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The Supply of Inorganic Fertilizers to Smallholder Farmers in Mozambique

Evidence for Fertilizer Policy Development

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ABSTRACT

Inorganic fertilizer is one of a handful of agricultural technologies that have immense potential for raising the productivity of poor smallholders, enabling them to increase income, accumulate assets, and set themselves economically on a pathway out of poverty. The very low prevalence of fertilizer use by Mozambican farmers—below five percent—is evidence that farmers find it difficult to access fertilizers for their crops at a price that will allow them to obtain sufficient and reliable returns from their investment in fertilizer.

This paper presents the results of a broad study of fertilizer supply to smallholder farmers in Mozambique that was done to assess whether the taxes (explicit or implicit) that are applied at various points along the fertilizer importation and marketing chain, or the absence of key public goods and services, reduces the access that smallholder farmers have to fertilizer. The study involved a review of the literature of fertilizer supply, demand, and use; interviews with key participants in fertilizer importation and marketing in Mozambique; and two surveys—one with farmers and the other with input suppliers—in two farming areas where more fertilizer is used than is the norm for the country as a whole.

The government of Mozambique has adopted a generally hands-off approach in engaging with efforts to improve farmer access to fertilizer. Private-sector investment decisions drive the development of input markets, with government primarily having somewhat distant oversight. Fertilizer costs are high in Mozambique relative to costs in other coastal countries in Africa. Efforts are being started to strengthen the retail sector of agricultural inputs by better understanding the information and management needs of agricultural input retailers, but much work is still required in this regard.

However, given the problematic economics of fertilizer use by smallholders in Mozambique, the prospects for sharp increases in fertilizer use in the future are certainly much murkier there than elsewhere in Africa. Nonetheless, government can take two fertilizer-specific initiatives to accelerate use of fertilizer in Mozambique by smallholders:

1. Overcoming information constraints that smallholder farmers who might use fertilizer face. This includes both information on the proper agronomic use of the appropriate types of fertilizer on specific crops under specific agroecological conditions and information on the proper economic use of fertilizer under changing input and output market conditions so that farmers can derive reliable profits from their use of the technology.
2. Regulatory reform. The fertilizer regulations currently being proposed for Mozambique, if comprehensively implemented, would be a poor fit for the public benefits sought through the regulations. A considerably lighter regulatory regime would allow more fertilizer into Mozambique, resulting in lower costs for farmers. The Ministry of Agriculture should be judicious in its implementation of this legislation. Efforts to assure the quality of fertilizers in open and competitive markets are best achieved through self-regulation processes tied to sufficient information on product quality for farmers and ample choice in suppliers, rather than through heavy regulation and costly enforcement.

Keywords: fertilizer supply, agricultural input policy, Mozambique

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1. INTRODUCTION

Most of the poor in Mozambique, as throughout Africa south of the Sahara, are members of rural farming households. In order to escape poverty in a sustainable manner, households must enter into a process of savings and accumulation of productive assets whereby, based on the returns in income on those assets over time, they are able to enter a pattern of continual improvement in their welfare and move out of poverty. A key factor that enables smallholder farming households to enter into this beneficial pattern of household economic growth is enhanced agricultural productivity to increase the economic returns that they enjoy from their agricultural assets. Without improving the productivity of the assets that they possess, households produce little, are unable to save and accumulate, and are unable to invest in assets to increase their scale of household economic production. They remain in poverty, stuck in what is often termed a poverty trap (Carter and Barrett 2006).

Agricultural productivity, central to smallholder farmers' welfare, is often held back by inadequate use of modern inputs, improved technologies, and appropriate farming practices. Among these, insufficient plant nutrients in the farming system can be a particularly constraining factor. Inorganic fertilizer is a technology that can be used at all scales of agricultural production—from small vegetable plots to large plantations—to enhance productivity. As such, fertilizer is seen as one of a handful of agricultural technologies that have immense potential to enable poor smallholders to increase income, accumulate assets, and set themselves economically on a pathway out of poverty. However, poor farmers face high prices for fertilizer as well as important financial constraints on purchasing those fertilizers; they are unable to save sufficient cash from one cropping season to the next and unable to access credit to make up for the challenge of saving. Over the past 50 years, overcoming these constraints on access by smallholders to fertilizer has received considerable attention by policy researchers and governments through a range of interventions.

The study reported on here is in line with these efforts: Our focus is on identifying which elements of the policies of the government of Mozambique on fertilizer importation and marketing increase the farmgate cost that smallholder farmers pay for fertilizer and thereby inhibit the profitable use of the input. The policies of interest include any duties, taxes, fees, or other charges that are levied on the fertilizer importation and marketing chain actors, costs that they will then pass on to the end user—the smallholder farmer. However, in addition to these direct additional costs, this study considers where government has not sufficiently invested in public goods to facilitate farmers' access to fertilizer. These inadequate or missing public goods might include insufficient and costly transportation infrastructure; poor-quality or missing information related to fertilizer—whether in fertilizer markets or for farmers seeking to maximize the efficiency with which they use the costly input on crops on their farm in order to derive maximum profits; or deficient institutions involved in promoting fertilizer use or regulating fertilizer trade.

The economics of fertilizer use by many Mozambican smallholder farmers is challenging. In 2010, the total amount of fertilizer used in the country was estimated at 51,400 metric tons (Zandemela 2011). However, 90 percent of this fertilizer was applied to tobacco and sugarcane. The TIA (*Trabalho de Inquérito Agrícola*) surveys of smallholder farmers between 2005 and 2008 estimated that only between 4 and 5 percent use any inorganic fertilizer (MINAG/DE 2005–08). This rather low prevalence of fertilizer use by smallholders is evidence that farmers find it difficult to access the correct inorganic fertilizers for their particular crops at a price that will allow them to obtain sufficient and reliable returns from their investment in the input. There are several reasons for this difficulty:

- The input is costly, being a bulky commodity produced overseas and shipped inland from Mozambique's ports or, more commonly, imported into South Africa from overseas sources and then re-exported to the Mozambique market. Most of these trans-shipments of fertilizer are undertaken by expensive road transportation.
- Information for farmers as to how they can make most efficient and profitable use of fertilizer is limited. What limited understanding there is of yield response patterns to the application of

inorganic fertilizer for the major crops grown in Mozambique is not communicated in a manner that can be easily understood by farmers or by local agricultural extension staff.

- Inadequate or costly credit markets and significant household cash constraints present added barriers to fertilizer use by smallholder farmers. The deficiencies in Mozambican credit markets also make it difficult for fertilizer suppliers and traders to efficiently supply fertilizer at low cost.
- On the crop output side, there are substantial risks to fertilizer use. Farmers may not obtain the returns in crop yields or revenues from crop sales necessary to pay for the fertilizer used, for two reasons:
  - Rainfed, low-input agriculture is inherently risky. Although the important cropping areas of Mozambique, particularly in the central provinces, have high potential productivity, variability in seasonal rainfall is an added source of risk in the use of fertilizer.
  - Output markets are volatile. For staple foods in Mozambique, cycles of crop surpluses and deficits commonly follow crop price booms and busts, respectively. Uncertain crop prices make it difficult for farmers using fertilizer to be confident that they will obtain a sufficient return from the sale of the additional harvest that they obtain from the use of fertilizer to pay for the input. Many of the staple food crops grown in Mozambique are not extensively traded regionally. As a consequence, local crop production conditions affecting supply principally determine the prices that farmers receive for these less widely traded crops.
- Finally, while some rural areas of Mozambique are densely populated, the country as a whole still has a considerable amount of uncultivated arable land, even if it may not be of high production potential. About 60 percent of the total land area is considered agricultural, that is, under seasonal or permanent crops or under permanent pasture. However, of this agricultural land, less than 10 percent is under seasonal crops (World Bank 2011). It generally will be less costly for farmers in Mozambique to open new land to cultivation to produce more crops than to invest in yield-enhancing technologies, such as fertilizer, on existing land. In 2002, 85 percent of heads of farming households reported that they could obtain more agricultural land in their communities if needed (Walker et al. 2004). In those areas of Mozambique—particularly in the high-potential zones in Manica, Nampula, and Zambezia provinces and the Angonia region of Tete province—where uncultivated arable land may not be available to bring into production, due to the integration of crop markets across Mozambique, the output prices for crops that are traded in local markets in these high-potential areas nonetheless will be determined in part by the lower costs of production in the land-surplus areas of the country.[1] The resulting lower output prices for staple food crops render profitable use of fertilizer on such crops by all smallholders in Mozambique more difficult to achieve.

Relative to its neighbors, Malawi and Tanzania, Mozambique does not have a long history of its government promoting the adoption of inorganic fertilizer by smallholder farmers. While the Mozambican ports of Beira and Nacala handle large quantities of fertilizer annually, virtually all of it is shipped to Zambia, Zimbabwe, and Malawi. Most fertilizer used in Mozambique is obtained at higher cost from sources in South Africa. However, in the last several years, more attention has been paid to increasing the use of inorganic fertilizers in the country:

- Signaling the government's interest in seeing greater use of inorganic fertilizers for sustainable soil fertility management in the country, increased production and use of inorganic fertilizer features in the Strategic Plan for Agricultural Development for 2010–19 (*Plano Estratégico de Desenvolvimento do Sector Agrário* or PEDSA). However, the

[1] This relationship will not apply to internationally traded cash crops like tobacco, whose prices are determined in the international market, not in Mozambican or regional markets.

specifics of how these outcomes will be achieved will be considered in the investment plan for PEDSA that is to be formulated in 2012.

- Early in 2011, a draft fertilizer strategy and draft regulations for the fertilizer sector in Mozambique were prepared by the Ministry of Agriculture (Zandemela 2011). These drafts are under review.
- A private fertilizer blending plant, the Mozambique Fertilizer Company, was established in Manica province in 2006 to serve both the domestic market and neighboring countries. Moreover, the government is seeking foreign investment in nitrogen fertilizer production to make use, primarily, of the large natural gas reserves of the country. Mozambique also has some high-quality phosphate deposits that could be exploited (van Straaten 2002).
- The European Union, working with Mozambique's Ministry of Agriculture, the Food and Agriculture Organization of the United Nations, and the International Soil Fertility and Agricultural Development Centre, implemented a voucher-based fertilizer and seed subsidy program with a target of 25,000 smallholder farmers in 5 provinces of central and northern Mozambique in the 2010 and 2011 seasons to increase use of improved seed and fertilizer in food crop production.

