How India became self-sufficient in food

Once freed from the British yoke, India's population grew rapidly, prompting a scientific revolution in food production, and leaving the malthusians grinding their teeth. Ramtanu Maitra reports.

With a bumper wheat crop in northern India getting ready for harvest, the Food Corporation of India (FCI), the governmental agency for procurement, storage, and distribution of foodgrains, has warned that the grain accumulation may pose shortage problems in the near future. It is anticipated that following the harvest of winter wheat, India's foodgrain stock may go above 22 million tons. If the next monsoon turns out to be as good as the last one, the grain stock may exceed the 28.3 million tons—the highest ever—stockpiled in 1986. The stockpile was then brought down to 9.3 million tons by January 1989 due to the worst drought of the century in 1987. It has also been reported that India will be exporting 1 million tons of rice this year.

The problem of storing the growing foodstock that the FCI faces today is radically different from the crisis that Indian policymakers faced in the 1960s and early '70s. At that time India was ravaged by droughts and crippled by weak agricultural productivity, and had become an object of the derision and contempt of other nations. Malthusians around the world were gloating over the prospect that India's burgeoning population and depleted agricultural productivity would finally validate the theory propounded by Parson Thomas Malthus. Many sincerely believed that the famines, after taking off in India, would soon encompass other nations of South Asia and even parts of Southeast Asia.

In the midst of these drought-stricken years of the 1960s, two Americans, William Paddock and Paul Paddock, jointly brought out a book *Famine—1975: America's Decision, Who Will Survive?* in which they asserted: "So the famine will come. Riding alongside will surely be riots and civil tensions which the Central Government will be too weak to control. . . . If we cut off the food to India we are not losing a friend. Nor do we gain an enemy able to do us serious hurt."

The prediction and policy prescription was coming from those who "ought to know": one Paddock was a retired diplomat who had served in the Soviet Union, China and at posts in Asia and Africa, while the other was an agronomist and plant pathologist, who had worked as the head of a tropical research station and school of agriculture in Central America and as a consultant in tropical agricultural development in Washington. The Paddocks mobilized others to their perverse vision of "triage" economics, with India targeted as the test case and model. "The future of mankind is now being ground out in India," stated Roger Revelle, another reputed American with vast experience in India, in his book *World War on Hunger*. "If no solution [is found], all the world will live as India does now," said Revelle.

The Paddock brothers worked to mobilize public opinion for a cutoff of food aid to India, the crucial input to India's stagnated agricultural production in the 1960s. The aid came in the form of the Public Law 480 (PL-480) program under a signed agreement between the two nations. The Paddocks accused India of absorbing 25% of the American wheat crop "like a blotter." They, and others, concluded that even if all the necessary food was imported, the deaths of millions could not be prevented because neither India's ports, its transport network, nor its administration could cope with the task involved. In *Famine—1975* the Paddocks condemned the Indi-

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Lyndon and Helga LaRouche at the Indian Agricultural Research Institute near New Delhi on July 15, 1983. With them is IARI director H.K. Jain. The institute is the center of India's program to modernize its agriculture, providing research, education and transfer of technology to farmers.

an leadership: "Of all national leaderships, the Indians come close to being the most childish and inefficient and perversely determined to cut the country's economic throat." Foreign journalists vied for airline seats to Bihar, one of the worst-hit provinces during the drought years and billed as a sure shot to produce a million new starvation deaths.

Lest one get the notion that there was anything more to the crisis in India than the failure of Indian leadership, the media remained eloquently silent on the chronic famines that had wiped out millions of Indians during the British Raj. During the 130 years from 1770 to 1900 there were 22 famines, 18 according to the Report of the Famine Commission in 1880 and four after 1880. The 1770 famine in Bengal alone claimed *10 million lives*. In 1943, only four years before the British finally left, the famine in Bengal that was precipitated by export of grain from Bengal to the war fronts was the most devastating of this century, claiming some 4.3 million lives.

Despite the lies and impassioned venom of the Paddocks and their fellow malthusians, reality did not bow to their wish in the 1960s. India's much-abused, ramshackle administration rose to the occasion to prevent a major famine from occurring. The famines overseen routinely by the British would not be repeated in independent India.

An uphill task

To fully appreciate the task that India's leadership and administrators faced, one as to look at the state of the Indian economy in 1947, and the state of agriculture in particular. For more than half a century before Independence, India's agriculture had been in utter stagnation. More specifically, between 1891 and 1947, aggregate grain output in British India grew at an average 0.11% per year; in the second half of this period, the rate of increase was 0.03%. Due to the poor foodgrain production and high mortality rates, population grew at a rate of 0.67% during this time. Even despite the low population growth rate, between 1914 and 1941 per capita availability of foodgrains—taking into account international trade flow—actually declined by as much as 26%!

