



Growing More Per Acre Leaves More Land for Nature

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Billions Served

Three decades after he launched the Green Revolution, agronomist Norman Borlaug is still fighting world hunger -- and the doomsayers who say it's a lost cause.

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By Ronald Bailey
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Who has saved more human lives than anyone else in history? Who won the Nobel Peace Prize in 1970? Who still teaches at Texas A&M at the age of 86? The answer is Norman Borlaug.

Who? Norman Borlaug, the father of the "Green Revolution," the dramatic improvement in agricultural productivity that swept the globe in the 1960s.

Borlaug grew up on a small farm in Iowa and graduated from the University of Minnesota, where he studied forestry and plant pathology, in the 1930s. In 1944, the Rockefeller Foundation invited him to work on a project to boost wheat production in Mexico. At the time Mexico was importing a good share of its grain. Borlaug and his staff in Mexico spent nearly 20 years breeding the high-yield dwarf wheat that sparked the Green Revolution, the transformation that forestalled the mass starvation predicted by neo-Malthusians.

In the late 1960s, most experts were speaking of imminent global famines in which billions would perish. "The battle to feed all of humanity is over," biologist Paul Ehrlich famously wrote in his 1968 bestseller *The Population Bomb*. "In the 1970s and 1980s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now." Ehrlich also said, "I have yet to meet anyone familiar with the situation who thinks India will be self-sufficient in food by 1971." He insisted that "India couldn't possibly feed two hundred million more people by 1980."

But Borlaug and his team were already engaged in the kind of crash program that Ehrlich declared wouldn't work. Their dwarf wheat varieties resisted a wide spectrum of plant pests and diseases and produced two to three times more grain than the traditional varieties. In 1965, they had begun a massive campaign to ship the miracle wheat to Pakistan and India and teach local farmers how to cultivate it properly. By 1968, when Ehrlich's book appeared, the U.S. Agency for International Development had already hailed Borlaug's achievement as a "Green Revolution."

In Pakistan, wheat yields rose from 4.6 million tons in 1965 to 8.4 million in 1970. In India, they rose from 12.3 million tons to 20 million. And the yields continue to increase. Last year, India harvested a record 73.5 million tons of wheat, up 11.5 percent from 1998. Since Ehrlich's dire predictions in 1968, India's population has more than doubled, its wheat production has more than tripled, and its economy has grown nine-fold. Soon after Borlaug's success with wheat, his colleagues at the Consultative Group on International Agricultural Research developed high-yield rice varieties that quickly spread the Green Revolution through most of Asia.

Contrary to Ehrlich's bold pronouncements, hundreds of millions didn't die in massive famines. India fed far more than 200 million more people, and it was close enough to self-sufficiency in food production by 1971 that Ehrlich discreetly omitted his prediction about that from later editions of *The Population Bomb*. The last four decades have seen a "progress explosion" that has handily outmatched any "population explosion."

Borlaug, who unfortunately is far less well-known than doom-sayer Ehrlich, is responsible for much of the progress humanity has made against hunger. Despite occasional local famines caused by armed conflicts or political mischief, food is more abundant and cheaper today than ever before in history, due in large part to the work of Borlaug and his colleagues.

More than 30 years ago, Borlaug wrote, "One of the greatest threats to mankind today is that the world may be choked by an explosively pervading but well camouflaged bureaucracy." As REASON's interview with him shows, he still believes that environmental activists and their allies in international agencies are a threat to progress on global food security. Barring such interference, he is confident that agricultural research, including biotechnology, will be able to boost crop production to meet the demand for food in a world of 8 billion or so, the projected population in 2025.

Meanwhile, media darlings like Worldwatch Institute founder Lester Brown keep up their drumbeat of doom. In 1981 Brown declared, "The period of global food security is over." In 1994, he wrote, "The world's farmers can no longer be counted on to feed the projected additions to our numbers." And as recently as 1997 he warned, "Food scarcity will be the defining issue of the new era now unfolding, much as ideological conflict was the defining issue of the historical era that recently ended."

Borlaug, by contrast, does not just wring his hands. He still works to get modern agricultural technology into the hands of hungry farmers in the developing world. Today, he is a consultant to the International Maize and Wheat Center in Mexico and president of the Sasakawa Africa Association, a private Japanese foundation working to spread the Green Revolution to sub-Saharan Africa.

