

# GRAIN MAN

*Bread for billions comes from the multiplied yields of farmers in China, India, Mexico, and other countries where Norman Borlaug and the Green Revolution have transformed agriculture in the past 30 years. Now he has a package plan for farmers where the greatest need remains—Africa.*

By Richard Critchfield

**H**OW MUCH CAN ONE MAN DO? Plenty, if he happens to be Norman Borlaug, the Iowa plant breeder who got the Green Revolution going 30 years ago. There is still no stopping him. On any given day he might jet off to India and Pakistan, where his high-yield dwarf wheat has quintupled grain output in 20 years. Or to China, which he helped to become the biggest food-producing country in history in the 1980s.

Or to Africa, to try to repeat this success with other crops—sorghum and maize—rescuing another continent from chronic starvation. To Poland, to lead an American mission seeking to transform its peasants into modern farmers. To Texas A&M in the fall to teach. To Mexico in the spring to breed new wheat strains. To audiences anywhere all year round to preach the need to curb population growth before it is too late.

At bottom, Dr. Borlaug believes, what is happening in the Soviet Union and Eastern Europe and China, too, are attempts at radical social engineering to enable their societies to adapt to late 20th-century science and high technology. Interestingly, Mikhail Gorbachev said as much when he

launched reforms at the 27th congress of the Soviet Communist Party four years ago. Gorbachev said technology was key, that the USSR had stagnated for lack of it, and he was going to stir it up and get it moving into modern times.

"The world is changing so fast now," Borlaug says. "We've all seen what's happened in Eastern Europe and more recently in Central America—the movement toward democratic forms of government. It's fantastic. But there are great expectations. Many of these countries are still largely agricultural. And unless these economies are resuscitated, the expectations may turn into bitterness." He anticipates progress in the USSR, Eastern Europe, and China, the whole of Eurasia really, but warns, "There are lots of traps and pitfalls ahead."

Some are born great, as Shakespeare said, some achieve greatness, and some have greatness thrust upon them. In Norman Borlaug's case there is something of all three. Certainly he was little known the day a group of Mexican reporters descended on him in the fields in 1970 to tell him he'd won the Nobel Peace Prize. I was out in an Indian village at the time and my old newspaper, The Washington Star, cabled me,

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FAMINE FIGHTER:  
*Norman Borlaug holds small symbol of vast contribution to Green Revolution—for which he won Nobel Peace Prize in 1970.*

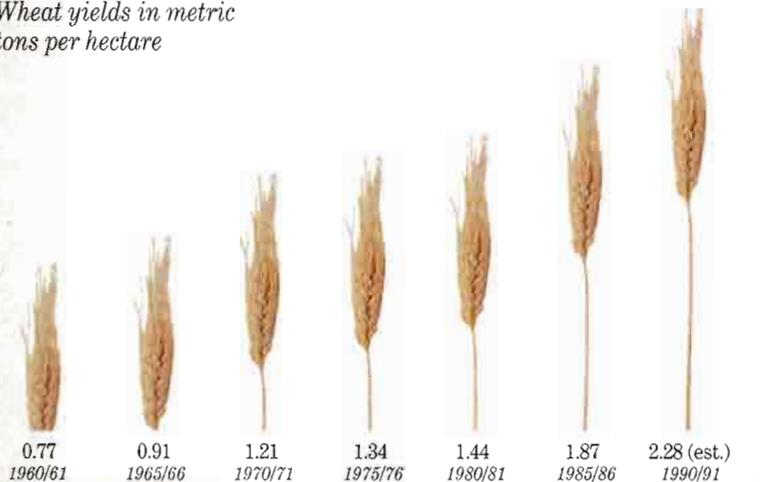


"What's this all about?"

My instinctive, one-word reply was "culture." As Arnold Toynbee predicted in 1946, the West, after a 200-year head start, was at last awakening

## India

Wheat yields in metric tons per hectare



Graphic by Dave Herring/Laura Frank

1 metric ton = 1,000 kilograms = 2,204.62 pounds. 1 hectare = 10,000 sq. meters = 2.471 acres

the world's peasant peoples with its sciences. First with health care, leading to increased populations; then with farming, so these vast new numbers could be fed.

From the beginning, Borlaug saw the Green Revolution as a race against time, that the new seeds had only "bought time" to get rates of population growth down. "This is no time to let up," he told an Iowa audience recently, "not with 1 billion more people to feed in the next 11 years."