Despite repeated famines and perennial food shortages that prevailed during the better part of British rule, no criticism of British "incompetence," comparable to the Paddocks' criticism of the Indian leadership, was heard from the West. There are several factors which explain the silence then, and sudden "discovery" of India's crisis after 1947. First, unlike the Indian leadership, the British Raj did not bother asking others to help alleviate the prevailing famine situations. They were happy to "let nature take its course," and the world came to know about the famines mostly after the fact. Second, in the post-Independence days, Western critics saw in India's food crisis an opportunity to ridicule what they termed Jawaharlal Nehru's "obsession" with the industrialization of India, as opposed to making India an agrarian country.

Third, once the British yoke was removed, India's population began to grow at a much higher rate than before. The malthusians were particularly upset over this and began to preach that famines have inevitably come to be a part of India because of the "population explosion." Later, these malthusians would use concern for the environment to curb the food-growing capability of the developing nations.

Finally, the geostrategists belonging to the pro-free world camp (as opposed to the Soviet gulag camp) were unhappy with Nehru because the Indian prime minister was deter-

TABLE 1
Foodgrain production and imports
(million tons)

Year	Production	Imports
1949-50	54.92	3.77
1955-56	69.34	0.71
1960-61	82.33	5.14
1963-64	79.40	4.56
1964-65	89.36	6.27
1965-66	72.35	7.46
1966-67	74.23	10.06
1967-68	95.05	8.67
1970-71	108.42	3.63
1975-76	121.03	7.41
1980-81	129.6	0.30
1985-86	150.5	Nil
1988-89	170.25	Nil

Source: Economic Survey, Govt. of India.

mined to chart an independent course for the less developed countries, and was thus instrumental in the founding of the Non-Aligned Movement.

The partition of the subcontinent into India and Pakistan in 1947 greatly increased the pressure on India's food supplies. Most of the wheat belt became West Pakistan, and the subcontinent's rice bowl became East Pakistan, now Bangladesh.

At the same time, Burma (now Myanmar), a big rice producer which had supplied rice to a rice-short British India every year, was also separated. The partition left India with 82% of the population but only 75% of the area under cereals, and only 69% of the total irrigated area—the area with an assured water supply. The magnificent canal-irrigated areas of Sindh and west Punjab, which at the time had made Punjab a food-surplus province, fell to Pakistan. In pre-Independence India, 24% of the cropped area was irrigated. After partition, only 19% of India's total cropped area was irrigated, compared to 44% in the case of Pakistan. All the traditional famine tracts during the British days, and areas frequently visited by drought, stayed with India.

At the time the British finally left, India had 347 million people and was producing about 45 million tons of cereals. India was a food importer. The country was experiencing annual grain shortfalls. Western observers pointed to India's perpetual "scarcity trap" and asserted that grain imports would become permanently necessary to meet growing consumption of a burgeoning population. With the population growing at a decennial rate of 25%, these experts described India's future as a "begging bowl era."

Throughout the 1950s, when India launched its five-year plans to build basic industries and infrastructure, agricultural production grew at a reasonable rate (see **Table 1**). Foodgrain production, which was 50.8 million tons in 1950-51, went to 82 million tons in 1960-61. But most of the increased production was the result of extensive farming—putting more land area under the plow—and production remained highly erratic and too dependent on rainfall to apply modern methods. Changes in productivity, whether per hectare or per capita, were very limited.

As a result, India seemed inexorably marching toward a malthusian nightmare whose potential extent was revealed by the unprecedented droughts of the 1960s. The situation grew worse because of the stagnation in foodgrain production which set in in the early 1960s with the beginning of the Third Five-Year Plan. Foodgrain production had reached 82.33 million tons in 1960-61, but went down to 79.4 million tons in 1963-64 and plummeted to 72.4 million tons in 1965-66 and 74.23 million tons in 1966-67. From being a steady importer of 2 to 3 million tons annually in the 1950s, India's import demand grew sharply in the 1960s. In 1961-62, India imported 5.14 million tons and in 1963-64, 4.56 million tons. Imports climbed steeply to a high of 10.96 million tons in 1966-67, then fell back to 8.67 million tons in 1967-68 and 5.69 million tons in 1968-69.

Architect of India's 'Green Revolution'

One of the architects behind India's success with the "Green Revolution" and subsequent achievement of self-sufficiency in foodgrain production is C. Subramaniam. Subramaniam was Minister of Food and Agriculture from 1964-67, the crucial years in India's agricultural history. Explaining the necessity of becoming self-sufficient in foodgrain production, Subramaniam once said: "The pressure was the pressure of scarcity."

