Staff Paper

Alternative Approaches for Promoting Fertilizer Use in Africa, with Particular Reference to the Role of Fertilizer Subsidies

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Abstract

This paper outlines the role of improved soil fertility in the process of structural transformation, and examines specific financial, economic, social, and political arguments in favor of promoting increased fertilizer use, particularly in smallholder farming systems. This paper draws experiences and insights from the literature on which policies and programs appear to work best and which least well in providing a consistent and growing supply of fertilizer to smallholders. Particular attention is given to addressing the question of fertilizer subsidies: Under what circumstances are they warranted and what form should they take, if and when they are implemented?

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Alternative Approaches for Promoting Fertilizer Use in Africa, with Particular Reference to the Role of Fertilizer Subsidies

By Eric W. Crawford, T. S. Jayne, and Valerie A. Kelly[1]

1. Introduction

This paper was commissioned by the World Bank (Africa Region, Environmental, Rural and Social Development Unit) as part of a project that supports its Africa Fertilizer Strategy Review (World Bank, 2004).[2] The terms of reference for the paper are:

> . . . to examine the financial, economic, social, and political arguments in favor of promoting increased fertilizer use, particularly in smallholder farming systems. The paper is intended to take the reader to the "frontier of knowledge" with respect to assessing which policies and programs appear to work best and which least well in providing a consistent and growing supply of fertilizer to smallholders. Specially, the paper should address the question: Under what circumstances are fertilizer subsidies warranted and what form should fertilizer subsidy programs take if and when they are implemented? (World Bank, 2004:18-19)

The paper has the following structure, which is a modification of the outline suggested in the terms of reference. While the focus on fertilizer as a key input follows from the terms of reference, Section 2 briefly describes the role of increased fertilizer use within the structural

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[1]We would like to acknowledge the very helpful research support provided by Andrew Kizito and Megan McGlinchy, and comments from Duncan Boughton and other colleagues at MSU.

[2]The project consisted of three background papers: (1) this paper; (2) a paper reviewing the demand-side constraints on fertilizer use and what can be done to overcome them; and (3) an analogous paper focusing on supply-side constraints on fertilizer use and alternative approaches for making fertilizer more readily available for smallholder African farmers. These papers served as background for an e-Forum conducted in February/March 2005 in order to elicit "lessons learned" from experienced practitioners. The background papers and e-Forum discussion were to provide a foundation for subsequent development of a "fertilizer tool kit" for use by World Bank staff and others engaged in promoting agricultural productivity growth in Africa.

transformation process that has served as the dominant model of economic growth and demographic transition for the past 40 years. We also review the rationale for promoting soil fertility and for including inorganic fertilizer in soil fertility management programs, based on the agronomic and soil science literature. Both of these strands of literature and evidence indicate a widespread consensus that sustainable development in most of Africa will require order-of-magnitude increases in fertilizer use over current levels (as well as other land and crop husbandry measures), and that there is some urgency to achieve these results quickly.

Section 3 reviews trends in fertilizer use in Africa, distinguishing countries by intensity of fertilizer use and by rates of growth in fertilizer use intensity. This review reveals wide differences across countries in Sub-Saharan Africa in fertilizer use intensity and the rate of growth in fertilizer use intensity. While it is beyond the scope of this paper to identify factors associated with relatively high fertilizer use and high growth rates in fertilizer use, we conclude that there may be high payoffs to more detailed analysis of the few cases of successful fertilizer consumption growth in the African context, to evaluate the potential for replicability more widely throughout the continent.

Section 4 presents a framework for evaluating alternative approaches for promoting fertilizer use. Benefit-cost analysis is the foundation of this framework, incorporating alternative perspectives on the set of objectives, outcomes, and impacts that should be counted, length of run issues, attention to general equilibrium and external effects, and assumptions about the way the economy operates. One purpose of this section is to make explicit the range of factors that often lead to differing conclusions about appropriate strategies for promoting fertilizer use in Africa.

Section 5 provides a typology of approaches to fertilizer promotion that have been tried in the past in Africa, and briefly reviews the empirical record of these approaches, as reported in a selected set of published studies and evaluations. Drawing upon the empirical and conceptual material of the preceding sections, Section 6 summarizes the arguments for and against subsidizing fertilizer use in Africa. Section 7 compares fertilizer subsidies to a range of alternative investments for achieving the same goal of promoting fertilizer use.

Section 8 presents conclusions and areas where consensus has not been achieved despite previous research and policy dialogue. The conclusions are limited because this paper, as a background document, was expected to be a balanced review rather than a report featuring the authors' prescriptions. Also, the e-Forum was expected to be an important source of recommendations based on the views of experienced practitioners.

There is a very considerable literature on the role of fertilizer in agricultural development, and on various types of programs and policies—especially fertilizer subsidies—used to promote fertilizer use by African farmers. Because of the short time period available for preparing the paper, our review of this literature has necessarily been selective. While we have tried to identify and review major elements of the literature, we have almost certainly omitted some important material. We assure the authors of those works that this was unintentional.

2. Rationale for increased use of fertilizer in Africa

2.1 Structural transformation and the role of soil fertility

The structural transformation paradigm has been the foundation of rural development thinking for four decades since the pioneering work of Johnston and Mellor (1961). Evidence from Asia and Latin America shows that agricultural productivity growth was an essential element of the structural transformation process that led to overall economic growth in these regions. Most current strategies for economic development in Africa take into account the structural transformation paradigm, with increasing attention being given to the need for major improvements in agricultural productivity to achieve GDP growth, food security, and poverty reduction goals (NEPAD, Millenium Development Goals, etc). The structural transformation process can be summarized as follows:

1. Movement of the economy away from subsistence-oriented household-level production towards an integrated economy fueled by agricultural productivity growth. In almost all areas where the transformation process has been documented, agricultural productivity growth has been driven by improved farm technologies, including hybrid seeds, fertilizer, and water control (Johnston and Kilby, 1975; Mellor, 1976; Gabre-Madhin and Johnston, 2002). Many functions formerly conducted on the farm, such as input production and output processing, are shifted to off-farm elements of the economy.

2. This agricultural productivity growth provides incentives for greater specialization, exchange, and the capturing of economies of scale. But not all farmers are able to benefit equally from the uptake of productivity-enhancing technology. The main beneficiaries are generally the top one-third of the rural population with relatively large landholdings, capital assets, and access to markets, who can profitably use the improved farm technology and translate it into higher incomes.

3. Income growth among this top one-third (roughly) of farmers translates into increased demand for hired farm labor and for goods and services off the farm. More subsistence-oriented farmers who have been unable to use the new technology profitably, and increasingly become uncompetitive and marginalized. They face incentives to migrate to fill the demand for farm labor by the top strata of farmers, and to seek employment opportunities in the rural and urban non-farm sectors, in response to the rising demand for non-farm goods and services fueled by agricultural income growth.

4. As labor shifts over time from farm to off-farm activities, an increasing proportion of employment and economic activity is accounted for by sectors other than agriculture. The economy becomes less agriculturally oriented in a relative sense, although agriculture and, more broadly, the food system continue to grow absolutely and generate important growth linkages to the rest of the economy. Structural transformation thus involves a net resource

transfer from agriculture to other sectors of the economy, over the long term (Johnston and Mellor, 1961; Mellor, 1976).

There are many other important features of the structural transformation process, but our point here is to highlight the catalytic role of agricultural productivity growth in starting these processes. Because a substantial majority of the population in most African countries reside in rural areas and earn the bulk of their incomes from agriculture, raising agricultural incomes will be critical to raising the demand for off-farm jobs associated with the demographic transition (Mellor, 1976; Johnston and Kilby, 1975). Not all farmers in a country can be expected to adopt and sustain soil fertility-enhancing investments to initiate the processes and benefits of structural transformation, due to factors such as inappropriate agro-ecological or market conditions or household resource constraints. Nonetheless, increased productivity growth must be achieved by a large enough proportion of farmers and on a sufficiently large share of cultivated land in order to achieve the multiplier effects and demographic shifts described in point 3 above. There is widespread agreement that increased soil fertility is a necessary precondition to initiate the growth of agricultural productivity associated with the transformation process.

There is growing evidence that meeting this challenge in Sub-Saharan Africa (SSA) will require more attention to soil fertility issues than was the case elsewhere. African soils have inherent difficulties for agriculture in terms of fertility, acidity, or drainage, and land use practices during the past several decades have exacerbated the situation through nutrient mining by crops, leaching, and inadequate erosion control (FAO, 2000; Scherr, 1999); UNEP, 1997, Stoorvogel and Smaling, 1990, Pol, 1992; Smaling et al., 1997; Buresh et al., 1997; Sanchez et al., 1997; Weight and Kelly, 1999). Most agricultural scientists agree that technological change in SSA will require more attention to maintaining and/or restoring soil fertility than was the case with the Asian Green Revolution, which was stimulated by investments in irrigation and the development of improved seed varieties that were highly responsive to fertilizer. For structural transformation to take place in Sub-Saharan Africa (SSA), there is a need to better understand the role that inorganic fertilizers can play in the process (vis-à-vis other technologies) and to identify the types of policies and investments needed to stimulate cost-effective use.

2.2 Soil fertility and fertilizer use in Africa

In this section we provide some background on the technical aspects of soil fertility in SSA and their implications for agricultural productivity change and fertilizer policy. We noted above that the natural endowment in SSA tends to be less favorable than elsewhere (see Paper 2 for a summary of the key evidence behind this conclusion). Although SSA's less favorable natural endowment has been recognized for a long time, research during the past 10-15 years has drawn attention to what appears to be an alarming rate of deterioration in the quality of SSA's soil capital. The advent of the new millennium found African policy makers facing a barrage of reports suggesting that soil quality decline was approaching crisis dimensions. Among the concerns were:

- Disappearing fallows: by 2010 fallows would be totally absent in 20 African countries and represent less than 25% of arable land in another 29 countries (Angé, 1993).
- Deforestation: expanding at double the average pace of the rest of the world (FAO 2000).
- General degradation: as much as 65% of Africa's agricultural land was already degraded (Scherr, 1999); with 30% of the Sahelian degradation having been induced by human activity (UNEP, 1997).
- Highly negative N, P, and K balances (Stoorvogel and Smaling, 1990; Pol, 1992; Smaling et al., 1997).

Although the majority of research on the African soil fertility situation supports the "crisis" point of view, some recent research, while recognizing that a problem does exist, draws more moderate conclusions about the rate of nutrient depletion, the likely impacts of soil degradation on future productivity trends, and the quantities of fertilizer (organic and inorganic) needed to develop sustainable agricultural systems (for example, Barbier (1999), Dalton (1996), Snapp (1998), and Mazzucato and Niemeijer (2000)).

Authors assign varying levels of importance to the different causes of Africa's land degradation problems, but most agree that farmers' failure to intensify agricultural production in a manner that maintains soil productivity is a key component (see Bationo et al., (1998), Breman, (1998), Cleaver and Schreiber, (1994), Gruhn et al., (2000), Kessler et al., (1995), Vierich and Stoop, (1990), all cited in Mazzucato and Niemeijer, (2001)). Consequently, there is general agreement that the improvements in soil fertility needed to stimulate agricultural productivity growth, improved food security, and increases in rural incomes will require substantial increases in fertilizer use (both organic and inorganic) in combination with improved land husbandry practices.

The key questions concern how government policies and programs should be designed to most effectively achieve these substantial increases in fertilizer use. Some favor a direct approach of kick-starting fertilizer consumption growth through subsidies, while simultaneously tackling the longer-run market-, infrastructure- and management-related constraints that have limited African farmers' use of fertilizer. For example, Sánchez et al. (1997) propose a comprehensive approach for addressing the soil fertility problem, which they summarize as "a cost-shared initial capital investment to purchase P fertilizer and germplasm to grow organic inputs combined with effective micro-credit for recurring costs such as N fertilizers and hybrid seed" (p. 38). They suggest P replenishment strategies that are mainly mineral fertilizer based, with supplementation from organic inputs, and N replenishment strategies that are mainly biologically based (e.g., using leguminous tree fallows and cover crops), but with mineral fertilizer supplementation. To support these measures, they recommend provision of infrastructure and improved technologies and policies to improve the functioning of input, output, and credit markets. They argue that improved soil fertility would generate environmental and social benefits for those outside Africa, in return for which those beneficiaries should be willing to contribute to the cost of P and N replenishment in Africa.