REASON Science Correspondent Ronald Bailey met with Borlaug at Texas A&M, where he is Distinguished Professor in the Soil and Crop Sciences Department and still teaches classes on occasion. Despite his achievements, Borlaug is a modest man who works out of a small windowless office in the university's agricultural complex. A few weeks before the interview, Texas A&M honored Borlaug by naming its new agricultural biotechnology center after him. "We have to have this new technology if we are to meet the growing food needs for the next 25 years," Borlaug declared at the dedication ceremony. If the naysayers do manage to stop agricultural biotech, he fears, they may finally bring on the famines they have been predicting for so long.

Reason: What are you currently working on?

Norman Borlaug: Since 1984, I've been involved in the Sasakawa Africa Association. Our program has devised the best package of farming practices we could with the best seed available, the best agronomic practices, the best rates and dates of seeding, the best controls for weeds and insects and

diseases, and put them into test plots in 14 countries. We have found that there is a large food production potential in these African countries which are now struggling with food shortages. The package of practices that we have devised uses modest levels of inputs so the cost is not particularly high compared to their traditional ways of farming. The yields are at the worst double, nearly always triple, and sometimes quadruple what the traditional practices are producing. African farmers are very enthusiastic about these new methods.

Reason: Could genetically engineered crops help farmers in developing countries?

Borlaug: Biotech has a big potential in Africa, not immediately, but down the road. Five to eight years from now, parts of it will play a role there. Take the case of maize with the gene that controls the tolerance level for the weed killer Roundup. Roundup kills all the weeds, but it's short-lived, so it doesn't have any residual effect, and from that standpoint it's safe for people and the environment. The gene for herbicide tolerance is built into the crop variety, so that when a farmer sprays he kills only weeds but not the crops. Roundup Ready soybeans and corn are being very widely used in the U.S. and Argentina. At this stage, we haven't used varieties with the tolerance for Roundup or any other weed killer [in Africa], but it will have a role to play.

Roundup Ready crops could be used in zero-tillage cultivation in African countries. In zero tillage, you leave the straw, the rice, the wheat if it's at high elevation, or most of the corn stock, remove only what's needed for animal feed, and plant directly [without plowing], because this will cut down erosion. Central African farmers don't have any animal power, because sleeping sickness kills all the animals--cattle, the horses, the burros and the mules. So draft animals don't exist, and farming is all by hand and the hand tools are hoes and machetes. Such hand tools are not very effective against the aggressive tropical grasses that typically invade farm fields. Some of those grasses have sharp spines on them, and they're not very edible. They invade the cornfields, and it gets so bad that farmers must abandon the fields for a while, move on, and clear some more forest. That's the way it's been going on for centuries, slash-and-burn farming. But with this kind of weed killer, Roundup, you can clear the fields of these invasive grasses and plant directly if you have the herbicide-tolerance gene in the crop plants.

Reason: What other problems do you see in Africa?

Borlaug: Supplying food to sub-Saharan African countries is made very complex because of a lack of infrastructure. For example, you bring fertilizer into a country like Ethiopia, and the cost of transporting the fertilizer up the mountain a few hundred miles to Addis Ababa doubles its cost. All through sub-Saharan Africa, the lack of roads is one of the biggest obstacles to development--and not just from the standpoint of moving agricultural inputs in and moving increased grain production to the cities. That's part of it, but I think roads also have great indirect value. If a road is built going across tribal groups and some beat-up old bus starts moving, in seven or eight years you'll hear people say, "You know, that tribe over there, they aren't so different from us after all, are they?"

And once there's a road and some vehicles moving along it, then you can build schools near a road. You go into the bush and you can get parents to build a school from local materials, but you can't get a teacher to come in because she or he will say, "Look, I spent six, eight years preparing myself to be a teacher. Now you want me to go back there in the bush? I won't be able to come out and see my family or friends for eight, nine months. No, I'm not going." The lack of roads in Africa greatly hinders agriculture, education, and development.

Reason: Environmental activists often oppose road building. They say such roads will lead to the destruction of the rain forests or other wildernesses. What would you say to them?

Borlaug: These extremists who are living in great affluence...are saying that poor people shouldn't have roads. I would like to see them not just go out in the bush backpacking for a week but be forced to

spend the rest of their lives out there and have their children raised out there. Let's see whether they'd have the same point of view then.

I should point out that I was originally trained as a forester. I worked for the U.S. Forest Service, and during one of my assignments I was reputed to be the most isolated member of the Forest Service, back in the middle fork of the Salmon River, the biggest primitive area in the southern 48 states. I like the back country, wildlife and all of that, but it's wrong to force poor people to live that way.

