Conserving the future

Story and photos by Adam Barclay

APPROPRIATE MACHINERY—such as these drill seeders—is key to the conservation agriculture approach. Equipment like this allows farmers to reduce seed and fertilizer waste, seed through existing crop residue, and incorporate residue into the soil.

As India's rice-wheat belt grapples with declining soil health and water tables, a vanguard of young, innovative farmers and researchers is leading a new approach that could hold the key to reversing the region's waning productivity

You've been farming for 20 years. You do things as your father did them, and his father before him. Then, one day, a scientist visits your farm. You discuss the problems that have been getting worse for the past few years. Productivity is declining and you need more fertilizer to get the same yields. You both agree that something different needs to be done. Together, you decide on a new approach.

Despite some skepticism, you allocate a significant portion of your land to a trial. But, early in the season, this experiment is looking disastrous. Your crop looks terrible. Your neighbors tell you you're crazy and laugh at you. You seriously consider plowing the whole field under.

Now jump ahead to harvest time. That same plot of land is now admired by your neighbors as one of the best in the area. The other farmers are lining up to try the same thing in their fields next season. On top of that, you've saved money and helped the environment.

Conservation agriculture, as this new approach is known, is still young. We won't know for a few years yet whether it lives up to its promise. Right now, though, that promise is exciting. And, make no mistake—conservation agriculture could be very important indeed. This isn't about niche farming to supplement the way things have always been done. This is about feeding a nation.

Agriculture in India is currently at a crossroads. In many areas—especially on the most productive farms in the rice-wheat belt of the Indo-Gangetic Plains in the country's northwest—decades of conventional farming have begun to take their toll. Years of the intensive irrigation required to grow rice have sucked the water table down, and it is dropping further each year.

On top of this, the combination of flooding the fields and the ever-increasing use of inputs, such as fertilizer, has led to sick and deteriorating soil. The situation is simply unsustainable.

"This is one of the biggest problems, although we don't see that yet," says J.K. Ladha, International Rice Research Institute (IRRI) representative to India and IRRI's Rice-Wheat Coordinator. "Right now, productivity is maintained because farmers are putting in more chemical inputs. But I think it's just a matter of time—five, ten years down the road—and we'll really start to see the visible effects of land degradation."

If that isn't disheartening enough, you can add another problem to the mix. Fewer and fewer of India's young want to farm. Growing up watching their parents work their fingers to the bone, often for little reward, has dissuaded a generation that sees a brighter future in India's burgeoning urban economy. And, often, they have the understanding and support of their parents.

"Both my sons want to get out of farming," explains Akhtar, a 45-year-old farmer from Kalugarhi village in the northwestern state of Uttar Pradesh. "My land is so small, I don't make profits—I can't fulfill my children's needs. I want them to get out. I'm not against children staying on the farm. But my land will be divided between my children—more fragmentation. This is already a problem. We should look for alternatives."

But what are the alternatives? In the next few years, scientists and farmers will discover whether conservation agriculture is one of

DR. JAT points to an experimental field at the Project Directorate for Cropping Systems Research in Modipuram, Uttar Pradesh. The field is part of an experiment on tillage and residue management in the rice-wheat cropping system. A field worker (*left*) at the Central Soil Salinity Research Institute in Karnal, Haryana, helps load just-harvested rice. Dr. Ladha (*top, at right*) talks to Uttar Pradesh farmer Akhtar Khan about the progress of his conservation agriculture trials.

FARMERS INSPECT a seed drill at a Central Soil Salinity Research Institute field day in October 2005 at the institute headquarters in Karnal, Haryana.

them. In India's rice-wheat belt, conservation agriculture holds great potential as part of an urgent and necessary change in the way people think about agriculture. That potential is currently being assessed in an Asian Development Bank-sponsored project, *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia*. The project, which is managed by IRRI under the leadership of Dr. Ladha, falls under the umbrella of the Rice-Wheat Consortium for the Indo-Gangetic Plains. Collaborating institutes include the International Maize and Wheat Improvement Center along with the national agricultural research and extension systems of India, Bangladesh, Nepal, and Pakistan.

One of the keys to its success is not only that it maintains or increases productivity but also that it is economically viable. If it cannot help farmers increase their incomes, it is doomed from the start. Several characteristics of conservation agriculture—such as zero-tillage and direct seeding—are likely to save farmers money (for more information on direct seeding, see *The direct approach* on pages 12-18 of *Rice Today* Vol. 5, No. 2) and, so far, farmers have achieved yields as high as or higher than those obtained by the conventional practice of transplanting seedlings into flooded fields (see table *below* for a description of conservation agriculture principles).