Others favor making fertilizer use more profitable for farmers through reducing the costs of fertilizer delivery and improving the physical crop response to fertilize use, viewing the role of fertilizer within a broader context of how to improve the profitability of soil management, plant nutrition, and land management. In this framework, fertilizer subsidies could still play a role, but it is acknowledged they carry an opportunity cost in terms of investments foregone in infrastructure, crop science technology, extension, management practices, output and financial market development, etc., which might have a higher payoff for small farmers than fertilizer subsidies. We examine the rationale, pros and cons of these two basic approaches in the latter sections of the report.

3. Fertilizer use in sub-Saharan Africa

Farmers in Sub-Saharan Africa (SSA) still lag far behind other developing areas in fertilizer use. The average intensity of fertilizer use throughout SSA (roughly 9 kilograms per hectare) remains much lower than elsewhere (e.g., 86 kg/ha in Latin America, 104 kg/ha in South Asia, and 142 kg/ha in Southeast Asia, averaged over the 2000/01 and 2002/03 years).

Table 1. Fertilizer Use in Sub-Saharan Africa Compared to Other Regions

Region	2000/01	2002/03
	(Kg of fertilizer nutrients per ha of arable land)	
Sub-Saharan Africa	9	9
South Asia	109	100
East and Southeast Asia	149	135
Latin America	99	73

Source: FAO, 2004b

Since the decade of the 1980s, fertilizer use in Sub-Saharan Africa (excluding South Africa) has risen only 17%, from 1.09 million tons in the 1980-89 period to 1.26 million tons in the 1996-2000 period. Over the same period, fertilizer use intensity, defined as the kilograms of fertilizer consumed per hectare of cultivated land, rose by only 5%.

Why are fertilizer use rates so low in Africa? Kherallah et al. (2002:28-29) give the following reasons:

- Fertilizer costs in Africa are higher than in Latin America and Asia;
- Africa has a much lower proportion of irrigated land than in other continents;
- African farmers rely more on traditional crop varieties that are less responsive to fertilizers than in Asia and Latin America where modern varieties of wheat and rice are highly responsive to fertilizer;

- Most areas of Africa have relatively low population density, providing less incentive to invest in land-saving technology.

Despite the relatively dismal aggregate trends in fertilizer use in Africa, the figures in Table 1 mask great variability in fertilizer use trends within Africa. Table 2 shows fertilizer use trends for the 30 Sub-Saharan Africa for which data is available on the FAOStat website. South Africa was excluded to maintain the focus on smallholder agriculture as much as possible. The countries are subdivided by row into those with low and high fertilizer use intensity (i.e., using less than or more than 25 kg/ha of fertilizer during the 1996-2002 period), and subdivided by column into those with low and high rates of growth in fertilizer use intensity (i.e., less than or more than 30% growth in mean levels of fertilizer use per hectare) between the 1990-95 and 1996-2002 periods. Table 2 shows that between these two periods, all of the 30 countries except four from Eastern and Southern Africa remained at a low level of fertilizer intensity, but about half of the 30 countries registered rapid growth in fertilizer intensity, albeit from small initial levels in the early 1990s.

If there is an encouraging point to highlight in the overall poor performance in fertilizer use, it is that a number of countries in Sub-Saharan Africa have achieved impressive trend growth in fertilizer use per unit of cultivated land over the past decade. This trend growth will need to be sustained, increased, and expanded in geographic scope over the next several decades to stimulate the structural transformation processes and associated development benefits described in the previous section.

Table 2. Fertilizer use intensity and growth in fertilizer use intensity, by country

Intensity of fertilizer use, 1996-2002	% growth in fertilizer use intensity (kg/ha cultivated) (mean 1996-2002 / mean 1990-95)	
	< +30%	> +30%
< 25 kg/ha	Angola (0.7, -69%) Burkina Faso (5.9, -28%) Burundi (2.3, -6%) DRC (0.5, -47%) Gambia (5.2, +15%) Guinea (2.0, -4%) Madagascar (2.9, -8%) Mali (9.0, +7%) Mauritania (4.0, -64%) Niger (0.9, +5%) Nigeria (5.6, -73%) Tanzania (4.8, -47%) Zambia (8.4, -34%)	Benin (17.6, +76%) Botswana (11.8, +294%) Ethiopia (14.4, +71%) Cameroon (5.9, +77%) Chad (4.3, +93%) Cote d'Ivoire (11.8, +53%) Ghana (3.6, +68% Lesotho (23.2, +35%) Mozambique (3.2, +142%) Rwanda (1.8, +89%) Senegal (13.2, +67%) Togo (7.0, +30%) Uganda (0.6, +237%)
> 25 kg/ha	Malawi (30.8, +9%) Swaziland (30.5, -40%) Zimbabwe (48.3, +9%)	Kenya (31.8, +33%)

Source: FAOStat website: http://faostat.fao.org/faostat/collections?subset=agriculture

Notes: Fertilizer use intensity is defined as kg of fertilizer applied per hectare cultivated to annual and permanent crops. Growth in fertilizer use intensity is defined as the percentage increase in mean fertilizer use intensity between the 1996-2002 period and the 1990-1995 period. Numbers in parentheses are mean fertilizer use intensity for 1996-2002, and the percentage increase in fertilizer use intensity as defined above.

Of the four countries using over 25 kg per hectare during the 1990s, three of them displayed moderate or negative growth between the 1990-95 and 1996-2002 periods, while only one country—Kenya—has achieved more than a 30% increase in fertilizer use intensity over this period. Fertilizer use in Kenya has risen from a mean of roughly 180,000 tons per year during the 1980s, to 230,000 tons per year during the early 1990s, to over 340,000 tons in the 1996-2003 period.[3] About 82 percent of small-scale farmers in the high-potential maize zones of Western Kenya use fertilizer; those that use fertilizer apply roughly 103 kg per hectare on maize, being comparable to mean levels in South and East Asia.[4] While it is beyond the scope of this paper to comprehensively analyze the factors driving inter-country differences in fertilizer consumption

[3]Annual data from 1980 to 2003 are drawn from the Ministry of Agriculture, Government of Kenya.

[4]These findings are derived from nationwide household surveys conducted by the Tegemeo Institute of Egerton University in 1997, 2000, and 2002. More detailed analysis of Kenya's fertilizer market development policy, fertilizer use trends, fertilizer prices and marketing margins are contained in Omamo and Mose (2001), Freeman and Omiti (2003), and Jayne et al. (2003).

trends in Africa, we feel that debates over the most effective ways to promote fertilizer use in Africa may be meaningfully informed by studying the areas of Africa where fertilizer use has risen impressively over the past decade and in previous decades.

4. Conceptual framework for designing fertilizer promotion strategies

4.1 General framework

The literature on why and how to promote fertilizer use in Africa reflects different perspectives on the objectives being sought through the use of agricultural policy instruments, and different assessments of their impact, costs and returns (see Box 1). Assumptions underlying a given argument or analysis are sometimes unstated. This makes it difficult to evaluate the validity or applicability of conclusions or recommendations that are advanced.

To provide a useful conceptual framework for thinking about why and how to promote fertilizer use in Africa, we first suggest a statement of the general policy problem or goal that we feel nearly everyone would accept. Second, we outline the various elements of the policy decision model that analysts or policy makers may conceptualize in different ways, on the basis of which they may reach different conclusions about the best way to promote fertilize use.

Box 1. Different Perspectives on Fertilizer Promotion Programs

Different disciplinary perspectives often come into play when evaluating the benefits and costs of alternative fertilizer promotion programs. The **economist** tends to focuses on net income at the individual and the national level. Economic impact is defined as net increases in national income, i.e., real productivity increases that occur when the value of output (yield times price) rises by more than the value of inputs used. The stream of such productivity increases over time is discounted and expressed in present value terms. If public benefits (also referred to as economic or social benefits) exceed private benefits (also referred to as individual or financial benefits), subsidies may be appropriate to allow full public benefits to be realized (Boadway, 1979:119).

The perspective of other disciplines evaluating the pros and cons of alternative programs to promote agricultural intensification would be different from the economist's perspective presented in the previous paragraph. It is important for an analyst to understand these different perspectives and attempt to reconcile them. For example, an **agronomist** or **soil scientist** might focus on nutrient balances and other physical measures of soil fertility. A particular input or input promotion program might be judged by its ability to maintain (or increase) soil nutrient stocks and levels of soil organic matter. The benefits of stocking nutrients and organic matter in the soil might be taken as given and nutrient stocks might be valued using the prevailing cost of N, P, and K fertilizers. (Alternatively, depletion of nutrient stocks may be taken into account as a cost and valued at prevailing fertilizer prices.) Unlike the economist, the agronomist or soil scientist would not necessarily value the nutrient stocks in terms of future productivity (e.g., the future yield impact due to changes in physical measures of soil fertility).

An **environmentalist** might have a third perspective, focusing on resource and ecosystem preservation. As with the agronomist or soil scientist, impact might be evaluated exclusively in terms of physical indicators, without translating them into economic terms or expressing them in present value terms. Some environmental resources may be considered to have intrinsic benefits for which quantification and monetary valuation are inappropriate (e.g., preservation of certain species, or of culturally significant sites).

The main differences among these three perspectives, then, concern the types of costs and benefits that are counted, the degree to which the contribution to future productivity (e.g., yields) is quantified and valued in monetary terms, and the extent to which the concept of discounting future benefits (i.e., giving future benefits less value than present benefits) is incorporated.

Adapted from Crawford and Kelly (2002)

Fundamentally, the policy problem is to choose the most cost-effective set of investments for achieving an agreed upon set of objectives. This implies that we have defined an objective function, a set of alternative investment or policy choices, and a set of constraints including resource availability. Implicit in these choices is a particular view of how the economy responds to alternative policy or investment choices.

We believe that nearly everyone would be prepared to accept the above statement of the policy problem *in principle*. The controversy, of course, relates to how the objective function should be defined (objectives to include, weights to use on different types of objectives, time horizon and discount rate), how alternative policy and investment choices affect the objective function, and what constraints are considered. (For further discussion, see Box 2.) In addition, analysts who agree on the content of the objective function may still disagree on the nature and effectiveness of approaches to maximizing it.

Box 2. Defining the Policy Problem

With respect to the **objective function**, what should be counted? Should social, political, and environmental as well as economic objectives be included? If there are multiple types of objectives, how should they be weighted? How should impacts with respect to each type of objective be valued? This includes both the valuation of nonmonetary impacts and the decision about the use of economic or financial prices. For example, if a fertilizer subsidy program is successful in promoting fertilizer use in remote areas where the cost of supplying the fertilizer exceeds the additional value of the crop produced, what weights should be put on the various arguments in the objective function relating to social equality, poverty alleviation, and economic efficiency?

What do we assume about the **resources available** for implementing the alternative interventions, and their costs? This includes not only supplies of inputs and other material resources, but also a judgment about what level of funding governments and donors are willing and able to provide.

Regarding the **decision rule**, since resources are limited it would be natural to use "cost-effectiveness" as a criterion for determining the appropriate set of interventions. In a world of scarce resources, this means maximizing the benefits obtained from a given set of resources. Political, social, or organizational limitations can be incorporated either as constraints or in the definition of the decision rule (e.g., pick the set of investments that maximizes national income providing that small farmers in Region X receive at least 75% of the benefits).

4.2 Specific guidelines

This section reviews the types of objectives articulated for previous programs in Africa. It takes a "positive" orientation based on views expressed in the literature rather than a prescriptive or normative one.

a. A given organization, project, or country strategy may not address all of the objectives of a fertilizer promotion program that have been discussed in the literature. We do suggest, however, that a broad perspective should be used in assessing the requirements and the impacts (costs and returns) of alternative interventions. This implies:
    1) going beyond a static analysis to take into account dynamic effects
    2) considering, in at least a qualitative sense, the general as well as partial equilibrium effects
    3) addressing social, political, agronomic, and environmental as well as economic dimensions of the issue.[5]

b. Related to the previous two points:
    1) taking a systems perspective rather than focusing only on one or two actors or levels in the system

[5]Unless non-economic objectives are explicitly excluded from the objective function, it is desirable to identify and report all impacts—at least in physical or qualitative terms—so that policy makers have the most complete information available with which to make a decision.

2) taking into account, at least qualitatively, national, regional and global impacts as well as sub-national or farmer/trader-level impacts.

c. Valuation of the impacts of fertilizer promotion programs or policies should be done in terms of economic (or "social") prices, not just financial prices. Financial analysis based on actual prices paid or received has a role to play in assessing incentives for those affected by the program or policy, or assessing credit needs. However, the value of the intervention to society or to the national economy should be assessed in terms of economic prices, based on opportunity cost and real resource use.[6] This distinction between financial and economic prices is familiar to many, but is not always clearly maintained in discussions of input promotion programs. This can make it difficult to determine whether statements about profitability or net benefits are based on financial (perhaps subsidized) prices or economic prices. Nor it is clear what economic prices really are - they are not observed and may be subject to debate over what should be taken into account in their computation.

d. The assumption one makes about the "counterfactual," i.e., what would have happened in the absence of the input program, must be made explicit since that determines the baseline against which to measure the incremental impact of the input promotion program or policy. The counterfactual may embody a rising or falling trend rather than the common assumption of no change over time.

