BIRTH OF SUPER FOOD

How science has created an amazing new plant to feed the world's hungry.

by John Bird (1967)

On my desk as I write this is a clear plastic tube containing a new form of life, something that seems straight out of science fiction.

The object in the tube resembles a ripe brownish-gold head of wheat.But an experienced grain farmer coming upon such a plant ripening in his fields would find it difficult to believe his eyes for this strange new plant is a giant. Its grain heavy head is at least twice as large as that of a normal wheat plant. In some tests it has yielded almost twice as much grain, and its kernels are especially rich in protein, the essential body building food element so badly needed by an ever hungrier world.

Looking at this monster, a farmer might wonder a bit uneasily about the forces that brought the new kind of plant into being. Did it come from a rare accident of nature? Could it be a fantastic mutation caused by radioactive fallout? The answer is that Triticale, as it is called, is the deliberate work of man. Scientists put it together by skillfully combining two different species of grain-wheat and rye – into a new and larger form. (It's name, pronounced "trit-i-cay-lee", is itself a combination of the scientific names for these two grains.)

Perhaps the most remarkable thing about Triticale is that it is the first crop species that man ever created. Originating a whole new species heretofore taken millions of years of evolution, and the fact that scientists have been able to do it in the laboratory opens up the exciting possibility that other super-plants may be developed. "Now that we know how to pass the evolutionary hurdles, there is virtually no limit to the new combinations we can make," declared Leonard H. Shebeski, dean of agriculture at the University of Manitoba and one of the men who pushed the development of the new kind of grain.

In their quest for Triticale the scientists found themselves dealing with the complex inner patterns of life itself. "You don't just glue the halves of two seeds together," as one researcher put it. Each species of plants and animals has its own particular genetic code which guards its identity assuring that the species will continue to reproduce its own kind, whether it be wheat or bacteria or elephants. Some closely related species can be crossbred, of curse, as are horses and donkeys to produce mules. But the hybrid offspring of such matings invariably are sterile. That is where Triticale is a breakthrough. It is a "fertile mule". It has the ability to reproduce its giant self, generation after generation.

Before making this breakthrough, plant breeders had to grope their way along an obscure, twisting trail beset with booby traps. What kept them going was the knowledge that such a new species was possible, at least in theory. Agronomists know that nature has produced new species from time to time, and they have been able to trace the development of modern food crops back to their evolutionary beginnings. They have found, for example, that common bread wheat, *Triticum aestieum*, was born in Asia Minor perhaps 10,000 years ago, when a primitive, grasslike wheat, einkorn, happened to crossbreed with species of goat grass, a spindly little wild plant. Normally such a mating would produce a sterile hybrid, but some unknown force, perhaps an intense cold shock at just the right moment, caused the genetic elements in the growing cells of the hybrid to rearrange themselves into a pattern that could produce fertile seed. From this miracle came durum wheat, a hard, tasty grain more complex than either of its parents but simpler than modern bread wheats.

Some time later, in another miracle much like the first, durum wheat crossed with another kind of goat grass; again something made the hybrid fertile, and it became the ancestor of the wheats we use today.

It is the undistinguished goat grass in wheat's family tree that has always bothered and challenged the scientists. They wondered, in effect, *Why can't we re-evolve wheat, and this time give it better ancestors?* Rye, for instance, might make an ancestor far superior to the goat grasses. So plant breeders set out many years ago to find ways of forcing wheat and rye to mate. In some cases wheat-rye plants were produced, but they were always sterile.

This was to be expected, of course. Normally a body cell of any living thing, plant or animal, has a certain number of threadlike bodies called chromosomes, and on each chromosome are genes carrying the genetic code. The chromosomes are arranged in pairs, and when an organism produces sex cells, each sex cell carries one chromosome from each of the parent's pairs. During fertilization the chromosomes from the male sex cells "pair up" with those from the female, restoring the original number of chromosomes.

The trouble with the wheat-rye matings was that the chromosome numbers of the two species are different. The durum wheat used in the crosses has 14 chromosomes in its sex cells; those of rye have just seven. When brought together the two sets don't form pairs; they string out as 21 single chromosomes. Without pairs to divide, a wheat-rye plant couldn't possibly form sex cells. It was a new species, but it was already the end of the line.

