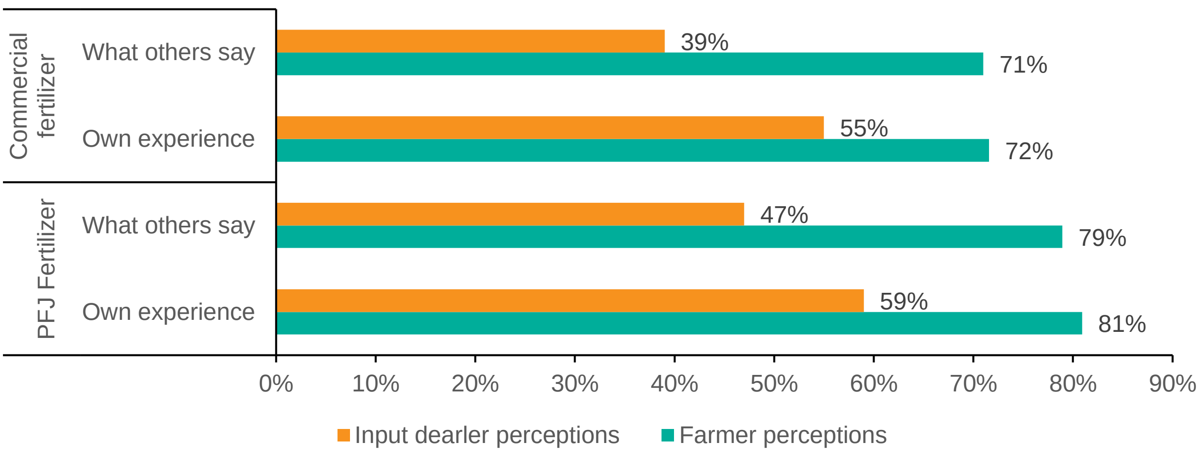
	Percentage (%)	Number
No complaints	29.5	61
Fertilizer is not of good quality	47.3	98
Type of fertilizer farmer wants is not available	41.6	86
Fertilizer is too expensive	25.1	52
Other	22.7	47
Decline to answer	0.5	1

Source: GSSP-IFPRI Survey 2019

Perception of the quality of PFJ and full price commercial fertilizers

Input dealers and farmers were both asked to provide an assessment of the quality of fertilizer in their district. The question was framed such that respondents had to provide an estimate of the number of bags, out of every ten sold or bought, they considered to be of good quality as opposed to substandard or inferior quality. The question was further asked in two ways: first, so that respondents could share their impression of what they hear from other dealers or farmers about the quality of fertilizers in their town or district, in general; and second, to share their impression of the quality of fertilizer they sold from their own shops or bought for their own farms. Figure 1 presents the shares of commercial and PFJ fertilizers considered to be of good quality as reported by dealers and farmers.

Figure 1: Share of PFJ and commercial fertilizer considered to be of good quality



Source: GSSP-IFPRI Survey 2019 and ISSER Survey 2020

The results are interesting. Farmers are significantly more optimistic about fertilizer quality than input dealers. Their own perceptions of quality closely match the perceptions they believe their peers hold. And they believe government supplied PFJ fertilizer is of a higher quality, on average, than commercially sold fertilizer. Input dealers, on the other hand, believe the fertilizer in their own stores are much better quality than what is available in the market. As with farmers, dealers believe PFJ fertilizer is better than commercial fertilizer. It is of course possible that these responses are biased, even though respondents remain anonymous. Both sets of respondents may avoid expressing negative views of PFJ fertilizer in fear of being excluded from the program in future. Even if the PFJ fertilizer is inferior, dealers and farmers still benefit from increased sales and lower prices and would not want the program to be cancelled. Input dealers may also overstate the quality of their own fertilizer relative to that sold in other shops in the hope of attracting more business.