India's practical problems in assuring an adequate foodgrain supply through imports, were exacerbated by the use of food as a weapon against India's determination to carry out a foreign policy independent of the two power blocs. India had signed the first PL-480 agreement with the United States in 1956, but it was not until the 1960s that the PL-480 foodgrain supply became a lifeline for many in India. Initially the PL-480 agreement was one of mutual convenience: The United States was laden with a large grain surplus it was eager to offload, and Indian authorities, eager to concentrate on building basic industries and infrastructure, were looking for a breathing space.

But, by the middle of the 1960s, the U.S. attitude underwent a change. The Paddocks and others were spinning out the propaganda to prove that, in their words, "today's trends show it will be beyond the resources of the United States to keep famine out of India during the 1970s." This drumbeat cohered with opposition in the U.S. House of Representatives against the "waste of resources in an unproductive war" between India and Pakistan in 1965, which led to the U.S. government's refusal to sign a long-term agreement with India under PL-480 when the existing agreement expired in August 1965. Egged on by growing congressional opposition to concessional food aid for India, the Johnson administration

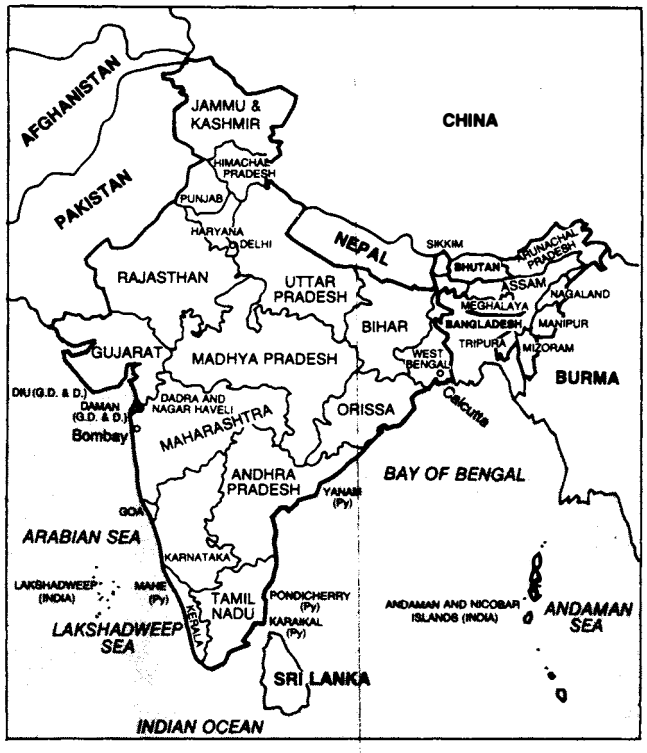
adopted a "short-tether" policy of doling out stocks sufficient to meet requirements for only a few months at a time, and tied the continuation of even this to India's adoption of policies aimed at increasing agricultural production—i.e., shifting developmental funds from the industrial to the agricultural sector—and curbing population growth.

In 1966, the U.S. Congress categorically refused to renew the PL-480 agreement authorizing sale of surplus commodities for local currencies which expired on June 30 of that year. Upset by India's criticism of the American presence in Vietnam, the Johnson administration declared that all U.S. shipments of food would henceforth be financed by long-term credits repayable in U.S. dollars only. This new policy, called "Food for Peace," further aggravated India's balance of payments situation, which in turn began to seriously affect the government's ability to import sufficient raw materials, machinery, and spare parts to maintain the nascent industries. A personal appeal to President Johnson by the newly appointed prime minister, Mrs. Indira Gandhi, met with partial success. The United States announced the release of $100 million out of the balance of $388 million covered by agreements signed before the termination of PL-480.

In June 1966, with the government and political parties deeply divided, a 36.5% devaluation of the Indian rupee was announced. Devaluation as a policy had been vigorously promoted by the World Bank and, in fact, was set in motion with the bank-sponsored mission, led by Bernard Bell, in 1965. The 1966 rupee devaluation, which set back the Indian planning process for years, came along with a package which prescribed reductions in import duties and elimination of major export policies. Announcing a liberal import policy to allow market forces a much larger role in the allocation of foreign exchange, the Indian finance minister also short-listed 59 priority industries accounting for 80% of industrial production that were to be given import licenses as and when needed for components, raw materials, and spare parts. Within ten days of the finance minister's announcement, the United States said it would resume economic aid to India.

Besides criticizing India's mismanagement of foreign exchange during the Third Five-Year Plan period and deriding India's "obsession" with industrial development at the expense of agriculture, the Bell mission report also called for large-scale import liberalization along the lines the finance minister announced. The report argued that a devalued rupee would encourage industries to divert output from the domestic market to overseas outlets.