Our study is situated within the challenging economic context of fertilizer use by Mozambican smallholder farmers, where very few have economic or physical access to the input, and also within the context of the government's growing interest in and its increasing interventions aimed at increasing domestic fertilizer supply and use. Our focus is on private-sector procurement of fertilizer for wholesale or retail trade, and on how smallholder farmers then access the fertilizer offered by traders.

Problem Statement, Design, and Organization of Study

The policies of the government of Mozambique on fertilizer importation and marketing, including any subsidies offered along the supply chain, can either promote or inhibit the profitable use of fertilizer by smallholder farmers. A close assessment should be made of the social value of any policies shown to increase the farmgate price for fertilizer. This paper presents the results of a broad study of fertilizer supply to smallholder farmers in Mozambique to assess whether the taxes (explicit or implicit) that are applied at various points along the fertilizer importation and marketing chains, or the absence or inadequacy of key public goods and services, inhibits the efficiency with which those chains operate and reduces the access that smallholder farmers have to inorganic fertilizer. The evidence offered by this study is intended to support efforts by the Mozambican government to streamline its engagement in fertilizer importation and marketing chains in order to improve the profitability of fertilizer use by smallholder farmers.

The overall objective of the study is to investigate supply-side constraints on fertilizer use by smallholder famers in Mozambique in which the government is implicated. However, the study meets this objective indirectly by examining how fertilizer is supplied to smallholder farmers and how they do or do not make use of it. So, while the objective is to determine what policy changes might reduce fertilizer costs for farmers, these policy changes are identified by studying how the input is supplied. The study identifies inefficiencies in supply-related activities, deficiencies in information, and design flaws in regulations on fertilizer supply.

The principal data collection activities for this study were as follows:

- First, a thorough review of the (unfortunately quite sparse) literature on fertilizer supply, demand, and use in Mozambique was undertaken.
- Next, a dozen interviews were conducted with key participants in fertilizer importation and marketing in Mozambique, primarily in Maputo.

- Finally, two surveys were conducted in each of two farming areas of Mozambique where more fertilizer is used by smallholders than is the norm for the country as a whole—Manica district in Manica province and Ribaué district in Nampula province. Maize and vegetables are the principal crops receiving fertilizer in these study areas.
  - Fertilizer traders based in market centers serving the study areas were interviewed using a questionnaire with about 210 questions. Both large- and small-scale traders were involved, 13 in total.
  - A questionnaire of about 230 questions was administered to a sample of 160 smallholder farmers in the farming areas of the study, focusing on their cropping practices and, for fertilizer users, how they acquired and made use of this input.

The presentation in this paper draws upon these data sources in a somewhat sequential fashion. The following section provides an overview of fertilizer use in Mozambique drawing from the literature review, interviews, and available data. The next section uses information collected through the interviews of key participants in the fertilizer importation, distribution, and marketing chain to describe how fertilizer is brought into the country and made available to farmers. The results from the trader survey are then discussed in some detail, followed by a similar discussion of the results of the farmer survey. The final section reviews key policy issues emerging from the study.

A final remark on the scope of this study: Most fertilizer used in Mozambique is used by large-scale agricultural plantations or through the contract farming systems that some of these large-scale agricultural firms manage—tobacco and sugarcane, most notably. These firms generally import their fertilizer stocks directly or through tenders let to fertilizer importers and do not participate greatly in the fertilizer distribution and marketing chains serving smallholder farmers. However, this study does not consider this important component of fertilizer use in Mozambique, focusing rather on the supply of fertilizer to smallholder farmers.

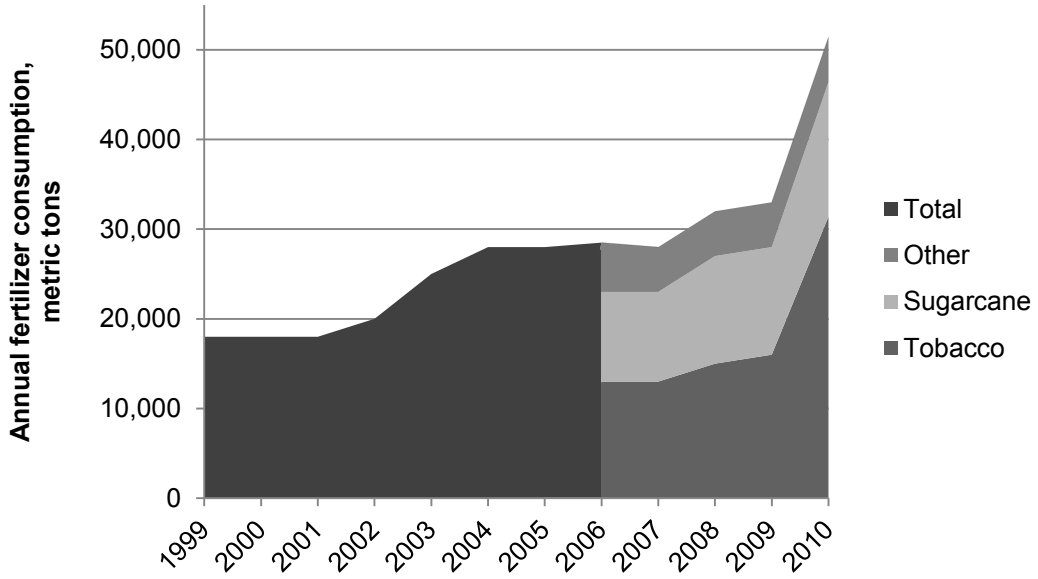
2. OVERVIEW OF FERTILIZER SUPPLY AND USE IN MOZAMBIQUE

In this section of the paper, we review the amount of fertilizer consumed annually in Mozambique and consider the costs that farmers face in obtaining fertilizer, based on the buildup of costs in delivering fertilizer to the up-country fertilizer retailers from international suppliers.

Fertilizer Quantities

Currently all of the inorganic fertilizer used in the country is imported. Estimates of annual total fertilizer consumption in Mozambique between 1999 and 2010 are graphed in Figure 2.1. From 2006 on, the figure disaggregates consumption by major crop, showing the dominance of tobacco and sugarcane in the national demand for inorganic fertilizer. There has been a rising trend in total fertilizer consumption. However, there is no evidence of any increase in use in the smallholder farming sector.[2] Increased use of fertilizer on tobacco is the principal driver of increased consumption levels.

Figure 2.1—Total annual fertilizer consumption in Mozambique, 1999–2010



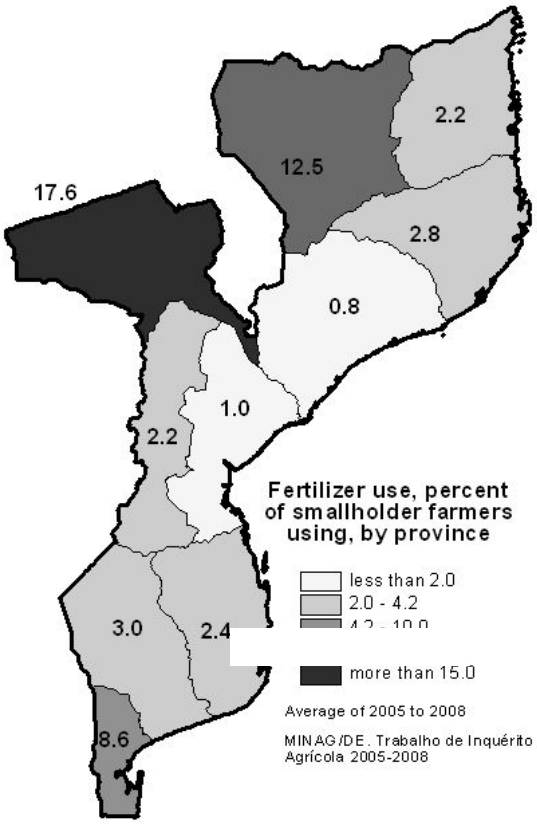
Source: Zandemela 2011.

Most of the fertilizers consumed are nitrogen fertilizers (urea, principally) and NPK (nitrogen, phosphorous, and potassium) blends. The proportions of fertilizer imports by weight during 2010 for Agrifocus, the largest importer of fertilizer for the domestic market, were 47 percent nitrogen fertilizers, 44 percent blends, 8 percent phosphate fertilizers, and only about 1 percent potassium fertilizers (Mr. A.C.A. de Vasconcelos Ribeiro, personal communication 2011). These proportions likely correspond to the proportions in the overall national mix of fertilizers consumed in Mozambique.

[2] The subsidized input voucher program of 2010 and 2011 in Mozambique was relatively small, targeting 25,000 farmers with 2 bags of fertilizer each. This involved a total of 2,500 metric tons of fertilizer each year of the program, which, though significant in the context of smallholder fertilizer use in Mozambique, is much less than the amounts involved in subsidy programs operating at the same time in Malawi and Tanzania—the Tanzania voucher program at its height, for example, is designed to involve the distribution of 200,000 metric tons annually.

In terms of application rates, the reported 51,400 metric tons of fertilizer used in 2010 in Mozambique correspond to national application levels of about 1.1 kg/ha on agricultural land and 11.4 kg/ha on arable land.[3] The annual average of smallholder inorganic fertilizer use reported in the 2005 to 2008 TIA (*Trabalho de Inquérito Agrícola*) agricultural surveys for Mozambique (MINAG/DE 2005–08) was only 4.2 percent (see Figure 2.2). While higher levels of use are seen in Tete province, where smallholder contract farming of tobacco is relatively common, lower levels than the national average are found in some of the central provinces with higher agricultural potential, such as Zambezia and Nampula. In spite of increasing technical and political interest in the uptake of inorganic fertilizer by Mozambican farmers, fertilizer use by smallholder farmers in Mozambique remains more the exception than the rule.

Figure 2.2—Smallholder use of fertilizer by province, 2005–08



Source: MINAG/DE 2005–08.

