Improving Agricultural Input Supply Systems in Sub-Saharan Africa: A Review of Literature

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Improving Agricultural Input Supply Systems in Sub-Saharan Africa: A Review of Literature

by

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<th>Description</th>
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<tbody>
<tr>
<td>ADMARC</td>
<td>Agricultural Development and Marketing Corporation</td>
</tr>
<tr>
<td>AFRACA</td>
<td>African Rural and Agricultural Credit Association</td>
</tr>
<tr>
<td>ATA</td>
<td>Agribusiness Trade Association</td>
</tr>
<tr>
<td>BRAC</td>
<td>Bangladesh Rural Advancement Committee</td>
</tr>
<tr>
<td>CARE</td>
<td>Cooperative for Assistance and Relief Everywhere, Inc.</td>
</tr>
<tr>
<td>CIMMYT</td>
<td>Centro Internacional de Mayoramiento de Maiz y Trigo</td>
</tr>
<tr>
<td>CMDT</td>
<td>Compagnie Malienne de Développement des Textiles</td>
</tr>
<tr>
<td>EPHTA</td>
<td>Ecoregional Programme for the Humid Tropics of Africa</td>
</tr>
<tr>
<td>EPTAT</td>
<td>Environmental and Natural Resources Policy and Training</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the UN</td>
</tr>
<tr>
<td>GTZ</td>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit</td>
</tr>
<tr>
<td>GTZ</td>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit</td>
</tr>
<tr>
<td>Hectare</td>
<td>Hectare</td>
</tr>
<tr>
<td>IAR</td>
<td>International Agricultural Research</td>
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<tr>
<td>IARC</td>
<td>International Agricultural Research Center</td>
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<tr>
<td>IDA</td>
<td>International Development Association</td>
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<tr>
<td>IDEA</td>
<td>Institute for Democracy and Electoral Assistance</td>
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<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
</tr>
<tr>
<td>IFDC</td>
<td>International Fertilizer Development Center</td>
</tr>
<tr>
<td>IFST</td>
<td>International Federation of Seed Trade (FIS in French)</td>
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<tr>
<td>IITA</td>
<td>International Institute for Tropical Agriculture</td>
</tr>
<tr>
<td>IMF</td>
<td>International Monetary Fund</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
</tr>
<tr>
<td>ISTA</td>
<td>International Seed Trade Association</td>
</tr>
<tr>
<td>KFW</td>
<td>Kreditanstalt Für Wiederaufbau</td>
</tr>
<tr>
<td>KR-2</td>
<td>Kennedy Round 2</td>
</tr>
<tr>
<td>LEISA</td>
<td>Low External Input and Sustainable Agriculture</td>
</tr>
<tr>
<td>MIDEVIV</td>
<td>Mission de Développement des Cultures Vivirères</td>
</tr>
<tr>
<td>MOA</td>
<td>Ministry of Agriculture</td>
</tr>
<tr>
<td>NAR</td>
<td>National Agricultural Research</td>
</tr>
<tr>
<td>NARS</td>
<td>National Agricultural Research System</td>
</tr>
<tr>
<td>NGO</td>
<td>Non Governmental Organizations</td>
</tr>
<tr>
<td>NPK</td>
<td>Nitrogen, Phosphate, Potassium</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
</tr>
<tr>
<td>OPC</td>
<td>Open-Pollinated Crop</td>
</tr>
<tr>
<td>OPV</td>
<td>Open-Pollinated Variety</td>
</tr>
<tr>
<td>PCA</td>
<td>Producer Cooperative Association</td>
</tr>
<tr>
<td>PIC</td>
<td>Prior Informed Consent</td>
</tr>
<tr>
<td>PR</td>
<td>Phosphate Rock</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>SACOs</td>
<td>Savings and Credit Organizations</td>
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<tr>
<td>SACU</td>
<td>Southern African Customs Unions</td>
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<tr>
<td>Acronyms</td>
<td>Full Form</td>
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<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------</td>
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<tr>
<td>SADC</td>
<td>Southern African Development Community</td>
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<tr>
<td>SFFRFM</td>
<td>Smallholder Farmer Fertilizer Revolving Fund of Malawi</td>
</tr>
<tr>
<td>SG2000</td>
<td>Sasakawa Africa Association</td>
</tr>
<tr>
<td>SODECOTON</td>
<td>Société de Développement du Coton</td>
</tr>
<tr>
<td>SODEFITEX</td>
<td>Société de Développement des Fibres Textiles</td>
</tr>
<tr>
<td>SONAPRA</td>
<td>Société Nationale de Promotion Agricole du Benin</td>
</tr>
<tr>
<td>SPC</td>
<td>Self-Pollinated Crop</td>
</tr>
<tr>
<td>SSA</td>
<td>Sub-Saharan Africa</td>
</tr>
<tr>
<td>UPOV</td>
<td>Union Internationale pour la Protection des Obtentions Vegetales</td>
</tr>
<tr>
<td>Us</td>
<td>United States</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>VCR</td>
<td>Value-Cost Ratio</td>
</tr>
<tr>
<td>$</td>
<td>dollar</td>
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1. Introduction: The Structure and Performance of Input Supply in Sub-Saharan Africa

1.1 The Role and Performance of the Agricultural Sector

Agriculture is the most important sector in the economies of Sub-Saharan African (SSA) countries as it accounts for a significant share of gross domestic product (32%), employment (70%), and foreign exchange earnings. In addition, it is the most important source of food needed to meet domestic demand, and it offers other significant growth linkages with other sectors of the economy. In particular, rural households are the largest domestic market, and the agricultural sector is the most important source of raw materials for the industrial sector. In short, agriculture is the primary source of economic growth and food security in SSA because (i) other sectors of the economy are relatively small, (ii) agriculture is the most important contributor for manufacturing and services, and (iii) most poor and food-insecure people are rural dwellers.

Yet over the last three decades, annual growth rates of agricultural production (2.1%) averaged less than the average annual growth rate of population (3.1%). This has translated into a vicious cycle of widespread malnutrition, hunger, and poverty on one side and a progressive degradation of the natural resource base on the other. A net food exporter until the early 1970s, SSA now has the largest cereal deficits in the world, averaging about US $5.6 million of food imports annually in the 1990s (World Bank, 1998). The World Bank (1989) estimates that an annual agricultural production growth rate of at least 4% is required to stimulate broad-based improvement in food security and a satisfactory level of general economic development in SSA.

There is a debate among developers over the achievability of the 4% minimum agricultural growth target. If any thing, this debate indicates the magnitude of the required change for SSA. This is particularly the case for two fundamental reasons. First, much of the growth in food production in SSA has in recent years come through soil nutrient mining and extensification. Currently, there is an ever-increasing concern among developers that there are now limited opportunities for growth based on area expansion (despite a low population density) or low-cost expansion of irrigation (World Bank, 1989; Cleaver, 1993; and Yanggen et al., 1998). Even in places where opportunities for bringing new lands under cultivation exist, unrestrained expansion would lead to encroachment of ecologically fragile lands and subsequently to significant decline in agricultural productivity and competitiveness. For example, it is estimated that soil nutrient mining and soil degradation has led to a 7% loss in agricultural productivity on irrigated land, 14% loss on rainfed cropland, and 45% on rangeland (Crosson and Anderson, 1994). In other words, as clearly stated in the framework for national soil fertility improvement action plans (IFDC, 1997), SSA can no longer afford to increase food production under conditions of soil nutrient mining and extensification.

Second, achieving the targeted agricultural growth of at least 4% will involve significant import substitution and an expanding SSA share of the world market. Both import substitution and export growth will require significant improvements in efficiency in order to become more competitive. The continuing integration of countries in a global world and growing local pressures offer tremendous opportunities for access to competitiveness-enhancing information and technologies and for rethinking ways and institutions by which countries are governed. But, it also entails potentially high risks for countries that fail to meet the associated challenges by undertaking appropriate domestic economic and agricultural policy reforms. Thus, in addition to improving food security and protecting the environment, an increase in productivity of SSA’s agriculture is also essential for increasing its competitiveness in a new world of global integration and growing local pressures.

Given the current rapid population growth, rapid urbanization, and the trend toward a global marketplace, the agricultural sector in SSA would have to be literally transformed and its production capacity increased in order to meet the triple imperative of improving food security and agricultural competitiveness while protecting the environment. Thus, a sustainable agricultural intensification is indispensable. A sustainable improvement of agricultural productivity can best be achieved through a greater adoption of yield-increasing inputs and improved management practices (with subsequent improvement in natural resources management), and efficient markets. As shown by Kawagoe et al. (1985), the difference in labor productivity between developed and developing countries lies primarily in the level of use of modern inputs. This is par-
particularly the case for the rates of utilization of fertilizers, seed, and pesticides. Indeed, the Green Revolution in Asia was driven in large part by an intensive use of these inputs, particularly fertilizer and improved seed. This is not to say that other agricultural inputs such as farm power, tools, and equipment are not a major constraint to increased food production and productivity in SSA.

The declining per capita food production in SSA begs numerous key questions: what is the level of adoption of modern inputs, particularly seed, fertilizers, and pesticides in SSA agriculture? What is the potential for greater intensification of SSA agriculture? What incentives do suppliers have to produce/procure and distribute these inputs? Are the technologies sufficiently profitable to justify farmers’ and suppliers’ investments? What other factors constrain greater production, procurement, distribution and use of modern inputs? What are the policy implications for addressing these constraints?

This review addresses these questions in view of developing a strategic framework for African agricultural input supply system development. To achieve this, the analysis is based on a review of literature from some 300 sources, a mail survey involving 400 individuals in 30 countries, most of which were in Africa, a review of cases not well documented in the literature, a review of successful or “best practices” in Africa and elsewhere, and country case studies.

1.2. Structure of the Report

The report is organized in five main sections. This section presented the purpose of the review. The second section synthesizes the levels of adoption of seed, fertilizer, and pesticides and identifies factors explaining these levels. The third section summarizes the impact of policy reforms on agricultural efficiency, on the effectiveness of input supply, and on productivity and economic growth. The fourth section discusses the policies necessary to address the constraints identified. The final section highlights the key conclusions of the literature review and the lessons learned.

2. Level of Adoption of Modern Inputs and Constraints

This section focuses on the status of the supply and use of seed, fertilizers, and pesticides in SSA and identifies the constraints to greater intensification.

2.1. The Use and Supply of Improved Seeds

2.1.1. Sustained Variety Development but Limited Adoption—Evidence from the Green Revolution in Asia suggests that one of the key components to achieving a sustained and significant increase in food production is the availability and use of quality seed, particularly of improved varieties. Studies show that seed is the least expensive of the purchased inputs. Jaffee and Srivastava (1992) even argue that seed is the most important of all plant-based agricultural systems because until farmers have access to quality and fertilizer-responsive seed, it would not be economical for them to spend money on fertilizers, pesticides, and irrigation water. This is because quality seeds determine the upper limit of yield potential of a crop and enhance the productivity of these inputs. In other words, quality seeds are required to reap the full benefit of fertilizers, pesticides, and irrigation water.

It is therefore not surprising that over the past 30 years sustained research efforts and substantial investments in crop breeding programs at National Agricultural Research Systems (NARS) and International Agricultural Research Centers (IARCs) have been made in SSA to produce fertilizer-responsive varieties, especially maize in East and Southern Africa (Venkatesan, 1994). As a result, many varieties have been released. For example, since 1950 Zimbabwe’s NARS has released 35 maize hybrids, 8 sorghum, and 11 groundnut varieties. Similarly, Zambia’s NARS has released 18 maize hybrids, 8 sorghum, and 8 groundnut varieties since 1965.

There is a general lack of good and reliable seed data throughout SSA. But most researchers will agree that except for few crops, such as hybrid maize in southern Africa, sustained adoption of improved varieties is often limited to few large- to medium-scale private commercial seed users. These seed users are usually located in high potential areas with a well-established market infrastructure. They are small in number but have historically exerted a strong influence on the direction pursued by plant breeders and the way commercial seed organizations have developed in SSA. A limited sustained adoption by smallholder farmers is often linked to subsidized or free distribution (Rusike et al., 1997). This low adoption varies by crop with the highest rates observed for maize (FAO, 1994; Maredia and Howard, 1998). The adoption for other crops (mostly through non-market sources) is recent and much lower (FAO, 1994; Maredia and Howard, 1998).

Despite the lack of reliable seed statistics, it is widely accepted that the commercial seed market of SSA is very thin and represents only about 1.5% of the global market (US $500 million), 60% of which are accounted for by the Southern African region (Heffer, 1999). In other words, SSA involvement in international seed trade is very limited. It is focused

1. For example, in the 1990s, about 98% of the maize area in Zimbabwe and 60% of the maize area in Zambia are sown to hybrid seeds.
mainly on vegetables and maize (Heffer, 1999). Yet for the domestic and regional markets within the continent, there is evidence that improved seeds increased yields in SSA by 30%-50% when grown with other complementary inputs (fertilizer and irrigation) and by 10%-25% under normal conditions (Rusike et al., 1997). Much of the yield gains resulted from improving disease and insect resistance, drought tolerance, and post-harvest features.

2.1.2. Single Channel Cash Crop Based on Public Monopolies—Most seed supply activities throughout SSA are carried out through farmer-to-farmer informal systems. As a result, about 70%-90% of total seeds planted each year comes from the previous crop harvest (Venkatesan, 1994; Wright et al., 1994; Cromwell, 1996; Mareda and Howard, 1998). Only about one-third of the SSA countries have established formal seed production and distribution facilities for food crops (FAO, 1994; Mareda and Howard, 1998). In most countries, most of the attention in seed supply strategies has been geared towards providing financial and technical assistance to establish large- to medium-scale parastatal seed corporations, technical laboratories, processing plants, and certification departments. As a result, most of the seed systems put in place in the 1970s and 1980s were mainly single distribution channels dominated by costly public monopolies or large private companies focusing on export crops. The few seed systems dealing with food crops such as Mission de Développement des Cultures Vivières (MiDEVIV) Cameroon are focused on cereals (principalley maize and sorghum) and legumes and none on vegetatively propagated crops such as roots and tubers (Venkatesan, 1994).

