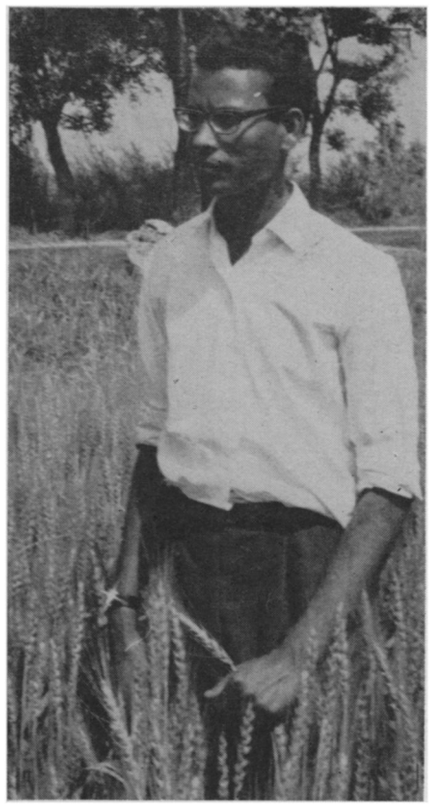
Hybrid dwarf wheat has high yield, but an even better strain is being tested.



Srivastava: farmers come to him.

FROM INDIA

Wheat and revolution

Success in developing high-yield strains is breaking down farmer's resistance to science; three-gene strains to come

by Barbara J. Culliton

Traditionally, the Indian farmer is a patient worker, satisfied if he has only a couple of acres, indifferent to science and too conservative to gamble his few rupees on the promises its holds.

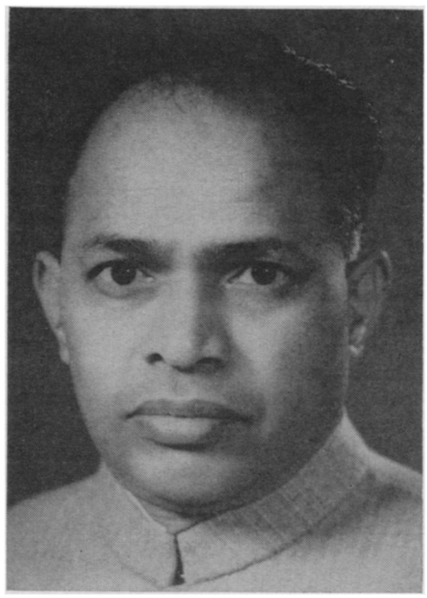
Researchers at India's agricultural stations—there are some 170 of them—have been working patiently in his behalf, trying to breed seeds that would give high yields in unirrigated and unfertilized soil.

Fertilization had produced heavy-bearded wheats on stalks so tall they lodged, or toppled, of their own weight before harvest. This kind of discouraging result militated sharply against further imports of foreign—principally Western — research and agricultural techniques. It also strengthened farmers' conservatism and resistance to innovation.

As if overnight, this year, political and scientific leaders are witnessing dramatic changes in India's bleak agricultural picture, signs that the farmer is on the verge of emancipation from his fear of science and from his unproductive stewardship of the land. "The farmer is less conservative than we thought," says Mr. Anna Saheb Shinde, State Minister for Food. "The farmer has gained faith in science. This is the corner turned."

Dr. M. S. Swaminathan, director of the prestigious Indian Agricultural Research Institute, categorically declares "agriculture is on the threshold of a major transformation from the natural to the exploitative phase." The heady prophesy that India is on the road to self-sufficiency in food has been taken up throughout New Delhi. It is accompanied by renewed enthusiasm for a broad advance in all aspects of agricultural research (SN: 5/18, p. 486).

The seeds of this agricultural revolution came from Mexico in 1963 when Rockefeller Foundation scientists and the Mexican Government sent India varieties of dwarf wheat that had helped Mexico treble its food production in just 20 years.



Shinde: ". . . the corner turned."

