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Inorganic fertilizer in Uganda—Knowledge gaps, profitability, subsidy, and implications of a national policy

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Agriculture is at the core of the livelihoods of most rural households in Uganda. It is a major engine for overall economic growth and possibly the single most important pathway out of poverty in the rural space. Although measures to enhance the rural farm economy are reflected in national policy through the Plan for Modernisation of Agriculture, tangible benefits, such as improved smallholder farm productivity, income growth, poverty reduction, and national food security, continue to elude the farm sector. Increasing the availability of inputs such as inorganic fertilizer and improved seed is critical to meeting the above policy objectives. The lack of functional and efficient agricultural inputs markets in Uganda is often highlighted among the major constraints to substantial agricultural growth in the country. Improved soil fertility management through increased levels of fertilizer use, increased use of available organic soil amendments, and improved farm management practices, together with the use of improved seed, can result in positive gains in farm productivity. This brief specifically addresses fertilizer use in Uganda.

For Uganda's case, four key questions need to be addressed if we are to understand better why farmers do not use inorganic fertilizer extensively.

- What are the trends of fertilizer use and what factors explain these trends?
- What are the existing knowledge gaps on inorganic fertilizer use in Uganda?
- Is fertilizer use profitable?
- What public investments will enable rural farmers to improve their access to and use of fertilizer?

A systematic analysis of the above questions can help to fill some of the knowledge gaps in understanding the use of inorganic fertilizer in Uganda. That is the objective of this report. It highlights fertilizer use trends, knowledge gaps, and the economic incentives for smallholder farmers to use inorganic fertilizer. In this report, an argument is made for some form of 'smart subsidy' to promote smallholder fertilizer use in Uganda, as well as other possible policy interventions.

Fertilizer use

Despite widespread recognition of the importance of inorganic fertilizer use, use rates remain alarmingly low – Ugandan farmers use an average of one kilogram of nutrients per hectare of arable land, compared to 35 in Kenya, 22 in Malawi and 13 in Tanzania (Wallace & Knausenberger, 1997). This low rate of fertilizer use is particularly worrisome given that Uganda has one of the highest rates of soil nutrient depletion among countries in sub-Saharan Africa (Stoorvogel and Smaling, 1990).

Table 1: Farmers using modern inputs in Uganda, percent

Region	Fertiliser	Improved seed	Manure
Central	1.3	5.5	8.7
Eastern	1.1	12	4.1
Northern	0.7	7.6	0.5
Western	0.6	2.2	9.6
NATIONAL	**1.0**	**6.3**	**6.8**

Source: UBOS, 2007.

Data on fertilizer use per hectare of arable land in Uganda is not available at regional level. However, as shown in Table 1, the 2005-06 Uganda National Household Survey (UNHS) offers some insights on the proportion of farmers that use fertilizer. Overall few farmers use fertilizer – only one percent of the total farm households surveyed applied inorganic fertilizer to their crops. Regionally, a greater proportion of farmers in the Central and Eastern regions use fertilizer than do farmers in the Northern and Western regions. Only 6.3 percent of households use improved seed. A combination of improved seed, inorganic fertilizer,

pesticides, and adequate water supply (rain or irrigation) should give farmers maximum yields. These low levels of use of both inorganic fertilizer and improved seed imply that the majority of farmers do not maximize their benefits from adopting new agricultural production technologies.

Knowledge gaps on fertilizer use

While there has been considerable research and policy analysis on fertilizer promotion and use around the world (Crawford et al., 2005), in Uganda this has not been the case. There remain knowledge gaps, including on the state of fertility of Uganda's soils; the yield response to fertilizer for key crops and, hence, the profitability of fertilizer use on them; the effectiveness of existing agricultural extension services in promoting fertilizer use; the potential effects of fertilizer subsidies on the private-sector fertilizer market development; and the likely effects of changing climatic conditions on the profitability of fertilizer use. Promoting the use of inorganic fertilizer requires a critical analysis of the supply and demand constraints that keep usage rates low in Uganda, especially among smallholder farmers. Ideally, inorganic fertilizer should be available, affordable, and profitable for both suppliers and farmers. Evidence from other countries shows that agricultural research and agricultural extension messages on appropriate fertilizer use coupled with input market development, the provision of credit to farmers for agricultural inputs, and, possibly, subsidized distribution channels can successfully increase fertilizer use on crops for increased productivity.