Perceived causes of low quality from dealers

Follow-up questions to input dealers probed about the causes of the low-quality fertilizer. Results are presented in Table 4. Around one-quarter of input dealers report having received complaints about the quality of commercial (28.5 percent) or PFJ fertilizer (24.2 percent). Interestingly, 56 percent of dealers did nothing when the complaints pertained to PFJ fertilizer, but 76.3 (100 – 23.7) acted when it pertained to commercial fertilizer. As to the reasons for substandard quality, a large share of input dealers believe that fertilizer brought into the district is already of low quality (43.5 and 39.6 percent for commercial and PFJ fertilizer, respectively). Another common response is that fertilizer sold is of good quality, but farmer handling reduces the quality (37.7 and 30 percent).

Table 4: Complaints received and perceived causes of low quality fertilizer

	Commercial		PFJ	
	N	(%)	N	(%)
Ever received a complaint on quality?				
No	148	71.5	157	75.9
Yes	59	28.5	50	24.2
What was done about complaint received?				
Did nothing	14	23.7	28	56.0
Stopped taking stock	22	37.3	9	18.0
Informed supplier/importer	29	49.2	11	22.0
Informed a PPRSD/MoFA officer	3	5.1	3	6.0
Other	8	13.6	4	8.0
Perceived causes of low-quality fertilizer				
Fertilizer brought into the district is sub-standard or low quality	90	43.5	82	39.6
Fertilizer quality reduced because of transport and handling	47	22.7	48	23.2
Fertilizer quality reduced because of storage	44	21.3	47	22.7
Fertilizer sold is good quality, but farmer handling reduces the quality	78	37.7	62	30.0
Other	20	9.7	29	14.0
Decline to answer	12	5.8	14	6.8
Do not know	55	26.6	50	24.2

Source: GSSP-IFPRI Survey 2019

Objective assessment of fertilizer quality

Although the intention was to collect samples of NPK and urea offered both in the commercial market and under the PFJ program, the limited quantities of commercial fertilizer meant that we only had a sizable sample for PFJ fertilizer to analyze. Additionally, relatively few stores stocked urea, with input dealers saying NPK was more popular among maize farmers. As a result, urea was also excluded, and we focus our analysis on samples of NPK fertilizer supplied under PFJ.

Physical characteristics

Table 5 presents the physical characteristics of PFJ NPK fertilizers sampled, which are assessed through physical inspection. The degree of segregation, i.e., the physical separation of granules from different components of bulk blends due to their granule size differences, was high among only 1.2 percent of samples. Uneven distribution of components can occur due to shaking during transportation and handling in warehouses and shops. Segregation is the result of small granules moving downward between spaces left by larger granules. The larger the granule size differences, the larger the segregation could be.

Table 5: Physical characteristics of PFJ NPK fertilizer

	Physical characteristics of PFJ NPK fertilizes (%)		
	Degree of segregation	Degree of Caking	Impurities (Visual observation)
None	86.7	80.6	
High	1.2	0.6	
Low	12.1	18.8	
Yes			0.6
No			99.4
Number of samples	**165**	**165**	**165**

Source: GSSP-IFPRI/PPRSD Survey 2019

We further find the degree of caking to be high in only 0.6 percent of PFJ NPK samples. Caking was qualitatively assessed through observation and by feeling for lumps in fertilizer bags. Caking occurs when the individual granules of the product fuse to form larger aggregates. In extreme cases of caking, entire bags become one solid body. Caking usually occurs when the fertilizer product comes into contact with water or when it is stored in damp or humid locations. Another factor contributing to caking is the pressure exerted by stacked bags. Lastly, impurities are foreign substances that become mixed with the fertilizer during manufacturing or because of improper management practices. We found 0.6 percent of samples to contain impurities.

Fertilizer quality tests

PFJ NPK samples were tested in a Ghanaian laboratory approved by the PPRSD for fertilizer testing. A random selection of 59 (out of 165) samples were tested. A subsample of 15 (out of 59) were also sent to an international laboratory in Canada for confirmatory tests. Each sample is about 500 grams, while a chemical analysis requires only 100 grams. It was therefore possible to conduct the tests in the international laboratory using the same sample used by the local laboratory. The chemical analysis performed by the local laboratory is presented in Table 6. Local laboratory results indicated very large deficiencies in nitrogen, with samples containing, on average, less than half of the labeled nitrogen (19.7 percent labeled versus 8.1 percent present), but the levels of phosphorus and potassium were within one percentage point of the amount stated on the label.