Despite this effort, certified seed rarely reached most farmers outside the high potential areas. The top-down approach and central-planning philosophy of these monopolies resulted in the inflexibility and inefficiencies of the seed system. These inefficiencies translated into seed supply shortages, high seed cost, and huge budget deficits. For example, the Tanzania Seed Company was providing less than 14% of the country’s certified seed needs in the mid-1980s, while recording operation losses on seed sold at roughly twice the price charged by competitors (Budden, 1986).

Only a few countries in SSA have seed development strategies consistent with their level of agricultural development. Most (63%) have pilot activities (e.g., improvement, quality control, production, and distribution). Successful initiatives have, with few exceptions, worked around the problem of providing an adequate supply of quality seed to small-scale farmers by developing ad hoc solutions that did not promote a broad sustainable system. These countries’ economic and food crises prompted a change in seed supply strategies, in particular, the component of the seed system where the public sector was prominent was privatized. Still, many development practitioners in the continent would recognize that research is urgently needed to guide public and private investments in seed improvement in Africa, because seed industry interventions have made so many false starts (Rusike and Eicher in Byerlee and Eicher, 1997). For example, Pioneer Hi-Bred International recently wrote off US $54 million in seed distribution and oilseeds processing investments in Nigeria, Morocco, Côte d’Ivoire, Ethiopia, Sudan, Cameroon, Egypt, and Zambia because of political and institutional barriers and the lack of adequate market to justify the level of investment (Pioneer Hi-Bred International, 1993).

2.1.3. Constraints to Greater Use of Improved Seed by Smallholder—The low adoption rates of improved seed in SSA are primarily influenced by low output prices relative to the high cost of improved seed, difficult access to credit, and/or high production risks. The high cost of improved seed is attributable to the inefficiency of the seed systems put in place by government in the 1970s and 1980s. The investment costs (equipment, research, marketing, and overhead) sometimes increase seed price 1.8 times for seed of self-pollinated crops (SPCs), and 20 times for hybrids (Louwaars, 1994). As a result, adoption requires a high return. The formal sector has been unable to produce sufficiently adapted varieties. Selection during the breeding process favored a wide adaptation to reduce the number of varieties. A limited contact between breeders and clients led to a misconception of needs. Consequently, in many cases, the varieties sometimes lack many desirable characteristics: high production potential, disease and pest resistance, drought tolerance, and early maturity.

Furthermore, in many cases, poor soil fertility or moisture condition does not allow the full realization of the crop potential unless complementary inputs are used. For example, Shapiro and Sanders (1998) report that while in the 1990s a series of new varieties of sorghum and millet are being introduced in SSA, the levels of inorganic fertilizer accompanying the new varieties are generally so low that the introduction of new varieties alone will not be a sustainable strategy but will eventually mine soil nutrients thereby contributing to and degrading the environment.

Throughout SSA the private sector has had little or no involvement in seed technology development and transfer. Tables 1 and 2 provide a synthesis of the constraints to greater participation of the private sector in seed marketing and solutions that various countries have tried.
<table>
<thead>
<tr>
<th>Issues/Problems</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorly targeted commodity-based or area-based seed relief programs (free or subsidized seed) competing with commercial channels.</td>
<td>(1) Discontinue direct distribution of relief seed for commodities that are available commercially and provide farmers with vouchers to purchase seed locally, (2) provide finance to induce traders to set up seed outgrower schemes under which the trader would supply improved seed, other inputs, extension advice and supervision.</td>
</tr>
<tr>
<td>Limited commercial demand by smallholder.</td>
<td>(1) Improve output market efficiency, (2) Expand post harvest markets for commodities traditionally produced by smallholder (sorghum, millet, peanut, ...) by, for example, providing preferential financing to entrepreneurs willing to access grains from a smallholder sector, (3) Strengthen research and extension for “small” crops that do not interest a for-profit private sector, (4) Improve rural infrastructure, (5) Improve availability of information.</td>
</tr>
<tr>
<td>High startup costs for seed production, especially given dispersed smallholder seed growers.</td>
<td>Reduce the transaction cost of dealing with smallholder seed producers, rural shopkeepers, and clients by providing links to NARS and IARCs to get information and seed of appropriate varieties.</td>
</tr>
<tr>
<td>Absence of adequate variety protection (breeders’ rights).</td>
<td>Develop and enforce a conducive plant protection right based on the Union Internationale pour la Protection des Obtenions Végétales (UPOV) system for example.</td>
</tr>
<tr>
<td>Market entry problems—Often government regulation makes it difficult for companies to introduce new varieties and to produce, import, or export seeds.</td>
<td>Develop and enforce conducive regulations including policy regarding seed importation, varietal release and notification, seed certification and quality control, access to lines and varieties developed by NARS, and germplasm import and clearly state roles of all agencies involved.</td>
</tr>
<tr>
<td>Issues/Problems</td>
<td>Possible Solutions</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lack of continuity in and predictability of government policies, and distrust of</td>
<td>Government needs to demonstrate to their own satisfaction and to that of the private sector that private inputs marketing will justify both long-term support and investment; convince private sector (through private dealer associations and a national fertilizer committee, for example) that it enjoys government support and there will be policy continuity.</td>
</tr>
<tr>
<td>traders and middlemen—fear of economic dominance by one group and/or fear to see farmers being “exploited.” Thus, the state was only a benevolent benefactor who had only the interest of the general population at heart.</td>
<td></td>
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<tr>
<td>Rent seeking coalition benefitting from the status quo.</td>
<td>Wholehearted government commitment to the change, monitoring parastatal divestment, appropriate legislation.</td>
</tr>
<tr>
<td>Lack of information on input demand, supply, and stock.</td>
<td>Establish an input unit in the Ministry of Agriculture (MOA) with linkages with other relevant agencies to monitor the marketing system, advise government on necessary legislative revision, and promote competition and greater attention to road maintenance.</td>
</tr>
<tr>
<td>Subsidy removal reduces demand and makes private sector reluctant to become involved.</td>
<td>Phased reduction, detailed studies of profitability of fertilizer marketing. Strengthen private sector through improving understanding of agri-import business.</td>
</tr>
<tr>
<td>Selective application of subsidies.</td>
<td>Avoid parallel marketing systems.</td>
</tr>
<tr>
<td>Pan-territorial pricing offers no incentive for traders to supply remote areas.</td>
<td>If price control necessary, should be applied only to regional centers, leaving village free trading.</td>
</tr>
<tr>
<td>Inconsistent and poorly enforced regulations.</td>
<td>Rationalize public sector regulations and functions taking into account the burden on the private sector, agro-climatic factors, cropping systems and crops’ technical characteristics, the country’s level of infrastructure development.</td>
</tr>
<tr>
<td>Poor contract enforcement.</td>
<td>(1) Strengthen the judicial system, (2) lower the cost of contract enforcement.</td>
</tr>
<tr>
<td>Accessibility: setting up marketing channels in rural areas (esp., remote areas</td>
<td>(1) Improve rural road infrastructure, (2) encourage seed companies to actively market seed processing byproducts, (3) improve rural infrastructure.</td>
</tr>
<tr>
<td>with usually the largest segment of the farming population) is expensive because of a poor rural road network, needed training for seed production, and strategic default behavior.</td>
<td></td>
</tr>
<tr>
<td>Profitability of “small” crop (vegetables, local food crops).</td>
<td>Strengthen research and extension for “small” crops that do not interest for-profit private sector.</td>
</tr>
</tbody>
</table>
2.2. The Use and Supply of Fertilizers

2.2.1. A Low Fertilizer Use in Smallholder Farming—Fertilizer is one of the crucial modern inputs necessary for increasing agricultural productivity and food production. It played an important role in fueling the green revolution in Asia and Latin America in helping farmers to overcome land constraints and to increase aggregate production. However, Lele et al. (1989) point out that far more dramatic technologies were available in Asia (particularly for rice and wheat) with high and assured returns from their adoption than in SSA. During the 1970s, donors generally used subsidies on fertilizer in development projects as a means of encouraging rapid growth in its use. Between 1973 and 1986, official fertiliser-related development assistance to SSA increased from about US $4 billion to nearly US $11 billion in constant prices (Lele et al., 1989). Granted donor support was dramatically reduced in the late 1980s due to increased budget deficits and doubts about the effectiveness of public sector interventions, the increase in fertilizer intensity and growth was not proportional to the massive amount of donor assistance. Today, the intensity and growth in fertilizer use per ha in SSA remains the lowest in the world. In 1997/98, FAO data set indicates that SSA fertilizer use (excluding South Africa) averaged 8 kg of nutrients per hectare of cultivable land compared to 68 for Latin America, 92 for South Asia, and 205 for East Asia (Figure 1).

However, average use rates in SSA are temporally and spatially variable. In 1997/98, for example, 24 of the 40 SSA countries (excluding South Africa) used less than 10 kg of nutrients/ha each, 10 used 10-20 kg/ha, four used 10-20 kg/ha, and only three (i.e., Zimbabwe, South Africa, and Malawi) used 30-60 kg/ha (Figure 2). A country like Nigeria that accounted for about a third of the fertilizer used in SSA (excluding South Africa) in 1990 now accounts for only 11% due to significant subsidy reduction (82% in 1990 to 0% in 1997). This corresponds to a dramatic decline in average nutrient application rates from 12.1 kg/ha in 1990 to 4.5 kg/ha 1997.

Historically, the average intensity of fertilizer use in SSA has never exceeded 10 kg of nutrients per hectare (Figure 3). The highest rates occurred in the late 1980s and early 1990s. The low rates of the 1970s are attributed to various factors including widespread droughts, deteriorating terms of trade, the oil shocks, and foreign exchange constraints brought about by debt crisis, particularly in the early 1980s (Sidhu, 1988). There were some marginal increases in the average intensity of fertilizer use in SSA in the mid-1980s and early 1990s. But, thereafter, this average declined as Nigeria’s rate of fertilizer application plummeted to the historical low of 4.5 kg/ha. Figure 3 does not capture the impact of liberalization on fertilizer use in part because, unlike in Eastern Europe where most countries terminated subsidies in 1988, SSA countries terminated or significantly reduced subsidies at different points in time.
Figure 2. Distribution of Average Annual Fertilizer Use (kg NPK/ha) in Africa, 1997/98

Figure 3. Trend in SSA Per Hectare Fertilizer Use, 1970/71 to 1997/98
The same FAO data set also indicates that the SSA share of fertilizer use in developing countries total fertilizer consumption has not changed dramatically since 1970/71. As shown in Figure 4, in 1970/71, SSA consumed 3.2% of the total fertilizer use in developing countries. In 1986/87, this share fell to 2.6%, and it was 1.6% in 1997/98. This slight declining trend occurs at a time when the share of developing countries in the world total fertilizer consumption almost doubled in each of the two time periods, changing from 19.9% in 1970/71 to 36.3% in 1986/87, and to 60.4% in 1997/98.

2.2.2. A Concentrated Import-Dependent Fertilizer Supply—Few countries account for a large proportion of total fertilizer used in SSA. For example, in 1997/98 South Africa and Nigeria accounted for 39% of the total fertilizer used in SSA. Zimbabwe, Kenya, Ethiopia, and Sudan accounted for 25%. Malawi, Tanzania, Zambia, Côte d’Ivoire, and Burkina Faso accounted for 16%. In other words, eleven countries accounted for 80% of total fertilizer used in SSA in 1997/98.

Most of the SSA countries are import-dependent for fertilizer supply, thereby spending substantial amounts of foreign exchange in imports. However, part of the nitrogenous and phosphate fertilizers used in SSA is produced locally. In 1997/98, the five largest nitrogen fertilizer-producing countries in SSA were South Africa, Zimbabwe, Nigeria, Senegal, and Mauritius (Appendix 1). South Africa, Senegal, Zimbabwe, Nigeria, and Burkina Faso (ground phosphate rock) were the largest phosphate fertilizer-producing countries (Appendix 2). Several countries have phosphate rock (PR) deposits. But there is no clear evidence that locally produced PRs are economically justifiable to import phosphates (Yanggen et al., 1998). There is at present no production of potassium in SSA, albeit


up to 1979 the Congo did have active mines.

The five largest nitrogen fertilizer-importing countries in SSA were Côte d’Ivoire, Ethiopia, Nigeria, South Africa, and Kenya (Appendix 3). Kenya, Ethiopia, Côte d’Ivoire, Zimbabwe, Nigeria, Zambia, Tanzania, and Benin were the largest phosphate fertilizer-importing countries (Appendix 4). All the potash used in SSA is imported from outside the continent. In 1997/98, South Africa, Côte d’Ivoire, Zimbabwe, Nigeria, Senegal, Mauritius, and Cameroon were the largest potash-importing countries (Appendix 5).

Few countries export nitrogen and phosphate fertilizers. In 1997/98 South Africa, Senegal, Zimbabwe, Mauritius, and Zambia were the largest nitrogen-exporting countries (Appendix 6). South Africa, Senegal, and Mauritius were the largest phosphate-exporting countries (Appendix 7).

2.2.3. A Fertilizer Demand Driven by Cash Crops—In much of SSA, demand for fertilizer has been driven by the cash-crop systems, which are usually non-cereal export crops (e.g., cocoa, coffee, cotton, sugarcane, tea, and tobacco). Such schemes include both public sector schemes such as the Tea Development Authority (Kenya), cooperative arrangements such as Murangi Coffee Cooperative (Kenya), and national and multinational estates such as the Brooke Bond (Kenya). Such schemes account for the bulk of national fertilizer consumption because they offer subsidized credits for fertilizer and profitable, reliable, and stable output outlets (Desai and Gandhi, 1990; Rusike et al., 1997). For example, according to IFDC (1999), about 95% of the fertilizers used in Uganda are applied by few commercial farmers to cash crops (tobacco, tea, and sugar) where acceptable returns are realized. In Malawi, an estimated

Figure 4. SSA Share of Fertilizer Use in Developing Countries and the World, 1970/71-1997/98
60% of the fertilizers are used on commercial crops (e.g., tobacco and sugarcane). Accessibility to small-scale farmers is increasing largely thanks to the work of nongovernmental organizations (NGOs) (e.g., Sasakawa Global 2000 (SG2000) and the USAID-funded IDEA project in Uganda, and the SCODP in Kenya) in Ethiopia, Ghana, Kenya, Mozambique, Tanzania, Uganda, and Zambia. This work is aimed at improving awareness of the benefits and accessibility to improved technologies, and stimulating increased private sector participation in fertilizer trade.

