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Economics of Farm Input Subsidies in Africa

Stein T. Holden

School of Economics and Business, Norwegian University of Life Sciences, 1432 Ås, Norway; email: stein.holden@nmbu.no

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Abstract

Fertilizer and other input subsidies have been prominent components of agricultural policies in many Asian and African countries since the 1960s. Their economic and political rationale is scrutinized with emphasis on the second generation of targeted input subsidy programs that were scaled up in Sub-Saharan Africa after 2005. The extent to which they fulfill the goal of being market smart is assessed after inspecting the potential for such subsidies in Sub-Saharan Africa. The new fertilizer subsidy programs do not live up to the market-smart principles and suffer from severe design and implementation failures. While a clear exit strategy was one of the key principles, this has been neglected, with the result that most current programs are more sticky than smart. They have only partially achieved the intended impacts and have resulted in a number of unintended negative impacts. Subsidy program redesign should start from a pilot stage testing basic mechanisms.

1. INTRODUCTION

This review evaluates the economics of farm input subsidies, with a particular focus on Africa. Input subsidies, and particularly fertilizer subsidies, are popular among politicians and the rural public in many developing countries, while they are highly controversial among economists, development agents, and policy analysts. The use of farm input subsidies has therefore been studied extensively across the developing world over the last 50–60 years since they were first introduced about 60 years ago in several Asian countries as part of the Asian Green Revolution (Hazell 2010).

A number of comprehensive reviews have covered the impacts and economics of farm input subsidies, including some recent reviews in the African context. An overview of this literature initially aims to clarify how this review complements and adds to existing ones. This review aims to be broader in terms of discussing the underlying theoretical ideas, the historical time horizon, and geographical coverage than most recent reviews that have concentrated on the current experiences with fertilizer subsidies in Sub-Saharan Africa (SSA). The hope is that this will stimulate critical thinking about how agricultural policies can enhance more sustainable agricultural intensification, especially in SSA. The continuing high population growth in rural areas of SSA contributes to land fragmentation into ever-smaller farms but also to deforestation at the extensive margin. Subsequently, the tightening land constraint highlights the stronger need for land-use intensification in a growing number of countries (Chamberlin et al. 2014). Low fertilizer use levels have been seen as a fundamental problem associated with low and stagnant crop yields hindering agricultural development in SSA (Sanchez et al. 2007). Crawford et al. (2006), in their review for the World Bank, reported average fertilizer rates as low as 9 kg/ha in SSA, while disappearing fallows, high levels of deforestation, land degradation, and nutrient depletion indicated nonsustainable land use (environmental externalities). Climate change and the need to reduce emissions from agriculture also point toward a need for intensification rather than area expansion to meet the food needs of future generations in SSA. Tilman et al. (2011) have estimated that the carbon emissions from a production increase through area expansion are approximately three times as high as a production increase through intensification and higher fertilizer use. Ensuring fertilizer use efficiency is a necessary requirement for such intensification. The potential future role of fertilizer subsidies in achieving this is therefore up to debate.

It is essential to see the economics of fertilizer subsidies in relation to the fundamental production relations in tropical agriculture. These relationships are nicely characterized by Binswanger & Rosenzweig (1986): (*a*) the dominance of rain-fed agriculture with strict seasonality constraints in land preparation, input use, and harvesting makes agricultural input and output markets highly seasonal; (*b*) the immobility and spatial dispersion of land enforce spatially dispersed production; (*c*) poor infrastructure and high transportation costs in geographically dispersed and thin seasonal markets affect the reach and competitiveness of input and output markets; (*d*) covariate risks link spatially correlated production risks with market price variations and market risks; and (*e*) moral hazard and adverse selection associated with information asymmetries affect the degree of (mal-)functioning of all markets and especially labor, credit, and insurance markets. Investments in infrastructure and irrigation can alleviate some of these constraints, and with the information technology revolution, the costs of obtaining information and communication have been dramatically reduced. These developments have also contributed to the start of a rural transformation process in a growing number of developing countries, including those in SSA. Such processes are strengthened by stimulating private sector development through training of rural retailers and agro-dealers, formation of producer organizations, and broader investments in value chain development from contract farming to supermarket development. Nevertheless, the fundamental production relations identified by Binswanger & Rosenzweig (1986) imply that rural factor market imperfections continue to condition the rural transformation processes and the way sustainable agricultural intensification can be facilitated, including the extent of purchased input use and whether and how input subsidies play a role (Gollin & Udry 2017, Sheahan & Barrett 2017).

We may roughly divide the past farm input subsidy programs into the first and second generations:

1. First generation. Universal input subsidy programs: In the 1960s and 1970s international donors supported the use of universal input subsidies to overcome market failures in input and finance markets. The general lesson from use of such subsidies in the African context was that they were ineffective in achieving their stated objectives (Morris et al. 2007, Jayne & Rashid 2013). The universal fertilizer subsidy benefited more the large farmers who grew fertilizer-intensive crops. The effect on smallholder farmers and their food security was therefore limited. With the debt crisis that many African countries faced in the 1980s, subsidy programs were scaled down or eliminated as part of the stabilization and structural adjustment programs implemented to get the indebted countries out of the crisis. Consequently, the general fertilizer subsidies were eliminated in most African countries.
2. Second generation. The market-smart and targeted subsidy programs: These new programs targeted smallholder farmers with packages of subsidized inputs aiming to enhance their production and food security. The new wave of programs after 2005 was triggered by the Malawian example, which gave new hope for an African Green Revolution (Sanchez et al. 2007, 2009; Denning et al. 2009). It also triggered rethinking in the World Bank and the development community in general that market-smart subsidy programs may work (Morris et al. 2007, World Bank 2007). By 2010 at least 10 African countries accounting for at least half the population in SSA had adopted such programs, costing US$0.6–1.0 billion per year and representing 14–26% of public expenditures on agriculture in these countries (Jayne et al. 2018). High international food prices and recovery after the debt crisis in many African countries through debt forgiveness also reduced the focus on conditionality among international donors (Jayne & Rashid 2013). This gave more political freedom to political leaders, who were competing to win local elections, to offer subsidies to buy votes.

This review explores the theoretical foundations and economic and political reasons that have been and could be used to argue for the use of farm input subsidies. These reasons are contrasted with characteristics of the production relations (Binswanger & Rosenzweig 1986) in the economies where such subsidies have been introduced. This is used as a basis for discussing the potential for market-smart subsidies in SSA, including agro-ecological, behavioral, and institutional constraints and opportunities. Typical design and implementation failures are outlined, and impact studies are then reviewed, including assessments of intended and unintended impacts from farm input subsidy programs. Finally, I review studies of economic returns to farm input subsidy programs.

