"Networking to Meet Nutrient Challenges"

International Fertilizer Development Center
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Guest Essay by Dr. Norman Borlaug

Fertilizer: To Nourish Infertile Soil That Feeds a Fertile Population That Crowds a Fragile World

Introduction

1994 marks my 50th year of continuous involvement in food production programs in developing nations. During this period, I have seen the disastrous hunger and misery of many millions of poor small-scale farmers in scores of countries who are trying to eke out a living on impoverished soils. My personal involvement in the development of improved agronomy and especially the proper use of fertilizer to restore soil fertility to "worn out" soils dates back to my initial work in Mexico. It became our standard practice that whenever a new wheat variety was being tested or demonstrated on farms or in seed production fields, the best possible package of agronomic practices was employed, including the application of near-optimum levels of the right kind of fertilizer, the best date and rate of seeding, timely weed control, and optimum use of moisture be it from rainfall or irrigation.

Dr. Norman E. Borlaug
Recipient of the Nobel Peace Prize, 1970

The advent of cheap and plentiful chemical fertilizers has been one of the great agricultural achievements of this century.

Over the past three decades, the use of improved varieties of maize, wheat, rice, and other food crops; a tenfold global increase in chemical fertilizer use; more effective control of weeds, diseases, and insects; and a greater reliance on irrigation and/or improved techniques for conserving moisture have allowed world food production to increase more rapidly than global population.

The Green Revolution and Fertilizer's Role

The breakthrough in wheat and rice production in Asia in the mid-1960s, which came to be known as the Green Revolution, started the process of using agricultural science to develop modern techniques for the developing countries. It began in Mexico with the "quiet" wheat revolution in the late 1950s. During the 1960s and 1970s, India, Pakistan, and the Philippines received world attention for their agricultural progress. Since 1980

China has been the greatest success story. Home to one-fifth of the world's people, China today is the world's largest food producer.

The advent of cheap and plentiful chemical fertilizers has been one of the great agricultural achievements of this century. During the past two decades, chemical fertilizers have permitted the densely populated nations of Asia to better feed their burgeoning populations and lower the real cost of food for both the rural and urban poor. Even in China, which makes the best use of recycled organic matter, animal manure, and night soil in the world, huge investments have been made in chemical fertilizer facilities during the past 20 years and virtually all Chinese farmers now use chemical fertilizers. Chemical fertilizer production has increased from 6,000 nutrient tonnes in 1949 to some 24 million tonnes in 1991. In 1992 China was the world's largest producer, importer, and consumer of nitrogen fertilizers and ranked first and second, respectively, in the consumption and production of phosphate fertilizers. China's investments in fertilizer production capacity have paid off handsomely. One of the driving factors in the spectacular Chinese progress in increasing yields and production, especially, has been the 13 large, modern 1,000-tonne-per-day ammonia plants (plus phosphate production) that came on stream in the late 1970s and early 1980s. The other factor has been government policies that liberalized crop production and grain marketing systems, essentially abandoning the commune system. By 1990 China had surpassed the United States as the world's largest cereal producer.

The Green Revolution, however, has not progressed at the same rate everywhere, nor has it reached all crops or all farming areas. Crop yields in many less-developed countries, especially in rainfed tropical and semitropical environments, remain stagnant and abysmally low. During the 1980s per capita food production increased the most in the East and South Asian regions; it is not coincidental that fertilizer consumption in these regions has increased nearly fivefold over the last 20 years, according to World Bank data. In contrast, sub-Saharan Africa had the lowest fertilizer consumption rate — 20% that of Latin America and 5% that of East Asia. Again, not coincidentally, sub-Saharan Africa also recorded the worst performance in food production, with the per capita food production index actually declining.

Looking at the present cereal yield levels of India and the former U.S.S.R., and considering available technology, it should be possible for both to increase grain yields and production greatly over the next decade, providing they maintain political stability, reign in the stifling bureaucracy that destroys entrepreneurial initiative, adopt stimulatory economic policies, and if both researchers and extension workers leave their cloistered laboratories, experiment stations, and offices and put science and technology to work at the farm level. In the short term, better use of existing technology is the answer to accelerate food production in these two countries while the public and private research entities try to unlock the potentials of molecular genetics and biotechnology.

