In 1944, the year Bir Bahadur (B.B.) Singh was born in the state of Uttar Pradesh in India, Indian agriculture was in shambles. During nearly 200 years of British rule, the country’s agricultural enterprise had been turned over to commodities such as cotton, indigo, and sugarcane for export; what little food was grown hinged on rainfall and the soil’s natural fertility—or lack of it. Crop yields were often abysmal as a result, and famine was common. So when India won independence from Britain in 1947, the Indian government enacted a sweeping program of nationwide, agrarian education.

That’s why when Singh graduated in 1956 from his village school with good grades and an interest in science, he found himself at one of India’s newly minted agricultural high schools. It was the only nearby school where he could study science, Singh says, as well as the closest high school to his home. Plus, his father wanted him to attend, saying, “Why don’t you study agriculture and see what help you can give to our people,” Singh recalls.

“So I was okay with going to an agricultural high school, and that later became my good luck,” he says. Turns out it also became the good luck of millions of the world’s smallholder farmers.

Today, Singh is among the most revered breeders of legume—or pulse—crops, credited with improving the diets, incomes, and lives of farming families across Africa, Asia, and South America. In the late 1960s and 1970s, for instance, the ASA and CSSA Fellow not only established the first systematic breeding program for soybean in India, but was also pivotal in bringing the novel food to millions of Indian people. Soybean production has since grown in India from just 5,000 tons in 1961 to about 12 million today. Yet this was only the start.

“Of course, B.B. is best known for his work with cowpea,” says Bill Payne, an ASA, CSSA, and SSSA Fellow who was at Texas A&M and CGIAR in Ethiopia before becoming dean of agriculture at the University of Nevada–Reno this winter. “Almost anywhere in the world, you cannot work on cowpea without running into him in some way, fashion, or form.”

Known also as black-eyed pea, cowpea is a staple crop in many tropical areas, and Singh’s signature achievement is a fast-maturing variety that fits into the rotational niches between wheat, maize, and rice. Due largely to this advance, worldwide cowpea production rose from 1.3 million to 7 million tons between 1981 and 2013—the only food legume...
to enjoy such an upswing. But the crop scientist, now in the 48th year of his career, isn’t content to stop there.

“I think there’s a very good possibility that we will have a surge in pulse production in the coming decades,” says Singh, who currently splits his time between Texas A&M University and India’s G.B. Pant University. The title of his new book, Cowpea—The Food Legume of the 21st Century (see page 8) asserts the same.

Those who know him don’t doubt it. “He’s just tenacious,” says CSSA President David Baltensperger, also an ASA and CSSA Fellow. He often compares Singh’s success with cowpea to Norman Borlaug’s accomplishments with wheat. “One of the secrets to B.B., like Dr. Borlaug, has been his ability to keep his eye on what he considers to be really powerful fundamentals. That leads to a lot of success over a long career.”

Good Decisions … and a Little Luck

Focus is indeed crucial for a researcher, and other colleagues add that Singh is highly intelligent, full of energy, and a careful listener—as well as supremely dedicated to helping farmers. “He is an excellent scientist—I mean, he publishes a lot,” says Ken Dashiell of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, from which Singh retired in 2006. “But he probably spends 98% of his energy on getting the best cowpea varieties for the farmers, and 2% of his energy on publishing.”

What Singh himself says is that he’s been lucky. “At every stage of my life, some good people have come, given me direction, and good things have happened,” he says. The first stroke of luck came when his father pushed him toward an agricultural high school because it helped gain him admission in 1960 to India’s first agricultural university: Uttar Pradesh Agricultural University (now Pant University). Singh then earned a scholarship in 1963 to do graduate studies in plant breeding at the University of Illinois, where again he made a fateful choice. After learning how much research was already under way to improve cereals, Singh resolved to study legumes to help India’s vegetarian multitudes meet their need for protein. And at the University of Illinois, that meant one option: soybean.