Even as late as 1977, the first time I interviewed Dr. Borlaug (see box), a global population of 5.2 billion—what it is now—seemed inconceivable. Failure on the population and food fronts, he said that day in Mexico, could mean all sorts of crises: Malthusian famine, non-survivable pollution, the decimation of mankind by a mutant virus (this was before AIDS), nuclear war (and then Iraq, Israel, India, and Pakistan weren't close to having the bomb).

Today I'd add a new danger, that of cultural, not just biological, extinction. When science allows so few to feed so many, man loses the essential cultural role of hunter, herder, cultivator, provider; urban society loses its rural cultural base, weakening such institutions as family and property.

In the narrowest sense, the Green Revolution refers to a purely scientific phenomenon: a breakthrough in plant genetics that allows man to breed and grow artificially short, stiff-stemmed wheat, rice, and other grain that can take and efficiently utilize large amounts of nitrogen fertilizer (up to 180 pounds per acre) without falling over. This increased tolerance for fertilizer, combined with a quick maturation period—often only 120 days compared to 180 with other species—made the new seeds two or three times more productive in

the tropics, provided they got the fresh water and nitrogen.

Thirty years of patient research—in Japan for the plant dwarfing genes, the American Pacific Northwest and Mexico for wheat, and the Philippines for rice—went into producing the seeds. They take hold best where there is a homogeneous, well-educated farming population culturally prepared for change, plus some degree of capital, water control (irrigation is best), and farm policies like land reform and farm wage laws to make sure higher incomes get shared.

### CHINA SETS ALL-TIME RECORD

Experience shows that introducing such science, practically applied as farm technology, can be politically explosive. The first great breakthroughs came in the 1960s in India (now up from 11 million tons of wheat per year to 56 million), Pakistan, and Mexico. But the biggest success story so far is China. Dr. Borlaug, first invited there when Mao Zedong was still in power, feels China has carried out the most spectacular modernization of peasant agriculture ever (he ranks India, Egypt, and Pakistan behind it).

In the mid-1980s, by applying the West's biological and chemical science, China very suddenly produced more than 400 million tons of grain per year, which was more than the production of the US, the Soviet Union, or any other country ever.

What worked in China was a combination of science and wise politics. Machines mattered little; most of the work is still done in the age-old way with hoes and sickles, sometimes without even a plow, two-thirds of it by women. What was crucial were the seeds, the water (Mao vastly extended irrigation), and the fertilizer (a huge investment in nitrogen plants was made after 1960; before that date chemical fertilizer was virtually unused).

China got off to a late start because it had to cross Borlaug's Mexican-bred wheat, which had been planted in Pakistan, with its own colder-weather varieties. Then Mao's Great Leap Forward (1958-60) and the Cultural Revolution (1966-76) set Chinese biological science back at least a generation. And it wasn't until Deng Xiaoping restored the family farm that peasants had sufficient incentives to grow more food.

When everything came together, Chinese agriculture really took off. China now leads the world in wheat, rice, and total grain production, and in many crops it gets higher yields per acre than Americans do. While anguishing political zigs and zags continue in China, there is no doubt the Chinese can at last, like the Indians, grow their own food.

### QUACK THEORIES SLOWED SOVIETS

The Soviet Union and Africa remain the two big unsolved problems.

As in China, the history of agriculture in the USSR over the past 70 years has been one long losing battle to make human nature fit the peculiar ideas of Marx and Lenin.

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It is true that large areas of the USSR are subject to five-year cycles of frost and drought, that there's generally low rainfall and a short growing season. The country also lacks the watered, warm, and fertile land that enabled China to adopt much of Borlaug's new tropical farm science.

But something more ails Soviet farming. Dr. Borlaug puts a lot of the blame on T.D. Lysenko, a quack agronomist who was allowed absolute control over biological research in the USSR from 1936 to 1964. Lysenko denounced Gregor Mendel's recognized chromosome theory of heredity and the theory of mutation and instead came up with what he called "vernalization," a wacky agronomic practice to obtain winter crops from summer planting. He destroyed N.I. Vavilov, one of the greatest Russian agricultural scientists of this century, who refused to accept his quackery.

"Bravo, Lysenko, bravo!" cheered Stalin famously, and Soviet biology and agriculture went off the rails for 50 years. Borlaug says that during visits to the Soviet Union in the 1970s he still found the influence of Lysenko's discredited dogmas being felt.

The idea that peasant villagers can be transformed into a rural proletariat on big state-run collective farms has proved to be just as unworkable. The Soviet Union, like China, needs the family farm. The answer for the USSR, as I wrote in my book "Villages" nearly a decade ago, is "tacit abandonment of the whole 64-year-old Leninist dream of world revolutionary conquest and a Chinese-style dash for scientific and economic freedom."