2. OVERVIEW OF EARLIER REVIEWS

Farm input subsidies have received much attention and have been covered by several recent reviews. I summarize these reviews, discuss how they differ in objectives and coverage, and clarify how this review adds to the literature in comparison.

Fertilizer Use in African Agriculture (Morris et al. 2007) is a broad review of alternative policies such as fertilizer subsidies to enhance fertilizer use in Africa. The book takes a broad and pragmatic view of the pros and cons of alternative approaches to stimulate fertilizer use where input subsidies are one possible element of more comprehensive policies. They introduce the concept of market-smart subsidies and discuss the requirements for them.

Jayne & Rashid (2013) synthesize recent evidence (after 2005) on input subsidy programs in SSA. They focus in particular on the characteristics of beneficiaries, crop response rates to fertilizer applications, implications for the performance of subsidy programs, and the impact on national fertilizer use, input distribution systems, food prices, and poverty rates. They compare the returns to fertilizer subsidies with returns to other research and development and infrastructure investments.

Gautam (2015) reviews the main arguments for and against agricultural subsidies and provides a selective review of empirical findings, primarily in Asia. The review assesses the relative size of fertilizer subsidies versus other types of agricultural subsidies, such as power subsidies, irrigation subsidies, and credit subsidies, and their effects using examples from India, Sri Lanka, and China. He concludes that most of these Asian subsidy schemes, which in the case of fertilizer subsidies have been of the universal subsidy type, have had distortionary effects due to design and implementation failures.

Jayne et al. (2018) take stock of the second generation of agricultural input subsidy programs in SSA with regard to their performance. They synthesize 80 studies in seven countries (Ethiopia, Ghana, Kenya, Malawi, Nigeria, Tanzania, and Zambia). In particular, they assess the impacts on total fertilizer use, food production, commercial input distribution systems, food prices, wages, and poverty.

Hemming et al. (2018) systematically review agricultural input subsidies for improving productivity, farm income, consumer welfare, and wider growth in low- and lower-middle income countries. Their review covers studies up to 2013. From an initial review of 4,480 unique studies, they found 1,120 with relevant outcomes and narrowed these down to 31 high-quality studies, of which 15 were experimental/quasi-experimental, and 16 were modeling studies that use computable models to simulate the effects of agricultural input subsidies on measures of consumer welfare and wider growth. Only 4 of the 31 studies were in Asia, whereas the rest were in SSA. Of those, 15 were in Malawi, showing the high interest in that subsidy program; three were in Zambia, two in Ethiopia and Tanzania, and only one study in Ghana, Madagascar, Mali, Mozambique, and Nigeria.

This review aims to complement these others by more thoroughly inspecting some of the theoretical foundations of input subsidy programs as well as their limitations and implications for future agricultural policies, with an emphasis on the SSA context.

3. THEORETICAL FOUNDATIONS FOR FERTILIZER SUBSIDIES

3.1. The Origin of Fertilizer Subsidies and Their Economic Rationale

The concept of external economies originates from Alfred Marshall [1920 (1890)] who associated this with increasing returns to scale. Pigou (1924) helped to refine this idea, stating that competitive industries enjoying external economies or downward sloping supply curves produce less than optimal levels of output. The market forces cannot in such a situation be relied upon to ensure optimal resource allocation, and government subsidies would be required to expand output toward an optimal level. On the other hand, increasing cost industries in a dynamic sense produces too much. It would, according to Pigou, be optimal to tax the increasing cost industries and use this tax to subsidize the decreasing cost industries. This is the origin of the idea that Pigouvian taxes and subsidies may be used to internalize externalities (external economies).

Since then, the concept of external economy or externality has been loaded with many different phenomena, including emptiness (Papandreou 1998). The most relevant phenomena or concepts used to argue for input subsidies are discussed below.

3.1.1. Externality. There is a vast literature in economics that loads externality with different meanings, including phenomenological and general equilibrium perspectives. One of the best-known definitions is that of Baumol & Oates (1975): when an activity of one person affects the utility of another person (positively or negatively) without the first person facing any cost or compensation for the effect on the other. To relate it to fertilizer use, we can think of pollution or soil acidification as negative externalities and the accumulation or replacement of lost nutrients as positive externalities. A tax may be appropriate to reduce the first type of externality, and a subsidy could stimulate the fertilizer use and thereby reduce the nutrient depletion in the second case. It may, however, be less obvious that the latter represents an externality given the definition above because a farmer, who depletes his own land by not replacing lost nutrients, is the one (or his children) who will also pay the future cost. In the broader sense, if an amount of food can be produced on a small piece of land by using more fertilizer rather than by cutting down trees to expand the area with less use of fertilizer, intensive farming with fertilizer may reduce the global externality associated with deforestation.

3.1.2. Market failure. Bator (1958) equates externality with market failure, associates this with Pareto inefficiency, and attempts to find causes for these. Arrow (1969) sees externalities as a subset of market failure and market failure as synonymous with nonexistence of markets. He also relates market failure with transaction costs, as in the case where transaction costs are so high that the market is no longer worthwhile. A more comprehensive integration of the concepts of transaction costs and Pareto efficiency is given by Greenwald & Stiglitz (1986) in their assessment of externalities in economies with imperfect information and incomplete markets. They define constrained Pareto efficiency and conclude that economies with such characteristics are rarely constrained Pareto efficient, implying that there can often be room for interventions that can improve efficiency. Externalities may potentially be associated with large multiplier effects. Farm input subsidies were initially introduced from the perspective of missing and imperfect markets as part of the Asian Green Revolution.

3.1.3. New technologies and learning effects. The Asian Green Revolution focused on the development and dissemination of new and more productive agricultural technologies, and farm input subsidies were part of the technology package to enhance the adoption of such technologies by accelerating the exposure and thereby learning. This improved the availability of new technologies and made them more affordable to poor farmers. The induced technological and institutional innovation approach was very efficient in stimulating rural development and yielded high returns through the 1960s and 1970s in Asia (Ruttan & Hayami 1984, Hazell 2010).

3.1.4. Poverty trap. The argument that low farm input use, poverty, and vulnerability represent a poverty trap that needs to be overcome through massive investments is associated with the literature on poverty traps, the Millennium Villages Project, and the sharp upscaling of the input subsidy program in Malawi in 2005 (Sachs 2005; Carter & Barrett 2006; Sanchez et al. 2007, 2009; Denning et al. 2009). This argument has been important for mobilizing funds to break the poverty trap, including funds for farm input subsidies in Africa.

