Case 20

The Green Revolution

Rockefeller Foundation, 1943

Scott Kohler

Background.

> For the last five years, we've had more people starving and hungry. But something has happened. Pakistan is self-sufficient in wheat and rice, and India is moving towards it. It wasn't a red, bloody revolution as predicted. It was a green revolution.

Norman Borlaug recalls William Gaud speaking these words at a small meeting in 1968.[280] Gaud, who, at the time, administered the United States Agency for International Development (USAID), was describing an almost unbelievable surge in food output then being achieved by a number of Asian nations that had seemed, until very recently, to be on the brink of disaster. The two nations cited by Gaud were especially worrisome. Neither Pakistan, a country of 115 million people, nor India, whose population already exceeded half a billion, had been producing enough food to meet the growing need of its rapidly expanding population. Famine, and its attendant turmoil, seemed inevitable. But Gaud was right. Something *had* happened. Within a few years, food production in India, Pakistan, and many of their neighbors, would outstrip population growth. The threat of mass starvation would loom less ominously over the land, and Borlaug, an agronomist working for the Rockefeller Foundation, would be a Nobel laureate credited with saving more lives than any person in human history.

Despite all appearances, this "green revolution" did not occur overnight. Its roots go back several decades earlier. In 1940, the Vice President-elect, Henry Wallace, traveled to Mexico. He was "appalled" by the conditions there. Masses of people were eking out an existence on meager quantities of food. At the time, Mexico was forced to import over half its wheat, and a significant portion of its maize.[281] Wallace met with an official of the Rockefeller Foundation, and, soon after, with the Foundation's president, Raymond Fosdick. He described the plight of the Mexican poor, emphasizing to Fosdick "that the all important thing was to expand the means of subsistence."[282] Fosdick and his colleagues at the Rockefeller Foundation were agreeable to the idea. The Foundation had a long history of combating disease in poverty-stricken regions, and there was a feeling among its officers that hunger and malnutrition were closely related to many of the world's health care problems. So, in 1943, when the Mexican government requested the Foundation's assistance in an effort to improve that nation's agricultural productivity, its trustees agreed, seeing the new project "as a natural outgrowth of [the Foundation's] interest in public health and the biological sciences..."[283] With an initial outlay of $20,000 for a survey in 1943, followed, in 1944, by $192,800 for construction costs and equipment, the Rockefeller Foundation embarked, with the Mexican Ministry of Agriculture, upon the Mexican Agricultural Project (MAP).

Strategy. From the start, the Foundation was deeply involved in the programmatic aspects of the operation. A team of Rockefeller scientists was sent to Chapingo, outside Mexico City, where they established an Office of Special Studies (OSS). Led by George Harrar (who, in 1961, would become the Foundation's president), the group included Borlaug and four other agricultural specialists. For almost two decades, this team employed a three-part strategy to "improve the yields of the basic food crops" in Mexico.[284]

The first element of the strategy was to engage in ongoing research in an effort to produce ever-better varieties of corn, wheat, potatoes, and other crops, and to develop ever better methods of

growing these crops. As soon as a new variety or technique was developed, it was put to use. "Research from the outset was production-oriented and restricted to that which was relevant to increasing wheat production. Researches in pursuit of irrelevant academic butterflies were discouraged...."[285] The second element of the strategy employed was a persistent outreach effort with two goals. First, the American scientists and their Mexican colleagues sought to teach Mexican farmers about their latest advances in agricultural science. And second, they worked to convince farmers to take advantage of these new breakthroughs, whether by planting a new type of seed or by fertilizing or irrigating their fields in new ways. The third element of the strategy adopted was to help train a corps of agronomists, plant protectionists, and other professionals, who would ultimately be able to assume primary responsibility for the well-being of agriculture in Mexico. This was accomplished by Foundation-sponsored fellowships and scholarships enabling hundreds of Mexican students to study at American universities on the cutting edge of agricultural sciences. Moreover, an intern program was incorporated into the Foundation's activities in Chapingo.