While the Gandhi government came under scathing attack on almost all ideological fronts, it looked as if the predictions of the Paddocks—("So the famines will come. Riding alongside will surely be riots and other civil tensions which the central government will be too weak to control")—would come true. But, it was not to be. A series of measures to push up agricultural production, under the able leadership of Agriculture Minister Subramaniam began to pay dividends and the foundation for



food self-sufficiency was soon established.

Even today, there are those who criticize the late Prime Minister Jawaharlal Nehru for pushing the development of heavy, capital-intensive industries and large waterworks when the country was short of foodgrains. Some critics point out that the first three five-year plans channeled the entire surplus created by the agricultural sector into building an industrial base. The sorry condition in which the agricultural sector found itself in the mid-1960s, they argue, was because the surplus was used to make agriculture more productive.

How it was done

But C. Subramaniam, in his book *India of My Dreams*, sets the record straight: "Epoch-making as it [the Green Revolution] has turned out to be, it would be less than fair to view it as an isolated quark of development insight. I say this because the new strategy was not—and could not be—independent of progress we had achieved till then in building up an industrial and infrastructural base. It was because this was available that the new strategy could even be conceived of. All innovations are built on what exists. So did our new strategy."

Subramaniam elaborates that without the development of basic industries that was carried out through the first three five-year plans, the Green Revolution would have fallen flat on its face. India never had enough foreign exchange to even think of sustaining the Green Revolution by importing such vital ingredients as high-yielding variety seeds and fertilizers for any length of time. Moreover, Punjab, Haryana, and western Uttar Pradesh—the wheat belt—could not have gone

TABLE 2
Area under foodgrain production
(million hectares)

Foodgrains	1955-56	1960-61	1965-66	1970-71	1975-76	1980-81	1985-86
Wheat, rice, coarse grains	110.56	115.58	115.10	124.32	128.18	126.67	128.0

Source: Economic Survey, Govt. of India.

for double-cropping of wheat without irrigation canals, built in the pre- and post-Independence days (see **Tables 2** and **3**).

The first two five-year plans, which drew the wrath of the World Bank, IMF, and others which believed India should remain a nation of traditional agriculture, such as China practiced, emphasized manufacture of steel and fertilizers as well as heavy machinery building facilities and heavy engineering fabrication works. Irrigation of cropland, directly related to agricultural development, was given high priority along with power generation. Most of the irrigated land in the post-Independence days was created through major and minor irrigation projects, and tubewell development.

India also possessed a scientific infrastructure in the agricultural sector. Following the great famine of 1899-1900, in 1905 the British rulers had decided to set apart a recurring grant of 2 million rupees to assist agricultural research and education in the provinces. At the same time, a sum of £30,000 was donated by Henry Phipps of Chicago to Lord Curzon, then Viceroy of India, for a projected institute at Pusa in Bihar. With the government grant, the Departments of Agriculture were established in the provinces, each headed by a director. Agricultural colleges were set up at Kanpur, Pune, Nagpur, Coimbatore, and Lyallpur (now Faisalabad in Pakistan), to provide basic training in teaching and agricultural research.

In 1929, the Royal Commission set up a central agency, the Imperial Council of Agricultural Research to oversee and coordinate agricultural research. After Independence in 1947, the name of the central agency was changed to the Indian Council of Agricultural Research (ICAR). Besides ICAR, however, there were also "Commodity Committees" which carried out research independently on specific commodities such as cotton, jute, tobacco, and oilseed.

Although the agricultural research institutes were set up in the British Raj days, and later vastly expanded by the Nehru government through large investments, they were not functioning adequately. Subramaniam blames the ineffectiveness of scientific work in those days on "the colonial setup," which "had led to a bureaucratic approach to the problems of the management of research." As he put it: "Research was treated very much as a division of officialdom and administration dominated creativity. The resulting problems of lack of communication and frustration had become so pervasive that even such a simple decision as only to appoint an eminent scientist as head of the research council was considered a heroic innovation in itself."

TABLE 3
Share of states in foodgrain production
(million tons)

State	1975-76	1985-86	1988-89
Punjab	8.83	16.1	17.08
Haryana	5.04	8.14	9.48
Uttar Pradesh	19.48	31.42	35.75
Bihar	9.18	10.96	11.70
West Bengal	8.59	9.13	11.51
Madhya Pradesh	12.00	15.29	15.90
Andhra Pradesh	9.43	10.37	12.99
Tamil Nadu	7.18	7.17	7.29

Fight for science and for parity prices

Subramaniam's first move following his assumption of office as food minister was replacement of a permanent civil servant by an eminent scientist as the head of the agricultural research establishment. Dr. B.P. Pal, an internationally known plant breeder, was made director general of ICAR and the governing body of the council was reconstituted to include a number of eminent agro-scientists. Subramaniam also put all research institutes, including those under the Ministry of Food and Agriculture and the institutes run by the Commodity Committees, under ICAR.