The World Food Production/Distribution Dilemma

There are two key problems involved in feeding the world's people. The first is the complex task of producing sufficient quantities of the desired foods to satisfy needs and to accomplish this Herculean feat in environmentally and economically sustainable ways. The second task, equally or even more daunting, is to distribute food equitably. The impediment to equitable food distribution is poverty — lack of purchasing power — resulting from unemployment or underemployment, which, in turn, is made more severe by rapid population growth.

It is clear that the solution to the world hunger dilemma must come from expanded food production in the low-income countries, where the majority

One of the Last Frontiers: The Brazilian Cerrado

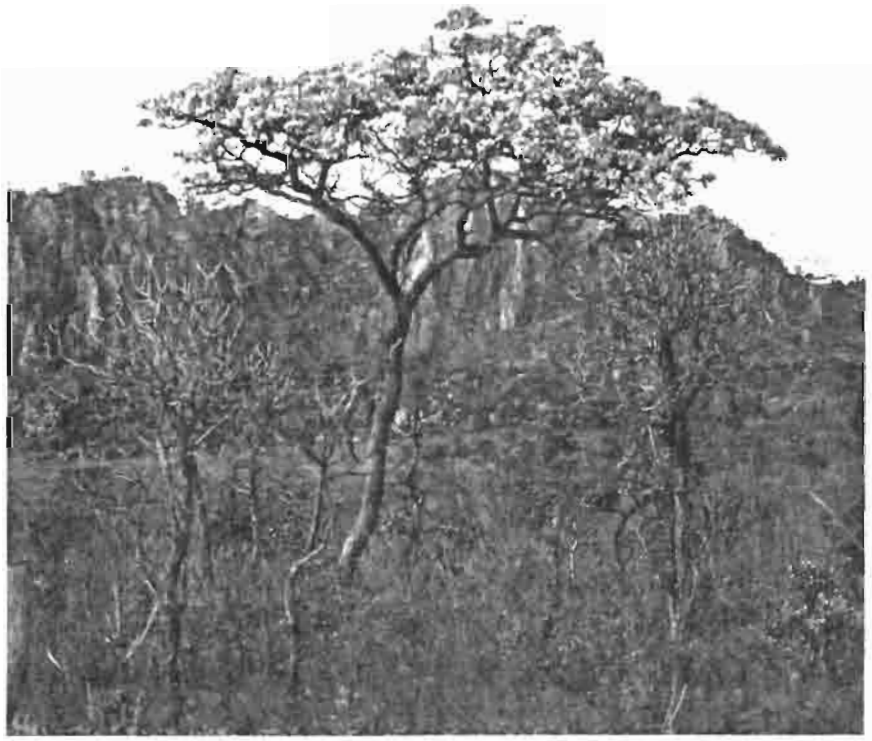
Bringing the world's unexploited potentially arable lands into agricultural production poses formidable challenges. The Brazilian Cerrado, or savanna, is a good case in point.

The Cerrado is a vast expanse of mostly flat to slightly rolling grasslands, with fire-induced semi-climax brush and stunted-tree ecotypes in some areas. Its total area is about 205 million ha, approximately equivalent to the combined area of Spain, France, Italy, and Britain. Today there is new frontier spirit of enthusiasm emerging in the Cerrado, as the potential agricultural giant begins to awaken. But how was research organized to permit this to happen? It has been a slow, painful process. By the second half of the 1960s, farming was being attempted in some parts of the Cerrado on a commercial scale as soil amendments began to be applied — liming to correct acidity and aluminum toxicity, combined with application of nitrogen, phosphorus, and potassium along with micronutrients. A new generation of crop varieties (forage grasses, rice, soybean, wheat, and maize) was developed that possessed tolerance to aluminum toxicity.

The creation in 1973 of the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), the national Brazilian Agricultural Research Corporation, provided a major impetus to research aimed at the Cerrado. EMBRAPA scientists initiated a more coordinated systematic program of interdisciplinary research, integrating past knowledge and generating new research information and products.

In all probability, some of the crop varieties and crop management technologies being developed for the Cerrado will be of considerable value in opening to agricultural production, areas in other regions with similar soil problems, such as the vast plains (Llanos) in Colombia and Venezuela and in central and southern Africa.

One of the last frontiers—the Brazilian Cerrado. IFDC is collaborating with national institutions in Brazil to develop and evaluate sustainable agricultural production systems. Crop models are being used in the Cerrado to study the fate of nutrients added to the soil in the form of pasture and crop residues and animal wastes.