The goals of the Mexican Agricultural Project were simple. Gordon Conway, the former president of the Rockefeller Foundation, writes that the Foundation wanted to "improve the yields of the basic food crops, maize, wheat, and beans."[286] Crop yields in Mexico were "low and static . . . soils were impoverished and chemical fertilizer virtually unknown."[287] But the Foundation did not want Mexican agriculture to become dependent on its involvement. Rather, as Borlaug describes, "the philosophy of the Rockefeller Foundation was to 'help Mexico help itself' in solving its food production problems, and in the process work itself out of a job."[288] And the Foundation was already thinking big. Conway writes that "[a] conscious objective of the Green Revolution from the beginning was to produce varieties that could be grown in a wide range of conditions throughout the developing world."[289]

Outcomes. "Officials at the Mexican Ministry of Agriculture," writes Deborah Fitzgerald, Professor of the History of Technology at MIT, "were pleased to have not only a revitalization of agricultural science, but also the input of Rockefeller dollars."[290] But progress on maize started out slowly. Fitzgerald suggests that this was because of systemic differences between the primarily subsistence-oriented corn farming in Mexico and its more commercial counterpart in the U.S. The farming techniques advocated by the Rockefeller team were not cheap, and few small farmers could afford the initial investment.[291]

Progress with wheat (which was Dr. Borlaug's division) was much faster. Mexican wheat farms were, in general, larger than local corn farms, and were more commercial than subsistence-oriented. In this way, they more closely resembled American farms. The scientists at Chapingo had developed wheat varieties resistant to stem rust, and these were distributed widely throughout the country. By 1956, Mexico was self-sufficient in its production of wheat, and it has remained so ever since. Furthermore, between 1954 and 1961, Borlaug had worked to produce a disease resistant, high-yield, photo-insensitive[292] dwarf wheat. He succeeded at this by crossing indigenous Mexican varieties with a Japanese dwarf wheat that had been cultivated centuries ago.[293] When the first seeds of the new dwarf hybrid were distributed in 1961, yields-per-hectare became even more impressive. Between 1948 and 1970, Mexican wheat yields rose from 750 kilos-per-hectare to almost 3,000—a four-fold increase in productivity.

In 1943, there had not been a single trained plant protectionist in Mexico. Local agriculture was outdated. Twenty years later, the Rockefeller Foundation had contributed, by providing funding, hands-on experience, and often both, to the training of over seven hundred Mexican scientists in fields of agriculture.

The success of the Foundation's efforts in Mexico led many of that country's neighbors to request similar assistance. To that end, the Foundation set up a similar program in Colombia in 1950. Other countries soon followed, and the benefits of Rockefeller-sponsored research were spread throughout Latin America. The Foundation's 1968 report proclaims that "it had been clearly demonstrated

...that, with organized assistance, a food-deficit nation could rapidly modernize its agriculture."

But Mexico had not been caught on a global wave of agricultural progress; the report continues: "Still, in most developing nations, efforts to increase production of major agricultural commodities were relatively ineffective [over the same period of time]." Several major factors had helped Mexico turn the corner. Certainly, the initiative of its government was one. But it was widely recognized that foundation-sponsored technological advances and the relentless labors of foundation scientists had been others.

Programs in Mexico, Colombia, and Chile had proven successful and had demonstrated the enormous potential for improvement in the food output of many developing nations. As the Rockefeller Foundation "worked itself out of a job," national governments began to assume primary responsibility for the existing programs, and the Rockefeller Foundation looked for the best way to apply the lessons of the past twenty years to other hunger-ravaged nations around the world.

And many nations were, indeed, being desolated by hunger. By the mid1960s, India, already the world's second most populous nation, consumed fully a quarter of all U.S. food aid each year.[294] Explosive population growth in much of Asia was making it less and less plausible that nations like India, Pakistan, and the Philippines would ever be able to feed themselves. In *Famine—1975! America's Decision: Who Will Survive?* William and Paul Paddock argued that a Time of Famines would soon lay waste the developing world. "The famines are inevitable," they warned. And "riding alongside [them] will surely be riots and other civil tensions which the central government[s] will be too weak to control." The Paddocks derided the naïve hope that "[s]omething [would] turn up" to forestall this doom.[295] The Paddocks were not alone in their assessment. Stanford biologist Paul Ehrlich, for example, argued that *Famine—1975!* "may be remembered as one of the most important books of our age."