As a next step, Subramaniam, who had the full support of Prime Ministers Lal Bahadur Shastri and Indira Gandhi, both of whose administrations he had worked in, established the Agricultural Research Service. The ARS provided improved salary and promotion prospects for the scientists.

From the outset Subramaniam was convinced that it would be only through scientific application that India's agricultural productivity could be enhanced. His first resolve was to put a quick end to the PL-480 imports. He said in his book: "Easy availability of food under the PL-480 had also dulled, in part, the zest for search for self-sufficiency. It had also encouraged the advocates of a cheap grain policy who did not quite realize the impact of such a policy on the

farmers' incentives."

Subramaniam laid out a "New Strategy." Based on the combination of high-yielding variety seeds—the product of agricultural research—with adequate water and fertilizer, the new strategy was centered around scientific research. In his book *The New Strategy in Agriculture: The First Decade and After,* Subramaniam wrote: "We organized agricultural scientific research in India, because we came to the conclusion that if we were to launch a new technology without the scientific and technological competence it might end in a disaster. . . . That was why, before introducing the New Strategy, we found it necessary to put agricultural science on a firm foundation, so that research work could be undertaken that would meet new challenges and problems."

Having set scientific research in order, Subramaniam braced up for the fight which formed the core of the New Strategy. He argued that the Indian farmer is a rational economic individual who would respond to incentives in improving productivity. Within six months of his coming to power, the government approved an increase of 15% in the procurement price of grain. Recalling the tussle, Subramaniam wrote: "While lip service was provided to the concept of remunerative prices, in practice difficulties arose because of the cheap grain emphasis. In these circumstances, it was almost inevitable that my advocacy of higher incentive prices and a support price policy should have been received with less than enthusiasm by my colleagues in the center and the states. Many refused to see the obvious. I remember vividly how difficult it was to convince my colleagues in the states and the center that in the long run, only a remunerative price could lead to self-sufficiency."

Along with the increased procurement price of grain, an Agricultural Price Commission was established to recommend periodic revision of farm prices. The Food Corporation of India was also set up to purchase foodgrains in support of established price levels.

An equally fundamental shift occurred in respect of the earlier policy that treated the country as a homogeneous agricultural area, and spread the resources so thinly (as in the so-called community development programs) as to become unproductive. A firm decision was taken to identify the maximum grain potential of areas and exploit that potential at the risk of exacerbating regional disparities. It was argued most vocally by Subramaniam that a situation of regional imbalances within the country was vastly preferable to a situation of uniform agricultural stagnation at home and food dependence abroad.

Subramaniam's argument, which won the day, in support of intensive agriculture where the situation is optimal paved the way for Punjab, Haryana, and western Uttar Pradesh to become highly productive foodgrain-growing areas. With the Bhakra Nangal hydroelectric project already set up, the parched lands of the Punjab and Haryana had become arable. The Punjab Agricultural University, which became the training ground for many Punjabi farmers, was created (see **Table 4**).

TABLE 4
Irrigated area under foodgrain production
(million hectares)

Foodgrains	1970-71	1980-81	1985-86
Wheat	9.9	15.5	17.5
Rice	14.4	16.3	17.7

Source: Economic Survey, Govt. of India.

The Bhakra Nangal hydroelectric project helped provide adequate electrical power to the area. Beside the canal irrigation, which was made possible due to the Bhakra Nangal project, the electrical power necessary for pumping water out of deep tubewells became available to farmers. The electrical power particularly helped those western Uttar Pradesh farmers who had no access to the irrigation water supplied by the canal system built during the British days.

In addition, Subramaniam's emphasis on intensive wheat production in Punjab and Haryana led to a more generous use of fertilizers, particularly of the N-P-K variety (see **Table 5**). With the rise of foodgrain productivity, and associated financial betterment of the farmers, a new phenomenon emerged. It soon became evident that many of the farmers were keen to educate themselves with different skills and not get tied to the land. This process created, what seems absurd in the Indian context, a manpower shortage. Faced with the newly developed constraints, the farmers, helped by cooperative loans, began to mechanize farm activities using tractors, mechancial threshers, and harvesters. The mechanization enhanced productivity further but did little to solve the manpower shortfall problem; machinery maintenance created more skilled jobs and helped to proliferate a whole range of small-scale industries feeding agricultural production. Today, the Punjab and Haryana farmers have become increasingly dependent on migrant laborers from Bihar and eastern Uttar Pradesh.

While the Ministry of Food and Agriculture was putting various elements associated with the New Strategy together, ICAR was consolidating the future potential of agricultural research. There were only eight agricultural universities prior to 1966, but this number shot up to 23 by 1983. There are also 38 agricultural research institutes under the control of ICAR, spread across the country. The premier research institution is the Indian Agricultural Research Institute (IARI) in New Delhi. With a staff of 1,400 scientists and technical personnel, and with 14 regional stations all over the country, IARI is one of the biggest institutes of its kind in the world.