Because of the availability of credits, improved technical knowledge, profitability, reliability, and stability of output outlets, the bulk of fertilizer use has generally been on the few export crops in countries where agricultural exports dominate foreign exchange earnings and government revenue. Yet these export crops occupy only a small proportion of the total area cultivated in SSA. Interestingly, evidence shows that SSA countries with relatively high level and impressive growth rates of fertilizer use are also the ones where food crops have a high share in total fertilizer use (Desai and Gandhi, 1990). It is of interest that in Asia the Green Revolution was due in large part to intensification of cereals rather than export crops. Unfortunately, in SSA only few countries such as Kenya, Malawi, Nigeria, Zimbabwe, Zambia, and more recently Ethiopia have developed national programs to promote fertilizer use on smallholder cereal fields. Such promotion was largely rooted in subsidizing schemes (e.g., Malawi and Nigeria), which have been dismantled. Today, with the exception of the SG2000-Ministry of Agriculture collaboration in Ethiopia, there is little evidence of a successful program to promote improved fertilizer among SSA small-scale farmers. Thus, without a doubt, there is considerable untapped potential for fertilizer use on food crops in SSA.

### 2.2.4. Evidence of Good Fertilizer Responses and Profitability

In a recent review of the fertilizer response literature for SSA, Yanggen et al. (1998) point out that contrary to a widely held perception, there is much evidence of good fertilizer response and profitability for smallholder farming in SSA. In some cases, these responses compare favorably to those in other parts of the world. For example, the adoption of hybrid maize with fertilizer in Zambia and Zimbabwe increased smallholder yields by an estimated 46%-64%. Comparing crop ratios in SSA, Yanggen et al. (1998) found that, in general, maize response to fertilizer was the highest among the main cereal crops grown in the region. However, maize response ratios reported in Eastern and Southern Africa were superior to those reported from West Africa, and they generally exceeded those from Latin America and Asia (10-15 kg of output/kg of nutrient). The highest maize response ratios in West Africa were comparable to those from Latin America and Asia. Generally, sorghum response ratios were comparable to those from other parts of the world. Similarly, rice response ratios (7-20 kg output/kg nutrient) were comparable to those from other developing countries. Millet response ratios were generally less than adequate.

Crop response to fertilizer application is influenced by various factors including fertilizer quality as suggested by recent adverse reports about the quality of some fertilizers in West African markets (Visker et al., 1996). This study shows that, while the physical properties of sampled fertilizers were acceptable, about 58% of the samples were underweight, and 43% were (not deliberately) nutrient deficient. In addition, Visker et al. (1996) mention that ventilation practices in the warehouses needed improvement, adulteration often occurred at the retail level, and the minimum requirement for fertilizer labels (net weight, guaranteed analysis, and name and address of the registrant or license) is not systematically indicated on the bags. Similarly, Yanggen et al. (1998) point out that the response ratios reported in the literature are highly variable, even under a relatively controlled environment, due to the variability of the inherent soil quality (physical, chemical, and microbiological), rainfall (quantity and spatial and temporal distribution), temperature, and the type of fertilizer applied.

Furthermore, Yanggen et al. (1998) report that while maize yields the highest response to fertilizer application in SSA, its value-cost ratios (VCR) were frequently less than 2 and not dramatically higher than that of the other main cereals. Sorghum and millet value-cost ratios were also frequently less than 2 as in most parts of the world. For rice, however, its value-cost ratios ranged between 1.5 and 4.0 and were comparable to those from Asia. The study notes that the highest value-cost ratios are attributed to high fertilizer subsidies which lowered fertilizer cost. This was the case for example in Nigeria during the 1980s.

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3. A crop response ratio to fertilizer application is the units of additional output produced over the units of nutrients used. Typically, as a rule of thumb, a value-cost ratio of 2 or more is considered adequate. Some authors have suggested that, in some situations, a potential value-cost ratio of at least 4 is necessary to stimulate the adoption of fertilizer application in smallholder farming in SSA due to risks associated with weather and price instability.
However, even where there is strong evidence that fertilizer use is profitable, few farmers use fertilizers suggesting that profitability is not the only constraint to the adoption of fertilizer by smallholder. Other factors include its profitability use relative to other alternatives, the risk associated with inter-annual variations in fertilizer response, and output price volatility. For example, this study reports that farmers in Senegal used little fertilizer on peanuts in the 1980s because expanding the area cultivated or increasing plant density was more profitable. Similarly, in many countries, such as in Burkina Faso, Zimbabwe, northern Ghana, the highlands of Tanzania, and Rwanda, disproportionately large amounts of fertilizers are applied on cash crops although fertilizer response is the highest on maize. Physical access is also a limiting factor to greater use of fertilizers in most countries because distribution networks are not extensive and farmers travel long distances for supply.

2.2.5. More Fertilizer as a Component of Soil Fertility Management—There is abundant reference in the literature reporting that the era of land abundance is fast coming to an end in much of SSA, and soils are being mined for nutrients in many countries as shifting cultivation is gradually disappearing (Bishop and Allen, 1989; Stocking, 1987; Lele et al., 1989; World Bank, 1989; Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), 1990; International Institute for Tropical Agriculture (IITA), 1991; Kanampiu et al., 1991; Speirs and Olsen, 1992; Cleaver and Schreiber, 1992; Smaling, 1993; Larson and Frisvold, 1996; Mwangi, 1997; IFDC, 1997; and Henao and Baanante, 1999). Henao and Baanante (1999), for example, estimate that over the 3-year period 1993-95, the rates of nutrient depletion throughout Africa were very high, particularly in Eastern, Central, and West Africa (Figure 5).

![Figure 5. Annual Rates of Nutrient (NPK) Depletion in Africa, 1993-95](image)

According to Henao and Baanante (1999), about 96% of the countries in Africa show negative average annual nutrient imbalances that are greater than 40 kg NPK/ha. They estimate that the annual loss of the natural NPK capital of these lands is equivalent to about US $1.5 billion of fertilizer nutrients. Furthermore, their estimation shows that nutrient losses from African soils are higher for nitrogen and potassium than for phosphorus. The loss of nitrogen and potassium is primarily associated with leaching, soil erosion, a low recycling of crop residues, low fertilizer use, and a continuous cropping of cereals without rotation with legumes. Such losses are highest in Guinea Bissau and Nigeria in West Africa. In east Africa, nitrogen losses are highest in Burundi, Ethiopia, Malawi, Rwanda, and Uganda, and phosphorus losses are highest in Burundi, Malawi, and Rwanda. Losses of phosphorus are associated with high erosion rates, particularly in East and West Africa.

These findings indicate that soil nutrient mining is a significant concern in large areas of SSA, particularly in East, Central, and West Africa. However, nutrient losses vary greatly across the regions. According to

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5. The term nutrient imbalance refers to the amount of nutrient added to soil (inflows) through organic and inorganic fertilizers minus the amount taken from the soil (outflows) through crop uptakes and soil erosion.
Henao and Baanante (1999), in the semiarid, arid, and Sudano-Sahelian areas, soil loses 60-100 kg of nitrogen, phosphorus, and magnesium per hectare each year, thereby restricting crop diversification (Henao and Baanante, 1999). Interestingly, population density in these regions is the lowest in the world (Bremen and Sissoko, 1998). These rates are moderate (30-60 kg of NPK/ha) in humid forests and wetlands in south Central Africa and high (above 60 kg of NPK/ha) in East African Highlands. The declining soil fertility and inadequate plant nutrients resulting from these nutrient losses stifled the productivity and profitability of other technologies. Most development specialists now recognize soil fertility improvement as a pathway toward food security, sustainable resource management, and rural well-being; they would agree that there are no fertilizer-free technologies available that can generate the increase in agricultural productivity needed in SSA.

Some authors such as Shapiro and Sanders (1998) have argued that the environmental impacts of greater use of fertilizer are wrongly assumed to be analogous to those in the developed countries. They point out that the low level of fertilizer use in SSA contributes to soil degradation by requiring extensification onto the more marginal lands to maintain output. Environmental issues resulting from over-intensification (N leaching into groundwater and P deposition in surface waters) do not present a widespread problem in SSA and will not become one as a result of applying 50 kg/ha with complementary integrated soil management practices (including incorporation of organic manure and water harvesting) (Baanante et al., 1989). Rather, for the foreseeable future, the main environmental concerns in agriculture in SSA stem from extensifying into the less productive and fragile marginal lands because of the associated high risk of long-term damage to the natural resource base and the environment (e.g., fuelwood supplies and the impact of its collection time on other productive activity [particularly for women], as well as fuel prices, wildlife, and biodiversity).

Indeed, in recognizing the heterogeneity of SSA countries in their natural resource endowment (resource-carrying capacity) and geography, it is widely accepted that in many cases the use of fertilizer alone is not enough to reverse the declining soil fertility in this region. For example, Shapiro and Sanders (1998) point out that where infiltration is a problem (e.g., Sudanian zone), water-retention techniques usually combined with manure reduce the risks and increase the returns from fertilization. Soil fertility quickly becomes a limiting constraint on these soils when water availability alone is ensured. In the sandy soils such as in the Sahelo-Soudanian zone, fertilization and higher plant density are sufficient to raise farm income at acceptable risk levels. Thus, in many cases, one would have to improve the moisture condition and the soil structure to improve the effectiveness of chemical fertilizers. Eswaran et al. (1997) note that the Green Revolution occurred in Asia in those countries where there was a serious effort to match technology with resource conditions and where advances in development and use of high-yielding crop varieties were accompanied by appropriate soil, water, and nutrient management.

There is ample evidence that organic fertilizers are sources of plant nutrients and improve soil characteristics and soil quality. Traditionally, farmers have used bush fallowing, farmyard manure, and household refuse to maintain soil fertility and increase production. However, management problems, their limited supply, the associated high transportation costs, and their low nutrient content and mix constrains their use. The management problems include:

- The need for species compatibilities with the micro conditions and soil physical, chemical, and biological factors.
- The dependence of the amount of biomass (and, thereby, nitrogen accumulation) upon successful seedling establishment.
- The length of the crop cycle.
- The labor requirement for incorporating legume residues in the soil.
- The much slower gradual release of nitrogen through the mineralization of crop residues compared with the nitrogen release process with inorganic fertilizer.

With regard to the supply constraints, Seckler (1994) points out that it takes as much as 120-360 ha of grazing land to sustain the nitrogen balance of 1 ha of maize land through application of animal manure. Similarly, it takes about 2 ha of land planted to leguminous plants to provide enough nitrogen for 1 ha of maize. Weight and Kelly (1999) point out that to haul the 100 kg N generally needed for 4 t/ha maize crop, it would take 217 kg of urea or 20 t of leaf biomass with 80% moisture and a 2.5% (25 g of N/kg) N concentration on a dry weight basis. Byerlee and Heisey (1992) note that while green manure from deep-rooting perennial trees provides more organic matter and draws up soil nutrients from deep levels, their

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6. For example, only recently, the Northern Ghana Low External Input and Sustainable Agriculture (LEISA) Working Group quickly realized, although organic manure leads to significant improvements in soil fertility and crop production over time, most farmers have a problem obtaining organic matter (Dittoh, 1999).
nutrient mix is poor since they provide a good source of nitrogen and an inadequate amount of phosphorus.

Consequently, many soil conservation practices are viewed as ways of slowing existing yield decline and soil degradation, and improving water conservation (stone contour bonds), but not as yield-increasing strategies (Cleaver and Schreiber, 1992). In other words, organic fertilizers (animal manure and crop residues) are important mainly for maintaining soil structure and moisture control but cannot supply all nutrients needed to sustain rapid yield growth.

Currently, the appropriate use of imported inorganic fertilizers is the only technically efficient and economically profitable way to overcome the soil fertility constraints in most SSA regions and for most farmers (Shapiro and Sanders, 1998; Yanggen et al., 1998). This observation led Harold et al. (1994) to conclude that, to achieve the minimum 4% annual growth in agricultural production, SSA inorganic fertilizer consumption must increase by 18% annually. This represents an unprecedented increase given the rates reported for South Asia (13%) and South East Asia (9%) throughout the 1960s onto the 1980s with much better soil, moisture, and crop market conditions.

But whatever the realistic growth rate of fertilizer use may be, unless processes underlying the decline in soil fertility are halted through sound soil conservation and integrated nutrient management practices sustained by conducive agricultural policies, efforts to increase agricultural production though intensification will be to no avail (IFDC, 1997). This suggests that farmers have access to and understand relevant information about effective and efficient fertilizer use. It also suggests that alternative ways of improving soil fertility must be considered as complements rather than substitutes for inorganic fertilizer. It is essential that fertilizers be used appropriately in the context of the overall soil management strategy and not as a substitute for proper soil management. In this regard, it is very encouraging that ten countries in SSA are currently developing national soil fertility action plans in collaboration with the FAO-Investment Center.7

### 2.2.6. Constraints to Greater Use of Fertilizer by Smallholder Farmers—Efforts to increase fertilizer use on smallholder farms are plagued with fundamental problems both on the demand and supply sides. Demand-side constraints are those associated with the fertilizer technology itself, farmers’ resource endowment, and socioeconomic factors affecting farmers attitudes and behavior vis-à-vis fertilizer application. In contrast, supply-side constraints are those associated with the importation, production, and marketing of fertilizers.

On the demand side, studies identify the following key constraints:

- The profitability and the risks associated with climatic and soil characteristics, and economic phenomena (e.g., output market outlets and prices).
- The lack of technical/management skills and information on application rates and agronomic methods to increase efficiency and profitability.
- Underdeveloped seasonal credit markets.

In their findings various authors such as Baanante and Thompson (1988) and Lele et al. (1989) emphasize the importance of the demand for agricultural output and the value of the crop among factors affecting fertilizer demand. In particular, Baanante and Thompson (1988) and Thompson (1991) note that the level of demand for food and agricultural commodities determines their prices which, in turn, determine the profitability of their production and the use of purchased inputs. However, stressing the importance of farmers’ risk-averseness, Fontaine and Sindzingre (1991) caution that an increase in output prices will not by itself induce optimal use of fertilizer. In all probability, the absolute demand for fertilizer will increase only by the amount necessary to produce the additional output using unchanged techniques.