The Rockefeller Foundation shared these men's sense of urgency. But, rather than advocate a triage system (as the Paddocks did), in which the worst-off nations would be denied assistance and left to their Darwinian fate, the Foundation looked for new ways to attack the problem. The Foundation had first extended its agriculture programs to India in 1956, at the request of the Indian national government. In the ensuing years, Rockefeller partnered with USAID and the U.S. Department of Agriculture (USDA). Together, they "helped establish five state agriculture universities in India."[296] These universities collaborated with their American counterparts on research and training. As it had in Mexico, the Foundation thereby contributed to the development, in India, of a community of home-grown agriculturalists with access to the most advanced technologies in the world. But their training would take time. And in India, as in many of its neighboring countries, time was of the essence, as Dr. Borlaug describes in his Nobel Lecture:

> So great is the food shortage in many underdeveloped and emerging countries that there is not enough time to develop an adequate corps of scientists before attacking food production problems. A shortcut and organizational change had to be invented to meet the needs. And so was born the first truly international research and training institute, the International Rice Research Institute (IRRI) at Los Banos, the Philippines, in 1960, to work exclusively on the regionally all-important but too-long-neglected rice crop."[297]

In 1959, the Rockefeller Foundation was joined in its food production efforts by the Ford Foundation, which paid $7.15 million to build the International Rice Research Institute and contributed an additional $750,000, for research and training, over the Institute's first three years of operation. The land upon which the Institute was built was provided by the Filipino government, and the Rockefeller Foundation assumed primary responsibility for staffing and operating IRRI, which proved to be the first of four major international centers for agricultural research and training on which Rockefeller and Ford collaborated.

International Rice Research Institute (IRRI)
Los Banos, Philippines 1961

International Center for Maize and Wheat Improvement (CIMMYT)
Chapingo, Mexico 1966

International Institute for Tropical Agriculture (IITA)
Lagos, Nigeria 1968

International Center for Tropical Agriculture (CIAT)*
Bogota, Colombia 1968

* CIAT was supported by the W. K. Kellogg Foundation as well as Rockefeller and Ford.

These international centers served as focal points for the global battle against hunger. No longer was the Foundation restricted to tackling, one at a time, the problems of individual nations. Scientists from around the world brought home from these centers the most up-to-date agricultural advances, and new high-yield crop varieties could be exported from these institutes out to a multitude of food-deprived nations.

Meanwhile, the Rockefeller and Ford Foundations remained directly involved in India and Pakistan respectively. From 1963–65, Dr. Borlaug worked in India and Pakistan to convince local farmers of the merits of Mexican dwarf wheat varieties and other recent advances. By 1965, food shortages on the subcontinent had gotten so bad that these nations' governments began to import large quantities of seed from CIMMYT and IRRI, especially after strong monsoons in 1966 and 1967 ravaged crop yields, leading to an increase in the global price of wheat and a greater acceptance, in those nations, that new techniques needed to be tried if widespread famine was to be averted.[298] In India, Rockefeller staff members "serve[d] as co-leaders of the national rice, wheat, and sorghum schemes. Leadership of the national coordinated maize program was provided by the Foundation for the first eight years," before it was assumed by an Indian scientist.[299]

Progress throughout Asia was dramatic. The first time Borlaug and his associates (mostly scientists he had trained in Mexico with Rockefeller Foundation funds) planted on the Indian subcontinent, they often worked "in sight of artillery flashes.[300] Sowed late, that [first wheat] crop germinated poorly, yet yields still rose 70 percent . . . the next harvest was ...a 98 percent improvement."[301] At IRRI, researchers developed IR8, widely hailed as "miracle rice" for its high yields. By 1967, just five years after IRRI was completed, the Philippines achieved self-sufficiency in rice.[302] In the same year, the Turkish government imported dwarf wheat from CIMMYT for the first time. Yields on the farms using the wheat soared to double, often triple, their previous averages. In 1968, Pakistan, which by then had imported tens of thousands of tons of high-yield seed from the international centers, became self-sufficient in wheat. And by 1974, India, which Paul Ehrlich had labeled "so far behind in the population-food game that there is no hope that our food aid will see them through to self-sufficiency," was self-sufficient in the production of all cereals. It has remained so ever since. By the time Norman Borlaug accepted the Nobel Peace Prize[303] in 1970, it was apparent that food production in the famine imperiled nations of Southeast Asia had, for a time at least, surpassed the rate of population growth, something that had seemed impossible to many observers.

