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Policies to Promote Environmentally Sustainable Fertilizer Use and Supply to 2020

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In the mid-1960s, when projections of global starvation were common, no one questioned the role of mineral fertilizer (plant nutrients, mainly nitrogen, phosphorus, and potassium from inorganic sources) in promoting food production in the food-deficit countries. On the contrary, fertilizer use was an integral part of the technological trinity--improved seed, irrigation, and fertilizer--responsible for bringing about the Green Revolution that helped many densely populated countries, including India and China, achieve food self-sufficiency in the short span of 20 to 25 years. In the early 1990s, however, fertilizer became a target of criticism mainly because of heavy use in the developed countries, where it was suspected of having an adverse impact on the environment through nitrate leaching, eutrophication, greenhouse gas emissions, and heavy metal uptakes by plants. Consequently, fertilizer use per se was mistakenly identified as an enemy of the environment.

The Need for Fertilizer

Although fertilizer use can contribute to environmental contamination unless managed properly, it is often an indispensable source of the nutrients required for plant growth and food production. Unless the nutrients removed are replaced in proper amounts from both organic and inorganic sources, crop production cannot be sustained: the soil will become degraded. In many developing countries, especially in Sub-Saharan Africa, nutrient mining has become a serious problem: nutrient removal exceeds nutrient replenishment by a factor of 3 to 4. Because crop residues are used for fuel, fodder, and construction material, nutrient supply from organic sources is limited, and supply from external sources becomes essential. Even for leguminous crops, which can fix nitrogen from the atmosphere, phosphorus and potassium must be externally supplied.

In meeting the twin challenges of food security and environmental protection in the next quarter century, developing countries must increasingly rely on science-based agriculture because there is limited scope for area expansion or grain imports from developed countries. In science-based agriculture, mineral fertilizer combined with other modern inputs plays a critical role.

- Fertilizer use is an integral part of the Green Revolution technologies. The high-yielding potential of improved seeds cannot be realized with the natural reserves of nutrients in most soils; these reserves must be augmented through fertilizer application.
- In the nutrient-poor soils of the tropics, proper and balanced use of fertilizer can create a win-win situation by increasing crop production and preventing soil degradation from nutrient mining.
- By promoting food production in high potential areas through agricultural intensification, fertilizer use can reduce pressures on marginal lands and forest clearing.
- In areas such as Sub-Saharan Africa where soils are acidic and soil fertility is low, phosphate rock and lime can be used to restore and enhance soil fertility and promote sustainable crop production.
- By creating additional biomass, fertilizer use can help reduce global warming by increasing the sequestration of carbon in soil organic matter.

Environmental and Energy Concerns

Fertilizer use requires judicious management. Improper and excessive use can harm the environment. High levels of nitrates in drinking water can be harmful to human health, especially for infants less than six months old. Nitrate leaching has been highly correlated with nitrogen applications higher than the agronomic maximum. Eutrophication is caused by the deposits of nitrate and phosphate in lakes, ponds, and other water bodies, leading to excessive growth of algae, which can result in oxygen depletion and fish mortality. Plants take up cadmium from phosphate fertilizer derived from cadmium-rich phosphate rocks, but how cadmium is transferred from phosphate fertilizer to food crops and then to human beings is not well established.

These environmental problems are caused by excessive amounts of nitrate and phosphate in soil or water bodies. While mineral fertilizer is one possible source

of these nutrients, other sources include organic fertilizer, animal manure, and industrial and urban wastes. High levels of nitrate in the water have largely been linked to animal manure in many European countries. In the developing countries, high nitrate levels are also linked to sewage disposal, septic tank drainage, and industrial wastes.

Thus, the issue is one of integrated management of all sources of nutrients in agricultural areas, so that total nutrient supply is below the agronomic maximum. Prevention of erosion and runoff is another management strategy that reduces pollution and maintains soil productivity. In the past, the emphasis has been on increased use of fertilizer; the approach now must shift to educating farmers to use organic, inorganic, and biological fertilizer optimally.

Today, the dominant use of nitrogen-based fertilizer in developing countries has led to an imbalance of nutrients in soils. To improve the efficiency of nitrogen fertilizer use and to minimize adverse environmental effects, nutrient balance should be improved by promoting the use of phosphate and potash fertilizers. Moreover, 50 to 60 percent of applied fertilizer nutrients are lost to the atmosphere. Nutrient losses can be reduced by proper timing, application, and placement of fertilizer products and by controlling soil erosion and water runoff. Reducing nutrient losses will promote economic efficiency and protect the environment.

Although fertilizer use has increased rapidly in the last few decades, especially in East Asia, fertilizer use is still too low to cause environmental damage in many developing countries. In some areas, such as Java in Indonesia, Punjab in India, and the Delta region in Egypt, where application rates are high, measures to monitor environmental impact are required to avoid potential damage. Because of low percolation rates, nitrate leaching does not occur from flooded paddy fields, which account for 60 to 70 percent of nitrogen fertilizer use in the East Asian countries, but nitrate contamination of rivers and lakes caused by nitrogen runoff from such fields warrants special attention. High applications of nitrogen in irrigated and high-rainfall areas with light-textured soils and vegetable crops should be managed carefully because such conditions promote nitrate leaching. The World Health Organization has established that nitrate levels in the drinking water should not exceed 50 milligrams per liter of water; where levels are higher, location-specific programs should be introduced.