3.1.5. Recovery after droughts and food shortages. Upscaling of farm input subsidies has been a response in some countries, such as Malawi, to rapidly recover from such shocks by increasing local food production to reduce the need to import foods and reestablish national food self-sufficiency (Dorward & Chirwa 2011). Levy (2005) calculates that the Starter Pack in Malawi costs less than one-third of the cost of importing the same amount of food generated by the program. Morris et al. (2007) emphasize that, in cases where fertilizer and food markets function poorly, fertilizer subsidies can be used as a safety net for the poor. However, this also critically depends on the targeting efficiency in terms of reaching the poor and food-deficient households, the efficiency of fertilizer use, and the relative cost-efficiency of the program.

3.1.6. Market-smart subsidies. This concept is elaborated in Morris et al. (2007) and in the World Development Report 2008 (World Bank 2007). For farm input subsidies to be called market smart, they should (*a*) stimulate new demand without displacing existing commercial sales, (*b*) encourage competition in the input distribution channels, and (*c*) be temporary and have a clear exit strategy (World Bank 2007, p. 152). Morris et al. (2007) furthermore emphasize that the subsidy must be part of a wider strategy providing complementary inputs and strengthened output markets and have a proper sequencing of interventions. Following a strong tradition in economics, they also emphasize that input use had to be economically efficient. As a tenth point, they add that equity considerations matter and pro-poor growth could be aimed for, as long as nine other principles are satisfied (Morris et al. 2007, p. 104). However, they add that poverty reduction or food security objectives may be given precedence over efficiency and sustainability goals if it can be determined that input interventions are a cost-effective way of addressing these problems. This is clearly in line with the market failure argument for use of subsidies where there could be efficiency gains from stimulating demand, market development and utilization of economies of scale, and complementarities between technologies and markets by reducing transaction costs, organization costs, and information asymmetries. The tools proposed to achieve this are demonstration packs, input vouchers, matching grants, and partial loan guarantees. This new thinking on subsidies contributed to the further scaling up of input subsidy programs in SSA after the initial perceived success in Malawi (Denning et al. 2009).

3.1.7. Farm input subsidies as a political instrument. It is important to understand the political economy of farm input subsidies. They have typically been introduced or scaled up at critical points in time, such as after droughts, and have thus been popular among those who have benefitted. At the same time, their popularity among broad segments of the population has made it very difficult for those in power to implement an exit strategy without committing political suicide. Even scaling down of input subsidy programs can affect election outcomes (Gautam 2015). Another reason for the stickiness of input subsidy programs is their potential for rent seeking (Holden & Lunduka 2013, Jayne et al. 2015). Such rent-seeking behavior can lead to leakages (diversion) and severe targeting errors that undermine the officially intended objectives and targeting efficiency. Political considerations and rent-seeking behaviors may also undermine the extent to which market-smart characteristics are taken into account in the design as well as the implementation of programs. Political factors and the fact that many stakeholder groups attempt to influence the design and implementation of such programs may also lead to unclear and contradictory objectives as well as implementation strategies over time due to competing interests. The potential outcome is very costly and inefficient programs that crowd out investments that could have yielded much higher long-term returns (Jayne et al. 2013, 2018).

From this brief review of the arguments for the use of input subsidies, particularly fertilizer subsidies, it is evident that market failures and recovery after droughts causing food shortages have been the primary arguments for scaling up such subsidy programs. It is also evident that there is a tension between short-term needs and longer-term benefits on one hand and between those in need and those with political power on the other. At the same time, those in power depend on the political support from those in need. This results in an emphasis on short-term rather than long-term objectives such as sustainable intensification and economic growth. The fertilizer subsidy programs therefore potentially threaten to reinforce the poverty trap rather than break it if they lead to a dependency on input subsidies that only leads to short-term production increases. However, the consequent economic and political crises may also potentially lend itself to the opportunities to redesign better policies.

4. ARE INPUT SUBSIDIES THE BEST WAY TO ENHANCE INTENSIFICATION IN SUB-SAHARAN AFRICA?

Fertilizer use levels have been much lower in SSA than in other parts of the world and have been associated with failed agricultural development (Morris et al. 2007). However, a recent examination of World Bank Living Standards Measurement Study (LSMS) data from six countries shows large variation in fertilizer use across countries. Some that use fertilizer subsidies (Ethiopia, Malawi, Nigeria) also have much higher levels of fertilizer use (Sheahan & Barrett 2017). Whereas Crawford et al. (2006) report an average fertilizer use rate of 9 kg/ha in SSA, Sheahan & Barrett (2017) report rates of 45, 146, and 128 kg/ha in Ethiopia, Malawi, and Ethiopia, respectively. These substantially higher rates are at least partly driven by fertilizer subsidies.

Zhang et al. (2015) emphasize the central role of nitrogen (N) to facilitate sustainable intensification and that large parts of SSA still face an undersupply of N that prevents intensification. At the same time, there is a strong need to increase yields to reduce area expansion. Does this mean that one should advocate for the introduction of fertilizer subsidies in more countries in SSA where fertilizer use rates still are low? And can temporary use of fertilizer subsidies lead to sustained use of higher levels of fertilizer? Answering this question requires a careful examination of the reasons for low fertilizer use and whether these represent market failures or externalities that can be cost-effectively removed.

4.1. Profitability of Fertilizer Use

Some studies have found that fertilizer adoption is low even when fertilizer use is profitable (Duflo et al. 2011, Holden & Lunduka 2014, Koussoubé & Nauges 2017). However, there is also evidence that under current input and output prices fertilizer use is only marginally profitable in many places: Kenya (Marenya & Barrett 2009, Sheahan et al. 2013), Nigeria (Liverpool-Tasie et al. 2017), Zambia (Burke et al. 2017), and Ethiopia (Minten et al. 2013); please see Jayne et al. (2018) for a more detailed summary. Reasons for this include low soil fertility, soil acidity, low organic matter content, continuing land degradation, high erosion levels, nutrient mining associated with existing land use practices, and poor market access contributing to high farm-gate input prices and low farm-gate output prices. This leads to low value-cost ratios and reluctance to purchase fertilizer at commercial prices (Jayne et al. 2018). However, relative input and output prices may change rapidly and vary locally, which may imply that higher fertilizer use levels could be profitable, especially with the introduction of new and better varieties and improved infrastructure. However, this does not mean that fertilizer subsidies represent the optimal solution; instead, improved technologies and investment in infrastructure and market development may yield higher and more lasting impacts. More research is needed to investigate this.