Components of the Price for Fertilizer in Mozambique

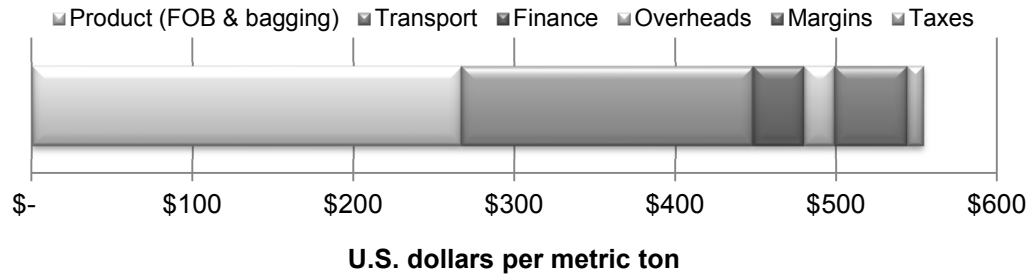
Since fertilizer is a commodity primarily imported from international suppliers, global commodity and transportation prices are the principal determinants of its price to users in Mozambique. A 2006 study of fertilizer supply in Mozambique estimated the average delivered cost of fertilizer to several up-country regional trading centers to be US$554[4] per metric ton (Figure 2.3) (Chemonics and IFDC 2007). Of this price, the free-on-board (FOB) commodity price bagged at the source in South Africa accounted for 48 percent, while transportation from the shipping port to Beira and on to the trading centers accounted for

[3] Agricultural land is defined as land that is arable, under permanent crops, or under permanent pasture. Arable land is land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow (World Bank 2011).

[4] All dollar amounts are in U.S. dollars.

33 percent. The margins obtained by the importers and traders were an estimated 8.1 percent of the cost, somewhat higher than what importers in Uganda and Tanzania obtain, for example. The Chemonics and IFDC (2007) study notes that fertilizer supply is notably inefficient, with high costs due to the use of an expensive source in South Africa, whose fertilizer industry does not enjoy the economies of scale of the major international producers; the small volumes shipped; and the high transportation costs incurred through use of both small vessels engaged in coastal shipping and trucks traveling over poor road networks. Mozambique's delivered fertilizer costs in 2006 exceeded those of its landlocked neighbor Malawi by about $60 per metric ton. In 2011, the average price of urea in Malawi was 15 percent lower than the average price in Mozambique (AMITSA 2012).

Figure 2.3—Components of average price of fertilizer delivered to several up-country centers in Mozambique, 2006



Source: Chemonics and IFDC 2007.

Globally, fertilizer prices have been quite volatile over the period 2007–11 and significantly higher than the 2006 prices shown in Figure 2.3. We compared the average international export price for the period August 2010 to July 2011 for urea (ex Arabian Gulf) of $381 per metric ton with local Mozambique retail prices (average of prices from retailers in several market centers) for urea of $827. Although the export and local Mozambique retail prices are significantly higher than those seen in 2006, the proportion of the Mozambique retail price made up by the international export cost—46 percent—in 2010–11 is similar to the 48 percent seen in 2006.

One of the motivations for our study of fertilizer supply in Mozambique was to assess the taxes levied on fertilizer importers and traders. It is important to note the low level of direct taxes in the buildup of the cost of fertilizer in Mozambique shown in Figure 2.3: Direct taxes and levies were estimated in the Chemonics and IFDC (2007) study to account for only 1.8 percent of the delivered cost of fertilizer up-country. However, it is notable that this level of taxation is 3 times that of Tanzania (0.5 percent) and 40 percent higher than that of Uganda (1.3 percent).

Mozambique is a price taker for fertilizer from international markets. Nonetheless, fertilizer importers could obtain their product from a cheaper producer than South Africa—competitive sourcing would lead to price reductions. The greatest scope for reducing costs is related to transportation. This would include improving port operations in Beira and Nacala, where virtually all fertilizer imported to Mozambique is off-loaded; using larger ships to bring in the fertilizer; and improving the domestic transportation infrastructure to reduce the costs of distribution after the fertilizer comes into the port. Economies of scale in shipping could be obtained through Mozambican importers' coordinating their shipments with those of other importers in the region, such as those in Malawi, Zambia, or Zimbabwe, so that larger shipments at lower unit cost could be off-loaded in the Mozambican ports. Smaller gains could be achieved through improving access to financing by importers and removing any indirect taxes and fees levied on fertilizer importers and dealers that work against the objectives of improving agricultural productivity and the profitability of farming for Mozambican smallholders.

3. SUPPLY: FERTILIZER IMPORTATION AND MARKETING IN MOZAMBIQUE

In this section, two elements of fertilizer supply in Mozambique are considered. The first is legislation that is being considered to govern importation and trade of inorganic fertilizers in the country. The second is fertilizer marketing—the importation, wholesaling, and retailing of fertilizer. This information is principally derived from a series of qualitative interviews conducted with fertilizer importers and others who oversee or are affected by their operations. Subsequently, more detail on fertilizer retailers is provided in the following section, which presents the results of the fertilizer trader survey conducted for this study.

Legislation

As one element of efforts to increase fertilizer utilization in Mozambique, attention is now being paid to establishing a regulatory framework for the importation, distribution, marketing, storage, and use of the input. The country currently has no specific laws or regulations governing how fertilizer should be marketed and handled. Early in 2011, a draft fertilizer strategy and draft regulations for the fertilizer sector in Mozambique were prepared by the Ministry of Agriculture (Zandemela 2011). The document is still in draft form but has been widely circulated for comment. The key elements of the proposed regulations are summarized in Box 3.1.

One of the basic functions of the state with regard to the economy is the regulation of markets to ensure that activities in those markets contribute to aggregate social welfare, however that might be defined within a society. Ensuring that the objective quality of products sold in the market meets the purported quality of the products as advertised by sellers—the control of fraudulent practices by sellers of goods—is commonly the responsibility of state agencies. Inorganic fertilizers have a long history of regulation globally. In general, these regulations have been characterized by a truth-in-labeling approach, whereby farmers must have the information that they require to determine how a particular fertilizer might contribute to increasing the productivity of the soil that they farm.

However, regulations add to the cost of products offered for sale in the market. Producers and traders need to demonstrate that their products meet the standards of quality expected of those products by the regulators. Doing so adds to the cost of the product. However, at a broader level it is expected that the benefits to the consumer and to the public as a whole will outweigh the costs of implementing the regulations. Fertilizer regulations are no different.

"Enforcement of regulations adds further to the costs of fertilizers.… These costs, inherent in controlling fertilizer composition at the retail level, are compensated by the inherent benefits. Without basic regulations, the fertilizer trade would become chaotic. As with other regulations, care should be taken to limit them to the essentials" (UNIDO and IFDC 1998, 5).

In this section we briefly examine this trade-off between the costs of proposed regulations on inorganic fertilizer in Mozambique and the benefits that those regulations provide for the farmer and the general public, for public health, and for the environment, among others. Several issues arise.

Box 3.1—Proposed regulations on fertilizers in Mozambique, draft of July 2011: Key elements

- Proposed regulations are to encourage and promote the use of fertilizers in order to achieve agricultural development without harming public health, the environment, or the soils of the country. The objective of the proposed law is to create a regulatory system that assures the quality of fertilizers used in Mozambique while safeguarding public, animal, and environmental health through appropriate engagement of stakeholders in fertilizer-using sectors.
  - Fertilizer is defined as any substance that contains one or more nutrients that, if applied to the soil or the plant, is designed to promote the growth of the plant. Fertilizers can be organic or inorganic, natural or synthetic.
- The proposed regulations apply to all engaged in the manufacturing, importation, distribution, transportation, and use of fertilizers.
- The director of the *Direcção Nacional de Serviços Agrários* (DNSA, or National Directorate of Agrarian Services) of the Ministry of Agriculture will be responsible for implementing the regulations at national level. The *Direcção Provincial da Agricultura* (DPA, or Provincial Directorate of Agriculture) will be responsible at the provincial level.
  - A fertilizer regulatory committee will be established to guide the director on strategic issues related to fertilizer.
    - Membership will be primarily made up of public-sector agencies—primarily from the agriculture sector but also from agencies concerned with national standards, health, mineral resources, and the environment—as well as a representative from both the national smallholder farmers' union and the private sector.
- Inspection
  - DNSA or its authorized agent may take samples, inspect, analyze, and test commercial fertilizers whenever it deems necessary to determine whether such fertilizers comply with the provisions of the regulations.
  - DNSA-authorized inspectors may enter any public or private establishment during normal business hours to inspect commercial fertilizers or any related documentation.
- Registration
  - Traders in fertilizer need to be licensed under the applicable commercial law and also be registered as traders in fertilizers with DNSA.
  - Fertilizer registration
    - Any fertilizer produced, distributed, imported, or used in Mozambique must be registered.
    - Only licensed fertilizer traders may submit fertilizer for registration.
    - If approved, the registration is assigned to the applicant, not to the fertilizer. This means that another firm seeking to trade in the same fertilizer will need to apply for its own registration for the same product.
    - Registration is dependent upon efficacy and safety of product for humans, animals, and the environment.
  - Producers of fertilizer must operate within the established regulatory framework and must be registered.
  - Proposed annual registration fees range from MT 1,000 to 3,000 (Mozambican meticais, about US$30 to US$100), depending on type of registration.
- Importation of fertilizer requires prior authorization by the registrar.
  - Only registered and licensed fertilizer traders can import fertilizer.
  - Permits to import a fertilizer can only be given to traders who hold a registration for the fertilizer to be imported.
  - Imported fertilizer must be made available for testing to determine if it meets stipulated quality standards.
- Marketing
  - Fertilizer traders must submit quarterly reports to the registrar on the stocks on hand and quantities of fertilizer traded through each of their establishments.
- Export of fertilizer or transit of fertilizer through Mozambique requires prior authorization from the registrar.
- All fertilizer packaged and distributed in Mozambique must be labeled with an approved label in Portuguese.
  - Regulations establish the margin of error allowed between the chemical content stated on label and the actual. If the difference exceeds this margin, penalties will be imposed on the fertilizer trader.
- Importation, sale, and use of outdated fertilizers are prohibited.
  - However, if a trader has such fertilizer, the product can be submitted to the registrar for analysis. If the quality remains within regulations, the validity period can be extended.
  - Expired fertilizer for which the validity period cannot be extended must be destroyed, but only under the authorization of the registrar and in a manner that safeguards the environment.