Supply-side constraints include:

- Poor rural road networks (high transportation costs).
- Shortages of foreign exchange or lengthy bureaucratic procedures in the allocation of available foreign exchange.
- High cost of capital and/or limited access to credit.
- Inexperience of private importers and dealers and weakness in the domestic procurement and distribution network that often lead to physical nonavailability of fertilizers in the right quantities and at the right time.
- Inappropriate donor aid in-kind.

While price issues are important and more often investigated, various authors such as Lele et al. (1989), Fontaine and Sindzingre (1991), and Sahn and Arulpragrasam (1991) have stressed that supply side constraints are by far the most significant constraints in expanding fertilizer use on a sustained basis. Tables 2 and 3 provide a synthesis of the constraints to greater participation of the private sector in fertilizer marketing.

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7. These countries are: Benin, Burkina Faso, Côte d’Ivoire, Ethiopia, Ghana, Guinea, Madagascar, Mali, Niger, and Senegal.
<table>
<thead>
<tr>
<th>Issues/Problems</th>
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<tbody>
<tr>
<td>Low and variable effective demand.</td>
<td>(1) Strengthen research and promotion for “small” crops that do not interest the private sector, (2) improve rural infrastructure, (3) improve availability of information, and (4) promote value-adding processing and regional markets.</td>
</tr>
<tr>
<td>Absence or limited number of local entrepreneurs ready and able to take over from the state.</td>
<td>Identify potential traders prior to the reform, plan for policy changes on the basis of private sector strength and organize training programs. Should be provided by independent, national and NGOs. Governments are not well equipped to provide training because (1) residual fear by the private sector that this may lead to various rules and regulations and (2) civil servants are poorly paid and may have no first-hand experience with entrepreneurial activities. Governments and international and bilateral aid agencies should assist in the development of such organizations.</td>
</tr>
<tr>
<td>Improper allocation of fertilizer aid-in-kind.</td>
<td>(1) Improve information flow to coordinate deliveries with private sector regarding time of delivery, product mix, and quantity. (2) Sell or auction aid consignments by tender while en route to the country and facilitate port clearance. (3) Lodge foreign exchange from donor aid with a bank as credit opportunity. (4) If allocation is maintained, prescreen dealers. Close government-businessmen-donors liaison to avoid market disturbances.</td>
</tr>
<tr>
<td>Banks’ preference to deal directly with suppliers rather than providing farmers with cash to make their purchases. Credit arrangements to determine which supplier will be successful.</td>
<td>In Zimbabwe, changes in the disbursement procedure by the Agricultural Finance Corporation to permit farmers to nominate their own suppliers enabled private suppliers to compete on equal terms. Avoid parallel marketing systems.</td>
</tr>
<tr>
<td>Lack of finance for capital items and trading, given the quick turn-around between purchase and sale. Distributors can tie up money in seasonal stocks for months, particularly at import and wholesale levels (average fertilizer storage can be up to one year).</td>
<td>Deferred payments or longer duration loans to cover the need to hold fertilizer stocks and extend credits to other traders and farmers. Manufacturers or foreign suppliers are unlikely to do this. Banks are reluctant to finance the trading sector due to the absence of bankable securities, or are not attuned to traders’ requirements.</td>
</tr>
<tr>
<td>Foreign exchange: shortages (liquidity problem) and slow and bureaucratic procedures—allocated administratively. Results in late imports and thus to storage costs that only subsidized parastatals could bear.</td>
<td>Minimize bureaucracies. If possible, reject allocation in favor of competitive bidding. For example, instead of several private importers, a government agency can retain responsibility for procurement and auctioning the fertilizer when it is still at the sea to take advantage of economies of scale associated with transport.</td>
</tr>
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</table>
Many countries in SSA have and/or continue to receive fertilizer aid-in-kind (e.g., KR-2 fertilizer or aid-in-kind fertilizer from USAID and the European Union). Prior to policy reforms, these inputs were generally distributed at subsidized prices by monopolistic public agencies. Counterpart funds received by the sale of these inputs were intended to be used to support rural development programs. With the privatization, donors typically open tenders with procurement and shipping restrictions. These restrictions generally limit the sourcing to only small eligible firms of the donor country. These firms usually charge a price substantially higher than that of commercial imports. The price differential is typically offset by the donor who requires from the country a payment to the designated counterpart fund equal to two-thirds to one-half of the f.o.b. price. As a result, the aid-in-kind fertilizers are often priced in the local market at well below the commercial value equivalent. Payment to the counterpart fund often involves a long grace period. Technical specifications are often written to benefit suppliers rather than as per market requirements. The supply is not integrated into the domestic fertilizer market and is often not timely. Consequently, in this form aid-in-kind becomes detrimental to the development of a private sector-based input supply system because prices, quantities, and timing of delivery remain uncertain in most cases.

2.3. The Use and Supply of Crop Protection Products

2.3.1. A Thin Pesticide Market Driven by Cash Crops—According to Yuldelman et al. (1998), various researchers estimate that as much as 50% of the total attainable crop production in SSA is lost through damages caused by pests (i.e., weeds, insects, and pathogens). Improving food security in SSA therefore requires not only a much greater use of improved seed and fertilizers but also that losses due to pests before and after harvest be substantially reduced. While pest problems vary considerably in SSA because of the diversity of the production environments, there is a general preference for chemical pest management fostered by a perception of risk reduction and the view that alternative measures are retrogressive (EPTAT/Winrock, 1994). Interestingly, there are little data on the use of pesticides in SSA, including the degree of environmental degradation due to pests, human cost of pesticide use, an accounting of the financial and economic benefits and costs of pesticide use.

Pesticide use in SSA is concentrated on high-value cash crops notably cocoa, coffee, and cotton but also banana and oil palm (EPTAT/Winrock, 1994). As a result, the leading pesticide users in SSA are countries like Cameroon, Côte d’Ivoire, Nigeria, Ghana, Kenya, Sudan, Tanzania, and Zimbabwe that have a well-developed cash crop sector (Adesina, 1994; EPTAT/Winrock, 1994). However, the use of pesticides on cash crops has some spillover effects on food crops. For example, the availability of the chemicals and application equipment through the cash crop systems and the issuing familiarity with pesticides also benefit food crops.

While herbicides are the most extensively used class of pesticides in the world, insecticides are the most widely used on both food and cash crops in SSA. In the early 1990s, for example, insecticides constituted about 45%-50% of total pesticide markets in SSA. This predominance of insecticides over other classes of pesticides is due to the fact that labor is typically in sufficient supply and available at prices lower than the chemicals used for weed control. In addition, hand-weeding provides livestock fodder. As labor becomes a significant constraint, other means of weed control gain in importance.

Most of the pesticides used in SSA are imported, often through direct importation of ready-to-use formulation by public crop protection agencies in the form of agricultural aid packages. But, there exists an informal, unrecorded, and often illegal market for pesticide. For example, large private commercial growers often buy pesticides directly from manufacturers or distributors in neighboring countries without involving government agencies. As agricultural aid packages, these pesticides are used as an emergency control method for migratory or perennial pest outbreaks and in prophylactic application against insecticides.

The active ingredients are manufactured outside SSA, and imported products are formulated in more than a dozen SSA countries. Some countries like Cameroon, Liberia, and Nigeria repackaged formulations (Youndewe, 1989). A few others like Cameroon, Nigeria, Ghana, Senegal, and Côte d’Ivoire have the capacity to produce pesticides locally. For example, 80% of the pesticides used in Côte d’Ivoire in the 1980s were produced locally. Small amounts are also produced in Mali.

Most authors consider the SSA market to be thin due to prevailing economic conditions and depressed markets. The level of pesticide use is principally and directly related to the variability of world prices of the concerned crops but also to insect infestation. However, because northern hemisphere markets are generally saturated, European and American corporations that dominate the global pesticide market look to Africa and other developing countries for their future growth.
2.3.2. The Dominance of Chemical Pest Management—

Although many SSA countries have accepted nonchemical approaches to controlling damage caused by pests as an important aspect of their agricultural policy, the corresponding technologies are only marginally used. These technologies, which are considered as natural and environmentally friendly methods, include biological control agents, plant breeding, biotechnology, and integrated pest management (IPM). The excessive and often indiscriminate use of the chemical approach has overshadowed the real potential of the nonchemical means. Most researchers argue that the demand for chemical pesticides will increase as SSA intensifies agriculture. Most of the pesticides used tend to be very toxic. While there exist less toxic products, their use is constrained by:

- Their higher cost relative to that of toxic products.
- The maturity and saturation of markets in developed countries that cause manufacturers to look to Africa for growth.
- The insufficient institutional structures and capacities for enforcing laws and regulations in SSA.

Probably the most talked about SSA success stories in pest biological control is IITA’s biological program. The most significant achievement of the program is its outstanding success in controlling cassava mealybugs throughout the cassava-growing belt in SSA. The program has also made significant progress in the biological control of cassava mites. The expertise within the program is used to address various other pest-related problems in SSA such as mango mealybug, locusts and grasshoppers, grain borers, and water hyacinths (in collaboration with Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Despite its appeal, biological control has not had a broad-based impact on the practice of pest management (Yuldelman et al., 1998).

The use of biotechnology for plant protection centers around use of genetically engineered plants that are herbicide resistant (i.e., do not succumb to herbicide applications) or pest resistant (i.e., resistant to pests without the need for pesticides). In recent years, private corporations such as Monsanto have invested heavily in genetic research and development. Most of the applications of such research in agriculture (e.g., soybeans, maize, cotton) have been primarily limited to problems in developed countries and large farmers in a few developing countries (Pinstrup-Andersen et al., 1998). Yuldelman et al. (1998) argue that there will be a substantial increase in the use of genetically engineered plants in the world in the next 20 years.

Probably the most pragmatic biologically based pest management approach is the promotion of IPM involving pest resistant crop varieties, cultivation practices such as crop rotation, and a judicious use of some chemical pesticides. This is particularly true now and in the immediate future given the current emphasis on use of chemicals in agriculture and the uncertainties about many nonchemical approaches. The emphasis on use of chemicals in pesticides is often fueled by:

- The maturity and saturation of markets in developed countries that cause manufacturers to look to Africa for growth.
- Limited information and research of IPM. Good information is the basic tenet of IPM and requires extensive data collection and analysis. Furthermore, there is little advancement in IPM-related research in SSA, and many extension services are under staffed and lack the technical expertise to advise on alternative pest management practices. The limited information has fostered a perception of risk reduction and the view that alternative measures are retrogressive.

Most of the IPM programs in SSA are promoted by NGOs such as Cooperative for Assistance and Relief Everywhere, Inc. (CARE) in direct collaboration with farmers and farmer representatives (Pinstrup-Andersen et al., 1998). Because these NGOs cannot easily increase the scope of their projects, small-scale farmers have little access to the technologies or services needed for IPM. Thus, the public sector needs to play a much larger role in promoting IPM among small-scale farmers. This implies a strong government commitment to IPM and institutional changes in motivating, training, creating, and disseminating knowledge among producers.

2.3.2. Ineffective Regulation and Limited Local Capacities—

Until recently, SSA governments promoted pesticide use through a system of direct and indirect subsidies. For example, Cameroon, Côte d’Ivoire, and Togo used to subsidize 100% of the pesticide cost for its major export crops (Adesina, 1994). These subsidies were eliminated with the introduction of structural adjustment programs, leading to high pesticide prices. While the price rise contributed to lower consumption in some countries such as Tanzania, in general, pesticide consumption continued to rise. Yet the problem of pest resistance and phytotoxicity is becoming significant in some countries, and there are pervasive issues associated with the use of chemical pesticides including:

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9 Some authors think of IPM as part of a broad-based approach that leads to a chemical-free agriculture, while others see it as a system that involves the most efficient use of chemical pesticides (Yuldelman et al., 1998).
The improper labeling and advertising of products (including the use of a language different from farmers’ local language).

The use of many organochloride pesticides such as DDT, lindane, chlordane, and heptachlor banned or severely restricted in Europe and North America (EPTAT/Winrock, 1994; Yuldeman et al., 1998).

The inappropriate use of cheap chemicals on food crops.

The lack of appropriate facilities for effective storage and disposal of old stocks and containers.

In many countries, particularly in West Africa, there are several public plant protection units within NARs geared towards improving pesticide efficacy, proper handling, test for eventual registration, and extension to farmers. But, according to Adesina (1994), the banned or severely restricted products are still used in SSA because of:

Their lower cost.

The relative ease of their manufacture.

Their broad spectrum control.

Their generally low handling hazard.

Their strong residual effectiveness.

Yet most countries have accepted the UN Prior Informed Consent (PIC) framework that provides guidelines to prevent unwanted imports. Despite the PIC framework, situations of toxic residues, availability of banned products, availability of unlabeled or improperly labeled products, supply of inferior quality products, improper advertising of pesticides, failure to provide users with adequate information, and instructions for safe and effective use are very common in SSA. Most authors attribute the existence of these problems to poor control and enforcement. Youdowei (1989) and Adesina (1994) identify six factors limiting effective control:

The lack of appropriate legislative authority, residue, and formulation control.

The lack of basic infrastructures and equipment, including facilities to analyze pesticide product quality.

Free foreign aid in the form of pesticides (e.g., KR-2 program of Japan or GTZ) sold at low prices or given to plant protection units for use in the case of pest outbreaks.

Often conflicts between MOA and the Departments of Health sharing responsibility for pesticide regulatory procedures.

General lack of effective institutions and regulation for controlling imports, export, formulation, registration, advertising, and distribution for pesticides. However, SSA countries are at different levels of crop protection legislation. For example, among the 10 Southern African Development Community (SADC) countries only Tanzania, Mozambique, and Zimbabwe have pesticide regulations. The situation is even worse in West Africa where neither legislation nor registration and control schemes exist in most countries, except in Benin, Burkina Faso, Cameroon, Côte d’Ivoire, Gambia, Niger, and Senegal. But several countries are actively pursuing the development of pesticide registration systems.

Insufficient knowledge of specific guidelines. This tends to limit the capacity of some countries to implement the International Code of Conduct on the Distribution and Use of Pesticides adopted by FAO in 1985.