4.2. Soil Quality and Sustainable Intensification

If soil degradation causes low profitability of fertilizer use, can investment in soil conservation and other land management practices also enhance the profitability of fertilizer use and thereby increase demand? And can input subsidies potentially be used to enhance intensification and conservation incentives?

Acidic soils, such as oxisols and ultisols, are widespread in the humid and subhumid tropics and are estimated to cover 43% of tropical soils such as in savannas and tropical forests (Sanchez & Salinas 1981). The low soil fertility and poor infrastructure in these areas have protected them from cultivation, but the pressure is increasing with population growth and infrastructure development. Expansion of cropping areas and shortening of fallow periods are associated with increasing deforestation (Holden 1993). Introduction of pan-territorial prices and input subsidies resulted in the reduced deforestation and rapid expansion of maize production in Zambia beginning in the late 1970s (Holden 1991). However, the following removal of these transportation and input subsidies resulted in a reversal into more extensive farming systems with more deforestation as a result (Holden 1997, 2001; Holden et al. 1999). It may be more efficient to minimize deforestation by not building roads or improving infrastructure near areas that should remain forested and, instead, develop infrastructure, promote intensive agriculture in high-potential areas, and stimulate migration to such areas. Moreover, intensive maize production on acidic soils has its own sustainability problems.

Burke et al. (2017) show that soil acidity is a major constraint to intensification in Zambia. This results in especially low response to basal fertilizer applications because most of the phosphorous in the fertilizer is captured by the acidic soils and becomes unavailable to the plants. Continuous maize production with fertilizer has also reduced soil organic carbon (SOC) levels and made the soils even more acidic, which also contributes to aluminum toxicity and micronutrient deficiencies (Woode 1983, Singh et al. 1995). Aluminum toxicity is more severe in the subsoils where SOC levels are lower; this can limit rooting depth and the plants' ability to access nutrients and water, with consequences for plant growth and susceptibility to droughts (Lal & Singh 1998). Liming can be used to increase soil pH, but high amounts of lime are needed to have a significant impact, and the transportation costs have so far been prohibitive in the African context (Burke et al. 2017). There have been attempts at breeding acidity-tolerant crops, but these attempts have so far not been very successful for maize (Pandey et al. 2007). Some fertilizers, particularly N fertilizers, contribute to enhancing soil acidity, especially sulfate of ammonia but also urea, while calcium ammonium nitrate has a slight positive effect on pH. This implies that sulfate of ammonia should be avoided on acidic soils. An environmental externality perspective on soil acidity may also point to a tax rather than a subsidy on urea, whereas it can be easier to defend a subsidy on calcium ammonium nitrate. One could also argue for subsidies on lime, but more research is needed to assess their cost-effectiveness (Øygard 1987; Burke et al. 2017). It may, however, be possible to ameliorate aluminum toxicity and phosphorus fixation in soil by the addition of organic residues (Haynes & Mokolobate 2001). More research is needed to find the best ways to maintain or enhance SOC levels and reduce soil acidity and toxicity problems related to intensive cultivation on acidic tropical soils. Soil carbon sequestration can also be a way to mitigate or reduce the speed of climate change (Lal 2004).

Bhargava et al. (2018) combine the World Bank's LSMS data with high-resolution remote-sensing soil data and find a strong positive correlation between SOC content and agricultural profitability, with a higher sensitivity for farmers with poorer quality land. The question is how best to raise SOC levels. The following approaches have received considerable attention in recent years as potential solutions.

Conservation agriculture (CA) has three principles—minimum soil disturbance, soil coverage with organic matter, and crop rotation/intercropping—and has been proposed and tested as a way forward for sustainable intensification in SSA (Hobbs et al. 2008; Giller et al. 2009, 2015). CA can help raise SOC and has been promoted in several SSA countries (Giller et al. 2015). CA has received significant support from donors but has shown disappointing adoption levels so far compared to Latin America (Arslan et al. 2015; Giller et al. 2009, 2015; Fisher et al. 2018; Holden et al. 2018).

Vanlauwe et al. (2014) have argued that CA needs to be combined with a fourth principle in SSA, the use of adequate quantities of inorganic fertilizer. This is consistent with the integrated soil fertility management (ISFM) approach, which is defined as a set of practices that combines fertilizer, organic inputs, improved germplasm, and knowledge of how to adapt these to local conditions to maximize agronomic use efficiency of the applied nutrients in improving crop productivity based on sound agronomic principles (Vanlauwe et al. 2010, 2015). Yet the widespread adoption of ISFM is lacking, perhaps partly for the same reasons as CA and/or the complexity of adapting the principles in highly heterogeneous agro-ecological and socioeconomic conditions. Such adaptation is highly knowledge intensive and may be beyond the capacity of smallholder farmers without sophisticated management advice.

Holden et al. (2018) found that low adoption rates of CA in Malawi were caused by low short-term returns and high initial labor or cash costs due to weed control problems. They predict that the adoption hurdle may be overcome with an orchestrated transition using herbicides and fertilizers with technical support (especially for weed control) to raise short-term returns while also relieving labor and cash constraints until a more productive and less labor-demanding CA/ISFM production system has been established. Such an approach may qualify as a market-smart subsidy package but will require pilot testing before scaling up.

Another strand of the literature has discussed nutrient flows and land degradation in Africa (Stoorvogel & Smaling 1990, Lal 1998). Large net nutrient losses were observed in many African farming systems and particularly so on the more densely populated and intensively utilized fertile soils. However, research has shown that net loss of nutrients may not result in declining yields in the short run, as some soils have high stocks of some nutrients (Vanlauwe & Giller 2006). Net nutrient loss may thus not necessarily represent an environmental externality that merits intervention. However, there are situations where such nutrient leaching is associated with severe erosion and land degradation with declining land productivity as an outcome and where interventions are needed to reduce the extent of leaching, erosion, and land going permanently out of production (Shiferaw & Holden 1998, 1999). Evidence showed that smallholder farmers had insufficient incentives on their own to implement conservation investments due to the low short-term returns to such investments and their severe levels of poverty in an environment with highly imperfect factor markets (Shiferaw & Holden 2000, Holden et al. 2001). This could therefore be a case where an input subsidy could be justified if it could be used to stimulate conservation investments and enhance short-term returns to such investments. This rests on the combined situation of poorly functioning factor markets and poverty associated with myopic behavior limiting investment (Holden et al. 1998). The primary policy tool used was food for conservation work, which has taken place on a large scale in Ethiopia, and where access to subsidized fertilizer also has contributed to raising the short-term returns to conservation. It is interesting that fertilizer for conservation work has not been used as an alternative approach in the Ethiopian case, whereas this was at one point attempted in Malawi. The implicit fertilizer subsidy in Ethiopia is of the old universal type and is not targeted by use of vouchers like in some other countries (Jayne et al. 2018).