4.3 Typical objectives of input promotion strategies

The objectives of input promotion strategies have typically been articulated in the following terms:[7]

a. To boost agricultural productivity by reducing the cost and/or increasing the supply of inputs and increasing the quantities of inputs used. Intermediate objectives often proposed as ways of achieving this overall objective include the following (Ellis, 1992:127-128):
   1) To compensate for the adverse impact of other policies affecting price incentives;
   2) To foster learning by farmers, e.g., to overcome their under-valuing of the returns to new inputs, owing to risk aversion or lack of information; [see fnote 22]
   3) To avoid wrong choices concerning fertilizer types, use rates, or combinations based on trial-and-error decision making by farmers (although an improved understanding of farmer circumstances might show that the choices are not necessarily wrong);

[6]Of course, determining economic prices is not always straightforward. Their definition and method of calculation can be a matter of considerable debate.

[7]This section draws on Crawford et al. (2003).

4) To create a competitive fertilizer supply system where the use of fertilizer is thought to be profitable or contribute effectively to other important objectives yet private markets are non-existent or inefficient;
5) To combine input delivery with credit provision to alleviate the working capital constraint;
6) To support the domestic fertilizer industry by encouraging use of local fertilizer types, which may otherwise not be competitive with imports.

b. To arrest or reverse the decline in soil fertility caused by low fertilizer use and infrequent fallowing. Relatedly, to reduce the incentives that households with infertile land may have to move into marginal or forested areas thus causing land degradation and deforestation.
c. To alleviate poverty, or to raise productivity and incomes in particular regions.
d. To improve food security or nutrition, or more generally to reduce the risks and vulnerability faced by poor households.
e. To address social or political objectives, such as national food self-sufficiency, or the desire to support a domestic fertilizer production industry.
f. To maintain political power, e.g., by channeling benefits to politically important individuals or groups, such as urban residents.
g. To complement other parts of an emergency or disaster relief program.
h. To replace government-run programs by programs managed by NGOs or farmer groups, or to establish a private sector marketing system that would ensure similar functions.

These objectives can be grouped into five categories:

a. Financial: increases in the net income of farmers, traders, or other participants in the agricultural economy;
b. Economic: increases in real income for the economy or society overall, taking into account (at least in principle) positive and negative externalities (such as those related to environmental impacts) and linkage or multiplier effects,[8] and valuing costs and benefits in terms of opportunity cost rather than financial prices (which may be affected by taxes or subsidies).
c. Environmental: contributions to environmental objectives that are difficult to express in terms of economic gains, or that are regarded as having intrinsic value. The goal of

[8]Examples of externalities, in the classical sense of effects on others' productivity or utility that do not work through the price system, are negative pollution effects of fertilizer manufacture or intensive use, or positive contributions of fertilizer use to reduced rates of deforestation or encroachment onto marginal lands. Agricultural intensification could generate backward or forward production linkages or consumption linkages, e.g., expenditure multiplier effects associated with the real income increases created by increased demand for wage labor or reduced food prices. These dynamic linkage effects, which do work through the price system, are appropriately viewed as general equilibrium effects that should ideally be taken into account when evaluating the costs and benefits of alternative agricultural development strategies.

restoring soil fertility, for example, may be considered by some as a desirable end in itself, regardless of its economic implications.

d. Social: improvements in indicators of welfare that are difficult to quantify and value in monetary terms. Examples are objectives (d) through (g) above. Another common social objective focuses on equity, i.e., the distribution of benefits and costs, as distinct from the magnitude of net benefits. Thus, the objective of an inputs program might be poverty alleviation or improving incomes in certain geographical regions.[9]
e. Political: while the political balance is potentially affected by any change in the level or distribution of benefits as a result of government intervention, some programs may be designed deliberately (if not explicitly) to build political support. Often this involves benefitting some group(s) at the expense of others.

If multiple objectives are being addressed, e.g., some mix of economic and social objectives, then the assessment of overall effectiveness will depend on how the different objectives are weighted by decision makers.

4.4 International Fertilizer Development Center (IFDC) framework

Is the appropriate design of fertilizer promotion programs dependent on a country's particular stage of development? The IFDC's *Strategic Framework for African Agricultural Input Supply System Development* (IFDC, 2001) characterizes input market development in terms of four stages, which serve as part of the context for designing input market development programs:

Stage I: Subsistence. Improved varieties, chemical fertilizer and pesticides are generally not available. Farmers retain their own seed or exchange seed of poor quality and low yield. They rely on manure, crop residues and burning to maintain soil fertility.

Stage II: Emergence. Improved varieties, chemical fertilizer and pesticides emerge, especially for export crops. Both public and private sectors start input distribution, but farmer-retained seeds represent the bulk of seed used, especially for food crops. Formalized costly and inefficient government-controlled credit systems are often introduced.

Stage III: Growth. Food crops are increasingly commercialized. Modern seed, chemical fertilizer and pesticide use spread with both the private and the public sectors involved in procurement/ production and distribution. Resources are increasingly available, but informal financial arrangements remain dominant.

[9]In a standard benefit-cost analysis, benefits gained by poor households from increased wage earnings or lower food prices would be assigned the same weight as benefits realized by other groups. If poverty alleviation had a high social priority, however, a weight greater than one could be assigned to benefits obtained by poor households.

Stage IV: Maturity. The food and cash crop markets are globally integrated. Vibrant seed, fertilizer and pesticide industries develop as the private sector takes the leading role with ancillary support from the public sector in specified tasks. Farmers use higher levels of fertilizers and pesticides, and are very knowledgeable about fertilizer attributes and requirements, timing and methods of application. Requirements are refined and dealers provide informal extension services. The financial sector deepens and broadens its asset base and lending capacity. Financial links with foreign countries are strengthened, and the importance of informal financial arrangements decreases.

The current environment of most Sub-Saharan African countries is generally characterized by Stage I, II, or III (in cases such as Kenya, Zimbabwe, Zambia, and Malawi). The IFDC framework (IFDC, 2001:viii-ix) also proposes the following principles for the design and implementation of input market development programs:

a. Agricultural input markets should be developed in a holistic framework, recognizing that:

    - Farmers' effective demand is the ultimate driving force of input supply systems, but farmers are part of the total agribusiness system whose performance depends on the system's weakest link. This statement reflects a recognition that financial profitability of fertilizer use by farmers is the foundation of a sustainable fertilizer promotion strategy, and that the profitable use of fertilizer by farmers is determined by many factors, both on and off the farm, which will need to be addressed to ensure system viability;
    - Farmers and entrepreneurs "are not all the same."

b. Sustainable input supply systems are driven by <u>demand-pull</u> forces (financial profitability, level of risk, level of non-farm income). Determinants of these factors should be identified throughout the subsector. This approach differs dramatically from traditional <u>supply-push</u> strategies.

c. Input market development and fertilizer use are components of national soil fertility management strategy, not substitutes for proper soil management practices.

d. While competitive input markets are the ultimate goal, developing them is difficult. Markets can fail for a variety of reasons. However, input markets can be developed by nurturing the private sector and promoting agriculture as a business, which implies the implementation guidelines or initiatives shown in Annex A.

e. The reform process should be taken one step at a time, recognizing differences among countries, and within given countries.

5. Overview of fertilizer promotion programs

This section provides a brief historical review of fertilizer promotion programs in Africa since 1980, a description of the general types of fertilizer promotion programs that have been tried previously, and their generic pros and cons. Note that this discussion focuses on more specific program or project interventions than those whose purpose is to establish "enabling conditions" for more rapid agricultural growth, e.g., investments in agricultural research, extension, transport and communication infrastructure, institutional or human capacity building, market reforms, and macroeconomic policy changes. The issue of the importance of specific fertilizer promotion programs relative to investments in creation of enabling conditions will arise later in the paper, especially in sections 7 and 8.

5.1 Historical review

Kherallah et al. (2002:34-39) describe the evolution of fertilizer policy and marketing arrangements in Africa.[10] The pre-reform period in the 1970s and early 1980s was characterized by five types of fertilizer policy or program interventions:[11]

a. Government-controlled imports and distribution, usually through state enterprises. State monopolies existed in 30 of 39 countries surveyed by FAO in the mid-1980s (FAO, 1986).
b. Imposition of price controls and subsidies on the retail price of fertilizer, partly in response to increased N prices following the oil price shock of the mid-1970s. Explicit subsidies ranged from 10-80% of full cost.
c. Provision of credit to farmers for fertilizer purchase, with repayment often required through state marketing agencies. Interest rates tended to be negative in real terms, and most credit was received by estates, large farmers, or commercial cash crop growers, not small farmers.
d. Fertilizer provided as aid-in-kind by donors, often making up all or a substantial part of fertilizer imports.
e. Incentives for fertilizer use stemming from exchange rate and trade policy. Overvalued local currencies provided an implicit subsidy for fertilizer imports, which were also sometimes given preference in allocating scarce foreign exchange.

[10] An informative summary is contained in their Table 3.5, pp. 40-43.

[11] Reasons for these policies given by Kherallah et al. (2002:39) include: suspicion of traders and optimism about the capacity of state agencies; the assumption that efficiency required large-scale "modern" transport; use of parastatals in order to facilitate credit recovery; availability of donor funding for state-organized activities; and opportunities for patronage created by state enterprises.

In the mid-1980s and 1990s, governments began to reduce or eliminate fertilizer marketing controls and phase out fertilizer subsidies. To summarize the considerable literature on these reforms:

a. Reasons for reforms included the fiscal burden of subsidies, recognition of the limitations of central planning approaches, pressure from international organizations such as the World Bank and IMF, and changes in macroeconomic and trade policy, e.g., import liberalization and market-determined exchange rates (Jayne and Jones, 1997; Kherallah et al., 2002).
b. Other reasons for reforms that pertain specifically to the fertilizer sector included chronic problems of late or insufficient delivery of fertilizer; realization that subsidies intended for the poor were captured mostly by larger farmers; and the declining relevance of the argument for subsidies as a compensation for food price controls and export crop taxes once export and food crop markets became liberalized (Kherallah et al., 2002:44).
c. Along with phase-out of subsidies, fertilizer imports and distribution were opened up to the private sector, the financial system and credit programs were given a greater market orientation, and exchange rate depreciation removed much of the implicit subsidy on fertilizer imports (Kherallah et al., 2002:44-45).

A typology of fertilizer promotion programs is presented in the next section, and summarized in Table 3, located at the end of section 5.2. Our aim is to briefly highlight the main institutional features and their basic strengths and weaknesses, without attempting to be exhaustive.

5.2 Typology of fertilizer promotion programs

As noted at the outset of section 5, this discussion focuses on specific program or project interventions, not on investments in creating “enabling conditions” for stimulating agricultural growth.

5.2.1 Controlled state input distribution programs

The basic feature of this model is a controlled system of input and output marketing in which the state distributes fertilizer and other inputs (often on credit) to farmers and recoups the input loan at harvest time when the farmer sells crops to the state or its agents. Seasonal finance, input delivery and sale of output are interlinked through state control of the input and output markets. Generally, input subsidies are applied broadly to reduce the market price of fertilizer without attempting to target subsidies to specific groups. Variants of this basic system were implemented in much of Asia during its “green revolution” phase, and by African countries such as Kenya, Tanzania, Malawi, Zimbabwe, and Zambia in the 1980s until their implementation of structural adjustment policies. The empirical record of these programs in Africa is described in Kherallah et al (2002); Jayne and Jones (1997); and Donovan (1996). Fertilizer subsidies were an important feature of this model except in the case of Kenya.

Pros: In many African cases, and for brief periods of time, this system successfully increased fertilizer use and food output by farmers, especially in more remote areas where fertilizer use was otherwise unprofitable. Multiplier effects from broad-based farm income can help initiate structural transformation processes as long as the system can be financially sustained.