#### THE RED DUST OF AFRICA

As for Africa, where both mankind and farming started, it is paradoxically the planet's most intractable agricultural problem. Western science continues to fail Africa. Its population growth rate of 3% shows no signs of slowing down. Per capita food production is falling. Droughts are long and severe. The Sahara keeps creeping south. One asks:

How can Asia, with half the earth's 5.2 billion people, grow food surpluses on just a quarter of the earth's farmland, while sub-Sahara Africa, with 435 million people and vast empty land reserves, goes hungry?

One answer occurred to me during a United Nations-sponsored tour of famine-stricken areas in the African Sahel—Senegal, Mali, and Mauritania. All that red dust, the soil looked completely worn out.

"The problem with Africa's soil," Borlaug says,

"is that calcium and magnesium, which make it alkaline, along with potassium, an essential plant nutrient, have been leached by high temperatures and heavy rains over thousands of years. As a result, the soil becomes acid, its phosphorus becoming unavailable, aluminum becoming soluble and toxic to plants. Nitrogen content is low. Much of Africa is left with reddish, infertile soil incapable of sustaining a very dense population."

He explains that you have to go back to the beginning, 2 million or 3 million years ago. When icecaps covered Northern Europe, America, and Asia, the great sand sea of the Sahara formed in Africa. Farther south the tropical jungle shrank to its present size. Open grassland with thorny bush, baobab, and acacia trees became the landscape of Africa's east and south, as it remains today.

#### THE ROLE OF RIVER VALLEYS

In this savanna something like a man evolved from apes and hunted game and gathered wild food plants to survive. About 1 million years ago, primitive man learned to make fire, shape flint tools, and probably talk. He broke through the Saharan barrier, most likely by walking down the Nile Valley. By the time the ice age reached its peak, mod-

**CURRENT PROJECT:**  
*Borlaug talks with farmers participating in field tests on maize in Ghana, where availability of good agricultural data made it one of the first countries selected for his Africa program.*



Photo © The Carter Center

ern man had spread through Eurasia, reaching the Americas last of all.

About 10,000 to 15,000 years ago in the Middle East, Neolithic women, we assume, invented farming, logical because women were the gatherers of berries, roots, and wild grain. Men, the hunters, didn't enter farming until draft animals did. Some

chose not to become settled farmers; they became and remain herdsmen to this day.

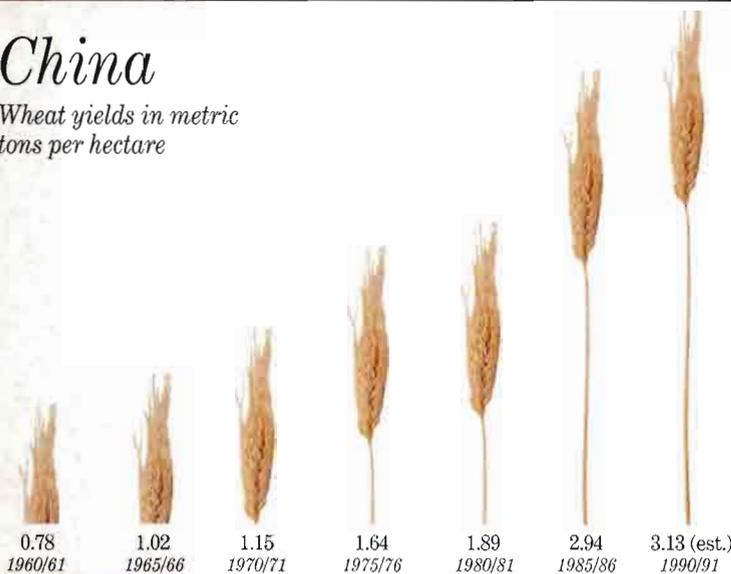
For the rest, the invention of the plow and irrigation led to the rise in the Fertile Crescent (pre-

hoes and digging sticks. Women still grow 75% of Africa's food this way. Most of them till a few acres, move on when yields fall, and leave old fields fallow.

Slash-and-burn cultivation rarely supports more than 250 people per square mile, while wet rice cultivation supports about 800 per square mile in Java and Bangladesh and close to 2,000 in China's Yangtze and Yellow river basins.

## China

Wheat yields in metric tons per hectare



Graphic by Dave Herring/Laura Frank

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sent-day Syria, Iraq, and Egypt) of the first river valley civilizations about 6,000 years ago. (Indeed, Egypt's agriculture today is so advanced and high yielding that, as in Java or Mexico's Central Highlands, the population has already overshot local resources; the situation is virtually unsolvable.)