3. Policy Reforms and Their Impacts

3.1. Justification for and Extent of Liberalization

Throughout the 1960s and 1970s, the institutional setting of agricultural input supply in SSA was characterized by extensive direct government interventions with specialized public institutions controlling input procurement and distribution. Similarly, direct government interventions dominated crop production and marketing, particularly for export crops. This pervasive direct government intervention was rationalized on the grounds that government had to play a dominant role to achieve the industry-driven regional development fueled by the Afro-optimism of the 1960s while addressing the equity concerns (World Bank, 1989). Agriculture was relegated to the secondary role of supplying raw materials and providing tax revenues to finance other sectors. This was because agriculture policymakers proclaimed that:

The prospect for commodity exports was poor.

They strongly desire to reduce dependence on manufactured imports.

Markets alone will not induce optimal production decisions and “socially” desirable outcomes.

According to the World Bank (1989), the distrust of market mechanisms is based on:

A mistrust of foreign business.

The perception that domestic private entrepreneurs charge high prices and are not innovative enough or are unable to produce enough and to operate the needed well-functioning domestic markets.
✓ The fragmented nature of the delivery services has higher operating costs that act as a disincentive for private sector investment.

As a result, on the input side, governments heavily subsidized the use of modern agricultural inputs to bear the risk associated with their use and allocate credit and foreign exchange. On the output side, governments invested in large state-owned state-run core industries and set up marketing boards or other mechanisms to assume the risks associated with the excessive volatility of the international commodity market.

However, there were some important differences in the structure, conduct, and performance of input supply systems among SSA countries. These differences were strongly influenced by national food policies. A cross-country study carried out by Jayne et al. (1998) shows that food policies in SSA exhibit a regional pattern mirroring their different colonial heritage. In general, both West and Central African countries follow similar policies characterized by direct government involvement through state marketing boards and cheap import-dependent food policies of meeting politically powerful urban consumers’ demands.

In contrast, in Eastern and Southern Africa where European settlers’ agriculture was prominent during the colonial period, the level of direct government intervention varied depending on the importance of settler agriculture. Typically, the greater the importance of European agriculture, the greater the degree of state intervention in food and input marketing activities, and the greater the subsidization of selected producers. But, unlike in West and Central Africa, the rise of politically powerful farm lobbies in Eastern and Southern Africa figured prominently in the determination of agricultural policy, and consumption depended more heavily on domestically produced cereals (Byerlee and Eicher, 1997; and Jayne et al., 1998).

While much was achieved by SSA governments (particularly in the 1960s) in reducing ignorance, poverty, and impact diseases (e.g., expanded life expectancy and health care), a review of available literature reveals that a feature common to the pervasive direct public interventions in West, Central, Eastern, and Southern Africa is the associated inefficiencies and rent seeking, which in the 1970s led to:

✓ Excessive distribution costs.
✓ Sustained suppression of domestic producer prices and incentives.
✓ Stagnant or declining agricultural production due in large part to declining investment and productivity.
✓ Soaring budgetary drains because of the high cost of public monopolies in procurement and distribution.
✓ Rapid balance of trade deterioration.
✓ The low rate of adoption of modern technologies.
✓ The failure to promote smallholder farming systems and technology development.

The poor performance of public institutions in a context of deepening economic crisis led to mounting donor pressure and leverage for significant reforms, which culminated in the 1980s with structural adjustment programs supported by the International Monetary Funds (IMF) and the World Bank. Initially the objective of the reforms, particularly in the early 1980s, was to reduce budget deficits and improve balance of payments.

In the mid-1980s, it became apparent that there were some internal rigidities that limited the ability of economic agents to respond to the incentives created by the macro policy changes. Consequently, sectoral reforms were initiated with the objective of reducing public intervention and encouraging private sector participation in a way that increases efficiency and improves long-term growth. Reforms in the input sub-sectors have therefore generally involved a reduction in the subsidization of farm inputs, privatization or demonopolization of input procurement and distribution, and price and trade liberalization. As a result, in the last decade, SSA input markets have been changing rapidly.

There are only few documented assessments of domestic market liberalization efforts in SSA. Post-reform trends show that reforms have been partial and the transition process has been slow. In many countries such as Ghana and Uganda, a few firms dominate input and output marketing or regulate 10 the entry and activities of the private sector (Goletti and Alfano, 1995; Kempkes, 1997). This is often in part because of the continued involvement of State Owned Agencies in the provision of inputs for export crops. 11 This situation is exacerbated by the thin input market for food crops and the high capital costs of importing, storing, and distributing imported inputs.

10. For example, the Société Nationale de Promotion Agricole (SONAPRA) regulates the operations of six fertilizer importing companies in Benin (Badiane et al., 1997).

11. For example, according to Badiane et al. (1997), the Agricultural Development and Marketing Corporation (ADMARC) remains the main input supplier for small-scale farmers and the Smallholder Farmer Fertilizer Revolting Fund of Malawi (SFFRFM) the main fertilizer importer in Malawi. SENCHIRIM dominates commercial fertilizer distribution in Senegal.
According to Goletti and Alfano (1995) and Jayne et al. (1998), there has been some private sector response to the reforms. But, success stories are very limited because many problems still exist and the solutions have not always been easy to implement (Goletti and Alfano, 1995). The partial liberalization of input markets in SSA, which was often adopted to avoid the high cost and sudden shock of full liberalization, strained input distribution, and led to market failures. In general, in both markets, the response to the demonopolization and subsidy removal has been variable, mixed, and frequently inconsistent with the expected increases in productivity across countries and between subsectors within a country. However, in general, private sector response has been much quicker in the output markets than in the input markets. The following three subsections synthesize the impact of input markets reforms in terms of how they affected the efficiency and effectiveness in the supply systems and the extent to which they contributed to growth.

3.2. Impact on Efficiency

Standard economic analysis suggests that the impact of policy reforms on efficiency throughout an input supply system can be measured in terms of their effect on:

- Prices as a result of changes in transaction costs in the form of reform-induced changes in per unit transportation costs, per unit storage, and per unit processing costs.

- The divergence between private and social values.

- Yield changes.

- Profitability at various off-farm and farm levels of the subsectors.

Various studies undertaken after reforms show that there is some evidence of reduced marketing costs. For example, Jones (1994) reports that parastatal output marketing efficiency improved during or following the reforms in Kenya, Malawi, and Zimbabwe. However, Cromwell (1992) argues that small-scale farmers did not benefit from the reforms either because reforms were not tailored to them or because they fail to account for macro-micro linkages between small farmers and the rest of the economy. For example, she notes that the overall effect of reforms has increased neither the incentives nor the ability of small farmers to use improved seeds. The same conclusion is echoed by Goletti and Alfano (1995), who report that, in Cameroon, liberalization policies have led to efficiency gains, but the benefits to smallholder farmers have been limited.

With regard to prices, most research shows that, despite evidence of reduced marketing costs, the reduction of farm inputs subsidies caused input prices to rise. Increases in input prices were exacerbated by the immediate effect of currency devaluation without sufficient compensating increases in produce prices (Kempkes, 1997; Reardon et al., 1997). For example, subsidy removal and continuous depreciation of the cedi in Ghana led to a 29% annual increase in the real price of compound fertilizer between 1980 and 1990 and a 27% annual increase in the real price of ammonium sulfate. This led to inventory accumulation and in 1991 no fertilizer imports were made, and fertilizer distribution in remote locations declined significantly (Jebuni and Seini, 1992). Still in Ghana, the use of insecticides and fungicides dropped by almost 90% in the 1980s, leading to a reintroduction of subsidies in recent years. Jager et al. (1998) report that in most West African countries, the removal of fertilizer subsidies has at best resulted in a stagnation of fertilizer use in the food crop sector.

It was expected that the benefits of improved internal terms of trade for agriculture brought about by devaluation and market liberalization would more that offset increased costs to farmers of higher fertilizer prices. While the primary benefit of market liberalization has been the budgetary gain to government, there is no evidence to support this expectation for food crops. Chambezi’s (1993) analysis of supply response for Malawi’s small-scale farmers, for example, shows that fertilizer demand is very quick to respond to price changes, and the effects of fertilizer price on its use are stronger than the effect of product prices. Furthermore, the expected impact of reforms did not materialize because food crop prices are determined by domestic market forces, and with few exceptions (e.g., rice) there was little government intervention in food markets.

As a result, with few exceptions, increased prices made the use of inputs less attractive for farmers. For example, Gerner et al. (1995) report that in Ghana and Mali, the VCR for maize has fallen below 2. The VCR for rice in Mali has fallen to 4. According to Breman (1997), in Burkina Faso, the VCR for millet and sorghum fell from 5.3 in 1981 to 2.6 in 1989 and 2.9 in 1996 while that of cotton fell from 6.6 in 1981 to 4.2 in 1989 and 4.0 in 1996. In Togo, Koffi-Tessio (1996) reports that the VCRs for food crops (maize, cassava, sorghum, yam, and millet) fell from 6-16 in 1983 to 1-4 in 1994. In contrast, Doward et al. (1998) note that despite the upward input price trend, in general, the use of purchased inputs remains profitable on small-scale cash crop farms in many parts of SSA. However, private agents have been unable to effectively take over from the public sector due to insufficient incentives and a shrinking input use by farmers. But, where opportunities for profit-making exists, private sector
actors innovate to overcome failure in important markets, including that for seasonal input credit.

3.3. Impact on the Effectiveness of Input Supply

The impact of reforms on the effectiveness of the input supply systems is often measured in terms of changes in:

- ✔ The availability of these inputs as reflected by changes in the number of market outlets.
- ✔ The accessibility of the inputs to farmers as reflected by improvements in infrastructure and transportation linking farmers to markets.
- ✔ Timeliness of inputs delivery.
- ✔ The appropriateness of these inputs.
- ✔ The use of inputs, both in terms of adoption rate and the intensity of use.

With regard to accessibility, a cross-country study by Badiane et al. (1997) conducted in Benin, Ghana, Madagascar, Malawi, and Senegal shows that market reforms have introduced some degree of competition in the input and output markets. For example, in Benin the private sector’s share of the fertilizer distributed grew from 21% in 1992 to 75% in 1996. Consequently, more flexibility and options are now available to farmers as a result of the market reforms. This positive effect is observed even in countries where the system is dominated by few economic agents (e.g., Senegal and Malawi).

Badiane et al. (1997) also report that market reforms have negatively affected the use of seed of improved varieties and fertilizers. With the exception of countries such as Malawi, Madagascar, and Zimbabwe that have benefitted from in-kind donor aid, consumption of fertilizer or improved seed declined after reforms, and there still is very limited use of fertilizer by small-scale farmers on food crops. For example, the use of modern inputs declined in rice production in Senegal and maize production in Ghana. They attribute this negative effect of the reforms to the high prices and reduced access to financial services previously provided by the public sector and not to physical constraints. This finding concerning financial services is consistent with an earlier FAO (1994) report suggesting that increases in commercial interest rates, strategic default behavior and the lack of collateral left the farmers dependent on either informal sources of finance or savings for investing in inputs, thereby limiting input consumption in small-scale farming. In Malawi, it was deemed necessary to maintain certain subsidies following reforms for the purpose of ensuring access to fertilizer markets by small farmers (Goletti and Alfano, 1995).

It is important to distinguish between the response in areas of secure water (irrigated areas or well-watered rainfed areas) and the drier rainfed areas. There is a lot of evidence from irrigated rice areas and the horticultural subsectors that there has been rapid response by the private sector in areas where access to water is good and production is profitable (e.g., in the potato-producing areas around Sikasso in Mali; also the truck farms that supply Bamako with vegetables). The real problem comes in the rainfed cereal production areas, where the risks of providing inputs like fertilizer are much greater, because farmers decide whether to purchase the inputs only after they have seen how the rains are proceeding. This strategy leaves the input dealer bearing all the inventory risk.

In general, investment in rural infrastructure does not seem to have accelerated with market reforms (Badiane et al., 1997). In other words, reforms have not improved the effectiveness of markets in reaching small farmers. Even in countries like Ghana where there was a massive increase in investment in roads throughout the country since the Economic Recovery program, reforms have increased the concentration of the distribution of fertilizer networks in urban areas, resulting in the inability of the market to provide for small farmers located in remote areas (Goletti and Alfano, 1995). Similarly, with the exception of Ghana, the expectation that reforms will lead to improvements in research and extension due to increased government efficiency has not been fulfilled as the corresponding investments have declined. The weakening extension services make farmers more dependent on NGOs for support. This is often exacerbated by the growing international support going to NGOs. Ideally, the private sector will fill the gap of advisor to farmers.

The research undertaken by the Productivity, Technology Assessment, and Strategic Planning additions to the MSU-FS II underlined the importance of well-functioning markets (along with extension and credit programs) in supporting farmers’ adoption of modern technologies. The same research found that these markets served farmers best when there was some degree of vertical coordination among input distribution, output marketing, and credit functions. Vertical coordination reduces transaction costs by streamlining the delivery of services such as marketing, credit extension and recovery, and dispute resolution.

3.4. Impact on Productivity and Economic Growth

Assessments of the impact of reforms on productivity are often based on corresponding changes in labor and land productivity. The few stud-
ies that have looked into this issue show a mixed story. For example, Badiane et al. (1997) found that market reform does not seem to have accelerated growth in agricultural productivity in Benin, Ghana, Madagascar, Malawi, and Senegal. Jayne et al. (1998) observed that while aggregate labor and land productivity declined in Zimbabwe, Zambia, and Senegal during the 1990s, they increased in Ethiopia, Mali, and Burkina Faso following the reforms.

However, Jayne et al. (1998) argue that an important determinant of the response of agricultural productivity to reforms has been the extent to which agriculture was supported or depressed prior to reform. In countries where state activities were clearly depressive such as in Ethiopia and Mali, agricultural productivity growth brought about by intensification between 1985-89 and 1990-95 has been encouraging despite the still existing constraints. By contrast, where smallholder grain production was supported by state interventions such as in Zimbabwe and to a lesser extent in Kenya and Zambia, agricultural productivity growth in the same period has been stagnant. In addition, the supply response to sectoral and macro policy reform seems to have been greatest in those countries where the reforms were coupled with long-term investments in agricultural technology and human capital development (Goletti and Alfano, 1995; Jayne et al., 1998).