How do fertilizer and other input subsidies affect the adoption of natural resource management (NRM) practices? This likely depends on complex substitution and complementarity relationships between inputs as well as outputs. On the one hand, it is possible that cheap fertilizers become a substitute for other but costlier yield-enhancing inputs. On the other hand, it is possible that the use of certain NRM practices also enhances fertilizer use efficiency. Evidence from Malawi indicates that fertilizer subsidies have weak or mixed effects on various NRM practices

(Holden & Lunduka 2012, Koppmair et al. 2017, Katengeza et al. 2019). A different targeted or conditional subsidy is required if certain NRM practices are to be stimulated in combination with fertilizer use.

4.3. Incentives and Behavioral Constraints

Are behavioral constraints causing extremely low input use, and can this be an argument for input subsidies? Impatience, high discount rates, risk aversion, and risk perceptions may undermine incentives to invest and buy risky inputs. There is growing evidence in the behavioral and experimental economics literature that some of the systematic deviations from expected utility theory may be of importance and relevance here. Anomalies in intertemporal choice associated with high discount rates, present bias, hyperbolic responses, and magnitude effects are examples (Holden et al. 1998, Holden & Quiggin 2017a). In the risk domain, examples include risk aversion in small gambles, limited asset integration, probability weighting, and reference-dependent utility (Binswanger 1981, Tanaka et al. 2010, Rabin 2013, Holden & Quiggin 2018). Further studies of these behavioral anomalies can be instructive and have policy relevance.

Duflo et al. (2011) found that Kenyan farmers underinvested in fertilizer when it was profitable and associated this with impatience and time-inconsistent behavior. They suggested and demonstrated that, rather than selling fertilizer at subsidized prices at planting time, it may be cheaper and may stimulate fertilizer use as much to sell farmers unsubsidized fertilizer at harvest time when farmers have just sold their crops and still have cash. Holden & Lunduka (2014) investigated whether a similar approach could work in Malawi. The main problem with the approach was that output prices are much lower at harvest time than at planting time, whereas fertilizer prices do not vary in the same way. Cash constraints may force households to sell their crops at a low price at harvest time rather than storing them and selling them at a higher price closer to planting time (enabling them to buy even more fertilizer). Selling fertilizer to farmers at harvest time therefore may not solve the cash liquidity problem. Therefore, it seems that cash and credit constraints are the underlying restrictions explaining low fertilizer use where such use is profitable, such as in Malawi, where unconstrained demand is very high (Holden & Lunduka 2014). Other studies have assessed the profitability of fertilizer use in Kenya and concluded that fertilizer rates are close to optimal and, thus, fertilizer use is constrained by low profitability (Suri 2011, Sheahan et al. 2013).

Because fertilizer is a risky input in risky environments, it is optimal for a risk-averse producer to use less of the risky input than it would be for a risk-neutral producer (Sandmo 1971). Smallholder farmers have been found to be risk averse in the sense that they have concave utility functions (Binswanger 1981, Binswanger & Sillers 1983, Wik et al. 2004, Yesuf & Bluffstone 2009). More recently, rank-dependent utility and prospect theory have been used to derive risk attitudes, and scholars have associated this with not only concavity of the utility function but also subjective probability weighting and loss aversion (Tanaka et al. 2010; Liu 2013; Liu & Huang 2013; Holden & Quiggin 2017b, 2018). Holden & Quiggin (2018) find that overweighting of low-probability bad events such as drought is associated with lower intensity of fertilizer use. Such overweighting of low probabilities is dominant in their sample of smallholder farmers in Malawi. Such overweighting is also found in studies in Vietnam (Tanaka et al. 2010), China (Liu 2013), and Ethiopia (Vieider et al. 2018). While it is possible that low use of risk-complementary inputs such as fertilizer is widespread, this requires further research. A recent study in Tanzania and Uganda, building on expected utility theory, also emphasized that the cost-increasing nature of investment in fertilizer makes it risk increasing and causes moderately risk-averse farmers to buy less fertilizer, which may also explain low demand for fertilizer in these countries (Mukasa 2018). This evidence is, however, insufficient to justify a fertilizer subsidy as the best policy response. More research is needed to further investigate this.

Resource poverty and short-term need constraints may limit conservation investments that only give positive returns after several years, and such constraints may be the main reasons for underinvestment in conservation in settings with pervasive factor market imperfections (Binswanger & Rosenzweig 1986, Holden et al. 2001). Such market imperfections are rooted in fundamental resource and behavioral characteristics that modern information technologies cannot fully overcome (Sheahan & Barrett 2017). Institutional innovations will therefore continue to play an important role to enhance investment incentives and promote rural transformation and economic development. Temporary input subsidies may be a part of such institutional designs.

5. INSTITUTIONAL CONSTRAINTS AND OPPORTUNITIES

Input subsidy programs should by now have a sufficiently long history to facilitate learning from past errors, even in the case of the so-called smart subsidy schemes implemented in SSA after 2005. I first outline some of the fundamental design and implementation challenges. I then summarize the evolution in a couple of countries (Sri Lanka and Malawi) and assess whether historical experience has resulted in refined and better designs in these two countries.

5.1. Design and Implementation of Input Subsidy Programs

A review of past and contemporary input subsidy programs reveals many problems that contribute to low and sometimes unintended impacts and low returns to these programs. We may broadly classify these failures into design failures and implementation failures although these two categories are also interconnected.

5.1.1. Design failures. Unclear and complex or contradictory objectives provide insufficient basis for developing smart design. For example, it may not be clear whether the subsidy program should address specific market failures, externalities, producers, consumers, short-term versus longer-term outcomes, or distributional outcomes (Druilhe & Barreiro-Hurlé 2012). Several programs have in particular aimed to enhance food security and recovery after a food crisis (safety net objective).

It is critical to carefully diagnose the characteristics of the economy and identify the relevant market failures or externalities where a subsidy potentially could enhance efficiency. This includes failure to address multiple constraints by making subsidies an integrated part of a holistic policy (Michael et al. 2018). Such failures may also relate to the heterogeneity of agro-ecological and socioeconomic characteristics, which may imply that multiple and heterogeneous market failures/externalities exist that cannot be addressed with a one-size-fits-all subsidy scheme.