“So, that’s how I decided to work on soybean,” he says, “and it was one of the best decisions that I took in my life.”

Soybean contains roughly twice the protein of other pulses, he explains, and by the time he earned his Ph.D., USAID and the University of Illinois were already trying to bring soybean to countries beset by malnutrition, including India. Meanwhile, the dean of agriculture at Pant University was monitoring Singh’s progress, and in 1968 sent him a “very personal and emotional letter,” Singh says. It offered him—now a postdoc at Cornell—an assistant professorship at Pant that included 50% more salary than what a new assistant professor in India typically earned. Singh had two competing offers from U.S. universities for substantially higher pay, but he never gave the decision a second thought. Later that year, he returned to India to begin the work that would transform soybean from an agricultural novelty into one of the nation’s principal foods (see page 7).

He might have stayed at Pant for the rest of his career. But in 1977, a change in university administration led to major campus unrest, including the shooting of several staff. Hoping to get away for a “breathing spell,” Singh began looking for other opportunities and was immediately offered soybean breeding positions by the United Nation’s Food and Agriculture Organization (FAO) in Zambia and by IITA in Nigeria. Opting for IITA because of his interest in research, he intended to stay abroad for just two years, but “then based on my work, they kept me there forever, and I spent my life there,” he says.

They asked something else of him, as well: to work not on soybean, but cowpea.

60-Day Cowpea

Cowpea is only an occasional food for most Westerners. But it’s essential in Africa, where it’s known
as “kunde,” “niebe,” or simply “beans,” depending on the region. For many families, the dried cowpea bean, or grain, is their best source of protein, says IITA’s Dashiell, as well as an important source of income if they grow more than they need. Cowpea is also harvested as a sweet pea early in the season, produces a high quality fodder for cattle, and can add nitrogen back to the soil.

Singh had never worked on cowpea before arriving in Africa in 1979, and it was during his orientation at IITA that he first got to see cowpea variety trials and a large number of cowpea germplasm lines. He subsequently spent most of his three weeks’ orientation carefully observing cowpea as a crop, learning the immediate breeding goals and getting familiar with the available germplasm’s genetic variability.

He then headed to his first research post in Ilonga, Tanzania, taking with him some interesting varieties and germplasm lines, including ones that were known to mature extra early. And sure enough, when Singh planted them he noticed that certain plants matured in about 55 days, although they grew just 12 to 18 inches tall and their yields were low. Still, he was intrigued. Maize was sown twice a year in the region where he worked: First, during a long rainy season in which the cereal did well, and next during a short rainy season in which it often suffered from terminal drought. Singh thought the fast-maturing cowpea could be ideal for the short rainy season if he could bring the yield up through breeding.

Thus began the work on the “60-day cowpea” for which Singh is best known. First in Tanzania, then in Ibadan, Nigeria, and finally in Kano—the heart of Nigerian cowpea production—Singh eventually developed more than 35 cowpea varieties for release not just in Africa, but in more than 45 countries around the world. In addition to maturing early and yielding well, Singh’s cowpeas tolerate drought, heat, and low-fertility conditions. They resist nearly every major pest and disease of the tropics, including aphids, thrips, bruchid, and parasitic weeds like Striga and Alectra. They’ve also been adapted to a range of agronomic purposes: for use as fodder, harvesting as sweet peas, and for slotting into different crop rotations.

The laundry list of improved traits speaks to Singh’s “vast, intimate knowledge of the cowpea germplasm,” says University of Nevada–Reno’s Payne, who first met Singh in Nigeria around 1992. “It’s amazing—he doesn’t have to go to DNA libraries like younger scientists do. He just knows [the germplasm] because he’s spent decades in the field working with all of it. So in very short order, he can create a tailored variety for a particular niche and a particular need.”

Still, the cornerstone of cowpea’s success remains its early maturity. In many parts of Africa, there is just one rainy season per year, and it may last for as little as two months. “Farmers really have to plant and harvest quickly,” Dashiell says. But Singh soon realized a second advantage of his 60-day varieties. Most other food legumes take 100 days or more to reach maturity, he explains, meaning that farmers are usually forced to choose between planting a pulse crop or a cereal. And cereals generally yield much higher.