Cons: Past experience indicates that these systems are difficult to sustain. The subsidies involved in stimulating fertilizer use (both through broadly applied fertilizer subsidies, output market price support, and non-repayment of credit, which effectively subsidizes fertilizer more so than official price levels would indicate) can create fiscal pressures, macroeconomic effects, and the potential breakdown of the system. Inefficiencies in government operations can induce farmers to side-sell farm output to parallel markets, thus exacerbating marketing boards' operating losses and causing greater difficulties in recovering input loans. Unless external financing is available to underwrite these operations, these systems have been difficult to sustain over time. These problems were endemic in most sub-Saharan African countries that attempted to implement this model of fertilizer promotion and were mostly discontinued in the face of fiscal crises.

5.2.2 Targeted government input distribution programs within a open market environment

This approach attempts to define a more truncated and financially sustainable role for public sector fertilizer distribution, by targeting input subsidies to selected farmers, while allowing the private sector to freely distribute inputs on commercial terms. State distribution programs may attempt to target farmers lacking the income to purchase fertilizer at market prices, while the private sector reaches farmers with commercial demand. This approach has been pursued in countries such as Zambia, Nigeria, and Zimbabwe during the 1990s up to the present.

Pros: If input subsidies can be effectively targeted to farmers lacking effective demand, this approach can raise overall fertilizer use and potentially contribute to both productivity and poverty alleviation objectives.

Cons: In practice, targeted government input distribution programs in Africa have generally been unable to effectively channel fertilizer subsidies to relatively low-income farmers (Govereh et al., 2002; Kherallah et al., 2002). To the extent that subsidies are captured disproportionately by relatively influential and high-income farmers, the objectives of poverty alleviation and productivity growth for relatively disadvantaged farmers are compromised. Moreover, to the extent that subsidized fertilizer is acquired by farmers with effective demand who otherwise would have purchased fertilizer from the market, the operation of government input distribution programs can erode the commercial demand for fertilizer that is necessary to develop well functioning private input delivery systems (Govereh et al., 2002).

5.2.3 Sasakawa Global-2000 programs

In the 1990s, the Sasakawa/Global 2000 Program (SG-2000) initiated a series of joint programs with African governments to demonstrate that substantial productivity increases could be achieved when farmers were given appropriate extension messages and agricultural inputs were delivered on time at reasonable prices. Pilot programs were set up, typically in relatively productive areas, to provide credit, inputs, and extension assistance to participants willing to establish half-hectare demonstration plots on their own land. After several years, participating farmers "graduate" from the program and are expected to continue using the productivity-enhancing technical package on their own. Over time, other farmers learn from the participating farmers, adopt their input use and management practices, and the technology diffusion process takes off. SG-2000 programs were implemented in a number of countries during the 1990s, including Ethiopia, Mozambique, Uganda, and Ghana.

Pros: Assessments by Howard et al. (1999; 2000) in Ethiopia and Mozambique indicate that farmers could significantly increase maize yields through the application of the recommended improved seed and fertilizer package, if inputs are delivered on time and crop management recommendations are followed. The input/management practices were found to be financially profitable in most of the agro-ecologically suitable areas of Ethiopia where pilot programs were initiated and evaluated. In these areas of Ethiopia, the increase in fertilizer use has been largely sustained through continued input distribution programs coordinated by the state but ostensibly implemented by private holding companies (Jayne et al., 2003). The Mozambique evaluation provided a more mixed picture of financial profitability of the high-input fertilizer package, where only one of the three sites evaluated showed that the high-input technology was superior to alternative low-fertilizer technical packages (Howard et al., 2000).

Cons: The main challenge of the SG-2000 programs has been how to sustain the progress made by farmers after they "graduate" from the program. Specifically, because the SG-2000 programs provided the package of fertilizer and improved seed on credit, and sometimes reduced farmers' output price risk by providing a floor price for crop sales, it became evident that the programs' ability to sustain the momentum depended on the development of viable and sustainable input distribution systems, output marketing systems, and financial systems that provide the services to farmers that the implementing agency provided during the initial "pilot phase". After experiencing impressive yield gains during the pilot period, farmers in most areas reverted back to old low-input practices because the "second generation" investments in input, crop and finance marketing were not in place, sometimes because the high-input technology was not financially profitable and hence did not generate effective demand for the input package.

5.2.4 Outgrower or cooperative programs with interlinked input-credit-output market transactions

In this model, an outgrower company or cooperative links together seasonal finance, input delivery and output marketing, similar to the controlled government programs described in section 5.2.1 (Dorward, Kydd, and Poulton, 1998). Farmers apply to become members of the outgrower company; membership makes them eligible to receive inputs on credit, farm management advice, and an assured output market for particular cash crops. In return, farmers agree to grow the particular cash crop in accordance with advised management practices, and sell the commodity to the outgrower company. Examples of this model are the coffee cooperatives and sugar outgrower schemes in Kenya, and the integrated cotton outgrower arrangements in Zambia, Mozambique, and Zimbabwe.

> *Pros:* Interlinked market transactions can improve coordination and reduce risks, just as an effective state-led input-credit-output market system can. The main difference is that the outgrower company is run on commercial terms, less prone to political interference, and hence there is little or no subsidization of inputs. This can be done while still providing incentives for farmers to stay in the system because these schemes are generally sited in areas where the particular cash crop is productive and is a financially viable proposition for most farmers. This helps maintain the sustainability of the operation for both farmers and the outgrower company. Also, there are documented cases of spillover effects, whereby the cash crop scheme can facilitate increased input use on food crops for participating farmers (Dione, 1989; Govereh and Jayne 2003; Jayne, Yamano and Nyoro, 2004).
>
> *Cons:* The sustainability of this system requires that the outgrower company represents farmers and their interests. Where outgrower companies' or cooperatives' boards of directors have reflected interests other than farmers, management and operating cost structures can become uncompetitive and erode incentives for farmers to remain in the scheme. Some coffee cooperatives and sugar companies in Kenya have faced this problem. The outgrower arrangement also requires that the output market is effectively controlled by the firm, so that farmers do not side-sell their commodity and cause problems of credit non-repayment. Competition between firms has in some cases exacerbated credit repayment problems for outgrower companies providing inputs to their farmers on loan, which has in some cases led to outgrower companies exiting the market (Govereh et al., 2000; Tschirley, Zulu and Shaffer 2004).

5.2.5 Public sector facilitation of private sector fertilizer supply

This approach to fertilizer promotion features a public goods investment approach to supporting private sector entry and investment in the fertilizer sector. The general strategy is to improve the demand for inputs by farmers and the incentives for private companies to serve farmers' needs by engaging in activities that reduce the costs of agricultural production and marketing, e.g., investing in roads, port facilities, and other forms of market infrastructure, improving

agricultural production and marketing extension services, investing in more fertilizer-responsive seed varieties, and supporting a conducive banking system for financing large-scale transactions. This approach has to a large extent been pursued in Kenya since the government reformed its fertilizer marketing system in 1993. By 1993, prices were decontrolled, donor imports dwindled to 5 percent of total consumption, and small-scale farmers relied almost exclusively on the private sector and cooperatives for fertilizer. In a number of other African countries, governments have ostensibly liberalized their fertilizer markets, but have continued to run government input distribution programs that reduce the size of the market for private firms, and/or invest very little in public goods designed to facilitate investment in the fertilizer sector.

Pros: There appears to be great variability in outcomes associated with this model, which may be related to inability to control for differences in implementation within the set of countries adopting this general approach. In the case of Kenya, there appears to have been a very rapid private sector response. Allgood and Kilungo (1996) report that by 1996, there were 12 major importers, 500 wholesalers, and roughly 5000 retailers distributing fertilizer in the country. IFDC (2001) estimates that the number of retailers rose to between 7000 and 8000 by 2000. Some of the largest importers were cooperatives and estate firms supplying their members, most of whom were small-scale farmers participating in tea, coffee, and sugarcane outgrower schemes. Several studies indicate that the market is generally competitive, particularly at the retail level (Argwings-Kodhek, 1996; Omamo and Mose, 2001; Wanzala et al., 2002). Fertilizer consumption has increased substantially, rising from roughly 230,000 tons in the early 1990s to over 350,000 tons since the 2001/02 season.

Cons: The system relies on the ability of the public sector to invest in a range of cost-reducing public goods, which are very expensive and most likely require major donor support for a number of years. Most farmers in the drier and less fertile parts of the country cannot use fertilizer profitably and hence must rely on other sectors such as livestock and non-farm employment as engines of growth, or other forms of assistance. A well-functioning banking system for financing fertilizer purchases must also be in place.

5.2.6 Starter pack programs (Malawi)

The “Starter Pack” program and its successor, the “Targeted Inputs Programme” (TIP) have been implemented by the Government of Malawi with financial assistance from numerous donors since the 1998/99 season. In its initial years of operation, the program provided almost every rural smallholder household with a free “pack” consisting of 15 kgs of fertilizer, 2 kgs of hybrid maize seed, and 1kg of legume seed. The inputs were sufficient for cultivation of 0.1 hectares according to extension recommendations (Oygard et al., 2003).

The Starter Pack program was intended to meet several objectives: increasing maize yields and food security, countering soil nutrient depletion, and making a new line of fertilizer-responsive semi-flint hybrids available to small farmers who otherwise might not take the risk to experiment with them. The Starter Pack program was originally conceived as a technology-based plan that

was cheaper than importing maize, but in later years it and its successor TIP program have doubled as a relief effort. The program demonstrated the government's efforts to "do something" to help rural households, and Levy (2003) concludes that the program contributed to the re-election of President Bakili Muzulu in 1999 (cited in Oygard et al., 2003).

Pros: During its initial years when every household nationwide was a recipient, the Starter Pack program was clearly able to put improved technology in the hands of poor farmers who otherwise would not have been able to afford these inputs. Consequently, and at least for the several years while the program operated at this scale, rural households' food security and income position was improved (Levy and Barahona, 2002; Cromwell et al., 2001; Oygard et al., 2003). Fertilizer importers appreciated the program because it purchased fertilizer from established importers rather than using independent channels for importing the program fertilizer.

Cons: Levy and Barahona (2002) aptly describe the Starter Pack program as neither a safety net program (according to their strict definition) nor a longer-term development program. It is something in between, a stop gap, imposing high financial opportunity costs in terms of foregone investments in infrastructure, extension, and market development that could drive down the costs of input and output marketing and thus contribute to long-run fertilizer use. After the program was scaled down to reduce the financial burden during the TIPS phase, the programs' expenditures were poorly targeted to relatively poor households, although this was a key objective (Mann 2003). The TIPS experience points out a more generalizable point about the extreme difficulties of targeting fertilizer subsidies with the local and national political economy contexts found in much of Sub-Saharan Africa.

Table 3. Typology of Fertilizer Promotion Strategies

Category	Example	Pros	Cons
State-led interlinked credit-input-output markets	Zimbabwe, Zambia, Kenya (1970s and 1980s)	1. Can promote fertilizer use and farmer income growth, particularly in relatively remote areas	1. Financially difficult to sustain due to high treasury costs 2. Economic cost of supplying fertilizer often exceeded additional value of crop produced
Targeted government fertilizer distribution programs	Zimbabwe, Zambia, Nigeria (1990s to present)	1. If programs are targeted to small farmers lacking effective demand, these programs can raise productivity and contribute to poverty alleviation objectives	1. Benefits are often captured by relatively well-off farmers, not the poor 2. Difficulties in targeting can crowd out private sector investment and retard development of commercial input delivery systems
SG-2000	Ethiopia, Mozambique, Zambia (1990s)	1. Demonstrable positive impact on yields 2. Enduring transfer of improved farmer management practices	1. Difficulty in responding to "second generation" issues of input market development, rural financial markets, and stable output markets
outgrower company model: interlinked credit-input-output markets	Kenya sugar/tea Zambia cotton Zimbabwe cotton Moz. Cotton	1. Reasonably successful track record in improving smallholder incomes and productivity in areas where particular cash crops are viable 2. Can often be used to overcome market failures in credit and input supply to increase fertilizer use on food crops for participating farmers.	1. Eligibility requirements for participation in outgrower arrangements tend to exclude participation of poor and female-headed households 2. System can break down if side-selling of output is not effectively addressed or if management becomes captured by interests other than farmers
Starter pack program	Malawi (1990s)	1. Able to put improved technology in the hands of poor farmers who otherwise would not have been able to afford these inputs. 2. Contributed to poverty alleviation, particularly in early years when nearly all rural households were beneficiaries	1. Expensive when program was designed for universal coverage; high opportunity costs 2. Difficulties in targeting the poorest groups lacking purchasing power to afford inputs 3. Eroded commercial demand of fertilizer retailers
Facilitation of private sector investment in input delivery and finance systems + public goods investments	Kenya since 1993	1. Facilitates long run increase in fertilizer use based on development of importer-wholesaler-retailer networks 2. Policy environment supportive of long run private sector investment 3. Potential synergies between cash crop outgrower-type schemes and fertilizer use intensification on food crops	1. Fertilizer use and crop productivity remains low in semi-arid areas where fertilizer profitability is not established 2. Fertilizer use on main food crops is constrained by problems in accessing seasonal finance for food crops 3. Fertilizer use broadly correlated with household income

6. Fertilizer subsidies

6.1 Typology

Fertilizer subsidies can differ in terms of:

a. The point at which the subsidy is applied (farmer, trader, domestic fertilizer producer);
b. The form of the subsidy, or how it is provided (cash payment, voucher/coupon, reduced market price, transport subsidy);
c. Related to the above, whether the subsidy is direct (types indicated in (b) above), or indirect, e.g., through subsidized credit for fertilizer purchase (Dalrymple, 1975; Hamilton and Kunte, 1997).