The plant breeders knew that on rare occasions a mysterious *something* in nature caused a plant's chromosomes to double; that obviously had happened in the evolution of wheat. Their only hope, they realized, was to find a mechanism to do the same thing. Then, in 1937 a team of botanists discovered that colchicine, a natural drug extracted from the autumn crocus and used for the treatment of gout, could cause a plant to double its genetic machinery inside the cell. They tried it on wheat-rye, and it worked.

With this barrier bypassed, plant scientists in many parts of the world began producing a few experimental Triticales. But these early strains displayed many defects which long had been suppressed in modern grains. They were weak in fertility, for example; their straw was tall and weak, and their grain tended to be light and shriveled. After some years of discouraging results, Triticale was put on a back shelf. Here and there a few lines were kept going as scientific curiosities.

Such was the situation when in 1953 the fate of Triticale passed temporarily from the hands of the scientists and into the hands of two very wealthy young Canadians, Edgar and Charles Bronfman. The Bronfman family had gotten its start in Winnipeg, out on the windswept plans of Manitoba where spring wheat is the mainstay crop. There the boys' father had worked his way to ownership of a hotel, then branched into the liquor-distilling business, eventually building the vast Distillers Corporation-Seagrams empire and a family fortune estimated at $300 to $400 million.

In Montreal on a summer day in 1953 Edgar and Charles decided that they and their sisters, Minda and Phyllis, should do something to memorialize the long and useful life of their maternal grandfather, Samuel Rosner, who had died in Winnipeg the previous fall. "He had a general store in the little town of Plum Coulee, fifty miles from Winnipeg. "Edgar Bronfman says of his grandfather, "and he also had some farms. When we were kids, he would visit us in Montreal and tell us stories about wheat farming – what a tough time farmers had when their crops were ruined by drought or frost or an epidemic of rust. He was a bug on education and research; he believed they would make farming better."

The upshot of the brotherly conversation was the establishment of the Samuel Rosner chair in agronomy at the University of Manitoba. The endowment had no strings attached. "We didn't pretend to know what was needed," says Edgar. "My only farming experience was growing radishes when I was twelve and selling them to my mother at exorbitant prices."

However, Leonard Shebeski, then head of the university's plant science department, had a good idea of some tasks the Rosner chair should undertake: Triticale, as well as some other difficult genetic research, Shebeski, an intense, bright-eyed man, was worried about the increasing shortage of food in backward countries, and he saw Triticale, crude as the early specimens were, as something that might help mankind feed itself.

Triticale is a real breakthrough: it is the first man-made grain.

The Triticale project went into business in an office and laboratory converted from an old cattle barn. The first Rosner professor, Dr. B.C. Jenkins, collected samples of Triticales from researchers all over the world and also produced some new specimens himself. But there are thousands of varieties of wheats and ryes, each a bit different from the others, and the possible combinations were endless. To speed up the search, Shebeski hired a veteran plant breeder named John N. Welsh to see what he could do to upgrade Triticale. Welsh went to work, patiently making new crosses and also intercrossing strains of the new species, selecting the more promising offspring. The trick was to get rid of some of Triticale's bad traits without losing the exceptionally good ones, especially [lysine] an amino acid essential to human nutrition but scarce in common wheat and corn. Slowly, Triticales began to appear with shorter, stronger straw, and earlier ripening habit, more grain per head, and kernels that were plumper and less wrinkled.

Welsh died in 1964, "Just about the time he was beginning to see the tremendous promise of the crop." Says his successor, Dr. Laurie E. Evans. "John had a fine eye for spotting valuable characteristics, sometimes in just a single plaint. He had a knack for putting the right things together. That just isn't the sort of thing you can do with a computer."

The whole process, in fact is like assembling a jigsaw puzzle, using living pieces. In his laboratory and greenhouse at the university, Dr. Edward N. Larter, a hearty, articulate geneticist who last year became the second Rosner professor, showed me how it is done. The starting materials are, of course, a wheat plant and a rye plant, both at the flowering stage, "First," says Larter, "we need a female parent, say the wheat. Normally it is self-fertilizing; its flower carries both male and female organs." With little scissors Larter snips along the rows of tiny flowers in a head of wheat. Then, using tweezers, he extracts the anthers, the pollen-bearing organs, from each flower. “The wheat,” he says, “now is entirely female.”

Next he moves to a plant of rye in which minute, yellow-green bodies, the anthers, hang outside each flower. “This is easy,” says Larter. “We just pluck these off with tweezers and transfer the pollen to the female wheat flowers.” If the tweezers-made marriage “takes” the first crisis will occur in about a week or 10 days when the rapidly growing embryo begins to run out of food. Left alone, the newly created hybrid will die.