Table 6: In-country laboratory tests

Plant Nutrient	Labeled com-position	Local test re-sults	Deficiency in percentage points	Percent difference
Nitrogen (N)	19.7	8.1	-11.6	-58.9
Phosphorus (P_2O_2)	11.4	11.0	-0.4	-3.5
Potassium (K_2O)	10.2	10.8	0.6	5.9
Number of samples	**59**			

Source: GSSP-IFPRI/PPRSD Survey 2020. Note: A variety of NPK formulations (grades) were sampled in the study. For example, out of the 165 samples, the majority were 20-10-10 (51 samples), 23-10-5 (35 samples), or 15-15-15 (28). The labeled and tested nitrogen, phosphorous and potassium contents shown in the table are simple averages across the tested samples.

The result for nitrogen is an obvious cause for concern. However, on seeing that Michelson et al. (2021) did confirmatory tests at an international laboratory in their Tanzania study, we decided to send a subsample to a certified international laboratory in Canada for confirmatory testing. The results are presented in Table 7. The table also includes the summary results for the same subsample of 15 as obtained from the local laboratory. The international laboratory results indicated no significant shortfalls in nutrients compared to the labeled values. Following this exercise, the local laboratory resampled some of the fertilizers and tested for nitrogen again. The second-round tests revealed an improvement in nitrogen content. The laboratory attributed their initial results to a faulty nitrogen digester.

Table 7: International laboratory tests

Plant Nutrient	Labeled composition	International test results (local result in brackets)	Deficiency in percentage points (local result in brackets)	Percent difference (local result in brackets)
Nitrogen (N)	19.0	18.4 (7.4)	-0.6 (-11.0)	-3.2 (-38.9)
Phosphorus (P_2O_2)	12.0	11.6 (10.6)	-0.4 (-1.0)	-3.3 (-3.3)
Potassium (K_2O)	10.8	11.6 (12.8)	0.8 (1.2)	7.4 (18.5)
Number of samples	**15**			

Source: GSSP-IFPRI/PPRSD Survey 2020

Following the guidance offered in the Ghanaian Plant Fertilizer Regulations 2012 (see Appendix 2), fertilizer is deemed noncompliant if laboratory analysis shows nutrient contents to be below or above the labeled composition by 1 percentage point or more. Focusing only on the confirmatory tests performed by the international laboratory (Table 8), the tested samples were, on average, within the regulatory requirements for each nutrient as specified on the labels of the fertilizer bags. Considering the response from the local laboratory, the results from the international laboratory more correctly describe the chemical composition of the Ghanaian fertilizer samples. Since such errors can have significant consequences for the credibility of a program such as PFJ, improving the capacity of the local laboratory ecosystem in Ghana is of key importance. Capacity building for local laboratories would be beneficial for PPRSD and would strengthen the broader system of monitoring quality within Ghana as PPRSD is mandated to use local laboratories for testing fertilizer samples for quality.

In sum, while it is reassuring that the fertilizer supplied under PFJ is generally of good quality, it remains a concern that about one-quarter of input dealers received complaints from customers about the quality of PFJ fertilizers (Table 4). Active work is necessary to overcome the perception that fertilizer quality is low in Ghana.

4. CONCLUSION

Assuring farmers, the end-users of agricultural inputs such as fertilizer and seed, that their investments in improved technologies will yield returns, will require adequate signals of the quality of the inputs. For fertilizer, years of anecdotal claims of bad quality may already have led to low willingness of farmers to adopt and increase use. This is a hurdle faced by producers and suppliers in the fertilizer market, but it is also an obstacle to the success of public sector input subsidy programs. In this paper we test the extent to which this may be happening in the context of the PFJ, Ghana’s large input subsidy program that started in 2017. We compare perceptions of fertilizer use among farmers, but also among the input dealers supplying the fertilizer, and compare those perceptions to the results of chemical tests in a local laboratory and an international one.