“So I reasoned that the way things were going, the three-, four-, or five-month-maturing pulses had no future because there would be no land for them. All the land has gone to the high-yielding cereals,” Singh says. “So I am boldly saying that it is crops like mung bean and cowpea, both of which mature in 60 days, that are the future legume crops because they fit into the niches between cereal and root crops.”

Taking the Extra Step: From Variety Development to Farmer Adoption

New varieties only have a future, though, if a breeder can convince farmers to adopt them—something at which Singh also excels, say his colleagues. Part of his success stems from his vast knowledge and global connections, says University of Illinois Professor Emeritus Bob Hoeft, who has gotten to know Singh in recent years during Singh’s visits to campus. “But I think the thing that really makes a difference is his willingness to work

continued on page 9
Transforming Soybean from a Novelty to a Principal Food in India

When B.B. Singh arrived at Pant University in 1968 to start a soybean breeding program, the Indian government, USAID, and the university were all convinced that soybean would be good for India. The Indian people had other ideas. The issue was that they preferred to prepare and eat pulses as dal, and soybean makes a poor one. Unlike other dried beans, soybeans fail to split and disintegrate into a creamy dal when cooked.

The problem first dawned on Singh when he gave 40 to 50 kg of unneeded soybeans from his field trials to his farm manager for sale, and there were absolutely no takers. Then friends started reminding him that even Mahatma Gandhi had tried to popularize soybean in India and failed. “They told me, ‘You are wasting your life and good career. You should switch to something else,’” Singh recalls. Another scientist might have heeded their advice. But Singh believed strongly in the potential of soybean and decided to see what could be done.

First, he and a trio of close colleagues persuaded the owner of an oil mill in Aligarh—about 200 km from the university—to begin extracting oil from soybean. About 85 such extraction plants already existed in India at the time, Singh says, but they often sat idle for months for want of raw materials.

Next, the team hatched a plan for using the leftovers from the oil extraction process: the defatted soybean cake. An extruded cooker for processing the cake into a meat-like product, called texturized soy protein (TSP), had recently been developed in the United States. So, Singh and his colleagues approached the missionaries running a nearby technical institute and convinced them to acquire one of the cookers to produce TSP. The product—which Singh dubbed “Nutri-Nugget”—proved an excellent substitute for paneer (raw cheese) and meat, and it became immediately popular.

Those two successes marked the start of a revolution in soy-based industries in India, but there was another enormous problem to overcome, as well. In 1970, two high-yielding soybean varieties from the southern U.S., Bragg and Lee, were released for cultivation in India—and then promptly succumbed to the pathogen, yellow mosaic virus. “Not even one plant growing in about 500 ac around our university was healthy,” Singh says. “Everything was affected by yellow mosaic.” So severe was the crisis that the Indian Council of Agricultural Research warned Singh if he didn’t find an answer to the disease, the entire soybean research program would be shuttered.

Singh wrote immediately to colleagues at the University of Illinois, asking them to send him every source of soybean germplasm they could find. Within two weeks, a package arrived on Singh’s desk containing the seeds of some 3,500 U.S. soybean lines. Roughly 450 of them were rejected by the Indian Plant Quarantine, but Singh planted the remaining ones in the field alongside 1,500 of his own germplasm lines. He then waited to see which of the lines—if any—would survive.

Just two of them did, but when they proved to be completely resistant to yellow mosaic, they were enough to save the Indian soybean program and Singh’s career.

“So, again, I am lucky,” Singh says. “I call myself lucky that things happened when I needed them most.”

The yellow mosaic resistant line of soybean (right).
The story of cowpea (black-eyed peas) is a fascinating example of how science can solve the world’s biggest problems—even more fascinating is the story of the scientist behind the research.

