



Norman Borlaug was awarded the Nobel Peace Prize in 1970. Since 1986, he has been engaged with Jimmy Carter and the Nippon Foundation of Japan in African agricultural development and is currently president of the Sasakawa Africa Association.

## Feeding a Hungry World

NEXT WEEK, MORE THAN 200 SCIENCE JOURNALS THROUGHOUT THE WORLD WILL simultaneously publish papers on global poverty and human development—a collaborative effort to increase awareness, interest, and research about these important issues of our time. Some 800 million people still experience chronic and transitory hunger each year. Over the next 50 years, we face the daunting job of feeding 3.5 billion additional people, most of whom will begin life in poverty. The battle to alleviate poverty and improve human health and productivity will require dynamic agricultural development.

Breakthroughs in wheat and rice production, which came to be known as the Green Revolution, signaled the dawn of applying agricultural science to the Third World's need for modern techniques. It began in Mexico in the late 1950s, spread to Asia during the 1960s and 1970s, and continued in China in the 1980s and 1990s. Over a 40-year period, the proportion of hungry people in the world declined from about 60% in 1960 to 17% in 2000. The Green Revolution also brought environmental benefits. If the global cereal yields of 1950 still prevailed in 2000, we would have needed nearly 1.2 billion more hectares of the same quality, instead of the 660 million hectares used, to achieve 2000's global harvest. Moreover, had environmentally fragile land been brought into agricultural production, the soil erosion, loss of forests and grasslands, reduction in biodiversity, and extinction of wildlife species would have been disastrous.

Today, nearly two-thirds of the world's hungry people are farmers and pastoralists who live in marginal lands in Asia and Africa, where agro-climatic stresses and/or extreme remoteness make agricultural production especially risky and costly. Africa has been the region of greatest concern. High rates of population growth and little application of improved production technology during the past three decades have resulted in declining per capita food production, escalating food deficits, deteriorating nutritional levels among the rural poor, and devastating environmental degradation. There are signs that smallholder food production may be turning around through the application of science and technology to basic food production, but this recovery is still fragile. But African capacity in science and technology needs strengthening, and massive investments in infrastructure are required, especially for roads and transport, potable water, and electricity.

For the foreseeable future, plants—especially the cereals—will continue to supply much of our increased food demand, both for direct human consumption and as livestock feed to satisfy the rapidly growing demand for meat in the newly industrializing countries. The demand for cereals will probably grow by 50% over the next 20 years, and even larger harvests will be needed if more grain is diverted to produce biofuels. Seventy percent of global water withdrawals are for irrigating agricultural lands, which contribute 40% of our global food harvest. Expanding irrigated areas will be critical to meet future food demand, but expansion must be accompanied by greater efficiencies in water management.

Although sizeable land areas, such as the Cerrados of Brazil, may responsibly be converted to agriculture, most food increases will have to come from lands already in production. Fortunately, productivity improvements in crop management can be made all along the line: in plant breeding, crop management, tillage, fertilization, weed and pest control, harvesting, and water use. Genetically engineered crops are playing an increasingly important role in world agriculture, enabling scientists to reach across genera for useful genes to enhance tolerance to drought, heat, cold, and waterlogging, all likely consequences of global warming. I believe biotechnology will be essential to meeting future food, feed, fiber, and biofuel demand.

The battle to ensure food security for hundreds of millions of miserably poor people is far from won. We must increase world food supplies but also recognize the links between population growth, food production, and environmental sustainability. Without a better balance, efforts to halt global poverty will grind to a halt.

— Norman Borlaug