Reason: Does the European ban on biotechnology encourage elites in developing countries to say, "Well, if it's not good enough for Europeans, it's not good enough for my people"?

Borlaug: Of course. This is a negative effect. We always have this. Take the case of DDT. When it was banned here in the U.S. and the European countries, I testified about the value of DDT for malaria control, especially throughout Africa and in many parts of Asia. The point I made in my testimony as a witness for the USDA was that if you ban DDT here in the U.S., where you don't have these problems, then OK, you've got other insecticides for agriculture, but when you ban it here and then exert pressures on heads of government in Africa and Asia, that's another matter. They've got serious human and animal diseases, and DDT is important. Of course, they did ban DDT, and the danger is that they will do the same thing with biotech now.

Reason: What do you see as the future of biotechnology in agriculture?

Borlaug: Biotechnology will help us do things that we couldn't do before, and do it in a more precise and safe way. Biotechnology will allow us to cross genetic barriers that we were never able to cross with conventional genetics and plant breeding. In the past, conventional plant breeders were forced to bring along many other genes with the genes, say, for insect or disease resistance that we wanted to incorporate in a new crop variety. These extra genes often had negative effects, and it took years of breeding to remove them. Conventional plant breeding is crude in comparison to the methods that are being used with genetic engineering. However, I believe that we have done a poor job of explaining the complexities and the importance of biotechnology to the general public.

Reason: A lot of activists say that it's wrong to cross genetic barriers between species. Do you agree?

Borlaug: No. As a matter of fact, Mother Nature has crossed species barriers, and sometimes nature crosses barriers between genera--that is, between unrelated groups of species. Take the case of wheat. It is the result of a natural cross made by Mother Nature long before there was scientific man. Today's modern red wheat variety is made up of three groups of seven chromosomes, and each of those three groups of seven chromosomes came from a different wild grass. First, Mother Nature crossed two of the grasses, and this cross became the durum wheats, which were the commercial grains of the first civilizations spanning from Sumeria until well into the Roman period. Then Mother Nature crossed that 14-chromosome durum wheat with another wild wheat grass to create what was essentially modern wheat at the time of the Roman Empire.

Durum wheat was OK for making flat Arab bread, but it didn't have elastic gluten. The thing that makes modern wheat different from all of the other cereals is that it has two proteins that give it the doughy quality when it's mixed with water. Durum wheats don't have gluten, and that's why we use them to make spaghetti today. The second cross of durum wheat with the other wild wheat produced a wheat whose dough could be fermented with yeast to produce a big loaf. So modern bread wheat is the result of crossing three species barriers, a kind of natural genetic engineering.

Reason: Environmentalists say agricultural biotech will harm biodiversity.

Borlaug: I don't believe that. If we grow our food and fiber on the land best suited to farming with the technology that we have and what's coming, including proper use of genetic engineering and

biotechnology, we will leave untouched vast tracts of land, with all of their plant and animal diversity. It is because we use farmland so effectively now that President Clinton was recently able to set aside another 50 or 60 million acres of land as wilderness areas. That would not have been possible had it not been for the efficiency of modern agriculture.

In 1960, the production of the 17 most important food, feed, and fiber crops--virtually all of the important crops grown in the U.S. at that time and still grown today--was 252 million tons. By 1990, it had more than doubled, to 596 million tons, and was produced on 25 million fewer acres than were cultivated in 1960. If we had tried to produce the harvest of 1990 with the technology of 1960, we would have had to have increased the cultivated area by another 177 million hectares, about 460 million more acres of land of the same quality--which we didn't have, and so it would have been much more. We would have moved into marginal grazing areas and plowed up things that wouldn't be productive in the long run. We would have had to move into rolling mountainous country and chop down our forests. President Clinton would not have had the nice job of setting aside millions of acres of land for restricted use, where you can't cut a tree even for paper and pulp or for lumber. So all of this ties together.

This applies to forestry, too. I'm pleased to see that some of the forestry companies are very modern and using good management, good breeding systems. Weyerhaeuser is Exhibit A. They are producing more wood products per unit of area than the old unmanaged forests. Producing trees this way means millions of acres can be left to natural forests.

Reason: A lot of environmental activists claim that the BT toxin gene, which is derived from *Bacillus thuringiensis* and which has been transferred into corn and cotton, is going to harm beneficial insects like the monarch butterfly. Is there any evidence of that?