6.2 Arguments for fertilizer subsidies

6.2.1 Overview

Relatively thorough nontechnical discussions of the objectives and arguments for fertilizer subsidies include Donovan (2004), Debra (2002), Ellis (1992, Ch. 6), IFDC (2003), Pender et al. (2004), and Yanggen et al. (1998).[12] A thorough presentation of the theoretical arguments for fertilizer subsidies, specifically focused on West Africa, is contained in Shalit and Binswanger (1984). The arguments may be classified into three basic categories, of which the first two are "economic" in a general sense.

a. Subsidies can provide benefits in terms of increased agricultural output and/or incomes. Arguments of this type often do not make an explicit case that the potential efficiency losses associated with subsidies will be offset by expected output or income gains. By focusing on farmer or trader profitability, these arguments tend to have a financial rather than an economic analysis perspective.

b. Subsidies can provide net economic benefits in one of two ways:
   1) by "kick-starting" a process of innovation or scale of economic activity that will increase agricultural productivity in the medium or long term if not the short term; or,
   2) by correcting missing or imperfect markets, policy-induced or otherwise. Most such arguments focus on benefits at the national level; some also focus on benefits at the transnational or global level.

[12]The more recent works tend to refer to and/or synthesize the earlier ones, so there is some overlap between them.

c. Subsidies can provide important benefits that are non-economic at least in the direct sense, such as restoration of soil fertility, improved food security, poverty alleviation, social protection, environmental protection, etc.[13]

For short-hand purposes, we will refer to these three categories of arguments as financial, economic, and non-economic. While this is not a perfect classification, we feel it will be useful to bring some organization to the following discussion of arguments for fertilizer subsidies.

6.2.2 Financial arguments for subsidies

a. To encourage farmers to use fertilizer and thereby to expand total production (Dalrymple, 1975:4). Subsidies would raise the net income from a given level of input use and move farmers closer to the profit-maximizing use level (Ellis, 1992:129).

b. To offset high fertilizer prices caused by high transport costs and limited market development (Pender et al., 2004; IFDC, 2003). Debra (2002) expresses this in terms of reducing input-output price ratios.

c. To help maintain fertilizer use in cases where fertilizer prices have risen, e.g., in response to oil price increases (Kherallah et al., 2002:39) but product prices have not risen or been raised correspondingly (Dalrymple, 1975), or when output prices have been held down to benefit urban consumers (Ellis, 1992:129).

d. To reduce credit needs, i.e., to offset the limited availability and high cost of credit (IFDC, 2003) that prevent cash-poor farmers who would like to use fertilizer from being able to do so.

e. To stimulate domestic production of fertilizer (IFDC, 2003; Debra, 2002).

6.2.3 Economic arguments for subsidies

f. To encourage farmer adoption of fertilizer, or use of optimal levels, when that is currently constrained by:
   1) Lack of knowledge of the benefits of fertilizer (Pender et al., 2004; IFDC, 2003).
   2) Risk aversion that discourages adoption of new technology or cash investments that carry financial risk (Donovan, 2004).
   3) Weak or missing formal financial markets in rural areas.

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[13]People no doubt differ in where they would draw the line between economic and non-economic benefits. Our intention in making this distinction is not to lay the groundwork for ruling out subsidies that address non-economic objectives, but rather to indicate differences in how such subsidies would have to be justified, if only through limitations on how far one can go in quantifying and valuing impacts.

These arguments usually stipulate that fertilizer subsidies designed to overcome knowledge and risk aversion constraints are expected to be temporary, and removable once farmers have had experience with fertilizers (e.g,. Ellis, 1992).

g. To offset policy-induced market distortions that increase input costs or reduce output prices relative to their free-market equilibrium levels. Cases mentioned here include:
   1) Export taxes or other explicit or implicit taxes on agriculture (IFDC, 2003).
   2) Subsidies on developed country agriculture that lead to unfair competition with agriculture in developing countries (Pender et al., 2004).

h. Related to the above, to offset transaction costs and risks associated with institutional weakness and market failure that otherwise keep farmers in an "under-development trap" (Dorward et al., 2004:2).[14]

i. To offset the social costs of soil fertility depletion which do not enter farmers' financial calculations, such as the following (Donovan, 2004; Gladwin et al., 2002):
   1) Loss of carbon to the atmosphere, contributing to global warming.
   2) Increased soil erosion reducing the quality of downstream water supplies.
   3) Deforestation and loss of biodiversity from acreage expansion.
   4) Consequent reductions in national food security, and increases in poverty, migration to urban areas, urban unemployment, and social unrest.

j. To stimulate domestic food production in cases where that is a lower-economic-cost alternative to food aid or food imports.[15]

k. To shield farmers or consumers from the risks associated with volatile world market prices (IFDC, 2003; Debra, 2002).[16]

6.2.4 Non-economic arguments for fertilizer subsidies[17]

l. To offset the unfair competition resulting from subsidies on agriculture in developed countries (Pender et al., 2004).[18]

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[14]Two examples discussed by Dorward et al. (2004) are coordination risks and risks of opportunism.

[15]This argument has been made recently. As an example, the short paper by Sachs (2003) is discussed in section 7. Other discussion of the validity of this argument can be found in the literature on the Malawi Starter Pack program; for a brief example, see Levy et al. (2004).

[16]IFDC (2003) notes that subsidies used for this purpose would, in the long run, prevent prices from "acting as resource allocation signals" (p. 15).

[17]One of our colleagues has suggested that all of the arguments in this section could be considered economic arguments in a political economy framework. See the footnote to point (c) in section 6.2.1.

m. To use subsidies on inorganic fertilizers to address the problem of soil nutrient depletion (Donovan, 1996). Specific arguments mentioned in (Pender et al., 2004) include:
   1) Solving the problem with organic fertilizers is infeasible or uneconomic.
   2) Severe nutrient depletion threatens the livelihoods of the poor.[19]

n. Related to m(2), to promote income distribution goals (Debra, 2002), to the extent that fertilizer subsidies are intended to benefit poor farmers.

6.2.5 Extended discussion of economic arguments for fertilizer subsidies

In this section, we present a more complete discussion of (a) the general basis for economic arguments for subsidies, and (b) the validity or situational applicability of certain specific arguments listed above.

General economic argument

In the first-best world of perfectly competitive markets, the introduction of subsidies results in economic inefficiency and net welfare losses. Departures from the conditions of perfect competition, however, may provide a rationale for public intervention, as discussed in any text on public economics (Boadway, 1979:119; Gramlich, 1990:Ch. 2).[20]

An example relevant to the fertilizer use issue is the existence of externalities, defined as benefits or costs stemming from a market transaction that are not received or paid for by those making

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[18]We treat this as a "non-economic" argument to the extent that it focuses on the issue of fairness or equity, rather than efficiency or productivity.

[19]These arguments are treated as non-economic because m(1) begs the question of whether inorganic fertilizer use is economic, and m(2) refers to the equity or distributional objective. We recognize, however, that Pender et al. may have had in mind the links between resolving these problems and contributing to economic objectives, but simply did not make them explicit.

[20]As noted in Shalit and Binswanger (1984:17): " . . . independently of what price policies are used--fertilizer subsidies, price supports, or output taxes--the distortions are such that national income and welfare are reduced over what it would be with no governmental intervention. However, it must be stated, that price policy instruments are not only used for the purpose of allocating the level of production or consumption in the agricultural sector but are mainly means of extracting tax revenues that will be available to other sectors of the national economy or for investments in agriculture." It is not clear whether the authors are implying that the returns from such investments in agriculture or other sectors might be sufficient to offset the losses associated with the distortions induced by price policies.

the transaction (Gramlich, 1990:18).[21] Here, the social demand for the good will not equal aggregate private demands.

- In the case of a negative externality (e.g., water or air pollution), the external cost is not borne by producers of the good, who as a result produce more of the good that is socially optimal. Public intervention, such as a tax on producers or regulations to require less-polluting production technology, is needed to move toward the social optimum.
- In the case of a positive externality (e.g., the fruit tree pollination benefits of beekeeping), the external benefit is not received by the beekeeper, whose production is therefore is below the social optimum.

Sánchez, et al. (1997:6-7) attribute several negative externalities to soil fertility depletion in Africa. Their argument is that soil fertility depletion lowers the returns to agricultural investment and, through linkage effects, lowers nonfarm incomes and employment. This increases the problems of rural poverty, which carry over into urban areas following rural out-migration, creating broader social and political problems. Negative environmental externalities are also created when declining soil fertility reduces on-farm yields, leading farmers to expand cultivation into marginal lands or forested areas. This in turn increases soil erosion, sedimentation of downstream water bodies, and CO_2 emissions to the atmosphere (due to the loss of topsoil organic C), and reduces above- and below-ground biodiversity.

Along these lines, an argument might be made that increased fertilizer use, by raising yields and biomass on currently cultivated lands, will generate external benefits in the form of carbon sequestration, or will avoid external costs in the form of deforestation or soil degradation resulting from expansion of cultivation on marginal lands. Farmers will not receive the benefits of carbon sequestration or bear the downstream costs of deforestation and soil erosion resulting from cultivation of marginal lands. Consequently, the incentives faced by farmers lead them to use less than the socially optimum level of fertilizer.

In principle, a subsidy in this situation can lead to net welfare gains by encouraging an expansion in fertilizer use toward the socially optimal level. In practice, whether the subsidy creates net gains or net losses depends on the specifics of the situation, including the magnitude of benefits generated and the costs of implementing the subsidy scheme and providing complementary services (e.g., extension, input or output marketing infrastructure) that are needed to allow an expansion of crop output (Yanggen et al., 1998:65; Crawford and Kelly, 2002:7).

If we broaden our evaluation criterion beyond economic efficiency, e.g., to take into account the equity of income distribution, then subsidies to encourage increased fertilizer use could be justified on the grounds that the social value of improving the income distribution by channeling

[21]Other examples of market failure that may justify government intervention include missing or imperfect markets (e.g., for capital or insurance against risk) and public goods (e.g., agricultural research).

income to relatively poor farmers outweighs any efficiency losses associated with intervening in the fertilizer market Whether this is true depends partly on the weight given to the distributive equity objective, and partly (as above) on the specific magnitudes involved—amount of income effectively transferred to poor farmers, costs of doing so, etc. Moreover, if financial resources available to governments and donors are considered scarce, then the question is not whether the benefits of fertilizer subsidies outweigh the costs, but whether they represent a more cost-effective approach to achieving these benefits than alternative types of programs or public investments.

If we take a dynamic, long-run view, we might argue that the costs of fertilizer subsidies in the short run will be outweighed by the later gains resulting from a vigorous expansion of agricultural output. This is a common argument, and not unlike the general "infant industry" argument. As an example, see the discussion below of the "dynamic disequilibrium" case in Ellis (1992:137-141). Of course, the mere possibility of future gains is not enough to justify an initial "investment" in fertilizer subsidies; a thorough analysis of the likely costs and returns is needed. As Sánchez, et al. (1997:19) note in discussing their proposal for investing in soil fertility replenishment, ". . . the discounted value of the increased production, aggregated over the number of years the investment continues to provide benefits, must exceed the cost of the investment."

Specific theoretical arguments

Shalit and Binswanger (1984) present a thorough review of the theoretical basis for many of the above-listed arguments for fertilizer subsidies. Their discussion and conclusions suggest strongly that there are few general rules that are broadly applicable. The justification for subsidies depends on crop type (e.g., how fertilizer-responsive it is), agroecological characteristics, farm size, effect of fertilizer on risk, among other factors. In their conclusion, Shalit and Binswanger state (p. 37):

> The only theoretical case for a permanent fertilizer subsidy is the existence of a non-optimal tax on output for public revenue purposes. . . . The only other valid theoretical reason for fertilizer subsidies is to speed up the adoption process. However, this is a case for a temporary subsidy in a particular crop region where fertilizers are freshly introduced or where much higher doses should be applied when varieties change.