Despite perceptions of low-quality fertilizers by both input dealers and farmers, chemical tests at an international laboratory found sampled fertilizers to be of good quality within +/- 1 percentage point of their labeled nutrient values. This finding, as well as any future evaluations of the quality of inputs available either commercially or through inputs subsidy programs, should be communicated to farmers to avoid misconceptions about inputs. Physical assessment of fertilizer samples also showed positive results, hence consistent training and monitoring conducted by PPRSD of MoFA on general handling and storage should be maintained to avoid contamination at the retailer level.

Capacity building of local laboratories in the medium-term is required by PPRSD and would strengthen the broader system of monitoring agricultural input quality within Ghana as PPRSD only uses the local laboratories. In the longer term PPRSD should be equipped with fertilizer testing laboratory equipment across the agroecological zones to ensure random testing of inputs along the supply chain to ensure the sale of high-quality inputs.

REFERENCES

Asante, F. A., and S. Bawakyillenuo. 2021. *Farm-level effects of the 2019 Ghana planting for food and jobs program: An analysis of household survey data.* GSSP Working Paper 57, Accra, Ghana: Ghana Strategy Support Program, International Food Policy Research Institute (IFPRI).

Asante, S., K. S. Andam, A. M. Simons, F. A. Amprofi, E. Osei-Assibey, A. Iddrisu, and S. Blohowiak. 2021. *Agricultural input markets in Ghana: A descriptive assessment of input dealers in eight districts.* GSSP Working Paper 58, Accra, Ghana: Ghana Strategy Support Program, International Food Policy Research Institute (IFPRI).

Bold, T., K. C. Kaizzi, and D. Yanagizawa-Drott. 2017. "Lemon Technologies and Adoption: Measurement, Theory, and Evidence from Agricultural Markets in Uganda." *The Quartely Journal of Economics* 132 (3): 1055 - 1100.

Business Ghana. 2017. "Public warns against fake Yara branded fertilizers." Accessed August 23, 2017. http://www.businessghana.com/site/news/Business/150692/Public-warns-against-fake-Yara-branded-fertilizer .

Conley, T.G, and C.R. Udry. 2010. "Learning about a New Technology: Pineapple in Ghana." *American Economic Review* 100 (1): 35-69.

Fuentes, P. A., B. Bumb, and M. Johnson. 2012. *Improving fertilizer markets in West Africa.* Paper Series IFDC-P-40, Muscle Shoals, Alabama, USA: International Fertilizer Development Center (IFDC).

Ghana Agricultural & Rural Development Journalists Association. 2015. "Stakeholders discuss fertilizer industry in Ghana." Accessed November 20, 2015. https://www.gardja.org/stakeholders-discuss-fertilizer-industry-in-ghana/.

Ghana Broadcasting Corporation. 2017. "Partners in Agro Chemical products express worry over high prices and fake Agro Chemical products in Ghana." Accessed February 3, 2017. http://www.gbcghana.com/1.1996521 .

GSS. 2019. *2017/18 Ghana Census of Agriculture.* National Report, Accra, Ghana: Ghana Statistical Service.

Hoel, J.B., H. Michelson, B. Norton, and V. Manyong. 2021. "Misattribution and uncertainty about beliefs prevent learning." Mimeo.

Iddrisu, Y., P.S. Bindraban, W.K. Atakora, B.T. Aremu, P. Annequin, K. Kouassi, A. Fernando, R. Wheeler, and F. Gyasi. 2021. *The Fetilizer Platform Study.* IFDC FERARI Research Report No. 3, International Fertilizer Development Center (IFDC).

IFDC. 2019. *Ghana fertilizer value chain optimization study.* IFDC Report, Muscle Shoals, Alabama, USA: International Fertilizer Development Center (IFDC).

Jayne, T.S., and R. Shahidur. 2013. "Input subsidy programs in sub-Saharaan Africa: A synthesis of recent evidence." *Agricultural Economics* 44 (6): 547-562.

Krausova, M., and A.B. Banful. 2010. *Overview of the Agricultural Input Sector in Ghana.* IFPRI Discussion Paper 1024, Washington , DC: International Food Policy Research Institute (IFPRI).

Maertens, A., H. Michelson, and V. Nourani. 2021. "How Do Farmers Learn from Extension Services? Evidence from Malawi." *American Journal of Agricultural Economics* 103 (2): 569-595.