The invention of heavier plows led to dryland farming and the progress of Europe, starting about 1,500 years ago. The Industrial Revolution followed 200 years ago, and the West, by harnessing science first, has been the dominant global power since. We now see a shift of science to Japan and, despite the presence of huge poverty-stricken masses, India and China. At the same time there seem to be some signs, if not very clear ones, of decline in the West (particularly in Britain, the first society to be industrialized by science).

In Asia the invention of wet rice paddy cultivation 5,000 years ago led to its own river valley civilizations. As in pharaonic Egypt, the need to control water led to fairly complex societies early on. Borlaug says wet rice cultivation, which floods the land much of the year, provides a relatively stable environment, as water protects the soil from the high temperatures and heavy rains of the tropics.

Since rice is labor intensive, Asian populations grew large and dense. India, China, and Indonesia, it turned out, were well-equipped to adopt Western farm science very quickly once Borlaug and his colleagues could offer their short, stiff-stemmed dwarf grain to solve the problem of "lodging" (being knocked down by wind or rain).

In Africa none of this complex agricultural development happened. To this day you can still find a few hunter-gatherer tribes living in happy anarchy. Right into this century many Africans clear fields by hand, burn brush, and cultivate with

### HOW HIS FORMULA WORKS

Borlaug says Africa's soil fertility can be restored by applying such nutrients as nitrogen, phosphorus, and potash. It takes money and skill, but South Africa and Zimbabwe have shown it can be done. Borlaug, who won his Nobel Prize as much for his single-minded tenacity as for his science, is confident Africa's problems, like those of India and China earlier, can be overcome. His formula is simple.

You start by pulling together all the available scientific data on Africa's two main crops of sorghum and maize. Then you pick one or two countries on which data is best—he originally chose Ghana and Sudan. You pick a few really good scientists prepared to slog it out in the African bush for a few years, have them put together a production package, and test it on half-hectare (about one-and-a-quarter-acre) plots in grass-hut villages.

This package, Borlaug explains, deals with what variety of crops to plant, when and how to plant them, how to fertilize, how to control weeds, insects, and diseases, and the proper utilization of moisture. On the basis of the first year's tests, you adjust the parts of the package—maybe a little more fertilizer or a little less, or more variety A if it turns out to be better than variety B—to improve it.

The next year the remade package is tested on hundreds of farmers' plots, followed by thousands of farmers' plots the third and fourth seasons. Yields must be at least double to stir up enough enthusiasm to persuade farmers to change old habits. If such yields are obtained, you go to the country's policymakers and persuade them to get fertilizer to farmers six weeks before planting, lend money to buy it repayable at harvest, and set a guaranteed loan price so they can afford to repay the loan.

### THE BIG PROBLEM IS POLITICAL

If governments can be persuaded, farmers do the rest. Over the past five years Borlaug's field testing and demonstration program has cost around \$5 million per country. He got the funds he needed from an octogenarian Japanese philanthropist, Ryoichi Sasakawa, who made his fortune by building up motorboat racing into a big gambling sport in Japan. Sasakawa wanted the project run out of Global 2000, a foundation set up by former President Jimmy Carter. Borlaug brought in some of his former colleagues who had helped pull off the successes in Mexico, India, and Pakistan.

Can Borlaug's teams of scientists transform African farming? The huge, sparsely populated

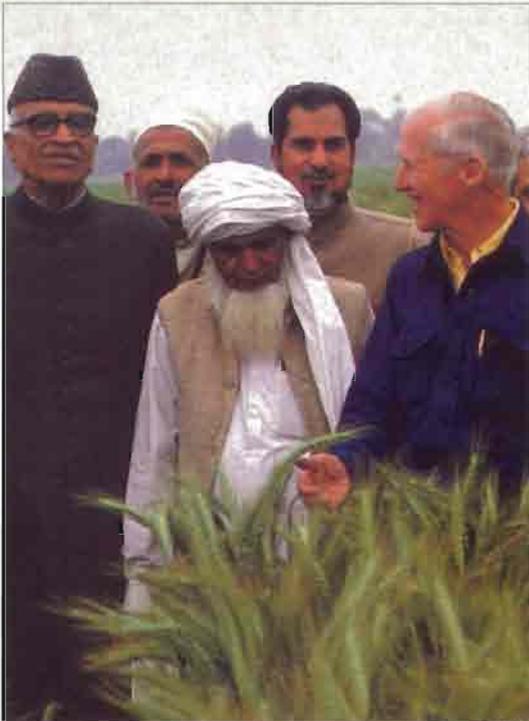


Photo © GIMMY

African farmlands, with their worn-out soils and bad transport and communications, offer a painful contrast with what he and his colleagues had to work with in India and Pakistan. The Punjab plain, with its uniform farms (most less than 15 acres each), sun, and irrigation, is a virtual greenhouse; the Indian side has a system of land tenure, education, and public investment that make it much easier for farmers to take advantage of Borlaug's science.