Source: Summarized from Zandemela 2011.

Scant Evidence of Adulterated Fertilizer

There is limited nationally representative, objective evidence on the degree to which adulterated fertilizers are sold to smallholders in Mozambique. Fertilizer is bulky, with a relatively low value-to-weight ratio, and therefore not a first-choice product for agricultural input traders to adulterate—adulteration of pesticides and seeds would, on the face of it, be more lucrative for traders choosing to engage in fraudulent practices. Yet anecdotal reports of a high level of adulterated fertilizer were cited by some respondents in parallel studies in both Uganda and Tanzania to be the principal rationale for the design of the enhanced regulatory regimes on fertilizer that are being proposed for those two study countries (Benson, Kirama, and Selejio 2011; Benson et al. 2011). However, the approach that Mozambique is taking with its proposed legislation seems pragmatic. It appears to be grounded in a conceptual expectation that such laws are needed so that the state will have instruments to regulate fertilizer quality in the marketplace when needed. This motivation has some merit if the regulations are designed in a way that is not burdensome on supply-chain actors for minor quality imperfections but that makes available more stringent regulatory procedures to be called into use in the case of egregious quality problems with fertilizer in the future. To some degree, the proposed regulations for Mozambique are based on this expectation—having the tools in place to address problems if and when they arise.

In contrast, however, for the regulations to be implemented in a proactive manner would seem to be against the interests of fertilizer traders and farmers. Doing so will raise the cost of fertilizer either though regulation-related fees, including those for the administrative overhead of the *Direcção Nacional de Serviços Agrários* (DNSA, or National Directorate of Agrarian Services), the organization responsible for implementing the regulations nationally; through the costs for traders to comply with the regulations; or by opening the door to corrupt practices as traders seek alternatives to following the regulations. These costs ultimately will come out of the pockets of farmers while also resulting in some reduction in the number of farmers using fertilizer in Mozambique.

Moreover, a vibrant and competitive agricultural input market in Mozambique will be somewhat self-regulating with regard to the quality of products marketed. Firms that sell adulterated or otherwise poorly performing fertilizer are unlikely to retain their customer base in subsequent farming seasons. If the proposed regulations on fertilizer are imposed with a heavy hand, they will restrict competition by placing relatively high hurdles for firms to enter or remain in the fertilizer business in Mozambique. With fewer traders and, consequently, less competition, in fact the chance of adulterated product's being sold is likely to increase.

High-Analysis Inorganic Fertilizers as Standard Products

Total global production of fertilizers in 2010 was estimated at around 210 million metric tons of nutrients (N, P_2O_5, and K_2O) (Heffer and Prud'homme 2011). As standard commodities that are traded globally, high-analysis fertilizers have well-known properties and well-known risks associated with their use. As such, we must question whether close controls are necessary on their importation and use in Mozambique. These fertilizers have been safely used by millions of farmers over many decades, and their nutrient quality and content can be expected to lie within a relatively narrow band. The regulations proposed for Mozambique requiring firm-specific registration of individual high-analysis fertilizer products from all international suppliers, and import permits to then bring in the products, will contribute to limiting access to the national input markets for international suppliers. These regulatory hurdles ultimately will result in some limitation on the supply of inorganic fertilizer to smallholder farmers and effectively raise the price that they must pay. So again, the regulations on fertilizer need to be prudent and appropriate for the purpose in this regard.

National Standards Agency

The proposed fertilizer regulations for Mozambique give very little role for the *Instituto Nacional de Normalização e Qualidade* (INNQ, or National Institute of Standards and Quality). This statutory agency is responsible for enforcing product standards for public health and safety by guarding against trade in dangerous, counterfeit, and substandard products. It can readily establish standards for the globally produced high-analysis fertilizers, covering the physical and chemical characteristics, packaging, and labeling expected. Inspectors and laboratory analysts from the INNQ can be expected to be able technically to readily assess the quality of these fertilizers in a manner at least equal to that of the DNSA and the provincial directorates of agriculture. Placing the quality assurance of high-analysis fertilizers within the responsibility of the standards agency, rather than with the Ministry of Agriculture agencies, also would permit a much broader set of distribution and marketing channels to be used for fertilizer.

Significant Costs of Following Regulations

There are potentially significant indirect costs associated with following the regulations for the importation and marketing of fertilizer. While the regular registration fees for fertilizer dealers, products, and premises may be relatively low and import permits may be provided by the DNSA at no or minimal direct cost, there are considerable indirect costs associated with following the regulations for the importation and sale of fertilizer. The importer or trader must be registered as a fertilizer dealer. Registration requires documented training on the use of fertilizer, followed by application for registration and payment of annual license fees. The importer also must be assured that the fertilizers that he or she will be importing are registered for use in the country. All of these regulations impose costs in time and money for the fertilizer importer or trader—costs that he or she will recover by selling the fertilizer at a price sufficient to cover the cost of the fertilizer plus all costs related to importing the product, including these regulatory costs.

To summarize this discussion of the proposed legislation, Mozambique is developing a system of control on the importation, marketing, and use of inorganic fertilizers. The benefits in terms of consumer protection, public and environmental health, and security from imposing these sorts of regulatory costs on the importation and sale of a standardized global product like high-analysis inorganic fertilizers clearly are quite small. Therefore the government of Mozambique should consider what it might do to ensure that the proposed regulations are as streamlined and light as possible, so that farmers derive the benefits of lower prices for the fertilizer that they obtain—benefits that likely exceed the value of any benefits from close regulation of fertilizer importation and marketing.

Marketing of Fertilizer in Mozambique

The fertilizer marketing system in Mozambique is liberalized but not very well developed. As was highlighted above, most of the fertilizer brought into the country is used for tobacco and sugarcane production, with less than 10 percent going to other crops. The fertilizer used by smallholders, except for those engaged in contract farming of tobacco, comes from this small portion of fertilizer imports.
The principal source of fertilizer for the Mozambique market is South Africa. The main fertilizers obtained are urea and various NPK (nitrogen, phosphorous, and potassium) blends that are used primarily on tobacco. The main basal dressing fertilizer is the NPK blend 12:24:12. These fertilizers are generally brought into Mozambique duty free under the trade rules of the Southern Africa Development Community (SADC). However, several respondents noted that urea imports from South Africa, since South Africa does not produce the product but imports it from elsewhere, outside of SADC, attract a 2.5 percent levy. No value-added tax or other fees are charged on fertilizer imports. In general, direct government intervention in fertilizer importation and marketing does not seem to unduly constrain the operations of the firms involved.

Agrifocus is the largest firm engaged in fertilizer marketing in Mozambique and is the principal commercial importer of fertilizer. While some of the sugar and tobacco firms will import their own fertilizer stocks, Agrifocus is their principal supplier. Agrifocus also provides fertilizer to other smaller fertilizer dealers. These smaller firms include Tekap, Procampo, and Agroquimicos. In Chimoio, Manica province, Savon is the local agent for Omnia fertilizers from South Africa, obtaining its stock from South Africa through Zimbabwe.

Two fertilizer blending plants have been established in Mozambique in the past five to six years. Also in the Chimoio area is the Mozambique Fertilizer Company, a fertilizer blender serving both the Mozambique market—particularly for sugar and tobacco—and those of neighboring countries, owned by the regional agricultural inputs corporation Meridian International. It is competing directly with Agrifocus in supplying fertilizer to the tobacco sector in particular. The Export Trading Group, a regional agribusiness headquartered in Dar es Salaam, also recently invested in a fertilizer blending plant in Beira. Both firms obtain high-analysis fertilizers from South Africa or other international producers and blend the fertilizer into products demanded by tobacco and sugar producers in Mozambique or by other customers in neighboring countries.

To date, none of these fertilizer firms have established extensive networks of retail dealers across the country. The demand for fertilizers at smallholder level at present is too small to merit the creation of such networks. Most firms will establish regional depots in farming areas where fertilizer is used, but will not be found in the smaller agricultural trading centers. However, these depots will serve wholesale and retail functions equally, with even small farmers obtaining fertilizer there.

At retail level in the districts, access to fertilizers is still thin. While none of the importers or larger wholesalers has established trading networks in rural districts, in those areas of the country where fertilizer is used, fertilizer dealers are present, even if not in great numbers. However, it is difficult to get a good understanding of the vibrancy of the retail agricultural inputs sector in the country. The number of retailers of agricultural inputs in Mozambique is not known exactly, although IFDC estimates there are about 800 nationally (Mr. E. Schmidt, personal communication, 2012). We were not able in the course of this study to obtain data from a census of agricultural input dealers or other comprehensive information on the numbers of dealers across the country. Therefore the relative scale of operations and the diversity of inputs that these retailers provide are unclear. Moreover, the distribution of retailers across the country is patchy, with several present in districts with higher agricultural potential, where there are likely to be clear positive returns on the use of commercial agricultural inputs, but with most districts having none.

As discussed in the next section, we were able to conduct a survey of just over a dozen dealers in Manica and Ribaué districts, but this number was considerably less than what we had intended for the design of our study, reflecting the low numbers of dealers even in areas where fertilizer is used more commonly than elsewhere in Mozambique. With the assistance of IFDC, an agro-input dealers' association has been established in the past several years, the *Associação Moçambicana de Provedores de Insumos Agro-pecuários*. However, it is not very well known and the information we obtained on its value was mixed.

The commercial sustainability of these input dealers is not assured. There is limited knowledge on the economics of fertilizer use in Mozambique. While good yield responses to nitrogen and, somewhat more erratically, to phosphate application may be seen in maize, tobacco, sugar, and vegetables, very little economic research has been done to explore whether fertilizer use under smallholder crop management and marketing conditions makes economic sense for farmers. Only very generalized fertilizer application recommendations have been formulated for Mozambique (see Zandemela 2011; Geurts and van den Berg 1998). However, the economics underlying these recommendations are uncertain, calling into question how they should be used under different price ratios between fertilizer and the crops being fertilized.