Other specific points are summarized below:

Learning

Regarding learning, Shalit and Binswanger (1984) refer to models of learning by doing (p. 31) where initially producers make "allocative errors since they are mistaken about the true values of certain parameters of the production function" (p. 31). With learning, producers adjust input levels.

Ellis (1992:136) discusses this in the context of what he calls a "dynamic disequilibrium" (cf. pp. 137-141). The problem is how to get farmers to adopt a higher-productivity technology, in this case to move from a zero or low level of fertilizer use to a higher level. Subsidies make farmers more willing and able to try higher fertilizer levels.[22]

An important issue is whether once farmers try higher fertilizer levels, they will become convinced of the benefits and will continue their adoption and use of higher fertilizer levels even when subsidies are removed. This seems likely to be location-specific, but Shalit and Binswanger (1984) argue that, especially where high-yielding varieties are available, once farmers realize that fertilizer is necessary to achieve high yields, subsidies can be removed since that should not affect adoption since " . . . once the adoption process proves successful, returning to the traditional cropping method will be economically inferior" (p. 35). Gladwin (1992) argues that women are more likely to be affected negatively by subsidy removal than men.

Ellis (1992), while noting the possibility that farmers will come to expect subsidies and exert political pressure to maintain them, nonetheless argues that once farmers have adjusted to the optimum levels of fertilizer use, phase-out of subsidies is unlikely to cause a severe fall in fertilizer use or yields (given that farmers are on the low-slope upper part of the yield-response-to-fertilizer function). Ellis cites evidence from Indonesia to support this (Hedley and Tabor, 1989; Ellis, 1990). Donovan (1996), quoted in (Yanggen et al., 1998:49-50), notes that while 16 of 29 African countries had reduced or eliminated fertilizer subsidies by 1994, fertilizer use seemed to have been more affected by other policy changes, e.g., devaluation, or by inefficient marketing systems, than by changes in subsidy rates. Cleaver (2003) states that government-distributed subsidized fertilizer programs have provided very little subsidized fertilizer to poor farmers, so that eliminating the programs rarely affected them.

Kherallah et al. (2002:50-52) present a broader discussion of the impact of fertilizer market reforms (including liberalization or privatization, subsidy removal, and movement toward market-determined exchange rates) on fertilizer prices. They argue that eliminating subsidies can cause the fertilizer price to rise less than proportionally, since (a) pre-reform prices may have been forced up by fertilizer shortages resulting from non-competitive marketing, and (b) greater competition and efficiency in post-reform markets will tend to reduce real costs of fertilizer supply. They note that the impact of exchange rate depreciation on the fertilizer-to-crop price ratio depends on whether the crop is tradable or not on the world market. Their Table 3.6 (p. 53) shows that for 10 African countries, the fertilizer-to-crop price ratios doubled for four countries (Benin, Ghana, Nigeria and Tanzania) between the early 1980s and mid-1990s, increased by at

[22] Others contend that because fertilizer has been familiar to farmers in most areas of Africa for a long time (even though use rates are low), the broad argument that fertilizer subsidies are needed to encourage small farmers to learn about their benefits is no longer justified (noted by a reviewer of this paper and argued by Elliott Berg as reported in Poulton, et al. (2005).

least 50 percent in three more (Zambia, Malawi, and Senegal), and fell in the remaining three (Ethiopia, Kenya, and Zimbabwe).[23]

Farm size and adoption

Shalit and Binswanger also cite work by Feder and Slade (1984:33) that adoption behavior varies by farm size, and note (p. 33) that unlike large farmers, very small farmers do not adopt new technology initially and do not seek to expand their knowledge about the technology. This suggests that temporary subsidies to promote learning and offset perceived risks would be more valuable for small farmers than for large farmers. However, they cite work by Just and Zilberman (1983) which indicates that whether large farmers use more or less fertilizer than small farmers depends on whether fertilizer is risk-increasing and on the nature of farmers' risk aversion.

Risk

Shalit and Binswanger (1984, pp. 23ff) discuss several questions that bear on the argument that fertilizer subsidies are justified as a way of offsetting farmers' aversion to risk. Their discussion indicates that the strength of the risk argument for fertilizer subsidies varies depending on:

- the degree of farmer risk aversion
- whether higher levels of fertilizer use increase risk
- how much of the gap between farmers' actual fertilizer use levels and the risk neutral (i.e., profit-maximizing) use level is explained by risk aversion, and
- whether countries are better at risk diffusion than private individuals.

On the third point above, they conclude, based on a review of six studies (five in Asia, one in Latin America), that:

> . . . risk aversion can explain only a small proportion of the gap between risk neutral and actual farm level use. Moreover, the impact of risk aversion—on average around 10% and not more than 17%—is not dramatic. A quite small subsidy would usually be sufficient to offset such small effects of risk aversion, but such a subsidy would probably do little to close the often far larger gaps which cannot be associated with risk aversion (p. 27).

The small impact of risk aversion cited above may be explained by the preponderance of the cases being from Asia, where improved water control may lower the risks in agriculture. As Shalit and Binswanger further note (p. 38): ". . . in the humid tropics yield risks are not that large and diversified cropping patterns usually allow for substantial risk diffusion at the farm level. In the semi-arid tropics, where risks are more severe, the lower level of fertilizer response of existing crop varieties again leads to a dismissal of the argument for a subsidy."

[23]For impacts on agricultural production, see Kherallah et al. (2002:60-66).

Food self-sufficiency

Shalit and Binswanger (p. 37) comment that the goal of increasing food self-sufficiency is "not usually economically efficient." Subject to that proviso, they indicate in Table 3 (p. 39) that fertilizer subsidies may be justified when applied in the humid tropics on crops that are highly responsive to fertilizer, but not in Sahelian countries where response is low.

Soil fertility

In discussing the argument for fertilizer subsidies to compensate for declining soil fertility, Shalit and Binswanger imply (p. 22) that mineral fertilizers and subsidies on their use would make sense only in areas of high population density (where traditional fallowing is no longer feasible) and where wages are high (justifying a substitution of inorganic fertilizers for labor-intensive organic fertilizers). Later (p. 38) they state: "No convincing case can be made to subsidize fertilizers to prevent declines in soil fertility as alternatives exist to chemical fertilizers. . . ." The feasibility of such alternatives appears to be in question, however. Pender et al. (2004) and Sánchez et al. (1997), the latter summarized in section 2.2 above, argue that application of organic material and implementation of soil conservation measures will not be sufficient to arrest soil fertility decline, without use of inorganic fertilizers as well.

6.3 Arguments against fertilizer subsidies

This section draws on Donovan (2004)—who cites IFDC (2003) and Crawford et al. (2003)—and on Pender et al. (2004), Ellis (1992), and additional material from Kherallah et al. (2002) and IFDC (2003). Arguments against using fertilizer subsidies include the following:

a. Fertilizer subsidies distort resource allocation at the farm level to the extent that they encourage (Ellis, 1992; IFDC, 2003):
    1) Excessive use of fertilizer, presumably meaning more than the profit-maximizing dose;
    2) Inefficient substitution of a scarce resource (e.g., chemical fertilizer) for an abundant resource (e.g., labor);
    3) Inefficient substitution of crops towards those that use the subsidized fertilizer.[24]
    4) Neglect of "more sustainable, profitable and promising land use practices, such as organic matter, minimum tillage and low input agro-forestry" (Donovan, 2004).

[24]Ellis (1992) also lists diversion of subsidized fertilizer from the crop targeted by the subsidy policy to other crops favored by farmers. A West African example might be subsidized cotton fertilizer being used on maize. Such diversion may not necessarily be inefficient, however.

b. Subsidies can also lead to resource misallocation in the domestic fertilizer production process, e.g., encouraging excessive use of energy and costly raw materials (IFDC, 2003:19).

c. Fertilizer subsidies are very hard to target; benefits have generally gone to the relatively well-off farmers (Donovan, 2004) or those with high cash incomes (Kherallah et al., 2002:67). Thus, input subsidies are regressive. This problem is referred to as "elite capture" by Pender et al. (2004), and Ellis (1992:133) gives the following reasons for its occurrence.
   1) ". . . wealthy clients [are] in a position to pay the 'under-the-table' costs of acquiring inputs supplies."
   2) Input delivery is linked to state credit provision, to which wealthier farmers have easier access.
   3) Bureaucratic procedures for delivering inputs "tend to favour those who can afford to persist with the paperwork or can pay others to do so."

d. A corollary to the targeting problem is that leakage of subsidized fertilizer can extend even across national borders (Donovan, 2004; Pender et al., 2004; Ellis, 1992).

e. Subsidy programs create a need for price control and rationing, which encourages rent-seeking behavior and thus increases the leakage problem (Donovan, 2004; Ellis, 1992).

f. Fertilizer subsidy programs impede the emergence or effective operation of the private sector input marketing system. Reasons cited for this include:
   1) Subsidies provided by state-run programs or enterprises take business away from private traders.
   2) Political interference and manipulation of subsidy schemes is common. The policy uncertainty and instability that this creates, along with the below-market fertilizer price, can discourage private input traders from participating in fertilizer marketing (IFDC, 2003; Jayne et al. (2003) and hence reduce farmers' overall access to fertilizer instead of promoting it.

g. Subsidy programs are costly to administer. The state-run programs or state enterprises that often implement them are governed by "non-market" rules, and their performance is likely to be sub-optimal (IFDC, 2003). A common example of this is late or unreliable delivery of fertilizer (Donovan, 2004), which can significantly reduce the yield effect of the fertilizer provided.

h. More generally, fertilizer subsidies have been financially unsustainable, and, in the words of Donovan (2004:3), "have helped bring some public treasuries near bankruptcy." For example:

1) Gulati and Narayanan(2003) state that fertilizer subsidies in India were the largest explicit subsidy in the government budget, amounting of 0.75% of GDP in 1999-2000.
2) Yanggen et al. (1998) give financial sustainability as the "principal argument against subsidies" (p. 49). Examples:
   (a) In 1993/94 in India, fertilizer subsidies were 3% of the national budget (Bumb and Baanante, 1996).
   (b) In Ghana, despite relatively low fertilizer use, fertilizer subsidies made up 3.5% of the national agricultural budget in 1980, and rose to 10.6% by 1988 (Donovan, 1996).

i. Subsidy programs, far from being temporary, have tended to create a hard-to-end dependency (Donovan, 2004). Gulati and Narayanan (2003) describe the pressure exerted particularly by domestic fertilizer producers on the Indian government to maintain fertilizer subsidies.

j. Subsidies for certain types of fertilizers may damage the soil by depleting certain nutrients or causing soil acidification (Pender et al., 2004). Moreover, Donovan (2004) notes that the argument for using fertilizer subsidies in order to avoid the social costs of soil fertility decline (cf. #9 in section 5) faces three problems:
   1) Soil fertility is only one of many factors creating those social costs (e.g., global warming, deforestation, etc.).
   2) Applying fertilizer is only one of many actions needed to address the soil fertility problem, as reflected in the integrated soil fertility management (ISFM) approach (Gruhn et al., 2000; Defoer, 2002).
   3) We do not have sufficient technical and economic knowledge to judge whether the costs of fertilizer subsidies would be outweighed by social benefits obtained from increased fertilizer use.[25]

k. The administrative costs, leakages, and targeting problems associated with fertilizer subsidies make them a very inefficient way to transfer income to the poor (Donovan, 1996).

l. Last but not least, fertilizer subsidies have been an inferior policy choice relative to other alternatives available, and do not address some of the major problems that cause low fertilizer use, e.g., supply and credit constraints to mention just a few (Donovan, 1996, 2004). Arguments on this point from Pender et al. (2004) include:
   1) The fertilizer price is not the only factor constraining demand for fertilizer.

[25] This is certainly a topic on which knowledge and data are weak, but environmental economists have devoted considerable effort and ingenuity to developing methods for this type of analysis. For a case study using a benefit-cost analysis approach, see Crawford (2002). For an analysis of the benefits of phosphate fertilization programs, see World Bank (1994).

2) Where fertilizer use is profitable, using subsidies is less cost-effective than addressing other constraints. (We would argue, however, that is a major empirical question, not a point that is necessarily true in general.)
3) Fertilizer subsidies have a high opportunity cost in terms of reducing the funds available for other valuable investments, especially including investment in public goods.

We explore this particular point in more detail in the next section.