The big problem is an old one. Borlaug mentioned it in our first interview 13 years ago. Political leaders keep farm prices down so as to get cheap food to feed their restless cities. Low food prices work to discourage farm output while attracting villagers into the cities, ultimately creating bigger problems. Years ago Pakistan's Premier Zulfikar Ali Bhutto told me he had no choice but to keep his cities pacified with cheap wheat; in time this practice caught up with him and, among other factors, led to his downfall and execution.

#### WHAT'S NEXT

At Jimmy Carter's urging, Borlaug agreed to extend his Africa experiment to Zambia and Tanzania, but veteran political leaders Kenneth Kaunda and Julius Nyerere proved equally stubborn about holding down farm prices. "This is one job I am going to pass the ball to President Carter and see what he can do with it," says Borlaug.

The biggest program difficulties have come in Sudan, torn by civil war. But Borlaug says:

"We are continuing in Sudan with a skeleton staff. The wheat and sorghum yields farmers are obtaining with the new technology are too great for us to abandon them now."

Much is left to be done to feed the world's peoples. But without the Green Revolution, it seems safe to say, China would not have reopened its

doors, and its ears, in headlong haste, to the West and its technology—nor would Gorbachev's Soviet Union have followed suit.

Future miracles will depend on wise politics and continued scientific advance. Wet-rice technology is not too far behind that for irrigated arid land as in Punjab and the Nile Valley, where the first big gains came. The challenge now is to find new crops and techniques for the small dry-land, rain-fed subsistence holding, which has stubbornly resisted modernization.

Vast new areas, such as Brazil's Cerrado Plateau, are now opening up, as Borlaug has long predicted. Farming in Australia and Canada keeps expanding. Borlaug sees much more exploitation of such rivers as the Ganges in India, Brahmaputra in Bangladesh, Mekong in Indochina, Congo and Niger in Africa, Amazon and Parana in Latin America, even the Yangtze and Yellow rivers of China. As he says, the task has only begun.

"The Green Revolution is a movement, not a condition," Borlaug says. "Microorganisms breed and change, new varieties have to be bred. Technology keeps changing, and men have to change with it."

Just about all that is unchanging and irreplaceable may be Norman Borlaug himself. It's hard to imagine what we would do without him. **WM**

**SCENE OF SUCCESS:**  
Borlaug, as a consultant, pays visit last spring to officials from early days of Green Revolution in Punjab. Malik Khuda Baskh Bocha (left) was Pakistani minister of agriculture at that time.

### THE WRITER, THE EXPERT, AND COMMON GROUND

**I** first interviewed Norman Borlaug in Mexico in 1977. He canceled his appointments for the rest of the day, I postponed a flight home, and we talked for hours and hours. It was a conversation that would continue in interviews, letters, and phone calls over the years.

*I had been studying the impact of Western science on non-Western villagers; in many ways Borlaug was the prime agent of that change. I find that his constant travel, intellectual curiosity, and scientific knowledge make him an unmatched authority for what is going on in world agriculture.*

*We soon discovered that we have similar roots. Borlaug is the grandson of immigrant Norwegian settlers in northeast Iowa. He went to a one-room country school just 40 miles and 15 years away from another one-room schoolhouse where my mother, age 17, taught in 1905. My grandfather, a Quaker doctor turned Methodist evangelist, preached in little towns all around Saude, Borlaug's Norwegian Lutheran settlement.*

*"Our farm, Dad owned just 56 acres and the rest was Granddad's that he rented, another 49 acres," Borlaug recalls. "We had chickens, sold pigs, eggs, and cream for cash. Each fall we'd sell six or seven head of beef, drive those cattle 13 miles into Cresco. Generally you and the neighbors at the same time, all Norwegians."*

*A wrestling scholarship got Borlaug to the University of Minnesota in forestry. His work-for-the-night-is-coming ethic is still strong. "You've got to make things happen," Borlaug says. "They don't just happen by themselves."—R.C.*