To skeptics in 1963, high-yielding Mexican dwarfs represented only false hope, dependent as they are on irrigation and high doses of chemical fertilizers, practices that bred lodging and disaster with the traditional tall wheat. At the beginning their doubts were borne out. The small quantities of Mexican grains that reached the market were rejected by buyers who found

Traditional tall wheat was ruined by rain before it could be harvested.

the reddish hue unpalatable, and farmers showed little inclination to experiment with new seeds that would force them to adopt modern agricultural practices.

Nevertheless, convinced that Mexico's success could be repeated in India, IARI geneticists took the most promising of the Mexican dwarfs, Sonora 64, subjected it to ionizing radiation and came up with a mutant with bold, amber grains, renamed Sharbati Sonora. At the IARI and the Uttar Pradesh Agricultural University at Pantnagar at the foothills of the Himalayas, scientists planted Sharbati Sonora in irrigated fields, feeding it heavy diets of nitrogen and phosphorus fertilizers. When farmers heard about harvests of as many as 250 maunds (about 10 tons) per hectare (2.5 acres), compared to their own 25 maunds of traditional wheat, interest at last took root.

It was the spectacular yields—under only average conditions Sharbati Sonora gives 125 maunds per hectare—that turned the tide. This season, scientists at Pantnagar estimate that 40 percent of the farmers in U.P. and the area around New Delhi are using the new variety and the new technique it demands. At the U.P. Agricultural University, Dr. Jitendra Srivastava says he sees something he's never seen before: "The farmers are coming to us, demanding seeds and lessons in growing them."

For fertilizer sales, the new wheat did what no amount of reasoned scientific prodding could. In a single year consumption of nitrogen fertilizer alone jumped 700,000 tons, and because the government has supported indigenous manufacture for the last few years, there is enough to meet the demand.

Encouraged by prospects of larger crops, the central and state governments are splitting the costs of new regional corporations that will construct irrigation canals and sell or lease tractors and other farm equipment.

Unsatisfied critics now complain that research money spent on their development is wasted because 80 percent of the land is still rainfed, and to increase yields so significantly in some select areas will only widen the gap between advanced and starving farmers and disrupt market prices.

But less than 10 percent of India's science budget goes to agriculture. Far from promoting instant revolution, the $10 million is hardly enough to support the modest progress begun.

Though agricultural statistics generally fail to separate yields of dwarf and traditional wheats, comparative market prices give some indication of what has happened in this bumper year of approximately 16 million tons of wheat—six million more than 1967-68. Dwarf wheats that last year sold for $17 per quintal (100 kilograms) are now going for only $10, while less plentiful traditional tall wheats cost $11 or more.

Short statured Sharbati Sonora, like its sturdy parent Sonora 64, has two genes for dwarfing: two successive mutations have been bred into it to keep height down. It has the same favorable resistance to lodging or being knocked down by heavy rains just before the harvest. It also has an unexpected bonus of higher protein—16.5 percent, with three to four grams of the amino acid lysine per 100 grams of protein, compared to Sonora 64's 14 percent protein and two grams of lysine. Traditional Indian wheats contain only seven percent.

Thus a major factor for protein and lysine synthesis appears to be located near the locus concerned with grain color. The new mutant has helped disprove the idea that protein quality and quantity cannot be improved at the same time. It also stands as a symbol of the possibility of developing high yielding, high quality varieties of cereals and other crops.

Now that two-gene dwarfs have earned their keep, scientists are at work on three-gene dwarfs even more resistant to lodging and genetically designed to capitalize on Indian field conditions. At Pantnagar, Dr. Srivastava is using genetic engineering for more than short stature alone.

"India gets fantastic amounts of solar energy," he says. "It should be exploited by plants with straight leaves to capture sunlight and permit carbon dioxide to circulate freely through the crops." He nurtures field after field of experimental mutant wheats with vertical leaves, angular leaves and normally folding leaves for comparative studies. He has varieties with long fertile ears of up to 20 grain heads per ear, and a highly productive three-gene dwarf with heavy, branched ears.

The Central government released two-gene Sharbati Sonora in 1967. Within two years, Dr. Srivastava predicts, it will release three-gene dwarfs.

A three-gene mutation being designed to exploit the available sunlight.