7. Comparison of subsidies to alternative interventions

7.1 General

A large number of policies and investments have been suggested as better alternatives for achieving the goals or addressing the problems for which fertilizer subsidies have been proposed as a solution. For example, the following approaches have been suggested to reduce the cost of fertilizer and to improve its effect on yield (Donovan, 1996:64; Donovan, 2004:3, Kherallah et al., 2002):[26]

a. Helping to establish efficient, competitive markets for inputs, financial services, and outputs. Kherallah et al. (2002:72) recommend promoting regional fertilizer markets as a way of allowing importers to handle larger quantities and thereby to achieve economies of scale.

b. Reducing the high costs of fertilizer handling, port clearance, and road transportation and distribution.

c. Changing economic policies, including reducing the taxation of agriculture.

d. Investing in agricultural research, extension, and education and training to:
   1) Develop responsive crop varieties and packages of improved technologies—including fertilizer recommendations—that are affordable by smallholders and appropriate for specific local conditions, taking into account transactions costs, spatial variation in prices, and other real-world deviations from "idealized conditions of good soils, adequate water, and guaranteed prices" (Kherallah et al., 2002:73).
   2) Improve communication of fertilizer use recommendations to farmers.
   3) Enable farmers to use the information more effectively.

[26]Yanggen et al. (1998:50) note, however, that the costs of these alternatives relative to their benefits would need to be analyzed in specific country situations before one could reach conclusions about their merits.

e. Improved soil testing to sharpen recommendations for different agro-ecological zones.

7.2 Comparison of subsidies to specific alternatives

A considerable literature also compares subsidies to alternative programs or policies. Some examples follow:

7.2.1 Subsidies vs. food aid

(Sachs, 2003) essentially argues that fertilizer subsidies may be cheaper than donor-supplied food aid as a means to ensure adequate food supplies at the household level. Fertilizer subsidies save money (a) because a given expenditure on fertilizer is assumed to produce more food than that provided by the same expenditure on food aid, and (b) having farmers buy subsidized fertilizer saves the farm-to-market transport cost incurred when farmers obtain fertilizer on credit and must repay the loan through sales of food grains in off-farm markets. This argument, while making a useful point about the value of basing policy/program decisions on the relative costs of alternative interventions, depends on many debatable assumptions, including (a) that subsidies could be effectively targeted to food-deficient households, (b) that credit has to be repaid by sales of farm output, (c) that growing conditions would allow sufficient yields for the fertilizer subsidy investment to "multiply" into the total amount of food needed, and (d) that the only policy alternative to fertilizer subsidies is donor-supplied food aid. Cleaver (2003) has also noted that in cases of emergency, subsidized fertilizer cannot be substituted for food aid, since one cannot wait for the growing season.

7.2.2 Subsidies versus output price supports

Ellis (1992:135) compares input subsidies to output price supports. Arguments in favor of subsidies include:

a. They can be useful in providing a temporary incentive to boost input use;
b. " . . . for a given level of net social cost, [they] may have a greater output effect than an output price policy."

Similar points are made in Barker and Hayami (1976). Shalit and Binswanger (1984:37) state that " . . . using fertilizer subsidies on highly responsive crops will be more treasury cost-effective than to use output price support."

In favor of output price supports, Ellis (1992) argues that they distort resource use less than input subsidies because the output price increase raises returns to all factors of production in proportion, so that the farmer is not induced to use inefficient input combinations. According to Yanggen et al. (1998:49), Timmer et al. (1983) support this view that using producer price supports to induce supply response is more efficient than input subsidies. In cases of alternative combinations of input subsidy and output price support, it is probably self-evident that the net

economic effect, and the distribution of gains and losses among government, farmers, and traders, depend on the specifics of the alternatives.[27]

7.2.3 Input subsidies versus credit subsidies

Ellis (1992:136) argues in favor of credit subsidies that they assist farmers to increase the use of all cash inputs, without interfering with relative opportunity costs. Subsidized credit programs suffer from many problems themselves, however (cf. Ch. 7 in Ellis, 1992).

7.2.4 Input subsidies versus input delivery programs

Ellis (1992:147) notes that recent emphasis in the literature has been on improving fertilizer delivery and information, rather than on price policy (Desai, 1988). Nonetheless there are unresolved problems with input delivery (Shepherd, 1989), and a continuing debate on the appropriate roles of the public and private sectors.

8. Summary and conclusions

In this section, we highlight key points from earlier in the paper and present a selective overview of the conclusions and recommendations that appear in the literature we have reviewed. We also summarize knowledge gaps mentioned in the literature or areas where consensus has not been reached. We then make a few final comments.

8.1 Summary and conclusions

The phrase "promoting fertilizer use" in the title of our paper may suggest that increasing the level of fertilizer use is a primary goal independent of others. However, much of the literature, and the discussion in the e-Forum (Poulton et al., 2005),[28] makes it clear that while "promoting" or "increasing" fertilizer use may be the way the issue is often stated, this is shorthand terminology that does not reflect the appreciation by most researchers and practitioners that complementary interventions must accompany fertilizer promotion programs, and that it is not adequate simply to increase fertilizer use without regard to improvements in general land husbandry practices, the type of fertilizer recommended, and methods of application. For example, the e-Forum report notes that ". . . it is worth reiterating that increased fertiliser use should not be seen as a goal in isolation. The broader goal is healthier soils for increased agricultural productivity and food security" (p. 2), where soil health is understood to involve characteristics of acidity, structure, organic matter content, and biodiversity (p. 11). E-Forum

[27]For an example, see the illustration in Table 6.2 of (Ellis, 1992:146).

[28]Subsequent references to points made in the e-Forum should be assumed to come from this report.

participant R. Voortman stated that ". . . increasing fertilizer use per se is not what should be pursued. What really matters is the right type of fertilizer, at the right dose, at the right time, at the right place" and we would add "in combination with good land husbandry practices" (p. 17).[29]

As background for the summary of major conclusions and recommendations that emerged from our literature review, let us restate two points made earlier. First, the literature on agricultural development and soil fertility reflects a variety of perspectives or objectives depending on the training, experience, and occupational position of each author. Naturally this influences the issues that are emphasized and the conclusions and recommendations that are put forward, and increases the breadth and variability of the recommendations and priorities that are expressed. Controlling for the disciplinary background of the various authors would reduce this variability to some extent. Second, we can distinguish conclusions and recommendations that pertain to the "enabling conditions" for improving fertilizer use from those related to specific fertilizer promotion programs. In general, we found much more consensus on desirable enabling conditions than on the nature of specific fertilizer promotion interventions.[30]

Regarding strategic measures to establish appropriate enabling conditions, the literature shows reasonable agreement. For example, it is argued that rapid growth in fertilizer use will require (a) increased investment in transportation and marketing infrastructure to stimulate private sector growth, drive down the costs of fertilizer and improve farmer output prices so that fertilizer use becomes more profitable for farmers; (b) the generation and diffusion of improved seeds that are more responsive to fertilizer application, (c) better extension services and extension messages that can improve small farmers' ability to use fertilizer profitably; (d) cost-effective means to reduce the risks of using fertilizer and producing for the market, e.g., through improving the predictability and transparency of government commodity policies; (e) greater attention to institutional development (improved legal systems and contract enforcement, grades and standards, market information) and capacity-building (farmer training, development of farmer organizations); and (f) facilitation of rural financial markets to promote smallholders' ability to finance fertilizer purchases.[31]

Regarding short-run fertilizer promotion programs in general, and fertilizer subsidies in particular, there is much less agreement. In part, this is because any comparison between

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[29]Debate within the e-Forum on soil fertility issues started with contrasting views on whether Africa's soils were uniformly poor, but then moved to more of a "consensus" position, recognizing the existence of important micronutrient deficiencies in certain locations together with widespread phosphorus and nitrogen deficiencies (Poulton et al., 2005: 9-11).

[30]Perhaps this explains why there were three times as many postings related to Theme 3 (interventions to promote fertilizer use, 155 postings), compared to Theme 1 (creating an enabling environment, 54 postings)!

[31]Donovan (2004), Kherallah et al., 2002; Dorward et al., 2004, and Pender et al. (2004) are among the many sources that discuss these and other recommendations.

alternative program models tends to reveal variable patterns of performance across different criteria, thus highlighting the inevitable tradeoffs between objectives such as output increases, market development, and poverty alleviation or emergency relief, or between the types of costs that are counted, how they are weighted, and who pays for them. It is not easy to find a type of program that dominates others when multiple objectives are pursued. These issues are illustrated in the discussion of programs that involve distribution of fertilizer or fertilizer and complementary inputs such as improved seed, where productivity gains can be achieved if the program focuses on larger and more capitalized farmers, or where poor farmers can be reached through mass distribution but at the cost of lower productivity and inefficient targeting.

While programs designed to quickly expand fertilizer use in Africa through free or heavily subsidized input distribution are often motivated by the desire to address urgent problems of poverty or food security, the cure can be worse than the disease. Unfortunately, most such programs have proven to be costly, difficult to sustain, ineffective at targeting relatively poor farmers, and injurious to the development of sustainable input delivery systems.

One response to this experience is to try out new approaches that promise to be effective but with fewer negative impacts. As an example, Poulton et al. (2005) report " . . . quite broad support [among e-Forum participants] for the use of fertiliser vouchers to both assist food insecure households access fertiliser and stimulate private fertiliser markets" (p. 18). In order to improve the targeting of voucher programs, many e-Forum contributors proposed linking voucher distribution to participation in public works programs, i.e., "fertilizer for work" programs. Despite the support for such programs, issues were still raised about whether to provide cash versus fertilizer vouchers (is the objective welfare or fertilizer market development?), and about the opportunity cost of channeling funds through voucher programs as opposed to making more fundamental long-run investments. Examples of the latter that were recommended by e-Forum participants as more effective though slower-acting interventions include investments to alleviate supply-side constraints (fertilizer importation, manufacture, and marketing), and demand-side constraints (increasing the efficiency of fertilizer use, improving access to output markets, enhancing affordability of fertilizer, and strengthening land tenure security), and to "kick-start" market development.

Much of the literature on agricultural intensification in general and improved input use in particular attempts to draw lessons from experience with particular cases. Natural questions, such as those posed in the terms of reference for this paper, are "What works best? What works least well?" Any researcher or practitioner would have an opinion on this. For example, our experience in West and East Africa leads us to say that, in terms of effectiveness in promoting adoption of fertilizer-seed technologies, programs that link credit with input and output markets work best (e.g., the West African cotton systems or East African tea and sugar systems). State-led programs of this type for food crops have in most cases proven unsustainable, partly because of difficulties in controlling the output market enough to ensure credit repayment, and governance failures that often arise in the implementation of such programs. In a few cases of cash crops, parastatal agencies such as the Kenya Tea Development Authority have been

reasonably effective in linking credit, input and output markets in a manner that provides farmers with desired levels of inputs and ensures high rates of credit repayment. Outgrower and cooperative programs tend to reach the middle/upper range of small farmers, not the really poor ones. These programs work better with high-value crops because (a) profitability is more apparent to farmers, and (b) there is enough income generated to cover some costs of inefficiency and still leave enough to ensure that farmers get a reasonable return.

However, not everyone may agree that the above statements are accurate, or a useful guide for improved future progams, and the statements themselves indicate a fairly specific set of prerequisites for success. In the end, it is hard to generalize about technologies, policies, or program models that would be successful across a broad range of African countries. Indeed, as the analysis in Shalit and Binswanger (1984) shows (see section 6.2.5 above), the justification for particular policies such as subsidies varies as a function of agroecological zone, type of crop grown, size of farm, etc. Donovan (2004) notes, ". . . in Sub-Saharan Africa, there is an extremely wide variety of specific circumstances, and **no solutions should be undertaken without specifying in detail the problem being addressed**" (p. 5; bold in original). If, following Voortman's prescription, we want to enable farmers to apply the "right type of fertilizer, at the right dose, at the right time, at the right place" (Poulton et al., 2005, p. 17), this will require carefully disaggregated research, extension, and market development. As an example, consider the Soil Fertility Initiative that was launched in the mid-1990s by the FAO and the World Bank, with other international organizations. This program sponsored soil fertility assessments in selected countries, which included a review of existing data on soil fertility research and disaggregation of results to sub-national zones where possible.

With respect to policy rather than program design choices, decisions regarding the allocation of funds among alternative investments and social programs should be based at least in part on local-level empirical analysis of likely impacts and their resulting costs and benefits. It is not enough to know the tradeoffs, i.e., types of benefits and costs, associated with alternative programs or investments. To decide among them also requires some estimate of the cost and benefit magnitudes. As suggested by Pender et al. (2004), in order to make better program and investment decisions we need to "move beyond story-telling and yield impacts; [we] need more evaluations of private and social costs and benefits of different technologies in SSA" (p. 14).