The seeds of hope

By 1964, there were reports of a breakthrough in wheat pioneered by the Rockefeller Foundation in Mexico. Hybrids

TABLE 5
Fertilizer production and consumption
(thousand tons)

Year	Nitrogenous		Phosphate		Potassic	
	Production	Consumption	Production	Consumption	Production	Consumption
1960-61	98	212	52	53	Nil	29
1970-71	830	1,479	229	541	Nil	236
1980-81	2,164	3,678	841	1,214	Nil	624
1985-86	4,328	5,661	1,428	2,005	Nil	808
1988-89	6,712	7,246	2,252	2,659		1,068

Source: Economic Survey, Govt. of India.

of Mexican wheat and dwarf-strains from Japan produced new, shorter varieties capable of absorbing a much higher dose of chemical fertilizers without lodging (falling over), to give yield levels of 2.5 tons per acre—more than twice the potential output of local Indian varieties. Similar advances were reported for rice in Los Banos, Philippines, where "miracle" seeds produced as a result of hybridization between indigenous tall varieties and dwarf strains from Taiwan were highly fertilizer-responsive and gave yields of 2.5 to 3.0 tons per acre—approximately three times the maximum of local varieties. Earlier, in collaboration with the Rockefeller Foundation, ICAR had succeeded in developing new hybrid varieties of maize suitable to Indian field conditions that were able to double the maximum yield of local varieties. But since maize constitutes only a small part of the diet of Indians generally, this development had little impact on the foodgrain scenario.

Though the development of hybrid rice (Mayo, Sonora 63, Sonora 64, and Lerma Rojo 64A) was there for all to see, data on the performance of these high-yielding varieties under Indian field conditions was still insufficient to establish their potential in India. Despite the fear of new pests and diseases raised by many scientists, Subramaniam selected the crop varieties that would most likely prove viable in India. In 1965-66, some 2.4 million hectares were earmarked for experimentation and 200 tons of Mexican wheat were imported, which was locally multiplied into 5,000 tons of seedgrain. In 1966-67, farmer enthusiasm for the new seeds was such that the 5,000 tons of seedgrain had to be supplemented with import of another 18,000 tons of Mexican wheat.

In 1965, Dr. B.P. Pal led an ambitious breeding program for high-yielding variety wheat, using exotic germ plasm for disease resistance. Dr. Pal used the Federation genome from Australia (for loose smut), the Kononso from Japan (for yellow rust), the Frontiera, Frondoso and Rio Negro from South America and the Gazin from Egypt (for brown rust), the Thatcher from the U.S.A., and the Gabo from Australia (for black rust).

The success of the breeding program was unqualified. It produced many high-yielding dwarf varieties, with amber seeds that were accepted by Indian consumers—Kalyan Sona, Safed Lerma, Chotti Lerma, Sonalika, and Sherbati Sonora. Of these, the last variety, Sherbati Sonora, is the result of mutation breeding of Sonora 64. As with other crops, wheat breeding is a continuous process. Sole dependence on one particular variety may lead to disaster. The agricultural scientist is thus always on the lookout for better varieties in terms of yield, disease resistance, growth cycle, fertilizer responsiveness, resistance to lodging and other attributes. In fact, the Central Subcommittee on Release of Varieties recommends new wheat varieties for different agro-climatic regions every year.

While the scientific approach to bring about the Green Revolution was adopted in all other seedgrains (millet, barley, sorghum, etc.), rice is the crop next in importance to wheat in India. The discovery in Taiwan of dwarf mutant Dee-geo-woo-gen played a key role in reorienting the Indian rice-breeding program. The mutant was half the height of traditional tall varieties, with stiff, erect leaves facilitating high photosynthesis (that is, not affected by the length of the day). Taichung Nation 1 (TN 1) was obtained by breeding Dee-geo-woo-gen with another local variety, Tsai Yuan-chung, and was subsequently picked up by the International Rice Research Institute (IRRI) in Manila for its rice-breeding program. The IR series has been developed by crossing tall varieties with the dwarf genome of Dee-geo-woo-gen, and has been introduced successfully in the All-India Coordinated Rice Improvement Project in Hyderabad. The Indian breeding program has concentrated on identifying varieties with bold grain type, high-yielding characteristic, disease resistance, and wide adaptability in different agro-climatic regions.