Any gains from conservation agriculture will be limited if only a few scattered farmers become converts—true success will mean wide-scale adoption across the rice-wheat belt. But, with any technology, good potential is no guarantee of success. More than 20 years ago, S.K. Sharma, director of the Project Directorate for Cropping Systems Research (PDCSR) in Modipuram, Uttar Pradesh, was heralding the benefits of direct-seeded rice, but it was never taken up in farmers' fields.

"There were concerns about weed management in direct-seeded rice, but now several technologies allow effective control of weeds," says Dr. Sharma. "Further, people said you need more water for direct-seeded rice. This is a myth! By using direct-seeded rice, farmers cut water use."

Yashpal Saharawat, a soil scientist based at the IRRI-India office in Delhi, points out the grave importance of such water savings. "In India, farmers are using underground water very fast. Currently, in Haryana's Karnal region, for example, the water table is dropping at around 1 meter per year. But farmers using direct seeding in this region are reducing their water use by around 25%."

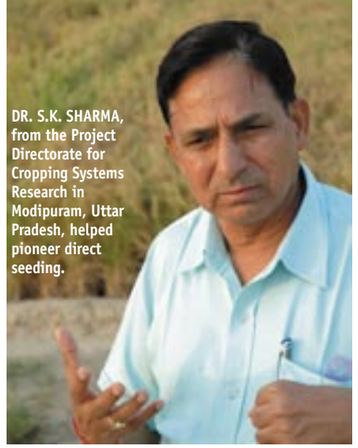
When Dr. Sharma first championed direct seeding, it was in some ways ahead of its time. The ideas were good but the machine technologies that would make it attractive to farmers were not available. That is no longer the case. Recent advances in machinery, along with growing shortages of labor and water and concerted research and technology dissemination efforts, mean the time is ripe for a fresh approach.

According to R.K. Gupta, the regional facilitator of the Rice-Wheat Consortium, machinery has a key role to play if conservation agriculture is to succeed on a wide scale.

"Recently developed machines allow more precise seeding," explains Dr. Gupta. "Seeders are now available that can meter the seed rate and simultaneously apply fertilizer. Such precision allows farmers to reduce the amount of seed and fertilizer they use and so save money."

The new seeders can also plow through the residue of the previous crop. The rotor disk drill, for example, can seed through up to 7 tons per hectare of loose residue. This offers two significant advantages. First, it allows farmers to leave their fields untilled, resulting in a big savings of labor.

M.L. Jat, senior agronomist at


DR. S.K. SHARMA, from the Project Directorate for Cropping Systems Research in Modipuram, Uttar Pradesh, helped pioneer direct seeding.

PDCSR, says that through reduced labor—using traditional methods, farmers plow at least 10 times—zero-tillage alone can save farmers 3,000 rupees (US$65) per acre (0.4 hectare). Yields are more or less the same as for conventional tillage, but even where they are slightly less, farmers win economically.

The second big advantage of zero-tillage is that farmers can leave the residue of the preceding crop in the field. That residue can then act as mulch, providing the soil with moisture and nutrients, and suppressing weed growth. And, as a double bonus, farmers no longer need to burn the residue, a practice that can harm the environment as well as soil and human health.

"We've developed some very good machines that can actually pick up the straw and then, after drilling the seed and putting fertilizer into place, throw the straw back for mulch," says Dr. Ladha. "If those machines become popular, then we are really into the conservation agriculture concept."

One of the reasons for tilling the land is to ensure that the soil is moist enough for germination. So why is zero-tillage, combined with direct seeding, now possible? The answer, again, lies in the availability of appropriate machinery. Older seed drills opened large furrows of 7.5–10 cm. If you used these to direct-seed an untilled field, the seeds would quickly dry out. The new, precise machines leave much smaller furrows, thereby eliminating this risk.

"Presently, we have around 2 million hectares under zero-tillage in

Potential benefits of key conservation agriculture technologies.

Conservation agriculture technologies	Potential benefits relative to transplanted rice
Laser leveler	Cuts water use; fewer bunds and irrigation channels; better soil nutrient distribution; less leaching of nitrates into groundwater; more efficient tractor use (reduced diesel consumption); increased area for cultivation.
Zero-tillage	Less labor required; soil physical structure is maintained (reduced nutrient loss, soil health maintained); less water required; avoids large cracks in soil after dry periods; can keep previous crop's residue in field for mulch (if appropriate drill seeder is used for seeding); subsoil layer is not compacted by tractors (compacted subsoil impedes root growth).
Crop residue mulch	Increases soil water-holding capacity, increases soil quality, reduces weed pressure, avoids burning.
Dry seeding	Less water required; less labor required (especially at peak transplanting time); postharvest condition of field is better for succeeding crop; deeper root growth (meaning better tolerance of dry conditions, better access to soil nutrients).
Drill seeder	Precise seeding (reduced seed rate); applies fertilizer and/or herbicide simultaneously with seed (increased input efficiency); seeds through previous crop's residue; incorporates previous crop's residue into soil (adds to soil fertility).
Green manure (*Sesbania*)	Fast early growth suppresses weeds; after herbicide treatment, it acts as mulch (reduces evaporative water loss; adds soil organic matter plus nutrients—especially nitrogen—to the soil).
Crop diversification (raised seedbeds, intercropping)	Two to three crops grow simultaneously (e.g., rice, chickpea, pigeon pea, maize); increased income; increased nutritional security.