Fertilizer production, especially nitrogen production, is energy-intensive, and critics argue that scarce energy resources should not be wasted in producing fertilizer. However, fertilizer accounts for only a small fraction of global energy use--2 percent in 1990. For every 1 million Btus of energy used in the fertilizer sector (equivalent to the energy used in driving a car from Washington, D.C., to New York City), an additional 218 kilograms of grain--enough to provide the minimum calorie intake for one person per year--could be produced. In 1990 the price of natural gas averaged about a dollar per million Btus in many energy-exporting countries. Therefore, converting energy into food security through fertilizer use offers a cost-effective and humane alternative for use of the worlds energy resources.

Reforming the Fertilizer Sector

Fertilizer production, import, and marketing has in most developing countries been a public sector function due to underdeveloped private markets, lack of private investment, and concerns about food security. The fertilizer sector has been characterized by protection, subsidies, and price controls. Although this has helped develop fertilizer markets, inefficiencies in resource use and unsustainable fiscal burdens now mandate a change.

In countries where fertilizer use levels are high and the private sector and financial markets are well developed, markets should be liberalized, subsidies removed, and the sector privatized to increase efficiency. Policy and organizational reforms are needed to make fertilizer markets more competitive, including gradual liberalization of trade policies to allow the private sector to compete in the international market. Proper sequencing and phasing of these reforms may pose a challenge because the simultaneous introduction of various policy reforms, including devaluation, subsidy removal, and closure of public sector enterprises, can lead to a drastic reduction in fertilizer use, as happened in Ghana, Poland, Russia, and Zambia. More research is needed to understand the dynamics of policy and organizational reforms.

Where fertilizer subsidies or crop price support programs have promoted excessive fertilizer use, the removal of subsidies and support measures will lead to the convergence of economic and environmental goals by promoting resource use efficiency, reducing fiscal deficits, and minimizing environmental damage.

Although energy consumption is essential for fertilizer production, energy use efficiency must be improved. While a modern plant uses about 30 million Btus per ton of ammonia production, fertilizer plants in many developing and reforming countries use 37 to 61 million Btus. Proper operation and maintenance, revamping of plants, and replacment of old technologies with new energy efficient technologies are essential.

The Policy Environment

The policy challenge over the next few years is to manage environmental problems in high-use areas, without losing the productivity benefits of fertilizer. In low-use areas the challenge is to increase fertilizer use in an environmentally sustainable manner. The following measures are appropriate to create a conducive and stable policy environment for promoting fertilizer use and supply:

- *Macroeconomic stability*, especially stability in the exchange rate, is essential for promoting growth in fertilizer use and supply. Rapid devaluation of domestic currency reduces both fertilizer use and supply by increasing costs and reducing investor confidence. Since many developing countries are not self-sufficient in fertilizer supplies, adequate and timely allocation of foreign exchange for fertilizer imports should receive high priority.
- Pricing policy should be managed so that it generates *adequate incentives* for fertilizer use by small farmers. Any price distortions should be eliminated. Although fertilizer subsidies should be carefully phased out, a case can be made for a temporary subsidy in those landlocked and food-deficit countries where markets are distorted, infrastructure is inadequate, environmental externalities are positive, and poverty is all-pervasive.
- Efficient and appropriate *organizations* should be created to ensure that fertilizer reaches the farm on time, in adequate amounts, and at minimal cost. The private sector should have the primary responsibility for marketing and distribution of fertilizer. The government should develop and implement appropriate regulatory and quality control measures for efficient functioning of the fertilizer markets. In those areas where markets are underdeveloped, the government may take the lead in developing markets and supporting infrastructure.
- Limited availability of funds for farmers to purchase fertilizers is a major constraint on fertilizer use. The growing participation of the private sectorin fertilizer marketing and distribution mandates that fertilizer dealers also have access to *financial resources*. Every effort should be made to ensure adequate funds at

reasonable interest rates for both farmers and fertilizer dealers.

- To encourage *capital investment* in fertilizer production and imports, the government should create a market-friendly environment. Fertilizer self-sufficiency per se should not be a cherished goal. Joint ventures between technology-rich developed countries and resource-rich developing countries should receive greater attention.
- Adequate *research, extension, and educational support* should be provided to farmers. Soil testing and new technologies suitable for targeted application of fertilizer should be encouraged.
- *Environmental monitoring* mechanisms should be instituted and corrective measures should be introduced. The adoption of appropriate practices and technologies should be encouraged to minimize adverse environmental effects.

Fertilizer use will remain an essential component of future strategies for ensuring food security and protecting the natural resource base. In fulfilling that role, however, fertilizer use should be approached differently in the future. Emphasis should be on growth with management rather than on growth per se, so that the broader goals of food security, agricultural growth, and environmental protection are not sacrificed.

"A 2020 Vision for Food, Agriculture, and the Environment" is an initiative of the International Food Policy Research Institute (IFPRI) to develop a shared vision and consensus for action on how to meet future world food needs while reducing poverty and protecting the environment. Through the 2020 Vision initiative, IFPRI is bringing together divergent schools of thought on these issues, generating research, and identifying recommendations. The *2020 Briefs* present information on various aspects of the issues.