Inorganic fertilizer does not improve agricultural productivity in isolation. Information on the fertility status and agricultural potential of the soils and on the types of crop pests and diseases and their control is also necessary. The National Agricultural Advisory Services (NAADS) program, a public-private agricultural extension service delivery program is responsible for dissemination of agricultural information to Ugandan smallholder farmers. An impact evaluation of the program indicated that it was having positive effects on the farmers' livelihoods however; farmers interviewed reported scarcity of agricultural inputs, including limited access to fertilizer as one of the major problems (Benin et al., 2007). Fertilizer is not only scarce but also information related to its use and the potential increases in productivity that it could bring about are unknown, thereby reducing the incentive for its use by farmers. Alongside this is a severe lack of research results on the profitability of the different soil-crop-fertilizer combinations that could be employed in the different parts of the country. Different crops on different soil types respond differently to different types of fertilizer. It would be worthwhile to carry out a thorough fertilizer profitability analysis for the whole country to establish the responsiveness of the major crops grown to the application of different plant nutrients – nitrogen, phosphorus, potassium, and selected micronutrients. An example of such an exercise is the fertilizer profitability analysis and fertilizer use recommendations prepared for Rwanda by Kelly and Murekezi (2000) based on a synthesis of results from fertilizer trials that had been established across the country.

The lack of such information on crop-fertilizer profitability across the country means that farmers cannot tell how much they stand to gain or lose by applying a particular type of fertilizer on a particular crop. This increases their risk and creates a disincentive for use of fertilizer. Information about profitability levels can serve as an incentive for inorganic fertilizer use. Most simply, expected Value Cost Ratios (VCR) from fertilizer use can guide farmers' decisions. The VCR refers to the value of additional crop yield obtained from using fertilizer divided by the cost of the fertilizer treatment. A VCR greater than two is generally considered an adequate incentive for fertilizer adoption – the financial returns to using fertilizer are two times greater than the cost (Kelly, 2006). VCRs should be established for different fertilizer-crop combinations in the different agroecological zones of Uganda.

Due to lack of adaptive and economic research studies on crop-fertilizer combinations in the different parts of the country, available fertilizer use recommendations have not been updated in a long time (MAAIF, 2007). With changing input and output prices over time, this implies that the fertilizer applied to farmers' crops do not provide optimal economic returns to farmers. Since fertilizer is costly, less than optimal returns are likely to discourage fertilizer use. On the supply side, fertilizer traders in rural areas should be equipped with knowledge on appropriate fertilizer use so that they can pass on the right kind of information and products to the farmers purchasing fertilizer from them.

Over seventy percent of fertilizer use in Uganda is imported directly by independent large-scale agribusiness companies engaged in the production of commercial crops such as tea, tobacco, rice, and sunflower. A small group of private sector companies selling fertilizer in the open market imports the remaining thirty percent (IFDC, 2007). With such a small number of traders involved, the fertilizer market is best described as an oligopoly. Addressing the constraints that limit entry and effective participation in the fertilizer market is essential to improve competitiveness and efficiency. Despite the fact that the whole country relies on this market for its fertilizer needs, very little has been done in terms of studying the marketing processes.

Omamo (2003) studied the Uganda fertilizer market structure and price formation system. He found the market to be oligopolistic in structure, but that the firms involved achieved quite low net margins. Since his study in 2003, sharp increases in world food and fertilizer prices have occurred. This has created some unease among Ugandan leaders as to whether the

country can meet its productivity and food security goals. Because of a weak infrastructure, transport costs are prohibitively high, and fertilizer prices have increased dramatically in the last few years due to global market factors. The resultant farm-gate prices are beyond the reach of most farmers (Chemonics & IFDC, 2007)

These fertilizer price increases have put fertilizer promotion programs and fertilizer subsidies high on the agenda of governments across Africa and their development partners. There is need to periodically study the input market environment, particularly supply and demand trends. It is also necessary to carry out fertilizer cost-chain analyses, detailing the costs incurred from the source of the product up to the smallholder farmer in his or her field. This approach will provide an up-to-date mechanism to monitor the price formation process and identify inefficiencies in this process, while giving insights on how fertilizer prices in Uganda respond to global economic changes.