B.B. Singh wrote this book to serve as an accessible summary of cowpea breeding, management, and use. He has devoted his life’s work to solving the “protein gap” of the Green Revolution in which the emphasis on corn and wheat neglected the protein-rich legumes vital to plant-based nutrition. Today, under his careful tending, cowpea truly has become the food legume of the century.

From genetics to recipes, he gives a full account of how cowpea belongs in our global agriculture and in every diet. Along the way, he shares his inspiring story.

2014, softcover, 7 x 10”, 184 pages
doi:10.2135/2014.cowpea
$45 ($36 members)
Item: B30499

ORDER TODAY
Online | www.societystore.org
Phone | 608-268-4960
Fax | 608-273-2021
Email | books@sciencesocieties.org

https://dl.sciencesocieties.org/publications/books

Crop Science Society of America | 5585 Guilford Rd., Madison, WI 53711-5801 | crops.org
Co-sponsored by International Institute of Tropical Agriculture | iita.org
with the people who need the help,” says Hoeft, an ASA and SSSA Fellow. “I can’t stress that enough.”

Dashiel agrees, adding that Singh had an important message for him when Dashiel was starting out at IITA in the mid-1980s. “He said, ‘Ken, plant breeders, like you and me, have the best job in the world. [Our work] can literally change the lives of millions and millions of farmers, just with the help of a seed.’”

The young scientist couldn’t help but be inspired. “That’s what really motivated me to continue in this line of work,” he says.

Singh, in turn, was inspired by Borlaug. In 1994, the Nobel Peace Prize winner began working in Kano, where his on-farm demonstration projects with wheat and maize made a strong impression on Singh. Singh also remembers vividly a visit Borlaug paid to Pant University in the early 1970s. “He gave a lecture at my university, and I will never forget what he said,” he recalls. “‘It is not enough for a breeder to develop a variety. He or she should get it released and take not one, or two, but three steps to make sure it is cultivated by farmers.’”

That’s why he, Dashiel, and others at IITA decided around the year 2000 to team with colleagues at ICRISAT and IRRI to bring a new intercropping system to Kano’s farmers. Many farmers already intercropped one row of cowpea with one row of maize, millet, or sorghum, but the yields were poor; what the scientists proposed was a system of four rows of an improved cowpea variety to two rows of cereal, combined with selective fertilizer and pesticide applications. Experiments suggested yield bumps of 300% were possible, but at first, local farmers weren’t interested. “They said: ‘Many others like you have come and spoken with us, and nothing has come of it,’” Singh says. “‘So, we don’t want to waste our time and your time.’”

Singh persisted, though. First he convinced one of Kano’s traditional rulers to hold a meeting with farmers; then he and his colleagues persuaded 11 of them to sign on. Their yields of cowpea were so high that the following year the entire village wanted to adopt the system. It spread from there to eight other northern Nigerian states, into neighboring Niger, and to some 300,000 farmers by 2006.

Many of those farmers were also Muslim women who Singh had to receive special dispensation to interact with and teach. But teach them he did (“One by one, I had 1,100 women farmers join the program,” he says), and before long, they started forming cooperatives, getting loans, and making enough extra income to buy things like school books for their children and goats for milking. One of the women even gave a lecture at a field day, something that was unheard of in Muslim regions, Singh says. “The whole gist of the story is that he used his science to make a difference in the world, to affect people in a very positive way,” Hoeft says. In return, Singh received many honors, including an Agricultural Honors Award from the Kano state government and several chieftaincy titles.

Among the latter is Sarkin Norma. It means “King of Farmers.”

An Expanding Role for Cowpea

That may seem like a fitting place to conclude the story, but Singh is making sure the end is nowhere in sight. He’s busier than ever since his “retirement” in 2006, he says with a laugh, spending his time between visiting professorships at Texas A&M and his former university, G.B. Pant.