If smallholders are assured of profitable use of fertilizer on their crops, then fertilizer retailers should have an assured market for their product. However, one should not assume that fertilizer can be profitably used by smallholders in Mozambique, particularly on food crops for which the prices are determined by variable local supply-and-demand conditions. The foundation for a strong agricultural input market in Mozambique, as elsewhere, is in strong output markets for the fertilized crops. However, the agricultural output markets in Mozambique for smallholder crops, particularly food crops, are not yet sufficiently developed to sustain commercial fertilizer suppliers throughout the country. The variability in output prices for food crops simply due to variability in rainfed production conditions or to bottlenecks in food crop value chains makes it likely that fertilizer use on food crops such as maize is insufficiently profitable in most farming areas to induce farmers to use fertilizer on a wholly commercial basis. Amid this uncertainty about the economic logic of Mozambican smallholder farmers' using commercial inputs such as fertilizer on their food crops, the sustainability of the growing network of rural agricultural input traders in Mozambique to serve smallholder farmers is similarly uncertain. The commercial agricultural sector of tobacco and sugarcane production is likely to remain the foundation for fertilizer importation and marketing activities in Mozambique for some time to come.

4. SURVEY OF TRADERS SUPPLYING FERTILIZERS

One of the principal ways in which information on fertilizer marketing in Mozambique was obtained for this study was through semistructured interviews with key individuals involved in fertilizer trade, in both private and public sectors. However, a more formal survey of fertilizer traders was also undertaken to obtain a broader understanding of their operations. In this section of the paper, we provide some findings from this survey.[5]

Survey Design

Following consultations with key informants on fertilizer marketing in Mozambique, two areas of the country with greater prevalence than elsewhere of fertilizer use by smallholder farmers on their crop plots were identified (see Figure 4.1):

1. Messica administrative post in Manica district in Manica province
2. Ribaué administrative post in Ribaué district in Nampula province

In both districts a voucher-based fertilizer subsidy program had been implemented in 2010, targeting 1,200 farmers in Manica district and 5,000 farmers in Ribaué. These two study areas were used as the strata for both a small set of trader interviews and the larger farmer survey for this study.

Figure 4.1—Study districts for trader and farmer surveys in Mozambique

Source: Authors' survey.

[5] Samuel Mugarura managed the entry and cleaning of both the farmer and trader survey data. Patrick Lubega and Stephen Bayite-Kasule of the IFPRI-Kampala office did additional cleaning and conducted an initial analysis of these two datasets. We are grateful for this assistance.

The survey protocol was for 15 to 20 traders in each study area to be randomly selected from a list of agrodealers who market fertilizer. However, only 13 were interviewed in total, simply because the number of agrodealers in each area is small, in spite of the greater prevalence of commercial agro-input use by smallholders in these areas than elsewhere in Mozambique.[6] These traders were interviewed in commercial centers in or near the study areas where farmers in the area obtained their commercial inputs. These commercial centers included Chimoio (plus a single trader in Manica town) in Manica province, and Nampula town and Namigonha trading center in Nampula province. In Chimoio, all traders selling fertilizer were interviewed.

A standardized questionnaire, only slightly modified from that used in parallel studies in Tanzania and Uganda, was used to interview the selected traders. This questionnaire was organized into modules on the personal characteristics of the trader, business characteristics, fertilizer inventory, fertilizer supply and supply costs, taxes and fees related to the trader's fertilizer business, fertilizer sales, and fertilizer business issues. The trader survey was conducted in March and April 2011 concurrently with the farmer survey.

In the presentation of results in the tables below, the sample is disaggregated by scale of operation based on the size of the largest order of fertilizer that the trader reported obtaining from a supplier in 2010. As shown in Table 4.1, a trader reporting a largest order of fewer than 1,000 50-kg bags was classified as small-scale. While some traders sold only a handful of bags in 2010, several of the traders are large local wholesalers, selling lots of up to several hundred bags at a time.

Table 4.1—Fertilizer trader scale of operations: Size of largest order from supplier in 2010

	Size of largest order in 2010, 50-kg bags of fertilizer				Small-scale traders (largest order < 1,000 bags), %	
Study area	Mean	Median	Min	Max		*n*
Manica	51,242	1,500	200	300,000	50.0	6
Ribaué	508	600	15	1,120	85.7	7
All	23,923	600	15	300,000	69.2	13

Source: Authors' survey.

Fertilizer Trader Characteristics

Table 4.2 provides descriptive statistics on the fertilizer traders in the sample for the survey, disaggregated by scale of operation. At 23.1 percent, more of the fertilizer traders are women than might be expected. The level of education attained by the traders is relatively good, with all those in the sample having completed primary school and most having completed secondary school. Large-scale traders generally have longer experience in the fertilizer trade and generally are older than small-scale traders.

Table 4.3 provides descriptive statistics on the characteristics of the fertilizer businesses of the traders in the sample for the survey, disaggregated by scale of operation. While 1 Manica trader reported annual sales in 2010 of 300,000 bags, the median annual quantity of sales of fertilizer by traders in the sample is 360 bags, or 18 metric tons. Just over half of the traders are the sole owners of their businesses. The small traders in the sample generally have only 1 place of business from which they trade. Of the 4 large-scale traders, 3 reported operating out of 3 branches, with the other large-scale trader having only a single location. The start-up capital for most traders came from their own personal savings. Only 1 trader in the sample, a small-scale trader, reported using a commercial loan to finance business start-up.

[6] Given the small sample size and the purposive selection of the strata where the interviewed traders were located based on higher prevalence of fertilizer use in the area, the results from the trader survey should not be treated as representative. Consequently, only unweighted survey results are presented.

Table 4.2—Fertilizer trader characteristics

	Small-scale	Large-scale	All
Age, mean, years	32.7	43.3	35.9
Female, %	22.2	25.0	23.1
Completed primary school, %	100.0	100.0	100.0
Completed secondary school, %	77.8	75.0	76.9
Fertilizer trading experience, mean, years	4.7	7.0	5.4
n	9	4	13

Source: Authors' survey.

Table 4.3—Fertilizer trader business characteristics

	Small-scale	Large-scale	All
Annual quantity of fertilizer sold, mean, 50-kg bags	561	76,412	23,900
median, 50-kg bags	200	2,700	360
Single owner, %	66.7	50.0	61.5
Personal savings as principal source of start-up capital, %	77.8	100.0	84.6
Assets			
More than 1 trading premises, %	11.1	75.0	30.8
Owns computer, %	55.6	100.0	69.2
Owns pickup truck, %	55.6	100.0	69.2
Owns truck of > 3 metric ton capacity, %	44.4	25.0	38.5
Has warehouse or other specialized storage space, %	88.9	100.0	92.3
Capacity of storage space for those with storage, mean, 50-kg bags	14,869	575,625	201,787
median, 50-kg bags	1,750	151,000	2,000
Composition of value of annual sales, %			
Fertilizer	18.1	18.7	18.3
Seeds or other planting materials	29.0	19.7	26.2
Pesticides or other agrochemicals	10.2	21.2	13.6
Farming implements	9.6	20.0	12.8
Veterinary supplies	7.0	11.7	8.5
Agricultural services (not goods)	3.6	7.5	4.8
Nonagricultural items or services	21.4	1.0	15.2

Source: Authors' survey.

Both small- and large-scale businesses trading in fertilizer have additional assets beyond their business premises and storage. More than half of the small-scale traders interviewed have a pickup truck and almost as many have a larger truck for transporting goods. All of the large-scale traders have a pickup, but only 1 had a larger truck. The business of the traders surveyed is specialized in agriculture—few of those in the sample sold many nonagricultural items, with large-scale traders showing the most specialization in agricultural goods. However, most fertilizer traders do not specialize in trading in fertilizer alone. While fertilizer is an important component of their sales on average—as should be expected given that the sample was chosen based on fertilizer trade—seeds, pesticides, and farming implements are also important elements of their business. Only 3 of the 13 traders in the sample reported obtaining more than 30 percent of the value of their total sales from fertilizer alone.

Types and Sources of Fertilizer Sold

Information on the various types of fertilizer and the quantities of those fertilizers that dealers sell is provided in Table 4.4. Very few fertilizer types are available for sale. Urea and the NPK (nitrogen, phosphorous, and potassium) blend 12:24:12 are the most commonly sold. The only other fertilizer stocked by some traders is limestone ammonium nitrate (or LAN, similar to if not the same as what elsewhere is called calcium ammonium nitrate, or CAN). A single trader reported selling the NPK blend 7:14:7. The principal crops on which all these fertilizers are used are maize and vegetables. NPK 12:24:12 is used on maize as a basal dressing applied shortly after crop emergence and urea as a topdressing applied 3 to 6 weeks later, when the maize plants are about knee-high but before they flower. High-analysis potassium fertilizers were not reported sold by any of the traders in the sample, nor did they report selling agricultural lime for soil amendment purposes.

Table 4.4—Fertilizer sales, by type

	Urea (46:0:0)			NPK 12:24:12		
	Small-scale	Large-scale	All	Small-scale	Large-scale	All
Percentage that sell	100.0	100.0	100.0	100.0	100.0	100.0
Annual sales of those who sell, mean, 50-kg bags	299	14,040	4,970	447	25,995	8,308
median, 50-kg bags	160	3,000	2,000	160	1,640	420
Price, MT per 50-kg bag, median	1,275	1,500	1,300	1,750	1,500	1,700
Traders who accepted subsidy vouchers in 2010, percent	33.3	75.0	53.8	33.3	50.0	38.5
Voucher sales in 2010 for those who accepted, mean, 50-kg bags	606	67,183	33,895	627	775	686
Used principally on	Maize, vegetables			Maize, vegetables		
	Limestone ammonium nitrate (LAN) 28:0:0					
Percentage that sell	11.1	25.0	15.4			
Annual sales of those who sell, mean, 50-kg bags	260	200	230			
Price, MT per 50-kg bag, median	--	--	1,750			
Used principally on	Maize, groundnut					

Source: Authors' survey.

Notes: Nutrient analysis of fertilizer is in terms of percentage $N:P_2O_5:K_2O$ by weight.
MT = Mozambican meticais; US$1.00 = MT 30.60 at time of survey in March and April 2011.