Universal designs without exit strategies dominated the first generation of fertilizer subsidy schemes. Universal fertilizer subsidy is costly and benefits mostly those who use a lot of fertilizer (large farmers growing fertilizer-intensive crops). This can lead to overuse of fertilizer in areas where farmers are familiar with fertilizer and have easy access to it. Overuse may result not only in low marginal returns (inefficiency) but also in pollution of groundwater, rivers, and lakes and soil acidification. Such effects have been observed in India, Sri Lanka, and China where fertilizer use levels are already high (Wang et al. 2011; Li et al. 2013; Gautam & Kar 2014; World Bank 2014, cited by Gautam 2015).

Targeting design errors can include unclear or contradictory targeting design criteria in the second-generation targeted fertilizer subsidy programs (Jayne et al. 2018). Competing stakeholder groups and political influence may result in inconsistent targeting objectives. Such design errors can result in failure to address relevant market failures/externalities, failure to target intended beneficiaries (errors of exclusion and errors of inclusion), and unintended effects with implications for efficiency, equity, and sustainability (Jayne et al. 2018).

Lack of an explicit and clearly specified exit strategy is a common design failure. This may be the result of political pressure and the short-term objectives of political pressure groups and decision makers (Gautam 2015, Jayne et al. 2018).

Lack of a comprehensive monitoring and impact assessment system is limiting progress. It is demanding to have such a system in place, and political leaders may prefer systems that give them more freedom to act without the consequences of their actions being carefully monitored or revealed. Underinvestment in monitoring and impact assessment is therefore widespread and contributes to poor evaluation of input subsidy programs (Ravallion 2009).

5.1.2. Implementation failures. Implementation failures include those where the objectives and designs are clear but the problems relate to their implementation. Such failures include (*a*) inefficient and incomplete implementation due to incompetent and unmotivated administrators; (*b*) rent seeking and leakages, causing diversion of funds; (*c*) targeting errors (errors of exclusion and inclusion), which may partly be outcomes of the first two points, unclear objectives and weak monitoring systems; (*d*) late delivery of inputs; and (*e*) crowding out of private sector agents.

These implementation failures are widespread and known (see **Table 1**), and they appear pervasive. The Malawian input subsidy program was scaled up in 2018/2019, which is an election year, but it had to be interrupted due to irregularities in its implementation (fake vouchers).

5.3. Evolution in the Designs: Do We See an Improvement?

We assess this by looking at two countries: one in Asia (Sri Lanka) and one in Africa (Malawi), where fertilizer subsidies have played a prominent role.

5.3.1. Sri Lanka. Sri Lanka was one of the early adopters of fertilizer subsidies, which were introduced in 1962 with the objective to encourage farmers to switch from traditional rice varieties to high-yielding and fertilizer-responsive varieties. Since then, fertilizer subsidies have been part of agricultural policies except for the short period 1990–1994 (Weerahewa et al. 2010). The design of the fertilizer subsidy has varied over time from a general subsidy of all fertilizers in the periods 1962–1989, 1995–1996, and 2006–2009. The subsidy levels for different types of fertilizer have also varied over time from being uniform across all fertilizers to applying only to some fertilizers in other periods. Fixed fertilizer prices to farmers have been implemented in periods regardless of world market prices. The subsidy rates have varied over time from a uniform rate of 33% in 1975, to 50% in 1978, and a differentiated rate of 85% for urea and 75% for other fertilizers in 1979. The complete removal of subsidies on sulfate of ammonia and rock phosphate occurred in 1988, with the complete removal of subsidies for all types of fertilizer in 1990–1994 and frequent variations in the following years. Fixed fertilizer prices and variable subsidy levels were introduced in 2006 and resulted in sharp increases in subsidy rates and expenditures in the following years with the increases in international oil, fertilizer and food prices. The political pressure is strong for continuing the fertilizer subsidy scheme in Sri Lanka because the subsidies are perceived to benefit large shares of the rural population, including 1.8 million smallholder paddy farmers. Continuing or improving the subsidy program is a popular promise of ruling and opposition parties during elections and is closely associated with food security (protection against price fluctuations) and poverty alleviation in the country rather than the alleviation of specific market failures or

Table 1 Overview of impact studies for smart (targeted) subsidy programs: unintended impacts

Impact	Country	Finding
Crowding out/in of commercial demand for fertilizer		
Ricker-Gilbert et al. (2011)	Malawi	Crowding out of 0.22 kg subsidized fertilizer Less for poor households (18%) than for rich households (30%)
Xu et al. (2009)	Zambia	Crowding out of 0.07–0.08 kg subsidized fertilizer
Mason & Jayne (2013)	Zambia	Crowding out of 0.13 kg subsidized fertilizer Higher where commercial sector is developed (0.23) than where it is not (0.07) Higher for farms >2 ha (0.21) than for farms <2 ha (0.11) Higher for male-headed households (0.15) than for female-headed households (0.09)
Liverpool-Tasie (2014)	Nigeria	Crowding in of commercial demand for fertilizer in Kano area where the private sector is weak
Takeshima & Nkonya (2014)	Nigeria	Access to 100 kg subsidized fertilizer reduces the probability of participation in the commercial fertilizer market by 10–21%
Targeting errors		
Holden & Lunduka (2012)	Malawi	Target group (resource-poor farmers) less likely to receive subsidized inputs than in a program with random distribution of inputs
Kilic et al. (2014)	Malawi	The program does not in reality target the poor
Pan & Christiaensen (2012)	Tanzania	Decentralization of targeting to local authorities does not improve targeting Local elites capture most benefits
Banful & Olayide (2010)	Nigeria	Widespread evidence that subsidized fertilizer is often captured by wealthy elites
Diversion/leakages		
Holden & Lunduka (2010, 2012)	Malawi	Total of 30–35% of input subsidies have been diverted (leaked out) before reaching target communities Diversion of vouchers and fertilizer
Dorward & Chirwa (2011)	Malawi	Voucher allocation to ghost beneficiaries Printing and distribution of fake vouchers
Mason & Jayne (2013)	Zambia	Under the subsidy program, 33% of the fertilizer does not reach the farmers
Banful & Olayide (2010)	Nigeria	Fertilizer is regularly stolen from the state government fertilizer depots Subsidized fertilizer is used to reward officials for providing political support Officials have been found conspiring with smugglers to transport fertilizer subsidized by the Nigerian government into neighboring countries Officials in charge of monitoring distribution of subsidized fertilizer also caught in scandals to divert fertilizer to their private warehouses and retail outlets
Liverpool-Tasie & Takeshima (2013)	Nigeria	More than 50% of the fertilizer distributed through the subsidy program has been diverted
Jayne et al. (2015)	Kenya, Malawi, Zambia	A total of 36% (Malawi), 23% (Zambia), and 19% (Kenya) of the subsidy transfer is appropriated by diverters over a five-year period
Late delivery of vouchers and inputs		
Druilhe & Barreiro-Hurlé (2012)	Ghana, Mali, Malawi, Senegal	Late delivery of vouchers
Banful (2009)	Ghana	Only half of the distributed vouchers delivered were redeemed due to late delivery
Banful & Olayide (2010)	Nigeria	Late or no delivery of fertilizer to local depots due to inefficient distribution through formal channels and leakages

externalities. It therefore serves, and is perceived, as more like a social welfare program than a program that enhances efficiency (see Weerahewa et al. 2010 for more details).