“That’s where bottle-feeding comes in,” explains Larter. “Using sterilized instruments, we remove the ovary from the plant and put it on an agar plate carrying plant food. Sometimes the embryos live, sometimes they die, and we don’t know why.”

If the baby hybrid survives this treatment, a remarkable phenomenon occurs. Instead of developing into a seed, as it would in nature, the artificially cultured embryo soon develops directly into a plant. When it has a root system, stem and leaves, it is transferred to soil in a greenhouse pot.”You have a new species of plant now,” says Larter, “but remember, you have to double its chromosomes before it can produce seed. All we do,” he continues, “is to take a fine hypodermic needle and inject a weak solution of colchicine into the hollow stem of the new plant so that it reaches the growing point. Colchicine isn’t perfect, but so far it’s the best method we have for changing those infertile plants with twenty-one chromosomes into fertile ones with the necessary forty-two.”

Putting a Triticale together is just the beginning of the job, however. From the plant-breeding plots promising types must move to dozens of other tests and evaluations. As yet the University of Manitoba has only a few lines of Triticale ready for large-scale field tests – but so far these have been impressive. Last year yields ran a high as 55 bushels per acre in south-western Manitoba, where the yields of common bread wheat were around 40. In an irrigated field in Arizona this spring, and early-ripening Triticale produced almost 70 bushels an acre.

In baking tests Triticale grain is milled into flour and baked into bread – and here the crop has acted a bit too much like rye, producing a flat loaf. To produce a light, fluffy loaf of the kind that Americans seem to want, Triticale flour must be mixed with wheat flour – but unmixed Triticale flour makes a fine, rich unleavened bread of the kind preferred by many people in other parts of the world. I tried a small loaf not long ago and found that it had a delicious, nutty flavor.

Triticale’s potential as a hunger fighter is now being explored by the Rockefeller Foundation’s Agricultural Service in such countries as India, Pakistan, Egypt, Iran, Turkey, Columbia, Chile, Ecuador and Guatemala. “The food crisis is here,” says Dr. Norman E. Borlaug, associate director of the service. “The only way to feed more people in a hurry is to raise more food grain per acre. That’s where Triticale fits in. It has more ‘yield ability’. It has more protein. You know a child in Asia simply can’t eat enough rice to meet the needs of a growing individual.”

The fight against hunger extends beyond Triticale. The Manitoba researchers are now assembling a new kind of plant called Agrotricum, a cross between durum wheat and a tall, sturdy grass. The hope is that the grass will contribute its disease resistance to Agrotricum and possibly even make the new plant a perennial. The project is exciting;

plant breeders have long sought a wheat that would grow every year without reseeding. But progress is necessarily slow, “We have a lot of work to do on it.” says one researcher.

Meanwhile, the Triticale crew has managed to double the rate at which test crops can be grown. After fall harvest in Manitoba, seed is sent to an experimental station in Sonora, Mexico where a second crop is grown and harvested in time for spring planting in Manitoba. Thus far two strains of Triticale have graduated from the nursery plots and seed is being raised for large-scale trials.

A breezy, super-organized seed grower named Al Arnott is chiefly responsible for field-testing the new wheat. Two years ago he started with just 80 pounds of seed, which he planted on his Manitoba farm. From this he harvested 2,500 pounds, which he trucked to Arizona where it yielded 50,000 pounds. By the time it was harvested, the spring planting season was almost over in Canada. “It looked like we might lose a whole year,” he said. “We loaded that grain on a trailer in Arizona on May 17, and within four days we were putting it in the ground in Canada. Last fall we harvested one and a half million pounds. Think of it – from eighty pounds to one an a half *million* pounds in just two years.

By 1970 the university hopes to have a least one variety of Triticale ready for commercial distribution to farmers, but at present Al Arnott is one of the very few who have actually grown the new grain. “I don’t have a doubt in the world,” he says, “that it’s going to be a terrific crop.” Arnott won’t tell where in Arizona he is growing it because “It really hits people when they see the stuff. They even swipe handfuls of it to take home and plant.”

This summer millions of people will have the chance to see Triticale – though not to swipe it. The university proudly has planted a very special plot of it in the Man The Provider area of Expo 67 in Montreal. The planting site is only about the size of a large rug, but in the long run the Triticale may prove to have been the most significant exhibit in the entire world’s fair.