The survey included questions on how the dealers obtained their supplies of fertilizer:

- Most of the traders surveyed, 69 percent (6 of the 9 small-scale traders and 3 of the 4 large-scale), use only 1 supplier. The other 4 traders reported using 2 suppliers—all of these traders are based in Nampula province. No trader interviewed used 3 or more suppliers. In Manica, the suppliers were all based in Chimoio (Mozambique Fertilizer Company, most prominently), while in Ribaué, supplies were obtained from Nampula, Chimoio, Maputo, and the district trading center of Iapala (the smallest quantity supplied).
- Small-scale traders are more likely to obtain several small orders from their supplier over a season, rather than 1 or 2 large orders. The mean number of fertilizer orders in 2010 that small-scale traders reported obtaining from their principal supplier was 3.8. However, for large-scale traders, the mean number of orders was 1.5.

- Generally, the traders are responsible for transporting the fertilizer ordered from the supplier to their business premises. Overall, only 15.4 percent of traders reported that their supplier delivered the fertilizer stocks—all in Nampula. Of the small-scale traders who arranged their own transportation for their fertilizer stocks, 38 percent used public transportation (all in Nampula), 38 percent hired transportation, and about a quarter had their own transportation. For large-scale traders who arranged their own transportation, most used their own vehicle.
- Only 2 traders—1 small-scale and 1 large-scale—reported that they were able to obtain fertilizer stocks from their principal supplier on credit.

Traders were asked whether they had experienced any problem with the quality of the fertilizer supplied by the principal supplier. Fertilizer quality seemingly is not a major concern for most traders; only three mentioned any problems. One trader surveyed complained that the fertilizer sometimes burns the crop. The other two complaints concerned poor packaging and being supplied caked urea fertilizer.

Costs for Traders to Acquire Fertilizer

A module of the survey questionnaire asked traders to consider all of the costs they incurred in obtaining an order from their principal supplier of fertilizer. These costs were standardized on the basis of cost per 50-kg bag. While the median order size for small-scale traders was 100 bags and that of large-scale traders was 1,200, the median payment per bag made to the supplier was the same for both categories of traders at MT 900 (Mozambican meticais).

The costs of loading and unloading transport vehicles were reported to be MT 5.00 in Ribaué and MT 9.00 in Manica. The cost of transportation per bag varied by source and destination. The median cost of transportation faced by fertilizer suppliers in Manica was MT 60 per bag, with all obtaining their product in Manica province. The median cost of transportation for Ribaué fertilizer suppliers was MT 50 per bag, representing the cost of transportation from Nampula. However, the median transportation cost for those suppliers who obtained their fertilizer from Chimoio was reported at MT 83 per bag, while the single Ribaué supplier who reported obtaining an order from Maputo paid MT 200 per bag.

Some fees associated with transportation may not be covered by the transporter as part of the overall transportation cost, such as road and bridge tolls. However, only one of the traders surveyed reported paying such fees separately from the costs of transportation. Most stated that they did not face any such charge on the transportation of their orders.

A set of questions addressed all other fees and taxes that a fertilizer trader might bear—import permit fees or taxes, local government taxes, income tax on the business, inspection fees, or trading permit fees. Most of the traders reported not paying such taxes and fees. The exceptions included these:

- One trader reported an annual local government tax payment of MT 3,000.
- Two traders, both small-scale, reported making a single income tax payment in 2010.
- Two traders reported making trading permit license fee payments.

However, the overall impression obtained from the information provided by the interviewed traders is that they are able to operate in a rather informal manner with regard to various taxes, fees, and regulatory oversight.

Sales of Fertilizer

The survey asked about the seasonality of fertilizer sales, which differs between Manica and Ribaué. For Manica, largest sales of fertilizer are made from November to January, corresponding to the start of the rainy season and field crop production. In Ribaué, while November was mentioned by the greatest number of traders as being the month of largest sales, others mentioned months of good sales in the dry season—May and June—when fertilizer is used on vegetables. Lowest sales occur from March to May in Manica and from July to September in Ribaué.

The survey also covered the types of customers that the fertilizer traders served and the amount of fertilizer that each type of customer would generally obtain in a single transaction. The aggregated responses are shown in Table 4.5.

Table 4.5—Breakdown of fertilizer traders' customers

		Small-scale	Large-scale	All
Other traders:	**% all transactions**	3.4	0.0	2.3
	Typical sale, 50-kg bags, mean	53.7	--	53.7
	median	60	--	60
Government, NGOs, or other projects:	**% all transactions**	21.4	23.7	22.1
	Typical sale, 50-kg bags, mean	143.8	500	262.5
	median	137.5	500	175
Farmers' groups:	**% all transactions**	6.6	15.0	9.2
	Typical sale, 50-kg bags, mean	90	41.7	61
	median	90	20	20
Individual farmers:	**% all transactions**	68.6	61.2	66.3
	Large-scale farmers, % all farmer customers	14.2	21.2	16.4
	Large-scale farmers, typical sale, 50-kg bags, mean	32.4	36.2	34.1
	median	20	35	20
	Small-scale farmers, typical sale, 50-kg bags, mean	2.0	65.5	25.2
	median	0.1	7.0	1.0
Subsidy voucher used for purchase:	**% of all customers**	10.4	53.0	24.6
Own-district customers:	**% all sales**	70.0	47.0	62.9
Neighboring-district customers:	**% all sales**	22.8	36.7	27.1
Customers from elsewhere in Mozambique:	**% all sales**	7.2	16.3	10.0
Other-country customers:	**% all sales**	0.0	0.0	0.0

Source: Authors' survey.
Note: NGO = Nongovernmental organization.

The majority of the traders' customers are farmers, primarily small-scale farmers. The amount of fertilizer purchased by individual small-scale farmers is small, with traders reporting median sales to an individual farmer of a single 50-kg bag—for small-scale traders, the median quantity sold in a transaction with a small-scale farmer is considerably less, at 5.0 kg. About a quarter of all sales of fertilizer were estimated by the traders to involve the use of a fertilizer subsidy voucher by the farmer to cover some part of the cost of the fertilizer purchase. However, voucher sales were made only by 5 of the traders interviewed—2 in Manica province and 3 in Nampula.

Finally, the fertilizer traders answered questions on several miscellaneous issues:

- Of the traders in the sample, 5 said they are willing to offer credit to customers. The terms of credit generally involve no down payment, but full payment is due within a month.
- Fertilizer is generally supplied to the traders in 50-kg bags. However, this quantity of fertilizer may exceed the needs of many small farmers, or the cost of this amount of fertilizer may exceed their ability to pay. Traders were asked if they sell fertilizer to customers in smaller quantities, and 11 of the 13 traders said they do. For small-scale traders that sell smaller quantities, sales of less than 50 kg account for about half their fertilizer sales; for large-scale traders that sell smaller quantities, these small sales represent 34 percent of their fertilizer sales. However, none of these traders obtain prepacked smaller packets of fertilizer from the wholesaler. Instead, they break 50-kg bags of fertilizer and either repack it

themselves into 1-kg bags (9 of the sampled traders) or simply sell it loose by volume using an empty beer can as the measure (2 traders).

- Three of the traders in the sample—a small-scale and 2 large-scale—reported that they are members of *Associação Moçambicana de Provedores de Insumos Agro-pecuários* (AMPIA), the national agro-input dealers' association. Asked how this membership benefits for their fertilizer business, they pointed to business management training and political leverage.
- Two of the sampled traders reported obtaining commercial credit for their business. The reasons were to either expand or improve the business premises or to purchase larger stock. One felt that the decision to obtain the loan was an appropriate business decision while the other had faced demands for kickbacks from bank officials and therefore was less certain.
- Asked how they obtain up-to-date information on fertilizer prices, 62 percent stated that they simply contact their principal supplier, while the others reported that they consult with fellow fertilizer traders to determine current prices.
- Most but not all of the surveyed traders will offer advice to farmers on proper use of fertilizer—2 traders said they do not do so. However, the means by which traders themselves obtain this information is quite varied and the quality of the information that they obtain is difficult to judge. Their own fertilizer supplier is the principal source of such information for 45 percent, with secondary sources including other fertilizer dealers, government extension staff, interactions with agricultural projects run by nongovernmental organizations, and their own experience.
- Finally, the dealers answered a set of subjective questions on their expectations over the next 3 years with regard to the numbers of fertilizer suppliers in the market, the number of customers, and the relative size of their own fertilizer business. The traders in the sample were generally optimistic, 85 percent expecting that there will be more suppliers in the market and significantly more customers for their fertilizer in 3 years. All but 1 of the traders in the survey sample expected their fertilizer businesses to grow over the next 3 years. When asked why they were optimistic about the prospects for their own business, the most common reason offered by those with an opinion was that they are seeing increased efforts to sensitize farmers to the benefits of using fertilizers, and they expect increased fertilizer demand to follow. Several also expressed their intent to make significant investments in their fertilizer business in the coming years in order to increase their customer base.

5. SURVEY OF FARMERS IN AREAS WHERE FERTILIZER IS USED

The second source of primary information on fertilizer supply in Mozambique for this study was a survey of a sample of farmers—the actors at the end of fertilizer importation and marketing chains in Mozambique. Here we provide selected findings from the survey.

The geographical areas from which the sample of farmers was chosen were the same as those used for the survey of fertilizer traders. Two communities in each study area were purposively selected—Bandula and Chirodzo in Manica district, and Cunle and Primeiro de Maio in Ribaué district—with 40 farmers surveyed from each community, for a total study sample of 160 farmers. The criteria used for selecting the communities included information from local experts indicating some fertilizer use by farmers in the community, although by no means by all farmers. No input dealers selling fertilizer were present in any of the communities in which the sample farmers resided.

Two lists of farmers were drawn up in each community, depending on whether they did or did not use fertilizer. A sample of 20 farmers from each list was randomly chosen. However, when the questionnaire was administered, it was found that some farmers in Manica who at the listing stage were said to have used fertilizer were found not to have done so over the reference period of 2010. Therefore the sample is not evenly split between fertilizer users and nonusers.

Characteristics of Farmers

General characteristics of the farming households in the sample are presented in Table 5.1. Table 5.2 shows differences in off-farm sources of income for the heads of farming households in the sample and descriptive statistics on the agricultural experience and aspects of the land that farmers in the study sample farm. Few differences are seen between the characteristics of fertilizer users and nonusers. More significant differences are apparent between the farmers in the different study areas than between fertilizer use categories. Nonetheless, fertilizer users have slightly more education, on average, and have somewhat more assets than nonusers. Users are less likely to engage in off-farm work, but if they do work off-farm, they engage in work requiring more skills than do nonusers of fertilizer. However, the amount of income derived from off-farm work does not present a clear contrast between fertilizer users and nonusers.