5.3.2. Malawi. Malawi, like many other countries in Africa, introduced general fertilizer subsidies as part of agricultural policies in the 1960s and 1970s when input and output prices were regulated (pan-territorial pricing). This implied a substantial taxation of the agricultural sector even though fertilizer and other input subsidies were present (Krueger 1991). National food security was a high priority in Malawi and was strongly maize focused through smallholder production, while the estates focused on cash crop production for export. With increasing debt problems came a change in policies in the 1980s based on guidance and pressure from the World Bank and International Monetary Fund to implement stabilization and structural adjustment reforms. These reforms included removal of price controls and input subsidies. Larger fluctuations in maize production were experienced in the following years with large deficits in some years, such as in 1987, 1992, and 1994, following droughts. This was also a turbulent period for agricultural policies in the country, including a collapse in the agricultural credit program due to a combination of unrealistic political promises, droughts, and production failures. A drought recovery input program was introduced in 1993 and distributed free seeds and fertilizer to 1.3 million smallholders (Devereux 1997). It was followed up by a supplementary inputs project targeting 0.8 million households in the following year with seeds and fertilizers and a poverty alleviation program providing public works with self-targeted food and cash for work (Devereux 1997). Following the next severe food deficit in 1997, the Starter Pack program was introduced and distributed free maize seeds (2 kg of a high-yielding hybrid), fertilizer (15 kg), and legume seeds (1 kg) to 2.8 million households. After two years, the program was replaced by the Targeted Input Program and scaled down to reach 1.5 and 1.0 million households in 2000 and 2001 to reduce the financial burden (Harrigan 2008). The program was again scaled up with the Extended Targeted Input Program in 2002/2003 to reach 2.8 and 1.7 million households, respectively.

Following a new and severe production failure due to drought in 2004/2005, which made 5 million people dependent on food aid, a new scaled-up input subsidy program that received considerable international attention was introduced from 2005 to 2006 (Denning et al. 2009). The new program distributed input packages about four times the size of the Starter Packs (0.4 ha versus 0.1 ha), with seeds and fertilizer at highly subsidized prices through a voucher system. Malawi's President Bingu wa Mutharika argued that it was cheaper to import fertilizer than maize. With the input subsidy program, maize yields and production doubled compared to the previous drought year. The subsidy program continued in the following two years, which saw good rainfall, and some surplus maize was exported in a period when international cereal prices increased sharply together with oil and fertilizer prices. These price increases contributed to the financial burden of the input subsidy program, which had to be scaled back despite its national popularity.

The international and national success contributed to the reelection of President Mutharika in 2009, but his popularity crumbled with the growing number of problems that followed, such as high food prices, fuel shortages, cutback of the subsidy program, and budget deficits. Targeting of the scaled-down program, who to target for subsidies, and how to achieve the targeting objectives became central issues. A number of impact studies revealed partial crowding out of commercial demand, late delivery of inputs, and inefficient targeting and diversion of inputs, leading to lower production and welfare effects than previously anticipated (Holden & Lunduka 2010, 2013; Dorward & Chirwa 2011; Ricker-Gilbert et al. 2011, 2013a,b; Chirwa & Dorward 2013; Jayne & Rashid 2013; Lunduka et al. 2013). Although weaknesses were revealed and attempts were made to remedy them, the efforts to reduce targeting errors and diversion problems appear not to have

Table 2 Overview of impact studies for smart (targeted) subsidy programs: intended impacts. Data from Hemming et al. (2018) and references therein

Impact and source	Countries	Key finding
Fertilizer adoption	Malawi, Zambia, Mali, Mozambique	Based on six studies, fertilizer adoption rates are on average 23% higher among subsidy recipients than nonrecipients
Crop yield	India, Malawi, Mozambique, Nigeria, Tanzania	Crop yields are on average 11% higher for recipients than for nonrecipients and higher for maize (18%) and rice (25%)
Income	Malawi, Nigeria, Zambia	Average income increased by 15% for recipients as compared to nonrecipients of input subsidies, based on three studies

been very successful (S. Holden, household panel data for 2006–2015; AGRA 2017). Recently, more subsidies have gone to more productive farmers, while the poorer and more vulnerable will be helped by the safety net program. This could enhance fertilizer use efficiency but also enhance crowding out of commercial demand. A positive outcome documented recently is that the subsidy program has contributed to accelerating the dissemination and adoption of drought-tolerant maize varieties (Holden & Fisher 2015, Holden & Quiggin 2017b, Katengeza et al. 2018).

6. IMPACTS AND ECONOMIC RETURNS

6.1. Impact Studies

I benefit from the selection of high-quality impact studies in the systematic review by Hemming et al. (2018) and the analysis of the second-generation input subsidy programs by Jayne et al. (2018). This review attempts not to repeat but to add to these recent reviews by briefly summarizing and drawing on their central findings. **Table 1** summarizes findings of unintended effects based on studies reviewed by Jayne et al. (2018), whereas **Table 2** summarizes key impacts in terms of intended effects based on studies reviewed by Hemming et al. (2018). In the next section, I summarize findings on overall economic returns to fertilizer subsidies in Asia and SSA before providing concluding comments.

6.2. Return to Investment Studies

Ideally, benefit-cost ratios (BCRs) for programs should be judged against the best alternative uses of the same funds. In most countries it is difficult and demanding to find such data. Few such assessments have therefore been made in the case of farm input subsidy programs; that of Fan et al. (2008) is an exception.