Impact. The impact of the Green Revolution was enormous. High-yield agriculture is credited with saving at least a billion lives since the mid1960s.[304] Global cereal production more than tripled between 1950 and 2000.[305] Absent an adequate supply of food, political stability and economic prosperity cannot be achieved. This is why, in 1970, the Nobel Committee recognized Dr. Borlaug with its prize for peace.

But Borlaug did not work alone. In his Nobel Lecture, he explains, "I am but one member of a vast team made up of many organizations, officials, thousands of scientists, and millions of

farmers—mostly small and humble—who for many years have been fighting a quiet, oftentimes losing war on the food production front." Certainly this is true. The Green Revolution could not have taken place without the collaboration of its many composite parts. And, as Borlaug, himself a Rockefeller scientist, makes clear, the Rockefeller Foundation was at the vanguard of the Revolution.

Certainly other organizations deserve credit. The governments of Mexico, Chile, Colombia, Thailand, India, Pakistan, and a host of others sought help from foundations, the U.N., and other governments. And they supported, within their own borders, the invigoration of agricultural sciences. But they were aware of the expertise that the Rockefeller staff had built up as one of the earliest coordinators of the modern attack on hunger, and they made the most of it. Foundation staffers were invited to direct national crop programs (as discussed earlier in the case of India) and, along with the international centers it helped to found, often administrated new efforts, as it did with Thailand's "network of eighteen experimental [rice breeding] stations" in the mid-1960s.[306]

Other foundations deserve credit as well. From 1959 onward, the Ford Foundation was a major participant in the spread of high-yield technologies, and the Kellogg Foundation soon added its support.

The United Nations and the U.S. government were also deeply involved. But early on, they had little success transferring "production technology from the industrialized temperate zones to the tropics and subtropics." This is why, according to Borlaug, the "Cooperative Mexican Government–Rockefeller Foundation" model "ultimately proved to be superior" to "public sector foreign technical assistance programs...."[307] By the time the Green Revolution really took off, these national and supranational bodies had recognized the success of the Foundation-pioneered model and supported it, as demonstrated by USAID's commitment of funds to the international centers.[308]

The Green Revolution would not have been possible without earlier scientific breakthroughs. Dr. Borlaug estimates that fully 40 percent of the world's current population would not be alive today were it not for the Haber-Bosch ammonia-synthesizing process.[309] The spread of Mexican dwarf wheat and IR8 rice (and their continually improving offspring) would have been impossible without such breakthroughs in fertilizer technology. But that is the nature of progress. Scientific achievement is not diminished by its debt to the work of previous generations.

It has been argued that the Green Revolution produced negative side effects commensurate with its benefits. Critics point out that, in some parts of the world, the greatest benefits of new seed varieties and agricultural technologies have flowed more to well-off, rather than poor, farmers. They also claim that the irrigation needs of high-yield agriculture drain local water resources. And fertilizer use, essential if high-yield crops are to reach their full potential, can lead to runoff that pollutes streams and rivers. Observers have also worried that, by enabling the developing world to feed more and more of its people, the Green Revolution has been a disincentive for them to get serious about population control. But population growth historically levels out in developed nations, and it is impossible to make the leap from developing to developed without an adequate supply of food. Advocates of high-yield agriculture say that runoff and water table depletion are problems only when planting techniques are misapplied. More education is obviously needed.[310] Dr. Borlaug, yet again a convincing spokesman for the revolution he helped to lead, explains that "[h]ad we tried to use the technology of 1950 to produce the harvest of 2000 it would have taken an additional 2.75 billion acres of land."[311] Environmentalists would agree with Borlaug that deforestation on such a massive scale would have been disastrous. Even more disastrous would have been the mass starvations once predicted for much of the developing world.

This is not to say that famine is not still a very real threat in many places. It is. But thanks to the Green Revolution, in which the Rockefeller Foundation was a widely acknowledged leader, food production has essentially kept up with population growth. If farmers, scientists, governments, and civil societies around the world continue to meet this challenge, and the challenges of environmental stewardship and the equitable distribution of food, then it may be possible to reach population

equilibrium without anyone's worst fears coming to pass.