Table 5.1—Household characteristics of farmers in survey sample

Study area	All	Fertilizer nonusers	Fertilizer users	Manica	Ribaué
Fertilizer use, %	45.6	--	--	41.3	50.0
Demographic characteristics					
Female-headed household, %	20.0	19.5	20.5	17.5	22.5
Household head age, years, mean	38.6	39.3	37.9	41.6	35.7
Household size, mean	5.7	5.4	6.1	6.1	5.3
Full-time household farm workers, mean	2.1	2.1	2.1	2.2	2.0
Educational attainment of household head					
Any education, %	84.8	83.7	86.1	79.7	89.9
Finished primary school, %	36.7	32.6	41.7	38.0	35.4
Finished secondary school, %	6.3	5.8	6.9	3.8	8.9
Household assets					
House with cement-mortared walls, %	9.4	6.9	12.3	18.7	0.0
Owns bicycle, %	66.2	58.6	75.3	67.5	65.0
Owns motorcycle, %	8.7	6.9	11.0	11.2	6.2
Owns motor vehicle, %	0.6	0.0	1.4	1.2	0.0
Owns any livestock, %	56.2	51.7	61.6	66.2	46.2
Cattle, herd size, mean	1.3	1.1	1.6	2.4	0.2
Goats, herd size, mean	1.7	1.7	1.7	2.5	0.9
Poultry, flock size, mean	6.0	5.8	6.4	10.0	2.1
n	160	87	73	80	80

Source: Authors' survey.

Table 5.2—Household head's engagement in off-farm income-generating activities, household head's agricultural experience, and farmland characteristics

	All	Fertilizer nonusers	Fertilizer users	Manica	Ribaué
Engaged in off-farm work, %	30.6	23.0	39.7	27.5	33.7
Of those, engaged in unskilled work, %	39.6	50.0	32.1	36.3	42.3
Skilled work, %	25.0	20.0	28.6	27.3	23.1
Trade, %	35.4	30.0	39.3	36.4	34.6
Months per year engaged in off-farm work, mean	7.6	8.7	6.8	5.9	9.1
Work days per month in off-farm work when engaged, mean	20.9	21.8	20.2	20.1	21.6
Off-farm work monthly income for those engaged, MT, mean	2,717	2,181	3,062	3,276	2,247
MT, median	1,550	1,750	1,550	2,400	900
Farming experience: mean, years	19.2	19.5	18.8	20.1	18.2
median, years	18.0	17.5	18.5	19.0	17.0
Farm area: mean, ha	2.2	2.1	2.3	2.1	2.2
median, ha	2.0	2.0	2.0	2.0	2.0
Acquired most of land by purchase or rent, %	2.5	3.4	1.4	3.7	1.2
Characterizes soil quality of farm as poor, %	53.7	50.6	57.5	45.0	62.5
n	160	87	73	80	80

Source: Authors' survey.
Notes: MT = Mozambican meticais; US$1.00 = MT 30.60 at time of survey in March and April 2011.

To further explore in a multivariate framework the farmer- and farm-level determinants of fertilizer use in the study areas, a logistic maximum-likelihood estimation approach was used to assess the relationship between several characteristics of the farming household and its farm, and whether or not fertilizer is used. The results of this multivariate analysis are shown in Table 5.3, presented as odds ratios rather than as coefficients.[7]

Table 5.3—Multivariate logistic analysis of farmer- and farm-level determinants of fertilizer use

Explanatory variables	Odds ratio	Standard error
Female household head (0/1)	2.171	1.08
Household size, members	1.099	0.10
Full-time farm workers in household, number	0.951	0.21
Primary school—head completed (0/1)	1.381	0.57
Secondary school—head completed (0/1)	1.365	1.13
House has cement-mortared walls (0/1)	1.246	0.88
Owns motorcycle (0/1)	2.603**	1.11
Engages in skilled off-farm employment (0/1)	2.989	2.13
Engages in trade off-farm (0/1)	3.061*	1.87
Farming experience, years	0.995	0.02
Land under crops, ha	1.022	0.13
Considers soil on farm to be poor (0/1)	1.440	0.57
Considers soil on farm to be good (0/1)	1.048	0.75
Purchased or rents most of farmland (0/1)	0.162	0.22
Owns livestock (0/1)	1.311	0.48
n	157	
pseudo-R-square	0.089	

Source: Authors' calculations based on farmer survey data.
Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

What is seen in the results is further confirmation that there is not much difference in the characteristics of sample farmers who do and do not use fertilizer, respectively. When these determinants are considered jointly in this multivariate model, only 2 are seen to be significantly correlated with fertilizer use, both positively—motorcycle ownership and whether the farmer engages in off-farm trade. However, it also is important to note that the pseudo-R-square for the model is very low, at 0.089. Much of why farmers in the sample choose to use or not use fertilizer is unexplained by this model.

Fertilizer Use on Crops

The farmer survey focused on two crops on which fertilizer is sometimes used in the study areas—maize and vegetables. Table 5.4 shows what proportion of the sample of farmers produces each crop, and of those farmers, what proportion uses fertilizer on the crop. Maize is the principal crop grown by Manica district farmers and is somewhat more likely than vegetables to receive fertilizer there. In Ribaué, maize is not so commonly grown and, if it is, is not likely to receive fertilizer. However, almost three-quarters of farmers in Ribaué who grow vegetables use fertilizer.

[7] The odds ratio is the chance that the dependent variable—fertilizer use by the farming household—will change from zero to one (a positive outcome in statistical terms) as a result of a one-unit positive change in the independent variable. In contrast to regression-based models, wherein a statistically insignificant coefficient is zero, a statistically insignificant odds ratio is one—that is, a one-to-one or even chance. Odds ratios that are less than one represent an inverse relationship between the independent and dependent variable, while odds ratios greater than one represent a direct relationship.

Table 5.4—Maize and vegetables: Proportion of farmers producing crop and using fertilizer on crop

	All	Manica	Ribaué
Maize, %	81.2	96.2	66.2
Of whom use fertilizer, %	24.6	37.7	5.7
Vegetables, %	56.2	43.7	68.7
Of whom use fertilizer, %	56.7	31.4	72.7
n	160	80	80

Source: Authors' survey.

Table 5.5 contrasts the crop management of farmers according to whether they use fertilizer on the crop in question. In general, farmers who use fertilizer on a crop will have a larger area planted in that crop, are more likely to use commercial improved seed, and are more likely to have hired labor from off-farm to perform some of the crop operations during the course of the growing season or at harvest. Pesticide use was reported only on vegetables, with fertilizer users being more likely to also use pesticides. However, fertilizer users are less likely to use available organic resources (mulch or manure, in particular) for soil fertility management on their maize and vegetable plots.

Table 5.5—Crop management characteristics, by crop and by fertilizer use on crop

Crop	**Maize**			**Vegetables**		
Fertilizer use	**Nonuser**	**User**	**All**	**Nonuser**	**User**	**All**
Area under crop, ha, mean	1.4	1.8	1.5	0.18	0.33	0.27
median	1.0	1.5	1.0	0.05	0.25	0.25
Commercial seed, %	9.2	28.1	13.8	41.0	62.7	53.3
Organic materials used for soil fertility management, %	45.9	25.0	40.8	64.1	27.5	43.3
Commercial pesticide use, %	nil	nil	nil	5.1	39.2	24.4
Off-farm labor hired for some crop operations, %	16.3	43.7	23.1	2.6	13.7	8.9
n	98	32	130	39	51	90

Source: Authors' survey.

Some information on fertilizer use by sample farmers is presented in Table 5.6.[8] Farmers use moderate amounts of fertilizer for maize. Sample farmers who used fertilizer were asked to estimate what their yields would have been had they not used fertilizer in 2010. Maize yields were estimated to have increased by half with fertilizer use.

[8] Because considerable variance was seen in the data, only medians are presented here. Since several vegetables were grown with fertilizer, aggregate statistics could not be computed.

Table 5.6—Fertilizer use, by crop

	Maize	Vegetables
Principal fertilizers applied	urea, 12:24:12	12:24:12, urea
Fertilizer application rate, kg/ha, median	112.5	133
Fertilized crop yield, kg/ha, median	1,100	--
Estimated unfertilized crop yield, kg/ha, median	725	--
Estimated fertilizer use efficiency (kg additional crop harvested per kg fertilizer applied), median	5.0	--
Price obtained for fertilized crop in 2010, MT/kg, median	8.50	--

Source: Authors' survey.
Note: MT = Mozambican meticais.

The most common vegetables to which fertilizer was applied by sample farmers were tomatoes, cabbage, and onions. Overall, maize and vegetables were the principal crops to which fertilizer was applied in the study areas. A handful of sample farmers reported applying fertilizer to other crops. However, the only other fertilized crop mentioned by more than one sample farmer was beans/peas, primarily in Manica.

Access to Fertilizer

Table 5.7 presents some characteristics of how the farmers in the study sample who use fertilizer obtain the input. Most farmers purchase fertilizer only once in the course of a year. Manica farmers purchase fertilizer at the time when the rains come or before. In contrast, purchases in Nampula occur as the rainy season is ending, before the vegetable production period in the dry season. Farmers in Manica purchased two bags of fertilizer on average in 2010, while those in Ribaué purchased one.

Table 5.7—Farmer access to fertilizer

	All	Manica	Ribaué
Fertilizer purchases in 2010, number, mean	1.3	1.5	1.1
median	1	1	1
Sample farmers who received input subsidy voucher for fertilizer in 2010, %	9.7	21.2	nil
Month of largest purchase	October	October	March/April
Total fertilizer purchased in largest purchase, kg, mean	76.9	100.8	57.1
median	70	100	50
Total fertilizer value purchased in largest purchase, MT, mean	1,877	2,248	1,571
median	1,700	1,960	1,281
n	72	33	39

Source: Authors' survey.
Note: MT = Mozambican meticais.

Table 5.8 presents the amount and price of fertilizer purchased, by type, for the 72 sample farmers reporting having purchased the fertilizer as part of their largest purchase reported.