However, much of the productivity increases are due to shifts in crop mix and location of production towards crops whose output markets were not liberalized. In other words, there is limited evidence of intensification of food crops. Much of the evidence of food crop intensification or extensification is linked to subsidized or free distribution of inputs. This was the case, for example, with sustained adoption of improved varieties by small-scale farmers in Zimbabwe and Zambia (Rusike et al., 1997; Jayne et al., 1998). Similarly, the proportion of sorghum area in Zimbabwe increased from 8%-12% to 30-36% after 1993 due to government and donors’ programs that distributed improved OPV for free through drought-relief programs (Rusike et al., 1997).

Analysis of aggregate data available through the early 1990s shows many cases of sharp declines in input use and agricultural productivity immediately following significant structural changes that dissolved parastatals and liberalized markets (Jayne et al., 1998; Yanggen et al., 1998). Most recent evidence shows that input use and productivity have begun to stabilize and in few cases even began to rise (e.g., Ethiopia, Mali, and Burkina Faso). Nevertheless, the rates of productivity growth remain far below rates needed to keep pace with population growth, and the use of improved technologies is far below that in other regions of the world (Yanggen et al., 1998).

### 4. Building Agricultural Input Supply Systems: Strategy Considerations

#### 4.1. Rethinking the Seed Supply System

To encourage private sector investment in seed supply systems, it is clear that policies and regulations need to be reformed. Investments in variety development are uneconomical if farmers do not know about the varieties developed by research. Few countries address adequately the important issue of providing access to good quality seed, particularly of improved varieties (Venkatesan, 1994). Jaffee and Srivastava (1992) suggest that even where NARS and IARCs have made significant breakthroughs, ineffective seed multiplication and distribution systems have limited the spread of improved seeds at the farm level, especially among small-scale farmers. The emerging consensus on the strategy to increase the effectiveness of seed systems in SSA is to take an integrated approach to seed system development emphasizing decentralization, broader participation of various actors while at the same time dealing with critical issues such as quality control, plant protection rights, risk bearing (e.g., liability for unsold stock), contract enforcement, and regional markets.

#### 4.1.1. A Public-Private Sector Division of Labor—Surveys of countries’ experiences by Desai (1985), Pray and Ramaswami (1991), and Jaffee and Srivastava (1992) show that the degree of public involvement in input supply systems in general varies between developed and developing countries and across various subsystems of the input development and distribution. In developing countries, basic research, germplasm enhancement, and plant breeding for self-pollinated crops (SPCs) still remain largely under the auspices of public institutions and IARCs, while the private sector is largely in R&D of specialized crops and hybrids. In addition, seed multiplication and distribution are mostly controlled by public institutions, and most governments intervene to control seed quality (when it exists), import, and prices. In contrast, in developed countries variety development and seed promotion and distribution fall under a mix of private and public control.
However, Desai (1985) and Pray and Ramaswami (1991) point out the importance of recognizing that:

- Seed supply systems go through stages of evolutionary development from a traditional to an advanced system.
- Within a country, there may be differences in the degree of development by commodity (e.g., export versus non-export crops) and geographical area.

But the move from the initial stage characterized by the use of traditional varieties and the absence of a seed industry to one where farmers begin to adopt improved varieties developed by the research system is prompted by the government through the establishment of institutions to produce and distribute the seeds. In the later stage, the private sector begins to be more of a source of new technology, as opportunities for private sector investment increase. Still the public sector will continue to dominate the development of open-pollinated crop (OPCs) varieties, and the private sector will continue to dominate hybrid seeds.\(^{14}\)

Seed policy must stem from farmers. However, since they cannot do all activities, the government must continue to provide training, equipment, and monitoring of the impact of infrastructure and policies on the purchase of seeds.

With regard to seed multiplication and processing, Jaffee et al. (1992) stress that direct public sector production of seed can be justified in the case of foundation seed for self-pollinated crops because this activity is generally unprofitable and is associated with significant externalities, or in the very early stage of seed systems development, or on equity ground (e.g., minor crops or crops specific to a location). Once the foundation seed is available, the private sector can take responsibility for production of commercial or certified seed.

However, there is ample scope for private sector to appropriate a sufficient proportion of the benefits to make such an investment profitable, especially when the demand for commercial seed is high or developing. But margins are much lower for self-pollinated crops than for hybrids. As a result, only small firms with very low overhead costs are able to profitably produce high-quality seed of self-pollinated crops. Still they would need to acquire improved seeds from public or private plant breeders at relatively low cost. The importance of seed policy with regard to seed quality comes to the forefront as many important attributes are not directly observable, and many factors affecting seed quality are difficult and costly to detect or measure.

With regard to seed marketing and distribution, Jaffee et al. (1992) also stress that the private sector can profitably perform these functions if prices are market-based and a significant proportion of farmers' production is commercialized. In contrast, the public sector has a comparative advantage promoting seed standards and enforcing regulation regarding important quality attributes of seeds that are not directly observable prior to planting. Seed subsidies are not necessary because they constitute a small proportion of total production cost for most crops, and available evidence indicates that farmers are willing to pay commercial prices for seed which is of truly superior quality. But for equity reasons, for example, the government may subsidize the distribution of seed in relatively remote or sparsely populated areas.

Finally, it is important to recognize that all input systems within a country (between crops) or between countries do not follow the same deterministic organizational and institutional development path, nor would they necessarily reach the same technical, organization and institutional complexity. The roles of public, private, formal and informal organizations in promoting the transformation process in the intermediate stages are dynamic. However, the evolutionary conceptions of the national seed development exhibit two common underlying themes: the changing but not necessarily declining role of the public sector accompanied by an increasing role for the private sector and the declining relative (but necessarily absolute) importance of the techniques of the informal seed system as the system develops.

4.1.2. Formal Versus Informal Seed Supply Systems—The distinction between formal and informal seed systems and their determinants were extensively discussed by Venkatesan (1994). In particular, he points out that the informal seed sector is often neglected. Yet the relative importance of the formal and informal systems is determined by:

- The biology of the crop (open-pollinated varieties and hybrids versus self-pollinated).
The multiplication rate of the seed (one generation net increase in seed quantity).

The availability of improved varieties.

Farmers’ market orientation with respect to a particular crop (commercial or subsistence consumption).

For self-pollinated crops such as rice, even improved varieties can be multiplied by farmers with some training. The seed system can be informal, and it is not necessary to set up expensive seed-processing plants and seed-certification units. For cross-pollinated crops such as maize and sorghum or for crops with a high seed rate and low multiplication rate such as groundnut, one can either select, hire, or contract with good seed growers and certify only seeds grown from their plots or encourage the development of a decentralized informal seed system.

These determinants suggest the need for diverse seed supply systems. Typically, the operational objectives and organizational structures of each system are determined by the nature of the controlling interest group. Thus, it is important not to focus only on the development of large-scale public and private commercial seed enterprises and regulatory agencies, while neglecting the role of informal channels and equity considerations of the public sector. Such considerations emphasize the diversity of seed demand reflecting categories of users and corresponding seed characteristics, quantity demanded, and frequency. In other words, Venkatesan (1994) argues that while much of the action needed depends upon the status of all factors relevant to seed systems, such as research, extension, infrastructure, and policies, a suitable mix of strategies recognizing that farmers fall under different categories is the best choice for most countries.

As a result, in each country:

The government needs to recognize that various components of the seed system are interrelated, and the seed system also has linkages with other systems, particularly research and extension systems, and with factors such as infrastructure and economic policies. Each of these components and linkages can determine the extent of private sector involvement in varietal development and seed production, and the growth of the informal sector.

The government needs to deregulate the seed industry and recognize the informal sector as an important low-cost source of quality seed and to use it as a vehicle for providing resource-poor farmers with quality seeds of modern varieties at affordable prices. This implies:

- Facilitating access to foundation and breeder seeds.
- Providing extension advice on seed production, processing, treatment, and storage.
- Developing a legal framework that permits marketing of certified and uncertified seed of acceptable genetic purity, germination quality, and moisture content.

Because the informal seed sector has often been neglected in SSA and because the bulk of seed that small-scale farmers use comes from the informal sector, most seed specialists would agree that improving the quality of seed farmers use (especially farmer-saved seed) is the single most important improvement in seed supply in this region of the world. This necessary improvement can be achieved by:

- Training farmers in the better selection, treatment, and storage of seeds from their own farms. This is the case, for example, for programs such as Winrock International’s On-Farm Seed Projects in Senegal and Gambia. Its focus on rice has increased availability of good quality seed at low cost.

- Encouraging farmers to make their own selection of traditional varieties, multiply, store, and sell them to other farmers.

- Developing modern varieties through research and production of good quality seed of modern varieties through either formal or informal channels.

4.1.3. Key Characteristics of an Effective Seed Supply System—Various authors have discussed the distinctive characteristics of an effective seed system and have identified several critical factors. Venkatesan (1994), for example, notes that, typically, an effective seed system is one that has these characteristics:

- It is based on an appropriate mix of strategies that guarantee quality, timeliness, access, and affordability.

- It covers all crops that most of the farmers grow.

- It is developed within a stable political and legal environment that ensures the release of new varieties of high quality seed of appropriate critical characteristics to farmers in a sustainable manner.

- It has a level of sophistication that is consistent with the level of agricultural and infrastructural development, and the maturity of the institutions in the agricultural sector of the country.

- It is consistent with the policies generally followed in the agricultural sector.
✓ It is well-supported by effective research and extension and other services such as fertilizer and pesticide supply systems, seasonal credit, and efficient output marketing systems.

Both the effectiveness and efficiency of a seed system depend on various factors including:

✓ The agroclimatic factors that, along with farmers’ purchasing power, determine their risk-tolerance capacity, and thereby the type of seed and seed system they are most likely to use.

✓ The crops’ technical characteristics that determine the crop specificity of the strategies.

✓ The country’s legal and regulatory framework and its enforcement capacity and ability. This is particularly the case for varietal release, notification, and certification because they affect private sector investment, breeding activities, and the informal system. Notification can be compulsory or optional. But compulsory notification and certification can restrict or delay the development of a seed system. However, a loose legal framework can result in too many varieties, many of which may not be accepted by farmers.

✓ The status of research and extension in terms of how they ensure the adequacy and appropriateness of the variety released. But resources allocated to seed research and extension can only be justified if there is a viable seed system in place.

✓ The level of infrastructure development, including rural roads network and seed storage infrastructure.

✓ The support services, particularly credit and output marketing.

✓ The seed marketing arrangements.

✓ The country’s economic policies, particularly with regard to exchange rates, producers’ output prices, policies aimed at reducing production risks.

4.1.4. The Imperative Need to Develop Regional Markets—The low average intensity of fertilizer use in SSA reflects a low effective fertilizer demand and a small size market. Typically, business transactions from small-scale farmers are too small to attract a significant private investment in input supply. This is exacerbated by a potential national market limited by natural endowment and a dispersed production system with a poor infrastructure network. Such small markets are a crucial problem for private sector investment as they cannot take advantage of the economies of scale of bulk imports. The dispersed production system and the poor infrastructure network increase input costs and therefore reduce profit and subsequently inputs supply and adoption.

There is an increasing recognition that facilitating the development of regional markets to increase market sizes will induce greater private investment and more effective input supply systems (Rusike, 1995; Gissequist, 1996). This requires a harmonization of trade policies and seed laws and regulations across countries. Such a harmonization also implies a harmonization of the phytosanitary regulation and the use of a plant health passport-like document to reduce the spread of pests. To foster the development of regional markets, regional organizations have an important role to play. Typically, they strengthen human resource training through a system of regional accreditation for inspectors. They also encourage private companies to join international organizations such as the International Federation of the Seed Trade (FST).

While the emergence of regional organizations such as the SADC and the Southern African Customs Unions (SACU) aimed at harmonizing seed laws and regulations among member countries in southern Africa is encouraging, there continue to be barriers hampering such developments in East and West Africa. In Southern Africa, the harmonization of seed laws and regulations is facilitated by the fact that varietal release, seed certification, and laboratory testing procedures are increasingly based on the International Seed Trade Association (ISTA) and the Organization for Economic Cooperation and Development (OECD) standards for certified seeds (Rusike, 1995).

4.2. Rethinking the Fertilizer Supply System

4.2.1. It Is Not Enough to Liberalize the Fertilizer Market—There has never been a consensus on policies to accelerate growth in fertilizer consumption in SSA. However, until the late 1970s, many countries (often with donor support) promoted fertilizer use through price and credit subsidies. According to Mwangi (1997), these instruments were often justified on the grounds that:

✓ Small-scale resource-poor farmers cannot afford to pay the high cost of fertilizer.

✓ Small-scale farmers needed to be compensated to offset production disincentives associated with cheap food policies that taxed them through low output prices benefitting politically powerful urban consumers.

✓ Subsidized fertilizer prices were perceived as a necessary educational device to jump-start adoption by overcoming farmers’ risk averseness created by the uncertainty of the profitability of fertilizer use.
Subsidizing the supply of fertilizers is expected to make them more readily available to small farmers.

In most countries, both price and credit subsidies typically resulted in:

- The neglect of the food crops grown by small-scale farmers.
- Misuse of fertilizers with high risk of human health in some cases.
- Leakages from subsidized programs to unsubsidized locations where such parallel fertilizer markets existed.
- Huge budgetary drains.
- Counter-productive effects on prices that kept producer prices below the world equivalent, thereby distorting production through misallocation of public funds and deterring more efficient private investments.

Furthermore, the subsidy schemes failed to mature into broad-based adoption as fertilizer use in SSA continued to remain low (Fontaine and Sindzingre, 1991). Consequently, starting in the early 1980s, agricultural policy debates largely centered around subsidy removal, privatization of distribution systems, and liberalization of import. By the mid-1980s, governments’ strategy of promoting fertilizer use through price and credit subsidies began to shift as reforms including exchange and interest rate policy, market liberalization, and privatization were being promoted.