Application of the new strategy began to show results in 1967-68, the second year of the introduction of modern farming. The first year, 1966-67, was another drought year, coming on top of the preceding year's unprecedented drought. In 1967-68, Subramaniam says, one of the most effective and spectacular transformations of traditional agriculture was attempted in the district of Tanjore in his own home state of Tamil Nadu. Nearly 400,000 out of 900,000

acres of the district experimented with double-crop paddy using the short duration, high-yielding variety A.D.T. 27. In 1967-68 India harvested a bumper crop of 95.1 million tons of foodgrains. By 1970-71 foodgrain production had crossed the 100 million ton mark. Between 1966 and 1971, India's wheat production doubled.

Malthusians gloat over difficulties

But carrying out the Green Revolution was not a smooth process. "It will fizzle out," a veteran administrator from the U.N. Food and Agriculture Organization had told an agronomist in 1969. The FAO administrator's motives aside, there was in fact cause for worry as the Green Revolution quickly stagnated. The stagnation came at a crucial period in Indian political economy. Indian involvement in the liberation of Bangladesh from Pakistan in 1971 had invited the wrath of the Nixon administration. Besides cutting off all aid to India, the United States had sent a naval task force as a warning to India. In retaliation India asked the American aid office to close down and put an end to PL-480 grain shipments. India declared that it would henceforth buy grain whenever necessary from the international commercial market.

In 1973, the effect of the stagnation in food production began to show up. In 1972-73 and again in 1974-75, foodgrain output fell below 100 million tons. More particularly, from 1970-71 to 1974-75, wheat production—the heart of the Green Revolution—was stagnant. Malthusians began to gloat. Richard Critchfield, an American writing in the *New Republic,* proclaimed: "India has lost one big historic chance to grow enough food. Instead the malthusian scourge has finally caught up with it. India will not have enough food this year or next or possibly ever again."

The problems associated with the stagnation were scientific and logistical. One problem was that the existing varieties of crops tended to lodge with heavier applications of fertilizer, and diminishing returns soon set in. It almost looked as if in the most intensive Green Revolution areas, further emphasis on fertilizers would be unproductive. The other problem was inadequate logistics to get new seeds and the fertilizer, water and pesticide inputs into the hands of the individual farmer in time.

Additionally, wheat-growing, which was the backbone of the Green Revolution, remained a regional phenomenon centered in Punjab, Haryana, and western Uttar Pradesh. In areas where the monsoon is highly active, rice is the main monsoon crop. But the vast Gangetic plain, where the success of the Green Revolution could produce a huge amount of foodgrain, suffers from drainage problems, which in turn affect the monsoon crop badly. It was also evident that the success that hybrid rice varieties had in Tanjore and in Andhra Pradesh was localized; the effect was only nominal in the eastern part of the country where the population consumes mostly rice. Deterioration of the seed quality through repeated use, plus the injection of new pests and diseases was also responsible for the leveling off of gains (see **Tables 6** and **7**).

TABLE 6
Growth rate in post-Green Revolution period
(percent per annum)

Crop	Sub-periods	
	1975-76	1976-87
Rice	1.96	2.75
Wheat	5.80	4.95
Total foodgrains	2.09	2.63

Source: Agricultural Survey, *The Hindu.*

TABLE 7
Annual growth rates of foodgrains
(percent per annum)

Period	Cropped area	Production	Productivity
1949-50 to 1967-68	1.41	2.94	1.43
1967-68 to 1980-81	0.35	2.39	1.56
1980-81 to 1986-87	0.06	2.45	2.51

Source: Agricultural Survey, *The Hindu.*

The crisis was soon averted, however, and the repair work done to the Green Revolution quickly paid off. In 1975-76 foodgrain output reached 121 million tons. Except for 1976-77, the subsequent years showed steady progress. India built up a significant 20 million tons surplus stock, which came in handy when a major drought struck in 1979-80. India did not have to resort to imports to feed its population. But the real payoff came in 1983-84, often described as the advent of the "Second Green Revolution." In that year foodgrain production shot up to 151.5 million tons—a 22 million ton jump in output over the previous year's haul. This quantum jump was more than the 20.8 million ton increase in 1967-68, the second year of the Green Revolution.

While the first Green Revolution arose from the introduction of new high-yielding varieties of Mexican wheat and dwarf rice evolved by IARI, the "Second Green Revolution" was totally indigenous. It was a success that can be attributed to the scientists, planners, policymakers and extension personnel, besides the farmers themselves.

While the first wave of the Green Revolution was confined to a few progressive areas of Punjab, Haryana, western Uttar Pradesh and Tamil Nadu, in the second wave eastern Uttar Pradesh, West Bengal, Bihar, Orissa and Madhya Pradesh—traditionally the weak agricultural parts of the country—showed remarkable growth rates. The second Green Revolution succeeded in bringing a wider area under

the sway of modern methods. During the second Green Revolution, it was not only wheat and rice productivity that showed improvement, but other cereals, classified as coarse grains, gained too. More important, perhaps, is the productivity growth in the rice sector. Total rice production had all along hovered between 50 and 60 million tons, but the second wave broke the shackles and pushed output close to 75 million tons.