African Agriculture in Crisis

More than any other region of the world, agriculture south of the Sahara is in crisis. High rates of population growth and little application of improved production technology have

resulted in declining per capita food production, escalating food deficits, and deteriorating nutritional levels, especially among the rural poor. Unless recent production trends are drastically altered, sub-Saharan Africa will only be producing 75% of its food requirements by the year 2000.

Sub-Saharan Africa's extreme poverty, poor soils, uncertain rainfall, increasing population pressures, changing ownership pattern for land and cattle, political and social turmoil, shortages of trained agriculturalists, and weak research and technology delivery systems, all make agricultural improvements difficult. But we should also realize that to a considerable extent the present food crisis is the result of the longtime neglect of agriculture by political leaders. Even though agriculture provides a livelihood to 70%-85% of the people in most countries, agricultural and rural development has been given low priority. Investments in distribution and marketing systems and in agricultural research and education are woefully inadequate. Furthermore, many governments have pursued and continue to pursue a policy of providing cheap food for the politically volatile urban dwellers at the expense of production incentives for farmers.

Many of the lowland tropical environments, especially the forest and transition areas, are fragile ecological systems, where deeply weathered, acidic soils lose fertility rapidly under repeated cultivation. Traditionally, slash-and-burn shifting cultivation and complex cropping patterns permitted low-yielding but relatively stable food production. Expanding populations and food requirements have pushed farmers onto more marginal lands and also have led to a shortening in the bush/fallow periods previously used to restore soil fertility. With more continuous cropping on the rise, organic material and nitrogen are being rapidly depleted while phosphorus and other nutrient reserves are being depleted slowly but steadily.

Since 1986 I have been involved in food crop production technology transfer projects in sub-Saharan Africa, sponsored by the Sasakawa Foundation and its Chairman, Mr. Ryoichi Sasakawa, and enthusiastically supported by former U.S. President Jimmy Carter. Our joint program is known as Sasakawa-Global 2000, and currently operates in six African countries: Ghana, Benin, Togo, Nigeria, Tanzania and, most recently, in Ethiopia. Previously, we also operated similar projects in Sudan and Zambia.

The heart of these projects has been dynamic field testing and demonstration programs for major food crops in which improved technology had been developed by national and international research organizations, but for various reasons, was not being adequately extended among farmers. Working with national extension services during the past 7 years, more than 150,000 one-acre production test plots have been grown by small-scale farmers. Most of these test plots have been concerned with demonstrating improved technology for basic food crops: maize, sorghum, wheat, cassava, and grain legumes. The packages of recommended production technology include: (1) the use of the best available commercial varieties or hybrids, (2) proper land preparation and seeding to achieve good stand establishment, (3) proper application of the appropriate fertilizers and, when needed, crop protection chemicals, (4) timely weed control, and (5) moisture conservation and/or better water use if under irrigation. Virtually without exception, yields of the production test plots are two to three times higher, and occasionally four times higher, than the control plots employing the farmers' traditional methods.

Despite the formidable challenges in Africa, the elements that worked in Latin America and Asia will also work there. If effective seed and fertilizer supply and marketing systems are developed, the nations of sub-Saharan Africa can make great strides in improving the nutritional and economic well-being of their desperately poor populations.

The Environmental Challenges of Developing Countries

In sharp contrast to the rich countries, where most environmental challenges are urban, industrial, and a consequence of high incomes, the critical environmental challenges in most of the low-income developing countries are rural, agricultural and poverty-based. About half of the world's poor live in rural areas that are environmentally fragile, and they rely on natural resources over which they have little legal control. Land-hungry farmers resort to cultivating unsuitable areas, such as erosion-prone hillsides, semiarid areas where soil degradation is rapid, and tropical forests where crop yields on cleared fields drop sharply after just a few years.

Some agricultural professionals contend that small-scale peasant food producers can be lifted out of poverty without the use of modern agricultural inputs, such as improved seed, fertilizer, and agricultural chemicals. They envision efficient crop production systems that are based on organic fertilizers; require little or no chemical fertilizer; rely on farmer-maintained indigenous varieties rather than those improved through science; practice only biological or mechanical control of weeds, diseases, and pests; and use only human power to carry out all farm operations. In our experience, small-scale farmers are reluctant to adopt such "low-input, low output" technologies since they tend to perpetuate human drudgery and risk of hunger; nor do we think that such technologies are environmentally sustainable.