With respect to fertilizer subsidies in particular, the e-Forum reports that ". . . there was much more negative comment against subsidies than positive support" (p. 17). Economists in particular tend to present lengthy lists of drawbacks or "hard lessons" of subsidy programs (Donovan, 2004).

Can one say when subsidies are warranted, and what form they should take if implemented (questions posed in the terms of reference for this paper)? Based on section 6.2 above, a general answer to the first question would be:

- (If economic growth objectives are a priority): when there is a clear prospect of significant gains in productivity in the medium to long run. This will depend on having an economically profitable technology (not just one that is financially profitable for farmers as a result of subsidies), and on having the supporting markets in place. In other words, subsidizing fertilizer use in areas where it is not economically profitable would entail a loss in national income.

- (If short-term poverty alleviation objectives are a priority): when subsidies are a less costly form of income transfer than the next best alternative (e.g., food aid).

- When the subsidy program, for whatever objective(s), can be designed in a way that has little negative impact on private markets.

Of course this just takes us back to the challenge of determining whether these conditions are likely to be met in a given situation, and what the costs and returns are relative to alternatives.

Kherallah et al. (2002:73-74) note that fertilizer subsidies could be justified on either efficiency or equity grounds in principle, but not in practice, given their poor performance. They state: "If a fertilizer subsidy program is to be economically justifiable, it should be designed (1) to preserve a competitive fertilizer marketing program, and/or (2) to provide benefits to poor farmers in a cost-effective way. It is not clear that either goal is feasible."

In Asia, fertilizer subsidies were a component of many countries' "Green Revolution" successes. However, the assertion that fertilizer subsidies should be promoted in Africa because they were important in Asia may need further analysis to take into account differences in governance and institutional capacity, differences in agro-ecology (e.g., the contribution of irrigation to the productivity and uptake of fertilizer use is an important feature differentiating Africa from much of Asia), and population densities. Experience in Africa to date has shown few if any subsidy schemes designed to promote increased fertilizer use that are reliably cost-effective and free of undesirable social, political, or institutional side effects. Yet the siren call of subsidies continues to be hard to resist; they are politically attractive, seem easy to implement, and the problems they are intended to address remain compelling at both the national and international levels.[32] At the same time, one can say that the current debate on the role of subsidies in programs to intensify agricultural production and improve food security is a step forward in that (a) it focuses on ways to improve targeting, and (b) fertilizer promotion programs are considered explicitly in relation to a range of alternative investments and policy tools, including but not limited to food aid. A danger is that subsidies are often being promoted without adequate attention to the need for accompanying improvements in land husbandry practices; without such improvements, the returns to fertilizer use will be low.

[32]The e-Forum report (p. 16) refers to calls for reintroduction of subsidies as a "cry of desperation (what else can be done to enable poor producers to access fertilisers?)"

Regarding the second question—what form should subsidies take if implemented—the literature usually gives us only goals in terms of desirable features to strive for, with few concrete guidelines for how to achieve those goals. For example, the desirable features of fertilizer subsidies, as for fertilizer promotion programs in general, include that they should be cost-effective, well-targeted, and not damaging to private markets. While such a statement may not seem to provide much of a guideline for action, it nevertheless reflects increasing recognition of the costs of poor targeting and undercutting of private sector activity by public programs. This has led to program innovations such as the use of vouchers. The UN Millenium Report also calls for "'Smart' subsidies for qualifying food-insecure farmers . . . targeted to very poor regions and translated into farm-site investments in soils, water, improved seed, and other critical needs—with an exit strategy as rural productivity and incomes rise over time" (United Nations, 2005, p. 70). Unfortunately, the above passage, while painting an enticing picture of smart subsidies, gives little guidance on what form they would take in practice and how traditional problems of elite capture and resale would be avoided.[33] Targeting remains an elusive goal. For example, a conclusion drawn in the DFID reports on the Malawi starter pack program (e.g., Levy et al., 2004) is that targeting within rural agricultural communities is politically and socially problematic, since almost everyone is "poor" and implementation of targeted programs can be more expensive than universal distribution.

8.2 Knowledge gaps

While much research and policy analysis has focused on fertilizer use and how to promote it, there are many questions on which a consensus has still not been reached, or where it is considered that more empirical study is needed. In many cases, the lack of consensus does not reflect inadequate research on the topic but different results obtained under different sets of agroecological or sociocultural circumstances—with inadequate attention to synthesizing the different experiences in terms of what works best under a given set of circumstances. In other cases, research may have been conducted in a few selected sites, without broad enough geographic coverage to satisfy the needs of SSA's diverse farming conditions—the need in this case is for more adaptive research to test the relevance of the initial findings under a variety of circumstances. In yet other cases, gaps mentioned in the literature may reflect inadequate transmission of research results across disciplines (e.g., from agronomists, environmentalists, and soil scientists to economists who need quantifiable data on yields and environmental impacts at a zone or national level in order to conduct benefit-cost analyses) or inadequate transmission of data needs (e.g., economists failing to communicate their needs to agricultural scientists). In each of these situations, the Soil Fertility Initiative's effort to support country-level studies to synthesize research results (economic, agronomic, and environmental) and develop soil fertility action plans strikes us as an important first step in identifying the relevant knowledge gaps for a particular national or sub-national situation.

[33]The e-Forum report (p. 18) suggests that fertilizer entitlements would be distributed on "smart cards." but how this would allow for better targeting than in other voucher programs is not clear.

Keeping in mind the above mentioned explanations for some already well-researched topics still being identified as "knowledge gaps", we list below a number of "gaps," many of which are drawn from two sources: Donovan (2004) and Poulton et al. (2005).[34]

Regarding soil fertility:

- How poor are African soils? A common view is that they are poor, but this is not always accepted. Donovan (2004) states this knowledge gap in terms of the need for more empirical study of the current status and trends in African soil fertility; we would add that this type of analysis needs to be done at the local level, since generalizing for an entire country or continent is unlikely to improve policy design.
- How to raise soil organic matter over time (EF, 11)?[35] More generally, what is the range of technical remedies for restoring depleted soils (Donovan, 2004)?[36]
- How to adjust fertilizer recommendations to respond to rainfall—a "surprisingly under-researched area" (EF, 13) but one where there has been some location-specific work (Kelly, 2005; Snapp et al., 2003).
- Can we say how far soil fertility can decline before it is irreversible (thus potentially creating much greater costs than just low fertility which can be remedied)? This type of information would improve economic analysis of the opportunity costs of failing to address declining soil fertility.
- Recognizing that increased fertilizer use alone is not a sufficient means of improving soil fertility, how significant are the other components of good land husbandry practices (soil conservation, water and land management, agroforestry, etc.) in terms of economic and environmental benefits, and how does the significance vary by location?

Regarding fertilizer response and profitability:

- What are the response functions for important crop-fertilizer combinations, and how do soils themselves respond to fertilizer (Donovan, 2004)?[37]

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[34]Knowledge gaps are not often identified as explicitly in the literature as they were in these two documents, so we found them especially useful. Since identifying knowledge gaps was not their main purpose, we hope we have not stretched the authors' suggestions too far.

[35]Let "EF" stand for the e-Forum moderators' report (Poulton et al., 2005).

[36]This is a topic on which much has been written (e.g., Sánchez et al., 1997; IFDC, 2000; Place et al., 2003; Weight and Kelly, 1999; Kelly, 2005), yet inevitably there will be occasions where not enough locally specific information is available to satisfy particular project design needs.

[37]In the same vein as the previous footnote, this is a topic on which much research has been carried out. A common problem is that the research results are very specific to a crop or location. A valuable exercise, then, can be to invest in synthesis and generalization of such results on a zonal or national scale. Examples of this are the fertilizer profitability analysis and fertilizer use recommendations prepared for Rwanda by Kelly and Murekezi (2000), based on a synthesis of

- In low-fertility areas, what can we say about the economic returns to increasing fertilizer use, and the complementary public investments and conservation practices that might raise these economic returns?

Regarding social costs and benefits:

- What are the social costs and benefits of different fertilizer-using technologies?
- In particular, what empirical evidence would allow us to quantity and value the "public goods" aspects of soil fertility depletion (Donovan, 2004)?

Regarding subsidies:

- How can subsidies be best administered, e.g., through private or state-controlled systems, and how can leakages and distortions from such systems be minimized (EF, 17)?
- Can we get a handle on the relative costs of subsidies versus other forms of income or food transfer?

Regarding program design:

- How to coordinate service provision for farmers in a given location, including input supply, credit, extension advice, and output markets (EF, 22)?
- What are the contrasts between Africa's experience with fertilizer and the experience of fertilizer uptake in Asia (Donovan, 2004)?[38]

Regarding long-run trends:

- How will potential future trends in climate change affect rainfall patterns in the tropics and hence the returns to increased fertilizer use?[39]

8.3 Final comments

Most would accept that fertilizer promotion is not an end in itself, but rather a means to achieving higher levels of welfare for smallholder farmers and the broader society. Many e-Forum contributions underscored the view that in the current environment, fertilizer use in the hands of farmers in some areas may contribute only marginally to these goals because unfavorable rainfall, soil and/or market conditions make fertilizer unprofitable. In other areas, fertilizer use has the potential to contribute to the achievement of broader development goals, providing that complementary public investments are made in extension and seed technology, improved infrastructure and marketing conditions. Therefore, the ability of fertilizer promotion

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results from fertilizer trials across the country, and an SFI review of fertilizer response data for Mali (Henao et al., 1999).

[38]A new book entitled *African Food Crisis—The Relevance of Asian Models* (Djurfeldt et al., 2005) may provide some guidance here, but we were unable to obtain a review copy for this paper.

[39]Recent work in Mali by Hart (2004) is an effort to address this gap.

programs to make cost-effective contributions to the development process is likely to depend on the pace of public investment in complementary measures to improve the productivity and profitability of fertilizer use under a wide range of small farmer conditions.

While there is an increasing perception among political leaders that there is a huge and unacceptable human cost in waiting for markets to develop well enough to support agricultural intensification in Africa , it may be equally important to ask what is the human cost of not taking active steps now to make markets work in the future. There is a very real possibility that quick fix approaches to promote fertilizer use may leave inadequate resources and little political will for effectively improving the situation for the long run.

Statements about the variability of soil fertility conditions across Africa, and about the need to tailor programs to fit local circumstances, may provoke an immediate reaction of frustration. Can we only say "it depends"? Is it not possible to draw general lessons that can be used to design better programs in the future? We would say "Yes," providing that the scale of the synthesis and generalization is at the national level or below. For example, the Soil Fertility Initiative included country-level soil fertility reviews and development of action plans, although few if any were funded and implemented. The plans may have had shortcomings; they may have focused too little attention on input/output marketing issues relative to the technical aspects of soil fertility. However, as integrated plans developed at the national level they could, if revived and updated, represent a more effective basis for tackling the challenge of sustainable agricultural intensification than resorting to massive fertilizer subsidies. Development of national plans could then be followed by regional meetings to explore ways of achieving economies in the import and domestic marketing of fertilizer by pooling the demands of several countries.

The external costs of soil fertility decline, which one might avoid or mitigate by promoting increased fertilizer use, are potentially very significant but hard to measure and value. This complicates the benefit-cost assessment of programs. Moreover, addressing the soil fertility problem on a scale that would significantly increase overall agricultural productivity will clearly require more resources that national governments can contribute. Donor countries will have to make significantly greater contributions than they have in the past, which of course is what is currently proposed in the Millennium Development Report. The economic justification for this could be significantly altered if supranational benefits could be counted, e.g., benefits associated with carbon sequestration and reduced deforestation. If that proves impractical, the justification will need to be based on the same objectives and values—moral, humanitarian, political—that currently provide the rationale for development assistance in general.

Annex A. Implementation Guidelines Incorporated in IFDC Framework (IFDC 2001)

- Removing explicit and implicit input subsidies for both production and marketing. But:
  - subsidy removal should be phased
  - if targeted subsidies are still needed for poor or remote farmers, they should be implemented in a way that does not hamper functioning of competitive input markets.
- Market information systems should be established
- Privatizing inefficient parastatals is difficult; vested interests may need to be overcome by promoting the private sector and "allowing the parastatals to compete." (viii)
- Reform the rural financial system
- Design and enforce input regulations
- Develop private integrated input market networks
- Create institutions to facilitate government and private sector interactions
- Encourage human capital development in public and private sectors
- Monitor impact of reforms and adjust so as to increase chances of reform success

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