Borlaug: To that I [respond], will BT harm beneficial insects more than the insecticides that are sprayed around in big doses? In fact, BT is more specific. There are lots of insects that it doesn't affect at all.

Reason: It affects only the ones that eat the crops.

Borlaug: Right.

Reason: So you don't think that putting the BT gene in corn or cotton is a big problem?

Borlaug: I think that whole monarch butterfly thing was a gross exaggeration. I think the researchers at Cornell who fed BT corn pollen to monarch butterflies were looking for something that would make them famous and create this big hullabaloo that's resulted. In the first place, corn pollen is pretty heavy. It doesn't fly long distances. Also, most monarchs are moving at different times of the season when there's no corn pollen. Sure, some of them might get killed by BT corn pollen, but how many get killed when they are sprayed with insecticides? Activists also say that BT genes in crops will put stress on the pest insects, and they'll mutate. Well, that's been going on with conventional insecticides. It's been going on all my life working with wheat. It's a problem that has been and can be managed.

Reason: But the Cornell researchers went ahead and published their paper on the effects of BT corn pollen on monarch butterflies in the laboratory.

Borlaug: Several of us tried to encourage them to run field tests before it was published. That's how science gets politicized. There's an element of Lysenkoism [Lysenko was Stalin's favorite biologist] all tangled up with this pseudoscience and environmentalism. I like to remind my friends what pseudoscience and misinformation can do to destroy a nation.

Reason: Some activists claim that herbicide-resistant crops end up increasing the amount of herbicide that's sprayed on fields. Do you think that's true?

Borlaug: Look, insecticides, herbicides, and fertilizer cost money, and the farmer doesn't have much margin. He's going to try to use the minimum amount that he can get by with. Probably in most cases, a farmer applies less than he should. I don't think farmers are likely to use too much.

Reason: What other crop pests might biotech control in the future?

Borlaug: All of the cereals except rice are susceptible to one to three different species of rust fungi. Now, rusts are obligate parasites. They can only live under green tissue, but they are long-lived. They can move in the air sometimes 100, 500, 800 miles, and they get in the jet stream and fall. If the crop variety is susceptible to rust fungi and moisture is there and the temperature is right, it's like lighting a fire. It just destroys crops. But rice isn't susceptible--no rust....One thing that I hope to live to see is somebody taking that block of rust-resistance genes in rice and putting it into all of the other cereals.

Reason: Do biotech crops pose a health risk to human beings?

Borlaug: I see no difference between the varieties carrying a BT gene or a herbicide resistance gene, or other genes that will come to be incorporated, and the varieties created by conventional plant breeding. I think the activists have blown the health risks of biotech all out of proportion.

Reason: What do you think of organic farming? A lot of people claim it's better for human health and the environment.

Borlaug: That's ridiculous. This shouldn't even be a debate. Even if you could use all the organic material that you have--the animal manures, the human waste, the plant residues--and get them back on the soil, you couldn't feed more than 4 billion people. In addition, if all agriculture were organic, you would have to increase cropland area dramatically, spreading out into marginal areas and cutting down millions of acres of forests.

At the present time, approximately 80 million tons of nitrogen nutrients are utilized each year. If you tried to produce this nitrogen organically, you would require an additional 5 or 6 billion head of cattle to supply the manure. How much wild land would you have to sacrifice just to produce the forage for these cows? There's a lot of nonsense going on here.

If people want to believe that the organic food has better nutritive value, it's up to them to make that foolish decision. But there's absolutely no research that shows that organic foods provide better nutrition. As far as plants are concerned, they can't tell whether that nitrate ion comes from artificial chemicals or from decomposed organic matter. If some consumers believe that it's better from the point of view of their health to have organic food, God bless them. Let them buy it. Let them pay a bit more. It's a free society. But don't tell the world that we can feed the present population without chemical fertilizer. That's when this misinformation becomes destructive.

Reason: What do you think of Worldwatch Institute founder Lester Brown and his work?

Borlaug: I've known Lester Brown personally for more than 40 years. He's done a lot of good, but he vacillates, depending on the way the political and economic winds are blowing, and he's sort of inclined to be a doomsayer.

Reason: He recently said, "The world's farmers can no longer be counted on to feed the projected additions to our numbers." Do you agree with that?

Borlaug: No, I do not. With the technology that we now have available, and with the research information that's in the pipeline and in the process of being finalized to move into production, we have the know-how to produce the food that will be needed to feed the population of 8.3 billion people that

will exist in the world in 2025.