Notes

280. Elizabeth Weise, "The Man Who Fed the World," *USA Today*, 10/21/2003, 9D.
281. Norman Borlaug, "Nobel Lecture: The Green Revolution, Peace, and Humanity," 12/11/1970, http://nobelprize.org/nobel_prizes/peace/laureates/1970/borlaug-lecture.html.
282. John C. Culver and John Hyde, *American Dreamer: The Life and Times of Henry A. Wallace* (New York: Norton, 2000).
283. Rockefeller Foundation, *Annual Report*, 1962.
284. Gordon Conway, *The Doubly Green Revolution: Food for All in the Twentieth Century.* (New York: Comstock, 1997), 47.
285. Norman Borlaug, "Nobel Lecture."
286. Conway, *Doubly Green Revolution*, 47.
287. Norman Borlaug, "Nobel Lecture."
288. Ibid.
289. Conway, *Doubly Green Revolution*, 54.
290. Deborah Fitzgerald, "Exporting American Agriculture," in *Missionaries of Science: The Rockefeller Foundation and Latin America*, Marcos Cueto, ed. (Bloomington: Indiana University Press, 1994), 72.
291. Furthermore, Fitzgerald argues, the Americans had not done enough to bring small farmers in at the planning stages of the MAP. Therefore, tactics to promote widespread adoption of new practices were initially geared toward a farming community, like that of the United States, which was based on the land-grant system.
292. It was important to develop crops that could flourish regardless of the length of the days, because such crops would grow in dissimilar regions of the world and could be planted twice a year, thereby doubling the potential yield per hectare.
293. Dwarf wheat has two major advantages over taller varieties. First, wheat evolved to compete for sunlight (that is, to grow very tall) has a tendency to fall down once it is laden too heavily with kernels. Second, shorter wheat hybrids do not expend as much energy growing inedible stalks, so they are more efficient producers of grain.
294. William Paddock and Paul Paddock, *Famine—1975! America's Decision: Who Will Survive?* (Boston: Little, Brown, 1967).
295. The Paddocks do acknowledge the advances that had theretofore been made by Dr. Borlaug and the Rockefeller Foundation. However, they argue that the spread of new agricultural technologies, like Mexican dwarf wheat, will be limited by the availability of qualified scientific personnel to adapt them to new (especially tropical) environments. Ultimately, they conclude that "The Population-Food Collision is Inevitable: It Is Foredoomed."
296. Ambassador David C. Mulford, "U.S.-India Partnership: Creating Economic Opportunities in Agriculture," remarks given on 4/16/2004, http://newdelhi.usembassy.gov/ambapr162004a.html.
297. Norman Borlaug, "Nobel Lecture."
298. Conway, *Doubly Green Revolution*, 55.
299. Rockefeller Foundation, *Annual Report*, 1968.
300. Pakistan and India had gone to war with one another while the first shipment of dwarf wheat seed to the region was on its way from Mexico.
301. Gregg Easterbrook, "Forgotten Benefactor of Humanity," *Atlantic Monthly*, Vol. 279, No. 1, January 1997, 74.
302. The Paddocks wrote of the Philippines, "no matter how miraculously the new research programs may improve agriculture the gains will be washed out by [a] tidal wave of new births." This has not proved to be the case.
303. The Nobel Committee awarded Borlaug its Peace Prize, as he explains in his acceptance speech, in recognition of "the actual and potential contributions of agricultural production to prosperity and peace among the nations and peoples of the world."
304. Elizabeth Weise, "The Man Who Fed the World."
305. Ibid.

306. Rockefeller Foundation, *Annual Report*, 1968.
307. Norman Borlaug, "The Green Revolution Revisited and The Road Ahead," remarks given on 9/8/2000, http://nobelprize.org/nobel_prizes/peace/articles/borlaug/borlaug-lecture.pdf.
308. Once the centers proved promising, the U.S. government provided funds. Over $1 million was allocated between 1966 and 1968, for example.
309. Norman Borlaug, "The Green Revolution Revisited and The Road Ahead."
310. In the 1970 *Annual Report* of the Rockefeller Foundation, president George Harrar lays out an in-depth assessment of the various critiques leveled at the Green Revolution. Ultimately, he concludes that the problems will be mitigated by further research and that, in any event, they are outweighed by the benefits.
311. Elizabeth Weise, "The Man Who Fed the World."