Texas was the United States’ largest grower of cowpea before being overtaken by California some years ago, says Payne, who along with Baltensperger played a big role in bringing Singh to Texas A&M. Now Singh is trying to boost production once again. Specifically, he wants the state’s producers to grow a 60-day cowpea in rotation with wheat for export to Africa and India. And there are benefits in Texas, too. “As the price of nitrogen fertilizer continues to skyrocket, I’m sure we’ll be looking more and more at biological
nitrogen fixation,” Payne says. “And because cowpea can survive in climates where crops like soybean cannot, I think in drier climates, it will have an important role.”

Cowpea can also contribute to wildlife habitat and serve as a cover crop or green manure. “So there is any number of uses for it, and I believed that B.B. was exactly the person we needed to begin pursuing those niches,” Payne says. “And he has done so.”

The core of Singh’s research, though, remains international. One of his proudest, recent achievements was convincing members of USAID and Monsanto’s South Africa operation to approach the company about donating its Bt (Bacillus thuringiensis) trait to Africa royalty free. The goal is to fight Maruca pod borer—a tropical pest of legumes that causes yield losses of up to 80% in West Africa and for which there is no natural source of resistance.

Monsanto agreed, and afterward, an Australian colleague of Singh’s, T.J. Higgins, transferred the Bt gene into cowpea with support from USAID. The transformed cowpea varieties are now being tested in Nigeria, Ghana, and Burkina Faso with good results, Singh reports, and he expects a “quantum jump” in cowpea production once they’re released in the next three to four years. “When it happens,” he says, “I and all the cowpea farmers will be extremely grateful to Monsanto, USAID, and T.J. Higgins for their kind contributions to help the African farmers.”

Singh also advises a cowpea improvement program in Brazil, has an ongoing project in South Africa, and hopes to do additional work in West Africa. And then there’s his current research in India, where everything began. Despite all the Indian government’s programs and advances of the Green Revolution, India is still food insecure today—especially when it comes to protein. So in typically quick fashion, Singh has devised a solution. He’s now squeezing in between wheat and rice, and rice and rice, a heat-tolerant, photoperiod-insensitive, 60-day cowpea. Four new varieties have already been released. And if the new crop proves valuable, it could potentially be grown on up to 10 million ha of wheat–rice lands in northern India.

In other words, cowpea could indeed become the “food legume of the 21st century.” But if that still seems overly optimistic, perhaps Singh can be forgiven. He has, after all, a rather singular perspective.

“If we all did what he has done,” says Hoeft, “we could make a big difference in this world.”

M. Fisher, science communications manager for ASA, CSSA, and SSSA

---

**Delicious cowpea recipes**

**Texas Caviar**

**Ingredients:** canned black-eyed peas, canned corn, chopped red and green bell peppers, chopped red onion, chopped green hot chili pepper, chopped tomatoes, crushed garlic, salt, sugar, black pepper powder, tabasco pepper sauce, vinegar, and water. This recipe is flexible, and other legumes or vegetables may be added according to your taste.

**Procedure:**
- Drain and rinse black-eyed peas. Combine in a large bowl with corn, peppers, onions, and tomatoes.
- Mix pepper, water, vinegar, tabasco pepper sauce, sugar, garlic, salt, and pepper.
- Pour dressing over salad and stir gently to coat. Refrigerate for several hours to overnight before serving.
- Serve as a dip with tortilla chips or as a salad.

**Cowpea Curry**

**Ingredients:** cowpea, onion, garlic, curry powder, chopped tomatoes or paste, and cooking oil

**Procedure:**
- Soak the cowpeas for about 4–6 hours. Rinse well with cold water.
- Add chopped onions to a medium-size pot with cooking oil. Sauté onions until light brown in color. Add the garlic.
- Add chopped tomatoes or paste and curry powder and other spices to taste. Stir well for about 3–4 minutes.
- Add the soaked and cleaned cowpeas, mix well, and add some water. Bring the pot to boil and cook for about 30 minutes. Canned or boiled cowpeas may also be used.
- Serve with rice or chapati.