Mason, N. M., and T. S. Jayne. 2013. "Fertiliser Subsidies and Smallholder Commercial Fertiliser Purchases: Crowding Out, Leakage and Policy Implications for Zambia." *Journal of Agricultural Economics* 64 (3): 558 - 582.

Michelson, H., A. Fairbairn, B. Ellison, A. Maertens, and V. Manyong. 2021. "Misperceived quality: Fertilizer in Tanzania." *Journal of Development Economics* 148 (102579).

Minten, B., B. Koru, and D. Stifel. 2013. "The last mile(s) in modern input distribution: Pricing, profitability, and adoption." *Journal of Agricultural Economics* 44 (6): 629 - 646.

MoFA. 2021. *2020 Annual Progress Report.* Draft 2020 APR, Accra Ghana: Ministry of Food and Agriculture (MoFA).

Nin-Pratt, A. 2015. *Inputs, productivity, and agricultural growth in Africa South of the Sahara.* IFPRI Discussion Paper 1432, Washington, D.C: International Food Policy Research Institute (IFPRI).

PPRSD. 2012. *Ghana Fertilizer Analytical Manual.* Accra, Ghana: Plant Protection and Regulatory Services Directorate (PPRSD), Ministry of Food and Agriculture.

Sababria, J., G. Dimithe, and E.K.M. Alognikou. 2013. *The Quality of Fertilizer Traded in West Africa: Evidence for Stronger Control.* A Joint ECOWAS, UEMOA and IFDC Report, International Fertilizer Development Center (IFDC).

Suri, T. 2011. "Selection and Comparative Advantage in Technology Adoption." *Econometrica* 79 (1): 159 - 209.

The World Bank. 2021. "World Development Indicators." Accessed November 2021. https: data.worldbank.org/indicator/AG.CON.FERT.ZS.

Tsiboe, F., I. S. Egyir, and G. Anaman. 2021. "Effect of fertilizer subsidy on household level cereal production in Ghana." *Scientific African* 13 (e00916): 1 - 14.

ANNEXES

Annex Table 1. Laboratory test results

Client ID	Laboratory Test	Labelled Composition	Nitrogen (N)		Phosphorus (P2O2)		Potassium (K2O)	
			Diff (Label-local lab.) - percentage points (pp)	Diff Label-foreign lab.) - percentage points (pp)	Diff (Label-local lab.) - percentage points (pp)	Diff Label-foreign lab.) - percentage points (pp)	Diff (Label-local lab.) - percentage points (pp)	Diff Label-foreign lab.) - percentage points (pp)
PFJ-7	Local	15-15-15	1.5		0		0	
FERT-7	Foreign			0.82		-2.32		-1.07
FERT-700	Foreign			0.53		-2.49		-2.16
PFJ-18	Local	20-10-10	12.29		0		0	
PFJ-1800	Local		13.7		-0.2		-0.24	
FERT-18	Foreign			1.47		1.01		-0.91
FERT-1800	Foreign			1.88		1.02		-1.36
PFJ-34	Local	17-10-10	8.84		0		0	
FERT-34	Foreign			0.36		-0.05		-1.13
PFJ-37	Local	23-10-5	15		0		-0.3	
FERT-37	Foreign			0.17		0.51		-1.18
FERT-3700	Foreign			0.64		0.98		-1.74
PFJ-61	Local	23-10-5	14.09		-0.22		-0.18	
FERT-61	Foreign			1.41		0.72		-0.35
PFJ-77	Local	20-10-10	10.58		0		0	
PFJ-7700	Local		10		0		0	
FERT-77	Foreign			-0.8		0.89		0.17
PFJ-82	Local	15-20-20	8.84		0		1.33	
FERT-82	Foreign			0.33		1		0.85
PFJ-200	Local	15-15-15	10.52		10.52		-3.51	
PFJ-20000	Local		10		10		-9.5	
FERT-200	Foreign			1.11		1.31		-0.57
PFJ-217	Local	23-10-10	12.55		0		-0.45	
FERT-217	Foreign			2.47		-0.09		-0.93
PFJ-222	Local	15-15-15	9.24		1.8		-9.5	
PFJ-22200	Local		10.24		1.85		-7.32	
FERT-222	Foreign			0.42		2.68		-1.99
PFJ-224	Local	23-10-5	17.4		2		-1.48	
PFJ-22400	Local		16		-1.22		-1.43	
FERT-224	Foreign			0.31		0.19		-1.15
PFJ-235A	Local	20-10-10	15.61		0		0	
FERT-235A	Foreign			0.11		0.52		-0.82