Fan et al. (2008) have estimated the marginal returns to alternative investments in rural areas in India over the period 1960–2000. The types of investments compared were those in roads, education, and irrigation; subsidies for irrigation, fertilizer, power, and credit; and agricultural research and development (R&D). They found high returns to all of these during the 1960s and 1970s during the Green Revolution, with roads, education, credit subsidies, and power subsidies yielding the highest returns and fertilizer and irrigation subsidies yielding the lowest, but still high, returns. The returns declined in the 1980s for all categories except fertilizer subsidies, which still had the lowest return (BCR = 1.94). In the 1990s fertilizer subsidies had negative returns (BCR = 0.85), whereas all other categories yielded positive returns. Roads, agricultural R&D, and education continued to give the highest returns (BCRs: 5.46–9.5). All subsidies in India amounted to about 2% of national GDP and 8–10% of agricultural GDP. Fan et al. conclude that the subsidies are in direct competition with more long-term investments in roads, education, and agricultural R&D and therefore undermine long-term growth and poverty reduction.

For African countries, Jayne et al. (2013) estimate BCRs for the input subsidy programs in Kenya, Malawi, and Zambia. These estimates are questioned by Dorward & Chirwa (2015), who provide alternative higher estimates, and Jayne et al. (2015) provide corrected rates based on the comments, but these rates are still lower than those of Dorward and Chirwa. The corrected BCRs for a five-year period (2006–2010) are 1.72 (Kenya), 1.26 (Malawi), and 0.86 (Zambia), including the diverted benefits to the rent seekers. Dorward & Chirwa (2015) assume higher returns to fertilizer use while studies of such returns indicate that Jayne et al. (2015) have used more appropriate maize fertilizer return estimates. Jayne et al. (2018) provide a more comprehensive review of maize fertilizer returns in a number of countries. The BCRs are also sensitive to maize and fertilizer prices and do not take into account the specific situations after a drought shock, which in some countries triggered the scaling up of the subsidy program. The rates do not include multiplier or general-equilibrium effects, which would move toward higher overall returns. There are no comparisons with alternative investment options such as infrastructure investments, agricultural extension services, or R&D. We see, however, large differences in the estimated BCRs and that Zambia's program is the most questionable, demonstrating negative returns.

7. CONCLUSIONS

This review has revealed that the second-generation, so-called market-smart targeted input subsidy programs that have been implemented primarily in SSA since 2005 are far from living up to the theoretical ideas on which they were built. Most programs violate many of the basic principles that were outlined by Morris et al. (2007) and suffer from substantial design and implementation errors. This gives reason to question whether the design principles were unrealistic as guidelines or whether the identified weaknesses should be easy to fix. The failure to design and implement an exit strategy is the obvious example, as poorly designed and implemented programs continue to be implemented. The fundamental reason for this is that they have been captured by elites who are able to reap the lion's share of the benefits and at the same time gain political support from the rural masses that hope to benefit from the subsidies. While corrupt practices have been revealed and shown to be massive, public knowledge of the problem has only to a limited extent resulted in improvements.

Although European countries, such as Norway and Switzerland, have implemented well-targeted subsidy programs to enhance sustainable land use (Tilman et al. 2002), these targeted programs build on reliable coupled land and farmer registries, which only partially exist in SSA countries, where the administrative costs therefore remain very high. However, the costs of land registration and certification have fallen dramatically, and some SSA countries are investing in establishing such registries. In the future, this may also help facilitate better targeted investments to enhance sustainable land use where subsidies could be part of an incentive package. This could facilitate transparency as well as minimize the administrative costs by utilizing electronic transfers where satellite imagery could help to verify the implementation of specific visible investments in target areas. In SSA, Rwanda is the closest to being able to implement such an approach, and Ethiopia is the second candidate, as it is also progressing in establishing modern low-cost land registries in areas with high agricultural potential (Deininger et al. 2008, Ali et al. 2014).

With a focus on enhancing sustainable land use in subsidy programs, spatial/geographic targeting needs to play a stronger role. Moreover, technically skilled people rather than policy makers and local leaders should lead the technical implementation while ensuring strong local participation in the identification of priorities.

There are few signs that the Malawian subsidy program, which has received most attention in SSA, has moved toward a smarter design since 2005. Although the program has contributed to hastening the adoption of drought-tolerant maize after recent droughts, there are still fundamental problems with crowding out, targeting, diversion, late delivery, and consequent inefficiencies. The high financial costs have forced a scaling down of the program, but politicians see the program as an important tool that can help them win the next election. The subsidy program is therefore more sticky than smart. This seems to be due more to a power trap (elite capture) than to a poverty trap because the lion's share of the profits from the subsidy program benefit the diverters. A pilot experiment was included in the program in 2017/2018 to target more productive farmers with the hope that this can increase the returns to the program. However, this is also likely associated with more crowding out, as more productive farmers are more likely to be able to purchase fertilizer at commercial prices. This implies that 13 years after the subsidy program was scaled up in 2005, the implementers have not found a reliable and efficient targeting approach. Although the program again is scaled up related to the elections in 2019, it was temporarily halted in November 2018 due to an abundance of fake vouchers available, a major problem seen 10 years earlier.

Input subsidy programs are commonly perceived among the broader public as social welfare programs rather than efficiency-enhancing policy instruments. This creates a gap between their view and that of economists, who aim to design policies to eliminate market failures. This difference in perceived objectives also creates a barrier toward adopting more market-smart designs. Smart designs require professional designers and implementers that are motivated to achieve the official goals of well-designed and efficient programs.

The social welfare focus of many programs point toward safety net programs as an alternative to achieve these goals. Alternatively, a combination or integration of the two approaches may facilitate the simultaneous achievement of targeting vulnerable groups and productive investments with more long-term productivity and sustainability impacts. This requires a targeted and conditional use of subsidies associated with offers of food-for-work and/or fertilizer-for-work, where the work is invested in local public goods such as soil conservation, irrigation, or tree planting. Thus, a fertilizer subsidy linked to a conservation requirement may enhance not only fertilizer use but also conservation and fertilizer use efficiency (Holden & Binswanger 1998). This has been demonstrated with bioeconomic models in the context of smallholder agriculture in the Ethiopian highlands (Holden et al. 2005, 2006).

Some of these ideas have been implemented under the Productive Safety Net Programme (PSNP) and related programs in Ethiopia. The approach is suited to address land degradation problems that also are associated with low profitability of fertilizer use. Such a conditional and conservation-oriented approach may not only be market smart but also conservation smart. Instead of a one-size-fits-all approach, it would be ideal to have built-in flexibility that allows alternative payment for labor investment in conservation or other public goods. A flexible choice, or mix of productive inputs, such as fertilizer and improved seeds, food, and/or cash, depending on household needs, would also be beneficial.

It may be market smart as well as climate smart to scale up input subsidy programs after weather shocks, such as droughts and floods. This may help to stabilize food prices and enhance food security. Such programs require skilled and motivated implementers that have the power and motivation to prevent elite capture, the most serious curse of current programs.

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