I don't like to try to see further than about 25 years. In 1970, at the Nobel Prize press conference, I said I can see that we have the technology to produce the food that's needed to the year 2000, and that we can do it without destroying a lot of the environment. Modern agriculture saves a lot of land for nature, for wildlife habitat, for flood control, for erosion control, for forest production. All of those are values that are important to society in general, and especially to the privileged who have a chance to spend a lot of long vacations out looking at nature. I say we can produce enough food with the technology available and what's in the process of being developed, assuming that we don't have all this agricultural progress destroyed by the doomsayers. That is, we will be able to produce enough food in 2025 without expanding the area under cultivation very much and without having to move into semi-arid or forested mountainous topographies.

Reason: It seems that every five years or so, Lester Brown predicts that massive famines are imminent. Why does he do that? They never happen.

Borlaug: I guess it sells. I guess what he writes has a lot to do with raising funds.

Reason: Brown notes that India tripled its wheat yields in the past three decades, but he says that will be impossible to do again. Do you think he's right?

Borlaug: No. The projections in food production in India continue to go up on the same slope. When we transferred the Green Revolution wheat technology to India, production was 12 million tons a year. Last year it was 74 million tons, and it is still going up. Once in a while production may go down by a couple of million tons when there's a drought, but in general it continues to go up. Also, the increase in production has occurred with very modest increases in cultivated area. A lot of wild land has been saved in India, China, and the United States by high-yield technology.

India has produced enough and sometimes has a surplus in grain. The problem is to get it into the stomachs of the hungry. There's a lack of purchasing power by too large a part of the population. There are still many hungry people, not dying from starvation, but needing more food to grow strong bodies and maintain health and work effectively. The grain is there in the warehouses, but it doesn't find its way into the stomachs of the hungry.

Reason: What do you think of Paul Ehrlich's work?

Borlaug: Ehrlich has made a great career as a predictor of doom. When we were moving the new wheat technology to India and Pakistan, he was one of the worst critics we had. He said, "This person, Borlaug, doesn't have any idea of the magnitude of the problems in food production." He said, "You aren't going to make any major impact on producing the food that's needed." Despite his criticisms, we succeeded, of course.

Reason: When an alleged expert like Ehrlich is being negative like that, does that discourage people? Does it hurt the efforts to boost food production?

Borlaug: Sure, because we were funded by a foundation....They'd hear his criticisms, and I'm sure there were some people at Rockefeller saying, "Maybe we shouldn't fund that program anymore." It always has adverse effects on budgeting.

Reason: Why do you think people still listen to Ehrlich? One can go back and read his doomsday scenarios and see that he was wrong.

Borlaug: People don't go back and read what he wrote. You do, but the great majority of the people don't, and their memory is short. As a matter of fact, I think this [lack of perspective] is true of our

whole food situation. Our elites live in big cities and are far removed from the fields. Whether it's Brown or Ehrlich or the head of the Sierra Club or the head of Greenpeace, they've never been hungry.

Reason: You mentioned that you are afraid that the doomsayers could stop the progress in food production.

Borlaug: It worries me, if they gum up all of these developments. It's elitism, and the American people are vulnerable to this, too. I'm talking about the extremists here and in Western Europe....In the U.S., 98 percent of consumers live in cities or urban areas or good-size towns. Only 2 percent still live out there on the land. In Western Europe also, a big percentage of the people live off the farms, and they don't understand the complexities of agriculture. So they are easily swayed by these scare stories that we are on the verge of being poisoned out of existence by farm chemicals.

Bruce Ames, the head of biochemistry at Berkeley, has analyzed hundreds and hundreds of foods, including all of the basic ones that we have been eating from the beginning of agriculture up to the present time. He has found that they contain trace amounts of many completely natural chemical compounds that are toxic or carcinogenic, but they're present in such small quantities that they apparently don't affect us.

Reason: Would you say the Green Revolution was a success?

Borlaug: Yes, but it's a never-ending job. When I was born in 1914, the world population was approximately 1.6 billion people. It has just turned 6 billion. We've had no major famines any place in the world since the Green Revolution began. We've had local famines where these African wars have been going on and are still going on. However, if we could get the infrastructure straightened out in African countries south of the Sahara, you could end hunger there pretty fast....And if you look at the data that's put out by the World Health Organization and [the U.N.'s Food and Agriculture Organization], there are probably 800 million people who are undernourished in the world. So there's still a lot of work to do.

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