Regulation of the market is also needed. In order to promote fertilizer use among smallholder farmers, the quality of fertilizer must be assured and not be compromised through adulteration or poor packaging and handling. Smallholder farmers are particularly vulnerable to unscrupulous dealers and manufacturers, since they have no reliable means of testing to assess the quality of fertilizer they buy. To ensure quality, regular inspection of fertilizer at all stages of the marketing chain should be carried out by officials of the Agricultural Chemicals Registration and Control Department of the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF).

Fertilizer profitability

Profitability is the principal incentive to adopt fertilizer and one of the major factors that determine fertilizer use patterns. An investment in fertilizer should not only be profitable, but should also be more profitable than alternative investments available, including non-farm activities. Absolute fertilizer profitability, thus, is a necessary but not a sufficient condition for fertilizer adoption (Yanggen et al., 1998). Evidence of fertilizer profitability in Uganda is scanty and some of the available estimates are conflicting.

Estimates on crop yields from the Uganda National Household Survey (UNHS) and results from trials by the National Agricultural Research Organisation give a picture of considerable scope for productivity increases in Uganda. As shown in Table 2, maize yields at research stations have been found to be at least 8 times higher than what a typical farmer harvests. Other crops show similar large yield gaps. If these gaps are due in part to inadequate soil fertility management by farmers, there is considerable scope for much higher productivity on farmers' fields with fertilizer. As such, if the economics of fertilizer use on these crops is sufficiently attractive – the price ratio of fertilizer to the crop output, in particular – these results indicate considerable potential for fertilizer use in Uganda.

Table 2: Yield gaps for selected crops in Uganda, kg/ha

Crop	Farmer yields (avg)	Research yields (avg)	Gap (%)
Maize	550	5000-8000	800-1350
Beans	350	2000-4000	470-1040
Groundnuts	630	2700-3500	330-460
Bananas	1870	4500	140
Coffee	360	3500	870

Source: NARO and UNHS 2005/06 Data.

However, an econometric study on yield response to fertilizer by Nkonya et al. (2005), based on a farm household survey, found that use of inorganic fertilizer appears not to be profitable for most farmers. Survey households using fertilizer realized an average total value of production of UGX 814,000 per acre and applied fertilizer at an average cost of UShs 43,457 per acre. However, the authors estimated for their sample that the elasticity of production response to fertilizer on a value basis was 0.027. This means that a one percent increase in mean fertilizer use, worth UShs 434 per acre, would increase the predicted value of production by only UShs 326 per acre. This translates into a marginal value/cost ratio (VCR) of fertilizer use of only 0.75. A minimum VCR of at least one is needed for additional fertilizer use to be profitable, while a VCR of at least two is needed for significant adoption of fertilizer. This study essentially dismisses the potential of using fertilizer profitably. However, this conclusion raises serious questions – most importantly, how can Ugandan farmers continue to apply fertilizer when they are not breaking even? A VCR ratio of 0.75 implies 25 percent losses. The Nkonya et al. results need confirmation.

Table 3: Benefit-to-cost analysis of applying inorganic fertilizer on maize

District	Treatment (kg N:P_2O_5 per ha)	Maize yield (kg/ha)	Marginal rate of return
Pallisa	90:40	6054	8.1
Iganga	30:40	3212	2.3
Mpigi	90:40	4312	3.0
Luwero	90:40	5104	4.0