Source: GSSP-IFPRI/PPRSD Survey 2020

Annex Table 2. Established level of nutrients in fertilizer

Guarantee Percent (%)	Nitrogen (N) Percent (%)	Available Phosphate (P_2O_2) Percent (%)	Potash (K_2O) Percent (%)
4 or less	0.49	0.67	0.41
5	0.51	0.67	0.43
6	0.52	0.67	0.47
7	0.54	0.68	0.53
8	0.55	0.68	0.60
9	0.57	0.68	0.65
10	0.58	0.69	0.70
12	0.61	0.69	0.79
14	0.63	0.70	0.87
16	0.67	0.70	0.94
18	0.70	0.71	1.01
20	0.73	0.72	1.08
22	0.75	0.72	1.15
24	0.78	0.73	1.21
26	0.81	0.73	1.27
28	0.83	0.74	1.33
30	0.86	0.75	1.39
32 or more	0.88	0.76	1.44

Source: Plant Fertilizer Regulations, 2012, L.I. 2194[1]

[1] A fertilizer is deficient if the analysis of an official sample for any plant nutrient is below the guarantee by an amount exceeding the values stated.

ABOUT THE AUTHORS

Seth Asante (s.asante@ciar.org) is a Senior Research Officer in the Development Strategy and Governance Division (DSGD) of IFPRI and Team Representative of IFPRI's Ghana Strategy Support Program (GSSP), based in Accra, Ghana. **Andrew M. Simons** is an Assistant Professor in the Department of Economics, Fordham University, based in New York, NY, USA. **Kwaw S. Andam** is a Research Fellow in the DSGD of the International Food Policy Research Institute (IFPRI) and Program Leader of IFPRI's Nigeria Strategy Support Program (NSSP) based in Abuja, Nigeria. **Felicia Ansah Amprofi** is the Director of Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA), based in Pokuase, Accra. **Ernest Osei Assibey** is the Head of Fertilizer Administration Unit at PPRSD, based in Pokuase, Accra. **Adisatu Iddrisu** is the Head of Fertilizer Analytical Unit at PPRSD, based in Pokuase, Accra.

ACKNOWLEDGMENTS

This Working Paper is a reproduction of a joint output of the International Food Policy Research institute (IFPRI) and the Government of Ghana through the Ministry of Food and Agriculture (MoFA) and the Ministry of Monitoring and Evaluation as part of the project "Planting for Food and Jobs Monitoring and Evaluation System" funded by the Alliance for a Green Revolution in Africa (AGRA) and its partners under the Partnership for Inclusive Agricultural Transformation in Africa (PIATA). Co-funding from the CGIAR Research Program on Policies, Institutions and Markets (PIM) as well as the International Finance Corporation (IFC) is gratefully acknowledged. We are also grateful to the staff of Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA) for their support in implementing this survey, and to Karl Pauw for comments on an earlier draft of the paper. Most importantly, we thank the input dealers and farmers who responded to our survey. The views expressed are those of the authors and do not necessarily reflect those of funding partners or employers.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
1201 Eye St, NW | Washington, DC 20005 USA
T. +1-202-862-5600 | F. +1-202-862-5606
Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info

IFPRI-ACCRA
c/o IWMI, PMB CT 112; Cantonments, Accra, Ghana
CSIR Campus (Opposite Chinese Embassy), Airport Residential Area
T. +233 (0) 302 780 716 | F. +233 (0) 302 784 752 | gssp.ifpri.info

The Ghana Strategy Support Program (GSSP) is managed by the International Food Policy Research Institute (IFPRI). The research presented here was conducted as part of the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI. This publication has been prepared as an output of GSSP. It has not been independently peer reviewed. Any opinions expressed here belong to the author(s) and do not necessarily reflect those of IFPRI, PIM, or CGIAR.