As discussed earlier, so far, documented post-reform experiences in SSA reveal a mixed performance. Evidence available suggest that, while throughout SSA much has been accomplished and the primary beneficiary of the reforms has been the budgetary gain to governments, macro policy reforms alone, though important, are not sufficient to spur a significantly higher level of agricultural inputs supply and use. In other words, there is more to be done in terms of nurturing the private sector, and this involves the creation of an environment conducive to profitable private investments, including:

- An integration of donor fertilizer aid-in-kind into the domestic fertilizer market

Our previous discussion indicated that fertilizer in various cases of aid-in-kind is often detrimental to the development of a private sector-based input delivery system because it is not integrated into the domestic fertilizer market. Key deficiencies include uncertainty with regard to the product type, as well as the price, quantity, and timing of delivery. Integration into the commercial market can be achieved in two possible ways. First, donors can provide free (untied) foreign exchange in place of aid-in-kind. Such foreign exchange can be used to create a fund to support private traders’ import of inputs.

Alternatively, donors can continue to provide the fertilizer aid-in-kind to these countries. Arrangements should be made to auction these inputs in a transparent manner to private traders and let the market determine the price. This approach, which was successfully used in Albania and Bangladesh, allows the private sector to integrate these imports with commercial imports. This requires that the quantity, type, and time of arrival of these imports be announced with a lead time so that private importers know what is coming into the country and make their plans to optimize their imports. The counterpart funds available from the sale of aid-in-kind inputs should be used either for creating a credit fund to provide loans to small dealers, for developmental activities, or to provide training and technical assistance for developing integrated dealer networks.

A minimization of unnecessary transaction costs

It is widely recognized that higher benefits are generated by improving non-pricing factors such as the land tenure regime, infrastructure and marketing services for food crops, and the effectiveness of research and the dissemination of technologies. These types of public investments should be such that they complement and spur private investments.

Similarly, reasonably accurate demand forecasting is essential to reduce procurement costs from the international market and ensure timely supply. Restrictive product specifications should be simplified to international norms, and port charges and tariffs should be minimized. These charges unduly burden farmers without raising significant government revenues. Banking and letter of credit (LOC) requirements should be simplified and dual or multiple-party letters of credit can be organized. Regional cooperation through major ports and on-shore bagging of bulk shipments provide opportunity to take advantage of economies of scale. When excessive transport distances and costs are involved, cost savings from back-hauling fertilizers at appropriate times may save more than additional inventory-carrying costs. Some of these savings can be achieved by entrepreneurial initiative, others require policy or regulatory reform.

- Educating farmers on the availability, benefits, and use of improved technologies

Country experiences show that one of the reasons why farmers do not use fertilizers is their limited knowledge of the products and their benefits and their risk aversion to investing in their use. Sasakawa Global 2000 (SG2000) experience in Ethiopia shows that by overcoming farmers’ risk aversion and improving their knowledge of the products
and their benefits, a country can significantly boost small-scale farmers’ demand for fertilizer and seeds of improved varieties. Through large-scale demonstrations in high potential payoff areas with intensive technical assistance at the field level, SG2000 in collaboration with the Ministry of Agriculture was able to generate an enthusiastic interest and subsequently greater adoption of these technologies by farmers. Simple, uniform, regional-level technology packages were made available. This simplifies the marketing campaign to farmers and the training of facilitators. Inputs are provided with up to 50% credit in-kind and farmers’ continued participation in the programs is subject to full credit repayment. Similar experiences include CARE work in Zimbabwe and that of BRAC in Bangladesh.

These initiatives prove that positive experiences are educational and critical in demonstrating the value of reforms. However, to mature into widespread sustained adoption behaviors, it is very important in planning such interventions that provision be made for moving the graduated farmers from the program after 2-3 years to full commercial participation. Without this provision the program can rapidly overextend the capacities of NGO and extension services.

- Encouraging and facilitating post-harvest value addition to crop

A review of the literature on ways to induce greater use of fertilizer also shows that effective demand from farmers is the ultimate driving force of the input supply systems. As a result, for sustainable input supply systems, there has to be a value-added demand pull and risk minimization at the farm level, created by competitive output markets, profit incentive, and appropriate technology transfer. Various countries have designed projects precisely aimed at boosting farmers’ demand for modern technologies through innovative schemes involving value-adding activities. However, in most cases, the success of such projects depends on what happens at the district level when projects are identified for funding or implemented.

- Nurturing the development of private fertilizer distributors’ networks

Throughout SSA the fertilizer market is dominated by imported fertilizers. With governments’ withdrawal from the procurement and distribution of fertilizers, farmers now have to be serviced by a nearby salesman or distributor (an agent, a dealer, or a farm cooperative). Post-reform experiences suggest that an effective network of private distributors does not develop overnight. It has to be nurtured over time through patient, well-thought and collaborative supporting initiatives. There are various ways in which private sector fertilizer importers and distributors have emerged in SSA. In Ghana and Ethiopia, for example, eligible private sector importers are required to have established market networks and marketing plans. In Mozambique, new market entrants are in some cases expanding their product lines to include agri-inputs. In Uganda, the USAID-funded IDEA project and SG2000 have been effective in encouraging private micro-enterprises to market agri-inputs. While a purposed selection of fertilizer distributors may be attempted at the early stage of development of the fertilizer subsector, it tends to limit possibility for multiple participants characteristic of competitive markets. In addition, it does not consider the comparative advantage of market participants in performing various functions. For example, some entrepreneurs may have a comparative advantage in international procurement but none in domestic distribution. Other participants, with comparative advantage in domestic distribution (e.g., established retail networks) but none in international procurement, require only domestic access to supply. At higher stages of development, however, self-selection by entrepreneurs for their participatory role is preferable to exogenous selection by whatever well-meaning criteria.

Typically, private sector entrepreneurs in SSA have a limited ability to perform their functions because of difficult access to procurement and distribution credits, limited entrepreneurial skills, and the lack of appropriate market information. Market development projects in SSA have almost exclusively concentrated on the needs of farmers and ignored the needs of private firms or entrepre-
neurs. IFDC experience in developing competitive agribusiness market networks and their constituent entrepreneurs shows that training requirements often span from business planning to management, marketing, and safety. Basic actions that are essential in fertilizer marketing include market understanding and evaluation, product knowledge, logistic analysis, and servicing the customer. Such training should be frequent, demand-driven, and responsive to the varied requirements of the participants. This requirement is well served by the supply and exchange of market information and the encouragement of voluntary formation of trade associations. Furthermore, it is also essential to build linkages between supplies of credits (banks) and agri-input entrepreneurs.

Generally, in SSA market information is at best fragmented and limited to domestic prices. To be useful, market information should extend beyond price data to include international price, domestic market demand forecasts, input and output product availability and prices, crop reports, and availability of complimentary products such as knapsack sprayers, cultivation tools, vegetable seeds, and saplings.

Farmer associations have been used in SSA. This is the case, for example, for the producer cooperative associations (PCA) such as the savings and credit organizations (SACOs) in Tanzania that are formed to improve markets for outputs and, in some cases, to reduce input costs through group purchasing activities. Such associations also help members in borrowing funds from commercial banks or other financial institutions by providing the group’s guarantee as a collateral. However, another important form of association that is often overlooked in SSA are agribusiness trade associations (ATA). These are voluntarily formed by private businesses to improve their businesses through education, training, exchange of information, and lobbying efforts. Through shared experiences, these businesses develop a group dynamic that hastens and sustains the development process. Unlike the PCAs, ATAs are not profit centers but should have sufficient revenue to provide desired member services. However, their development process has to be supported with provision of counseling and technical assistance to individual entrepreneurs to ensure sound business and technical development of agribusiness.

**4.2.2. Necessary Conducive Laws and Regulations**—Fertilizer quality is of utmost importance. As a result, there is a need to protect farmers, retailers, wholesalers, importers, and honest manufacturers. This requires a national fertilizer legal and regulatory system to monitor the quality of fertilizers at the procurement and distribution levels. Such laws and regulations involve adequate inspection and analysis of product quality throughout the distribution system with provision of appropriate enforcement mechanisms to penalize the noncompliance with enacted fertilizer laws and regulations.

Quality control starts at the import level with proper input specifications. However, compliance with input specification is normally resolved between the private sector importer and supplier and should not be imposed by the government. Usually, a system control by the importing private businessman or organization includes a system of penalties or discount to guard against shipments that do not meet the specifications. According to Visker et al. (1996), in addition to the product name, brand and/or grade, such a businessman or organization needs to focus on the following elements:

- Nutrient content(s) and concentration(s).
- Nutrient form, including the method of expressing the nutrient form (oxide or elemental form) and its availability/solubility (e.g., total, water-soluble or citrate-soluble for phosphate).
- Particle size and distribution, particularly for raw material used in blending to ensure its quality.
- Moisture content at the time of its manufacture given the potential to cake in storage.
- Physical conditions including its physical appearance (granular, prilled, crystalline, powder, coarse, or standard) and the presence of any conditioner or anti-caking agents.
- Safety, health, and environmental limitations associated with its use.
- Packaging requirements.
- Analytical methods used to determine the nutrient content and the physical characteristics of the fertilizer and that of the bags. Different analytical methods can yield different analytical results.
- Sampling techniques, including the equipment to be used and the frequency of sampling. This is particularly important because inadequate sampling methods can result in questionable analytical results.

However, Visker et al. (1996) stress that as much as specification should be complete, a complex and too detailed specification unnessessar-
ily increases fertilizer price and the difficulties to comply with the requirements.

Fertilizer regulators should be authorized by laws to perform their duties and should be guided in their authority and responsibilities by a set of regulations enacted under the laws. Fertilizer laws and regulations usually provide for the six distinct administrative areas:

- Registration of businesses and/or their products (labeled with guaranteed analysis and net weight).
- Inspection of fertilizer products and records by authorized inspectors (taking samples, noting the legality of the labels, checking bag weights, inspecting records).
- Analysis of samples taken by inspectors.
- Financing of the regulatory program through registration fees and inspection/tonnage fees.
- Administration, enforcement, and assessment of penalties by a designated authority.
- Publication of findings.

Typically, the laws and regulations cover the following aspects:

- **Definitions**
  
  It is important that the fertilizer law and regulations precisely and clearly define the main words, terms, and expressions used within them. Certain words, terms, and expressions may have meanings that are specific to the interpretation of the laws and regulations and are different from what might normally be defined in a standard dictionary.

- **Registration and/or licensing requirements**

  Regulations normally include provisions for all fertilizer businessmen to be registered with the appropriate authority. Registration constitutes a legal bond between the authority and the seller of fertilizers ensuring that the latter understands that there are regulations, what they are, what they mean, and that the seller agrees to abide by these regulations. It also provides a mechanism to identify all sellers of fertilizers in the country so that the authority and the inspection staff know whom they are regulating. Furthermore, it allows the inspection staff to randomly and fairly select sellers for inspection. Finally, a registration fee would generate some of the money required to operate the fertilizer regulatory program.

  It may also be appropriate that provisions be included in the regulations for product registration. However, it should not be used by the authority to limit or control the type of product or number of grades being offered for sale as long as the seller is making only nutrient claims. In other words, the product registration process should be “automatic” unless the seller is making claims other than nutrient content such as slow-release characteristics, in which case, efficacy testing may be required.

- **Labeling requirements**

  If fertilizer laws and regulations are to provide complete protection to the consumers, it is essential that labels (proper bag markings) be affixed to all containers of fertilizer so that the fertilizer can be easily identified. Labeling requirements are the “heart” of regulations based on the “truth-in-labeling” philosophy. The labeling requirement is a statement of guarantee by the seller that the product in the container is what it is claimed to be on the label. Labeling requirements include the net weight, brand, grade, guaranteed analysis, and name and address of the registrant.

- **Inspection/tonnage fees**

  If product registration is required, this mechanism can be used to collect inspection/tonnage fees to fund the operation of the regulatory system.

- **Plant nutrient forms**

  Nutrients, particularly phosphate and potassium, can be expressed in their oxide or elemental form. It is important that the regulations clearly state how such nutrients should be expressed on the label guarantee. It is also essential that the regulations clearly define in what form the various nutrients should be guaranteed (e.g., total, ammoniacal, nitrate, and/or urea for nitrogen, and total, water-soluble, citrate-soluble, and/or available for phosphate).

- **Guaranteed analysis requirements**

  It is important that the regulations clearly define what should be included in the guaranteed analysis stated on the label. Guaranteed analysis usually includes the minimum percentage of all plant nutrients claimed, the maximum percentage of harmful substances, and the nutrient form. The order in which the nutrients are claimed is also usually specified. This becomes a legal guarantee by the seller to the customer.

- **Violations**

  Violations include misbranding, adulteration, short-weight bags, and nutrient deficiencies. The regulations should clearly define what the violations entail. It should also define the procedure to be used by the authority in the case of a violation.

- **Sampling and inspection techniques** (usually referenced)

  The regulations should provide for proper sampling and inspection techniques. These are usually written up separately in a sampling and inspec-
tion manual and are referenced in the regulations.

- **Analytical methods** (usually referenced)

  The regulations should provide for proper analytical methods that are usually written up separately in an analytical manual and are referenced in the regulations.

- **Investigation allowances**

  Inherently, there are variances in the taking, preparing, and analyzing of a sample of fertilizer. These variances should be included in the regulations in the form of investigational allowances when determining whether a fertilizer is deficient in nutrient content.

- **A system of penalties**

  When a fertilizer businessman violates any of the statutes of the laws or regulations, there should be provisions in the laws and/or regulations to impose some sort of penalty. The most effective and efficient systems provide basically two types of penalties. The first type of penalty would be a result of a deliberate violation (e.g., adulteration) and could result in a significant monetary fine and/or prison sentence. The second type of penalty would be a result of an unintentional violation (e.g., nutrient deficiency) and could result in a monetary fine equivalent or somewhat higher than the commercial value of the deficiency and usually payable to the customer.

- **Stop sale and/or seizure authority and directives**

  The regulations should include provisions for the authority to stop the sale of or seize a fertilizer, which is in violation of the laws or regulations. Provisions should also be included to give the seller the opportunity to reprocess or relabel the fertilizer in violation to bring it into compliance.

- **Fertilizer specifications**

  Some countries include in their regulations a legal definition for fertilizer (as opposed to a scientific definition), which encompasses fertilizers where the authority has established standard specifications. This type of system is used in less that free-market systems and is in contrast to a “truth-in-labeling” system.