Source: SG2000 QPM report, 2003 cited in Namazzi, 2008

A second set of studies by the Uganda office of Sasakawa Global 2000 and Makerere University offered different conclusions. Fertilizer response trials on maize were carried out in 2003 in Iganga and Pallisa districts of eastern Uganda and Mpigi and Luwero districts in central Uganda to assess maize response to inorganic fertilizer. As shown in Table 3, maize yields respond positively to fertilizer application, although responses tend to be location

specific. Subjecting the trial results to an economic analysis, fertilizer application on maize was found generally to be profitable, although the levels of profitability were also location specific. Other data from NARO maize trials showed average control (no fertilizer applied) yields of 1770 kg/ha, while yields at 60:45:30 (kg $N:P_2O_5:K_2O$ per ha) averaged 4740 kg/ha, and yields at 120:90:60 averaged 5490 kg/ha. The nutrient use efficiency at the lower rate of application corresponds to 22.0 kg of maize per kg of nutrient applied, while at the higher rate, the efficiency is 13.8. Although the profitability of fertilizer use on maize depends also on the relative prices of fertilizer and maize, these nutrient use efficiencies, particularly at the lower rate of application, are promising.

More inorganic fertilizer yield response and profitability studies are needed for a range of crops in Uganda. Sasakawa-Global 2000 initiatives in several African countries including Uganda have demonstrated that smallholder farmers with access to fertilizer, improved seed, and agricultural extension services are able to produce high yields. However, with limited information on crop yield response and, as important, fertilizer costs and expected crop output prices, farmers will be hesitant to invest in fertilizer. Profitability ratios under a range of input and output cost scenarios should be determined across the country so that farmers can know beforehand what levels of inorganic fertilizer application will be profitable for them to use on a particular type of crop.

A holistic fertilizer promotion strategy—What should it entail?

Lessons learnt from past fertilizer promotion programs in sub-Saharan Africa show that donor-funded programs are not sustainable over the long run. Once funding ceases, the program activities typically end also. How then does a country like Uganda design a fertilizer promotion strategy that is sustainable over the long run? It is important that such a strategy clearly identify economic sources of fertilizer and other related critical inputs like seed, pesticides, and herbicides. Given that most smallholders in Uganda face severe cash constraints, reliable access to agricultural credit to purchase inputs is equally critical to increasing the use of inorganic fertilizers. Finally, fluctuation of agricultural commodity prices, especially following bumper harvests, often cause farmers to incur losses and serve as a disincentive to continued use of fertilizers. Output price stability is a key factor in promoting fertilizer use.

Although Uganda has a liberalized economy, there are avenues of stabilizing prices for both agricultural inputs and crop outputs without direct government intervention in the market. Bottlenecks in importing of fertilizers to Uganda related to inadequate infrastructure or to poorly designed regulatory frameworks can be solved. Improved crop marketing infrastructure and institutions can stabilize output prices. Increasing access to foreign markets, particularly for processed Ugandan primary commodities, can increase and stabilize demand and, thus, prices for farm produce. Moreover, there is need to invest heavily in agricultural research, in infrastructure and in extending agricultural knowledge to farmers. These investments will ensure that farmers are able to use fertilizer effectively at the lowest cost possible, while obtaining maximum returns from the crops they produce with fertilizer.

Considerable potential for public-private partnerships to deliver fertilizer to farmers exists in Uganda. Government can create incentives for private agents to enter into the fertilizer market through various financing or cost-sharing mechanisms. Moreover, government can play a significant role of providing fertilizer to the poorest households to improve their food security. In this regard, government efforts can be complementary and not necessarily competitive with the private sector and contribute to reducing concentration in input markets.

The fertilizer market in Uganda—Does a market failure exist?

A market failure is the failure of a more or less idealized system of price-market institutions to sustain 'desirable' activities or to stop 'undesirable' activities. Market failures are often associated with non-competitive markets and the existence of a market failure is often used as a justification for government intervention in a particular market. As such, might Uganda's fertilizer market be considered a case of market failure because the market is not competitive and it does not provide the desired good – fertilizer – to the would-be consumers – the rural farmers?

Economists recognize that government actions can sometimes successfully address undesirable market outcomes. Government can do so either by substituting some other mechanism of coordination for the market or by changing the setting and rules for markets. Government interventions are not costless, and there are many cases where it is better to live with market failures than to call on government to fix the problem (Hausman, 2008). The challenge therefore lies in formulating the right kind of government interventions that can provide a correctional response in the input markets.