Table 5.8—Fertilizer purchases by farmers

	Purchase amount, kg		Price, MT per 50-kg bag, median
	Mean	Median	
Urea	41.5	50	1,200
12:24:12	52.3	50	1,500

Source: Authors' survey.
Note: MT = Mozambican meticais.

A series of questions were asked of farmers who purchased fertilizer. Virtually all farmers purchased their fertilizer from traders. Only nine of the farmers in the sample that purchased fertilizer obtained it from a source other than traders—all of these nine obtained it through farmers' groups in Ribaué. Only one sample farmer reported having ordered fertilizer sometime before acquiring it—the rest purchased fertilizer from the stock of the trader on hand.

Only one of the sample farmers reported purchasing fertilizer on credit from the trader. One other farmer who purchased fertilizer reported obtaining a personal loan from family members in order to purchase fertilizer. Farmers in the study areas have very little access to credit for the purchase of fertilizer.

Table 5.9 provides some indication of the proximity of sample farmers to fertilizer dealers. In general, the sample farmers in Ribaué can find fertilizer for sale quite close to their farms—certainly much closer than is likely the case for most farmers in Mozambique. Recall that the sample was purposively chosen to focus on fertilizer use and is not representative of all smallholder farmers in Mozambique. Distance to fertilizer suppliers is further in Manica. In Manica, sample farmers transported the fertilizer to their farms from the supplier using their own bicycle or motorcycle or—the majority—by use of public transportation. In Ribaué, most farmers carried it by foot, bicycle, or motorcycle, with a few hiring a pickup to haul it. The median cost of transporting the fertilizer for those sample farmers who paid for transportation (either public transportation or special hire) was MT 1.00 (Mozambican meticais) per kg per km in both study areas.

Table 5.9—Transportation of fertilizer from dealer to farm and time from purchase to application

	All	Manica	Ribaué
Distance to fertilizer supplier from farm, km, mean	21.9	39.3	7.3
median	15	44	7
Fertilizer transportation cost from supplier to farm, MT/kg/km, mean	1.07	1.04	1.21
median	1.00	1.00	1.00
Time from fertilizer purchase to application, days, mean	19.1	21.6	17.0
median	10	10	7
n	72	33	39

Source: Authors' survey.
Note: MT = Mozambican meticais.

Most farmers obtain their fertilizer within a few weeks before they apply it. The median time period between purchase and application across the sample of farmers who purchased fertilizer was 10 days.

Farmers were asked the sources of the information they use on how best to employ fertilizer on their crops. In Ribaué, training and experience received through farmer group participation was the most commonly mentioned source of such information. In Manica, the government extension service was most commonly mentioned, followed by farmers' groups. However, even though farmers reported obtaining information on fertilizer use from the extension service, only 13 percent of the sample farmers reported participating in any activities of the government extension services. Nonetheless, if the information on fertilizer use offered by the extension service is appropriate, there is scope for expanding farmers' knowledge base on fertilizer use through improving the quality and intensity of their contacts with the extension service.

6. DISCUSSION

The overall objective of this study was to investigate supply-side constraints on fertilizer use by smallholder famers in Mozambique that are due in part either to government actions or to government inaction. The government actions that could constrain the supply of fertilizer include policies, regulations, or taxes that result in higher prices for fertilizer for smallholder farmers. Government inaction that could have a similar result are primarily in the area of missing investments in public goods that, were they in place, would reduce the cost or risks of using fertilizer for farmers.

The broad finding of this study is that the government of Mozambique has adopted a generally hands-off approach in engaging with efforts to improve farmer access to fertilizer. Private-sector investment decisions drive the development of these markets, with government primarily having somewhat distant oversight on these developments. The pool of importers and wholesalers of fertilizer in Mozambique remains quite small and Agrifocus dominates the sector. Fertilizer costs are high in Mozambique relative to other coastal countries in Africa. Likely the small concentration of fertilizer importers and wholesalers accounts for some of these higher costs, as do patterns of fertilizer supply that are not at the lowest costs available. Efforts are being started to strengthen the retail sector for agricultural inputs by better understanding the information and management needs of agricultural input retailers, but much work is still required in this regard. While a few direct taxes and fees on fertilizer supply activities remain that seem difficult to justify, in general fertilizer importation and marketing activities in Mozambique are relatively unencumbered in this regard. However, while overall some progress can be seen in the development of a private sector–led agricultural input market in Mozambique serving the needs of its smallholder farmers, given the problematic economics of fertilizer use by smallholders in Mozambique, the prospects for the future are certainly much murkier there than in Uganda and Tanzania, the other countries where parallel studies were done (Benson, Kirama, and Selejio 2011; Benson et al. 2011).

However, this study also pointed to several areas where government inaction is having an adverse effect on efforts to increase agricultural productivity in Mozambique through the increased use of inorganic fertilizer. The most important of these missing public goods are not specific to increasing smallholder adoption of inorganic fertilizer but are implicated in broad efforts to increase economic growth in Mozambique. Among these broader general initiatives that government must lead is improving transportation links within the country to reduce transportation costs for both input and output markets, regionally as well as locally. Other areas that the government should continue to address include expanding and strengthening agricultural credit supply by rural financial institutions for farmers and input retailers, as well as for large-scale fertilizer importers and wholesalers, and improving the flow of information to farmers and traders on market prices, which both groups need to make sound commercial decisions.

Nonetheless, there are two fertilizer-specific initiatives that the government should address to accelerate use of fertilizer in Mozambique by smallholders and higher levels of crop productivity nationally. These relate to the information constraints in the fertilizer market and to the regulatory environment for this input.

Overcoming Information Constraints

There are two areas where a lack of information with regard to fertilizer use results in either higher costs or inefficient use of inorganic fertilizer for smallholder farmers in Mozambique. First, farmers generally have very limited scientific information on the proper agronomic use of fertilizer on their crops within the particular agroecological conditions under which they farm. Many of those interviewed for this study, including farmers and traders, reported that farmers' use of fertilizer was done in a quite uninformed manner. For increased agricultural production in Mozambique through the use of modern production technologies, compilations of all knowledge on the proper application of these technologies, including inorganic fertilizer, is needed. Farmers and those who advise them need to know for the particular

agroecological zone in which they operate what nutrient deficiencies may be limiting crop yields and how those nutrient limitations can best be addressed using fertilizers as part of a comprehensive soil fertility management approach.

Basic crop- and area-specific fertilizer recommendations are a very valuable foundation to increased fertilizer use by smallholders. Consideration should also be given to the fertilizer formulations that are put on the market in Mozambique—are they providing the proper plant nutrients needed at the lowest cost? Thereafter, an extensive program of demonstrations of the application of different fertilizer packages side by side should be mounted in all of the higher-potential farming areas of the country where fertilizer is likely to make good sense for farmers to employ. Given its marketability and importance for local food security, maize is the principal crop of interest for such demonstrations, but any other food crops that research shows could profitably be produced using inorganic fertilizer in an area should also be included in such demonstrations.

Fertilizer recommendations are developed primarily from an economic analysis of crop yield response to fertilizer and not solely from consideration of the agronomic response observed in fertilizer trials and demonstrations. Therefore the second important information gap with regard to fertilizer use in Mozambique has to do with the economics of fertilizer use on maize and on the other crops grown by smallholder farmers on which fertilizer might profitably be used. Few farmers have access to this sort of information or know how they might determine for themselves whether fertilizer use will be profitable on their own farms. In its simplest form, such an analysis takes into account the full cost of fertilizer, the likely yield response the farmer will obtain from the use of fertilizer, and the returns that the farmer can expect to receive from the sale of her or his fertilized crop in local output markets. A regular and ongoing program of agronomic and economic research is required to compile, validate, and disseminate a consistent and robust set of simple crop- and area-specific fertilizer recommendations. These recommendations need to be adaptable to changing market price conditions both for fertilizer and for the crops on which the fertilizer is used. Data obtained from the fertilizer package demonstrations noted in the previous paragraph will provide a useful database by which to validate the fertilizer recommendations and reassess them as input and output prices change. Such recommendations should also be able to be modified appropriately for use by resource-constrained farmers who need to choose which elements of a recommended fertilizer application package they should prioritize in their farming practices.

Regulatory Reform

In the discussion on the legislation proposed to regulate the importation and marketing of inorganic fertilizer, we suggested that, at least for the standard, high-analysis fertilizers that are most commonly used in Mozambique, the fertilizer regulations currently being proposed, if comprehensively implemented, would be a poor fit for the public benefits sought through the regulations. A considerably lighter regulatory regime would allow more high-analysis fertilizer onto the Mozambique market in more places, resulting in lower costs for Mozambican farmers. The Ministry of Agriculture should be judicious in its implementation of this legislation. In doing so, the ministry must balance, with attention to the aggregate public interest, the need for continuing efforts at development of input markets against fraudulent behavior in these markets. The greater part of assuring the quality of fertilizers in open and competitive markets is achieved through self-regulation processes tied to sufficient information on product quality to inform farmers and ample choice in suppliers.

On this issue, the *Instituto Nacional de Normalização e Qualidade* (INNQ, or National Institute of Standards and Quality), the statutory agency responsible for enforcing product standards, must be given considerably greater responsibility for both analytical and policing functions related to the marketing of inorganic fertilizer. Arguments for duplication of functions across the INNQ and the Ministry of Agriculture with regard to inorganic fertilizer, in particular, are weak.

To conclude, Mozambique still has the land available to meet the food and other agriculture-supplied needs of its growing population by expanding the amount of arable land put into production. However, there is clearly need for intensification of agricultural production in several areas, particularly in the zones of the country that have high agricultural potential. The government of Mozambique must continue to pay attention to how it can enable smallholder farmers to profitably and appropriately make use of inorganic fertilizer, improved seed and planting materials, and other improved agricultural technologies for higher agricultural production by smallholders. Paying attention to supply-side factors related to the use of inorganic fertilizer is an important element of such efforts. The inorganic fertilizer sector in Mozambique is expanding slowly and smallholder farmers are, to a limited extent, involved in this expansion. However, the continued expansion of the sector is not assured. It is hoped that some of the insights offered through this study may prompt decisions that will propel and strengthen the profitable uptake by smallholder farmers of inorganic fertilizer to raise their productivity, resulting in sustained improvement in their own welfare, that of their households, and eventually, that of Mozambique's rural economy as a whole.

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