The Green Revolution permitted India, which had been written off as a "basket case" in the 1960s, to emerge self-sufficient in foodgrain production. Foodgrain output has been kept ahead of population growth. The experts whose forecasts and analyses have proven wrong were prejudiced because they believed the Indian leadership was bereft of responsibility and "childish." Some believed that India's low foodgrain productivity was the product of Hinduism's belief in fate. Others attributed the poor performance to socio-religious-cultural shortcomings. All were proven wrong. The Green Revolution has established what Agriculture Minister C. Subramaniam set out to establish in the first place: Scientific-technological input is the most important input.

An anecdote described in Sudhir Sen's book *Reaping the Green Revolution,* is to the point. When Norman Borlaug, the reputed agronomist who played a crucial role in developing the Mexican dwarf wheat and worked closely with his Indian counterparts for years, first visited India in 1961 for a quick reconnaissance of the wheat situation, he predicted that India could, with the dwarf seeds, double annual wheat production within ten years. In 1971, during one of his routine visits, Borlaug was delighted to see that his prediction went wrong: It took India only eight years to double wheat output!

The Indian effort to make the Green Revolution a success did have its share of help from abroad. India had received foreign capital and assistance—loans and grants—in building up its agricultural infrastructure. Financing of needed inputs such as fertilizers, in which Indian industry was badly lagging, also played a key role. Foreign technical assistance was extensive. Thousands of Western economists, agronomists, hydrologists, educators, and other specialists have applied their skills to finding solutions to India's problems. This effort, which had involved private foreign agencies as well as official bodies, has affected virtually all aspects of India's agricultural development including but not limited to technological developments, such as the improved seed varieties pioneered by the Rockefeller Foundation and the Intensive Agricultural District Program (IADP), which was supported by the Ford Foundation.

Looking ahead

While the second wave of the Green Revolution has established the reality that India is self-sufficient in food production and the periodic vagaries of nature will not be able to bring back another period of food crisis, much less famine, it is also expected that soon enough India will be reaping a sufficient food surplus to become a food exporter and aid-giver itself.

All this is good news, but does not convey the scope of the country's real potential in food production. A comparison of the Indian experience with that of the East Asian countries will show that the productivity per hectare and per capita in agriculture in India lags far behind that of Japan or South Korea. India's vast water resources, the monsoon rains, have remained virtually untapped, while a large part of the country, living in the rainshadow area, suffers continually from lack of water. Significant efforts are under way to harness and transport surplus water from one river valley to these drought-prone areas. However, the size of the program is inadequate to exploit any significant fraction of the full potential. Along the same lines, India, which has a large reservoir of natural gas, continues to flare it even though the farmland can use a lot more fertilizer to make the land more productive.

No one, in fact, has any concrete idea whether all the cropland can ever be properly irrigated. In the drylands, where the Green Revolution is irrelevant, a different strategy has to be worked out to stabilize and improve production. The main problem in rainfed areas is how best to harvest the rainwater and conserve the moisture as long as possible to ensure at least one crop and to have two crops wherever favorable conditions exist. Dry crops will have to be mainly millet, oilseeds, pulses, etc. New varieties of seeds for these crops which are drought tolerant and pest resistant will have to be evolved. Oilseeds development was made a national "technology mission" two years ago, with the aim of focusing a crash effort to build up production and productivity in this important, mostly dryland crop. India's need to import substantial amounts of vegetable oil for cooking is a severe drain on foreign exchange reserves.

In addition, India has done little to ease the massive problems that landless agricultural workers face. Land reform in many states has not been carried out to any significant extent, and as a result, a huge army of laborers remains in utter despair. India requires a program like that used to create economic miracle in Japan. There, government intervened to bring small industries up to par technologically with the large manufacturers, paving the way for a thriving small industry sector that readily absorbed surplus agricultural labor.

References

1. Fred H. Sanderson and Shymal Roy, *Food Trends and Prospects in India,* The Brookings Institution, Washington, D.C.
2. Annie Besant, *How India Wrought Freedom.*
3. Paul Street and Michael Lipton, *The Crisis of Indian Planning.*
4. Planning Commission, Government of India, *The New India.*
5. Baldev Raj Nayar, *India's Quest for Technological Independence.*
6. Lawrence M. Veit, *India's Second Revolution.*
7. Francine R. Frankel, *India's Political Economy: 1947-77.*
8. C. Subramaniam, *India of My Dreams.*
9. Sudhir Sen, *Reaping the Green Revolution.*
10. M.S. Randhawa, *The Green Revolution.*
11. IAAS-FAO, *Agricultural Growth in India.*
12. *Survey of Indian Agriculture: 1990.* A publication of *The Hindu.*