To improve the efficiency of the market for inorganic fertilizer in the country, the government of Uganda may choose to invest in fertilizer and soil science research, which will clearly demonstrate soil fertility status, and establish crop and area specific response rates for the different inorganic nutrient types. The results of such research should improve nutrient management efficiency by farmers. It might also choose to provide better agriculture extension services to increase information flows and expertise in the utilization of new agricultural technologies. Or government could create better import credit systems that will promote bulk importation of fertilizer and

increase economies of size and scale in seeking to lower prices sustainably or, alternatively, provide broader agricultural credit systems to expand farmer access to fertilizer and increase demand.

However, government intervention in the fertilizer market may face problems such as high administrative costs, lack of information, rent-seeking tendencies, and a failure of other markets like the labor and land markets to adjust flexibly to the new changes in the fertilizer market. For example, increased fertilizer use may increase labor demand and less demand for land or vice-versa. There is no simple formula. Consequently, in the interest of improving agricultural productivity, interventions should be implemented after a carefully thought out process. One of the most common government interventions in the fertilizer market is a fertilizer subsidy, as have been implemented recently in Malawi and Zambia.

Fertilizer subsidy—Is it feasible in Uganda?

Low inorganic fertilizer use not only poses food and nutritional challenges but also has negative environmental outcomes. Since the early 1990s, increases in agricultural production in Uganda have principally resulted from opening up of virgin land for agricultural production and not from increased agricultural productivity. Consequently, since the early 1990s the rate of total forest loss has been increasing and stands at 26.3 percent with an annual rate of forest loss of 2.3 percent (NEMA, 2008). Deforestation and other forms of soil degradation have unfavorable economic and environmental outcomes in rural areas including reduced incomes and desertification. This, alongside the discussed market failures, creates some ground to examine the feasibility of a fertilizer subsidy to increase agricultural productivity in Uganda and to alleviate household poverty.

Although some research findings demonstrate fertilizer use not to be privately profitable at household level (Nkonya et al., 2005), this notwithstanding there are compelling reasons to evaluate the extent to which increases in fertilizer use may be economically or socially profitable (Yanggen et al., 1998). Private profitability is indicative of the revenue gains or losses that may accrue to an individual farmer from investing in fertilizer use, while economic and social benefits include environmental benefits, indirect macroeconomic benefits, and other benefits that contribute to general social goals, such as equity. Conventional economic theory suggests that where there is a divergence between private and public interests, government funding of subsidies or other types of incentives may be warranted.

For Uganda's case, a fertilizer subsidy may make sense because of the economic, social, and environmental gains that will accrue. Fertilizer subsidies programs, if appropriately designed, can promote increased use of fertilizers along with complimentary inputs in ways that stimulate input market development without crowding out private investment. Theoretically, subsidies differ in terms of the point at which the subsidy is targeted – farmer or trader – and the form of the subsidy or how it is provided – cash payment, voucher, or reduced purchase price (Crawford et al., 2005). If designed well and implemented properly, fertilizer subsidies may generate economic benefits by correcting missing or imperfect markets or if they are aimed at kick-starting fertilizer use among the local population. Both constraints to increased fertilizer use by smallholders exist in Uganda, so subsidies should be considered among the policy instruments the government of Uganda might use to increase agricultural productivity and promote appropriate soil management practices. Promoting fertilizer use will increase per unit land productivity and reduce deforestation. Increased agricultural productivity will provide indirect stimuli for other sectors like manufacturing and create employment opportunities. Increased production will reduce food prices and result in welfare gains for the population in form of an increased consumer surplus and reduced poverty.

Conclusions

The drive to improve inorganic fertilizer market performance in Uganda requires a holistic approach that will strengthen both the private and public sectors. The private sector in Uganda has proven itself versatile, but it also is quite sensitive to public sector action. To increase efficiency in procurement and distribution of fertilizer, the Ugandan government should increase expenditure on infrastructure development, agricultural research, quality control, agricultural extension services, and the promotion of regional trade. In order to address the constraints farmers face in accessing fertilizer, government should evaluate whether a subsidy on inorganic fertilizer will significantly increase farmers' use of fertilizer, while at the same time strengthening private agricultural input market actors. On the market side, there should be a deliberate drive to improve information flow between suppliers, government, and the final consumers.

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