4.3. **Rethinking National Pests Management Strategies**

The safe use of pesticides and their impact on the environment continue to be an issue of concern throughout the world in general. According to Farah (1994), these concerns are the highest in SSA because of widespread illiteracy, lack of protective clothing and equipment, lack of access to adequate medical care, lack of training in safety procedures, and restrictions on the right to organize for safe working conditions. Under these circumstances and given the extent of negative externalities associated with their use (e.g., residue buildup in the food grain, contaminated drinking water, buildups of pest resistance to pesticide), pesticides represent a significant health and environmental hazard in SSA. As a result, it is very important that their use be supported by a good framework that provides guidelines to regulate the following aspects:

- trading practices
- testing
- registration
- labeling
- packaging
- storing
- disposal
- advertising
- residues
- availability
- distribution

- periodic assessment
- safety training for extension workers, dealers, and farmers

Such guidelines are provided in an FAO/UNEP-sponsored formal code of conduct for public and private institutions involved with the pesticide subsector. As discussed earlier, in SSA compliance to this code is often limited by countries’ capacities to create and implement a legal and regulatory system and by the global factors. In this context and given trends towards globalization, it is very important that national governments be supported in strengthening their technical and administrative capacities and their physical facilities including laboratories for quality control and residue analysis to allow close and effective monitoring and enforcement of the Code of Conduct that governs the distribution and use of pesticides. In particular, regional collaboration for testing can significantly contribute to increasing the effectiveness of quality control and thereby reduce harmful side effects from pesticide use.

But, it is equally critical that the pesticide industry organize into national and regional trade associations and networks that provide a forum for interaction and information among enterprises, represent the interests of the industry within national boundaries, and strengthen their position in the world community. These associations should play an important role in developing the legislation, bringing about the integration of phytosanitary regulations on a regional basis, creating international linkages, and facilitating the industry self-monitoring.

Indeed the industry, NGOs, and many governments have begun to address the problem by promoting safe procurement, transport, handling, and use of pesticides. Regional efforts are also being organized. For
example, a meeting was held in Ghana (1889) and Benin (1994) for regional legislation guiding pesticide use. A regional network for West Africa (Pesticide Management Network for West Africa) was established in 1989 following the Ghana meeting.

However, promoting the use of pesticide should be thought about in the context of national pest management strategy. Such a strategy should expand beyond pesticides by providing farmers with alternative pest control and management practices, including nonchemical pest management approaches such as the use of biological control agents, plant breeding (plant resistance), biotechnology, and IPM.

Decisions to institute and implement biotechnical controls in SSA are made complex by the uncertainty regarding the likelihood of technology-inherent and technology-transcending risks. The technology-inherent risks relate to the concerns that the rapid diffusion of these genetically engineered plant varieties may well induce insect-resistance and weed-resistance or give way to harmful side effects resulting from their long-term consumption by human beings and animals. The technology-transcending risks refer to the potential for widening the prosperity gap between classes within a country or between the North and South because of the difference in endowment. Indeed, according to Yuldelman et al. (1998), while SSA countries may benefit to some extent from advances in biotechnology in developed countries, they need to:

- Create social conditions ensuring that all social strata have reasonable chances of benefitting from the new technology.
- Develop skills to collaborate with international private sector and negotiate intellectual property rights and biosafety regulation that will facilitate access to new processes and products.
- Support public research.
- Facilitate greater involvement of the private sector in research, competitive seed production, and distribution.

Various studies suggest that not only are farmers concerned about both health and the environment, but also prices and public policies designed to change perceptions and improved information dissemination may encourage voluntary use of less harmful pest control methods.

4.4. Sequencing of Reforms

The success of reforms in input markets depends on the existence of services that facilitate the transition. Deregulation of input markets has often resulted in an increase in the cost of inputs previously subsidized or distributed on credit. When output prices have not increased by a sufficient margin, the increase of production has lowered the demand for inputs, compromising production growth and productivity (Badiane et al., 1997).

Typically, reforms have involved a combination of the following initiatives in various degrees of intensity and effectiveness: removal of restrictions on domestic marketing, removal of price controls, reduction of marketing subsidies and parastatals subvention requirements, and reduction of restriction on international trade. Most surveys of reforms recognize that the “big-bang” approach to reforms whereby the entire system is overhauled overnight is likely to compromise productivity and food security.

Many authors have concluded that the main obstacle to ensuring the success of market reforms has often been the timing and sequencing of reforms. For example, Goletti and Alfano (1995) and Thompson (1991) argue that the fact that in many countries government-run marketing boards and parastatals left to function alongside the private sector does not necessarily imply that reforms will be unsuccessful. These agencies can continue to function at a reduced level of operation, becoming more transparent and more accountable, and by taking steps to aid private agents in their entry into input markets. Similarly, Duncan and Jones (1993) suggest that it is imperative to develop the private sector by providing the necessary resources and incentives, before the complete removal of public sector marketing capacity. Shepherd (1989) stresses that greater emphasis needs to be placed on the time needed to achieve reforms.

Unfortunately, there has been very limited research in this area, and there is no consensus over the proper sequencing and timing of reforms. Some authors have looked at the issue of sequencing on a crop-by-crop or function-by-function basis. According to Thompson (1991), a crop-by-crop approach to reforms could induce switches from one crop to another where government support is still maintained, compromising the success of the overall reforms. As a result, many authors have advocated the function-by-function approach.

Bumb et al. (1996), for example, recommended a phased approach to reforming the fertilizer subsector in Ghana, starting from retail-level privatization to wholesale level and then the whole import and distribution system. FAO (1994), Goletti (1994), and Badiane et al. (1997) suggest that output markets should be liberalized before input markets. Duncan and Jones (1993) concluded that reforms supported by adequate research, reforms in infrastructure and financial sector, and pricing reforms are more likely to yield successful results. Following Spooner and Smith (1991) they recommend the process consisting of the following steps:
1. Moving towards market-determined prices and begin market reform and institutional improvement.
2. Initiating measures to promote the private sector.
3. Removing restrictions on private marketing.
4. Reducing the role of government through divestiture, contracting out, and closing inefficient organizations.

In addition, at the country level, Spooner and Smith (1991) suggest the following initiatives:

1. Relaxing controls on imports of critical agricultural inputs.
2. Devaluing to reach and maintain a competitive exchange rate.
3. Undertaking priority infrastructure rehabilitation.
4. Initiating reform to domestic financial, labor, and land markets.
5. Undertaking agricultural liberalization.
6. Undertaking external trade liberalization.

Ahmed (1994) suggests the introduction of competitive trading at the retail market level, followed by privatization of wholesale and international trade, and accompanied by a gradual expansion of the geographical coverage. FAO (1994) suggests starting where appropriate market conditions exist such as an already functioning private sector, a suitable environment for small-scale entrepreneurs, access to credit services, potential profit sufficient to attract entrants, high seasonal demand, access to foreign exchange, national security, and policy framework to private participation. Stressing the point that simultaneous introduction of exchange rate liberalization and subsidy removal in Ghana does not promote growth in fertilizer use and does not encourage private sector participation, Bumb et al. (1996) recommend that proper sequencing and phasing should be developed for each policy and, if needed, safety nets should be provided to minimize the undesirable policy effects.

The fact is that there is no universal recipe for the transition from a public-dominated to a private-based input supply system. Ideally, the transition process should be taken one step at a time, rationally linked to constraint removal. The real challenge is that each step requires cohesive reforms and simultaneously managed progress in all four areas (policies, institutions, infrastructure, and management skills). The rate of change in the transition process should be tailored to each individual country’s political and economic circumstances in that there is no universal recipe for the transition process. To be competitive, an appropriate division of labor between the public and private sector is imperative. Ultimately, the public sector should only focus on providing policy and regulatory support conducive to private sector investment.

4.5. The Importance of Output Markets and Access to Credit

In general, in much of SSA, demand for fertilizer was developed based on cash-crop systems that are usually non-cereal export crops such as cotton, tea, coffee, cocoa, and tobacco because in these systems there are credits for fertilizer and profitable, reliable, and stable output outlets. For example, the adoption of improved groundnut varieties has been extremely limited in Zambia and Zimbabwe despite the availability of releases that yield up to 80% more than local varieties in part because of the relative low market value of the crop.

When success is measured in terms of the farmers’ access to agricultural inputs and timeliness and adequacy of input supply, the most successful input supply systems have been those run by parastatals because they had the ability to exercise control over farmers’ marketing activities to guarantee loan repayment and dealt with high-value cash crops, and only rarely on food crops such as ADMARC with maize in Malawi. This is the case for example for SODECOTON with cotton in Cameroon, SODEFTEX with cotton in Senegal, CMDT with cotton in Mali, Office du Niger with rice in Mali, and SAED with rice in Senegal.

There is increasing empirical evidence that these high-value cash crop programs can provide certain synergies with food crops as farmers’ participation in these schemes give them access to inputs for other crops. Furthermore, Govereh and Jayne (1999) note that these schemes may also attract certain investments to a region with the potential to create spillover benefits to food crop farming. However, the extent to which these schemes can help mitigate the credit constraint depends on the credit limit of the farmer, which is often determined by the potential cash crop-generated income.

Similarly, smallholder fertilizer use rose dramatically in Zambia and Zimbabwe during the 1980s because an improved technology package (improved variety with good fertilizer responsiveness and strong consumer demand) was available and fundamental problems were addressed through state intervention and subsidies, using methods common in cash crop schemes such as guaranteed output markets, subsidized input and credit extension. In southern Cameroon, farmers are willing to pay cash for unsubsidized fertilizer for high-value vegetable crops near the main urban markets. In Ethiopia, fertilizer consumption doubled in 1992 due to the liberalization of the grain...
functions in the input subsectors. In areas where government withdrawal is completed, the private sector has not been able to effectively take over. Further effort to boost the input subsectors are therefore required and, to be successful, reforms should extend beyond liberalization by creating an environment conducive to private sector investment and nurturing its development. Fundamentally, this survey highlighted a number of key lessons:

- Countries’ experiences suggest that there are no universal prescriptions for reforming agricultural input supply systems. Policy reforms are complex, lengthy, incremental, iterative, confrontational, and managerially intensive.

- Policy reforms are unlikely to induce policy changes if governments do not demonstrate to their own satisfaction the need for change by participating in the process of policy review and formulation if they do not have the capacity to develop an understanding of the needed actions, utilize their findings, and demonstrate their confidence in the private sector. In most cases, such a commitment has been imposed to government in SSA by the severe economic crisis.

Furthermore, various experiences in SSA show that reforms have largely been on an ad hoc basis. Only in Ghana was a relatively well-researched package of reforms instituted. In many cases, policy prescriptions have been based upon a poor knowledge of the prevailing institutional details that define rights, costs, and incentives, and how they affect economic outcomes in particular economies. Therefore, reforms need to be science-based or based on empirical facts to ensure that it is guided by a proper understanding of the sector’s need and the private sector’s potential to take over from the public sector.

- The main obstacle to ensuring the success of market reforms has often been the timing, sequencing of reforms, and continuity of policies. The rate of change in the transition process should be tailored to each individual country’s political and economic circumstances in that there is no universal recipe for the transition process.

- In most countries, the private sector has been slow in taking over after government withdrawal and reforms have not improved the effectiveness of markets in reaching small farmers for several reasons including (1) discriminatory and anti-competitive government policies and regulations; (2) the neglected maintenance and rehabilitation of infrastructure and supporting services leading to a high cost of service provision, risky and low profitable farm-level input use, and poorly performing financial markets; (3) private entrepreneurs lack sufficient skills, knowledge, resources, and managerial capacity to participate vigorously in input supply activities and to expand their activities as new opportunities emerge; and (4) the public sector lacks the analytical and managerial skills needed to support and promote improvements in the efficiency of the agricultural input supply systems. Because these constraints are surmountable, they suggest that there is a tremendous growth potential in SSA agriculture.

- In addition, while market reforms have improved the distribution of agricultural inputs and outputs, it has been unable to increase farmers’ effective demand for these inputs in a way that would significantly increase productivity. Thus,
besides institutional reform in rural finance, extension, and improvements in rural infrastructure, there is a need to ensure a proper functioning of the output markets and to promote value-adding activities.

- Most small-scale farmers are poorly capitalized and do not have access to credit. Furthermore, production decisions and use of modern inputs depend not only on the limited availability and accessibility of inputs and capital but also on farmers and distributors’ lack of knowledge of the use of inputs, and the untimely and limited information about markets and technology.

- There are various categories of farmers as defined by the type of crops they grow, their resource endowments, and their risk-tolerance capacity. As a result, an effective seed system must have a strategy for each category of farmer.

- In many cases, many non-pricing policies may be more important than price incentive signals, particularly because of the constraints of underdeveloped markets and infrastructure. This is often the case for a land tenure system with regard to soil fertility improvement and the appropriation of the issuing flow of income. It is also the case for infrastructure development.

- Positive experiences are educational and critical in demonstrating the value of reforms both to the government and to the private sector.

- SSA needs to capture the full potential economic benefits of international trade liberalization by addressing their inadequate administrative and legal capacity, the insufficient national policy formulation capacity, the limited scientific, administrative, and infrastructure capacity to deal with food standards, and the lack of plant variety protection. Greater benefits can be derived from regional market and regional harmonization of laws and regulations but also ensuring that investors appropriate a good deal of the benefits generated by their investments. For example, despite some evidence that SSA countries are strengthening plant breeders’ rights, only a few countries such as South Africa have the ability to enforce them, leaving companies at risk of appropriation of intellectual property rights.

Clearly, developing sustainable input supply systems requires a holistic approach that takes into account an understanding of the needs, not only the needs of farmers but also those of private and public sectors. Thus, such an approach extends beyond the input sub-sectors as it covers the total agribusiness system. The performance of the system will depend on the strength of the various components and its robustness will be determined by the weakest link in the system.

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Appendix 1: The Ten Largest Nitrogen-Producing Countries in Africa, 1997/-98.

Appendix 2: The Ten Largest Phosphate-Producing Countries in Africa, 1997/-98.

Appendix 4: The Ten Largest Phosphate-Importing Countries in Africa, 1997/-98.
Appendix 5: The Ten Largest Potash-Importing Countries in Africa, 1997/-98.

Appendix 7: The Ten Largest Phosphate-Exporting Countries in Africa, 1997/-98.