A COMMON SIGHT: smoldering piles of rice straw (*left*) pouring carbon dioxide into the air and reducing soil organic content. This is one of the practices that Drs. Saharawat (*left*) and Gathala want to end. With machinery that can sow seeds through crop residue, leaving the stubble alone is a much more attractive option—as can be seen *below*, where rice seedlings are growing through wheat straw. *Right*, Drs. Saharawat and Gathala crouch in a rice field that has been dry-seeded after zero-tillage, thus reducing water use, labor requirements, and cracked soil.

SAMAR SINGH (*with microphone*), senior agronomist at the International Maize and Wheat Improvement Center-India Office, talks to farmers at the Central Soil Salinity Research Institute field day in October 2005. One of Dr. Singh's research areas is the co-planting of *Sesbania* with rice to suppress weed growth, act as mulch, and provide extra nitrogen.

the Indo-Gangetic Plains of India," says Dr. Jat. "This is after 3 or 4 years. We have a total of 10 million hectares under the rice-wheat cropping system in this region. I expect that, in the coming years, the whole area will go under conservation agriculture practices, including zero-tillage."

Another aspect of conservation agriculture that is gaining favor is planting the legume *Sesbania* simultaneously with rice. After 25–30 days, farmers spray their crop with a herbicide that kills the *Sesbania* along with other broadleaf weeds, but doesn't affect the rice plants. The quick-growing *Sesbania* initially suppresses weed growth—often enough for farmers to perform one less hand weeding, thus saving 1,500 rupees ($32). Then, after spraying, the *Sesbania* leaves act as mulch, further suppressing weed growth, reducing evaporative water loss, and providing around 15 kg per hectare of nitrogen.

One challenge, though, is providing equitable access to machinery, as many farmers can't afford their own seeders. A single machine, however, can service several farms. Currently, groups of farmers share machines or rent them from larger farmers. The same system is gaining momentum with laser land levelers.

According to Dr. Jat, laser leveling, which was first promoted four years ago on just a few hectares, has now been adopted on more than 3,000 hectares. By ensuring a perfectly flat, horizontal field, the technology reduces the need for bunds and irrigation channels and can cut average water use by 20–25% as well as reduce labor requirements. Further, the resultant uniform application of water leads to uniform distribution of nutrients in the soil and the fewer bunds and channels mean a 4–5% increase in cultivated land. Also, an undulating field leads to an accumulation of nitrogen fertilizer in low-lying areas, increasing the chance of nitrates polluting the groundwater.

"It's such an attractive technology; farmers really like to have it, and it's really an entry point," adds Dr. Ladha. "Once you've leveled the land, zero-tillage becomes easy, water management becomes easy, and weed management becomes easy."

A major part of the reason for the success of machinery adoption by farmers in this region is the consultation with farmers. "We consider our farmers as research partners rather than research clients—and there is a big difference between a partner and a client," explains Dr. Jat.

But all the machinery in the world is no good if no farmers are around to use it. So, in the face of the exodus from the farm to the city, who will produce India's food? Fortunately, there is light on the horizon. A new breed of farmers is emerging from India's agricultural communities. Young and innovative, they believe in science, they are open to new crop management systems and technologies, and they contradict the idea that farming is some sort of hell from which to escape.

"Older farmers often see farming as merely a livelihood," says M.K. Gathala, an IRRI agronomist based in Modipuram. "These young farmers see it as a business. They understand the market, they're aware of issues like water and soil health. If they have a problem, they'll go to the scientists and the private sector; they won't wait for someone to come to them."

Sandeep Kumar, a 25-year-old farmer from Lalpur village in Modipuram, typifies the new breed.

UTTAR PRADESH farmer Sandeep Kumar stands in a field of sugarcane residue. Newly developed drill seeders can happily sow rice seeds through residue this thick, meaning Sandeep can avoid the economic and environmental costs of burning or disposal.

Changing a mindset

The families of Akhtar Khan and Pradeep Singh have farmed near Kalugarhi village in Modipuram, Uttar Pradesh, for generations. Both 45 years old, they first tried conservation agriculture in the 2005 season, each dedicating 1 acre (0.4 hectare) to direct-seeded, zero-tilled rice. Akhtar recalls the initial skepticism of his neighbors.