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The Way Ahead

The ignorance of the average citizen about the critical need for fertilizer and the enormous benefits it has brought to humankind is both appalling and abominable. A major educational campaign is needed to inform the public of these issues.

In many developing countries, and especially in sub-Saharan Africa, correct information on proper procedures for fertilizer use needs to be made available to farmers. A huge training job needs to be done with fertilizer dealers to develop their technical understanding of the products they sell and their business ethics toward the farmer.

One of the great hallmarks of developed market economies has been efficient agricultural research and technology delivery systems in which private sector organizations play a major role in supplying information, inputs, and services to farmers. In contrast, most developing nations and the former centrally planned communist block countries have tried to rely on publicly funded organizations to deliver improved technologies to farmers without much success. Plagued by many bureaucratic inefficiencies, public sector organizations have failed to deliver improved seed, fertilizers, and other inputs cost effectively.

Most developing-country governments are looking for ways to get out of the business of supplying inputs, machinery, and other services to farmers and turn these responsibilities over to private sector entrepreneurs and subject them to the controls imposed by competition in an open market economy.

This is a time for the world fertilizer (and seed) industry to ensure the development of efficient delivery systems for an ever-improving array of agricultural inputs throughout the world. In the case of South Asia and the formerly centrally planned economies, privatization involves transforming large public sector organizations into private businesses. However, in the case of most sub-Sahara African countries, little public sector fertilizer activity exists (with the exception of Nigeria). Here a dynamic, private fertilizer sector must be built from scratch. In particular, sub-Saharan Africa, the region facing the greatest

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food insecurity now and in the foreseeable future, needs the support and assistance of all those organizations involved in the fertilizer sector.

Summing Up

The only way for agriculture to produce sufficient food, to keep pace with population, and to alleviate the hunger of the world's poor is to increase the intensity of agricultural production in those ecologies that lend themselves to intensification while decreasing the intensity of production in the more fragile ecologies.

Most of the increases in food production needed over the next several generations must be achieved through yield increases on land now under cultivation. Moreover, these yield increases must be achieved through the application of technology already available or well advanced in the research pipeline. This will not only lead to economic development but also it will do much to solve the serious environmental problems that result from trying to cultivate lands that are not suited to crop production. Fortunately, many of the more favored agricultural lands currently under cultivation are still producing food at yield levels far below their potential.

Given present scientific know-how, the use of chemical fertilizers must be expanded two- to threefold to maintain soil fertility and productivity in developing countries over the next 20 years if the world is to feed itself. Of course, the greatest need is in sub-Saharan Africa, which faces the horrifying prospect of producing only 75% of its food requirements by the year 2000, unless fertilizer use is tripled and combined with higher yielding varieties and improved crop management practices. Surely, raising the average use of plant nutrients from less than 10 kg/ha to something like 30 kg/ha cannot be an environmental problem — only an environmental solution. Fertilizer use also must be expanded in Latin America, especially in the favored lands of Argentina, Brazil, and Uruguay, and in South Asia, where the Green Revolution appears to have lost its momentum.

To achieve the needed production increases and to distribute the food equitably in the low-income, food-deficit countries will require the sustained and focused support of governments, international development agencies, and the private agribusiness sector. This task will not and cannot be achieved without major new investments in the agricultural sectors of the developing countries, particularly in the areas of transportation, fertilizer and seed supply, and water resource development.

At the closure of the Rio Summit, 425 members of the scientific and intellectual community presented to the Heads of State and Government what is now being called the Heidelberg Appeal. Since then, some 3,000 scientists have signed. The last paragraph of the Appeal reads as follows:

> The greatest evils which stalk our Earth are ignorance and oppression, and not Science, Technology, and Industry, whose instruments, when adequately managed, are indispensable tools of a future shaped by Humanity, by itself and for itself, in overcoming major problems like overpopulation, starvation and worldwide diseases.

For those of us on the food production front, let us all remember that world peace will not and cannot be built on empty stomachs. Deny farmers access to modern factors of production, such as improved varieties, fertilizers, and crop protection chemicals, and the world will be doomed, not from poisoning, as some say, but from starvation and social chaos.