"This was a complete shift, moving from puddling," he says. "My neighbors said, 'You're crazy!' Now, some of them are also trying it. The price of diesel [used to pump water] has gone up like crazy; zero-tilled rice saves water and therefore saves money."

It hasn't been all smooth sailing, though. Pradeep explains that they encountered some early challenges.

"Weed management is one problem," he says. "I feel the problem is worse in zero-tilled versus tilled land. I can overcome this, but I have to put in more herbicides. But I won't give up. These problems can be solved."

In addition, the first zero-tilled seeds did not germinate as well as hoped, although this is improving as the farmers optimize settings—such as seed depth—on the drill seeder.

IRRI's J.K. Ladha emphasizes that early problems are to be expected: "Whenever you bring in new technology, it's never a clean sweep. Never. There are always problems you have to solve."

Both Pradeep and Akhtar, who have two and four children, respectively, are concerned about the next generation.

"Farming is becoming less attractive," says Pradeep. "The younger generation wants to get out. We have seen benefits from conservation agriculture, but not yet on a larger scale. We don't know if this will work on a large scale. But the involvement of international centers gives us hope and confidence. Having the scientists come is having a very positive impact on our children, too."

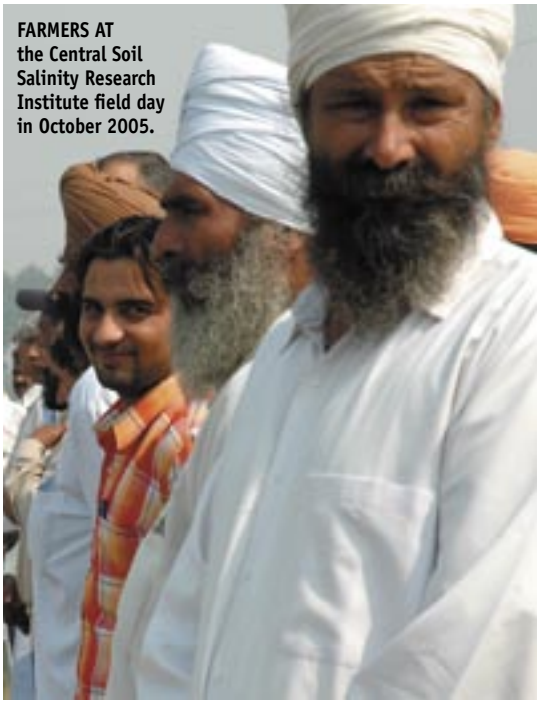
Part of the solution, suggests Pradeep, lies in changing the way farmers think about farming.

"Our fathers and forefathers were stubborn," he says. "They wouldn't listen to anybody about new technologies. But, because of our education, we're ready to change that mindset."

And, in the face of farming's trials and tribulations—the rising costs, the declining soil health, the backbreaking work—Pradeep and Akhtar remain philosophical.

"One of my children has left the farm already; the second is trying to get out," says Pradeep. "His father is trying to keep him here! I have 30-odd years of experience and I can't pass this on to my children—this is deeply frustrating. But, sitting here, people think the outside world has no problems. But it's full of problems. I'm happy. I want to stay here. At least I have time in the evenings to sit with my wife."

FARMERS PRADEEP SINGH (*center*) and Akhtar Khan (*left*) contemplate change with Drs. Ladha (*arms raised*) and Jat (*right*).



FARMERS AT the Central Soil Salinity Research Institute field day in October 2005.

"We have a group of young, educated farmers," explains Sandeep. "We're saving a lot of money and water. We want to adopt conservation agriculture as a whole. Our natural resources are being degraded; we need to sustain them. I hope this whole area will go for these technologies. We were the first farmers to adopt. At first, the district administration didn't believe, but after I showed them that mine was the best field in the area, they believed. Last year there was one field—mine. Next year, there will be 50! Next year, I want to plant other crops using conservation agriculture principles and technologies."

If a major shift is to take place, much more is needed than to merely disseminate technology and train people to use it.

"What is required is a change in mindset that prompts farmers to understand that good farm management is essential," says Dr. Gupta.

Younger, scientifically knowledgeable, innovative farmers will lead the next generation; having them on board the conservation agriculture bandwagon is crucial.

The next few years will reveal whether conservation agriculture takes hold and lives up to its early promise. The signs are good, though, and it is indisputable that something needs to change. The farmers who have tried it for themselves are enthusiastic—and it is these pioneers who will ultimately lead the way. Time and again, when asked about their early experiences, one common answer emerged: "My neighbors laughed and said I was crazy. Now they want to do the same as me."