The Adoption of Conservation Agriculture for Rice-Wheat Systems in South Asia: A Case Study from India

CIMMYT
International Maize and Wheat Improvement Center

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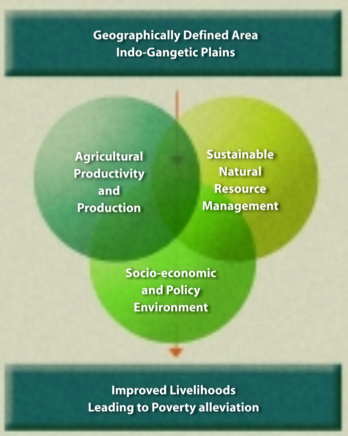
Rice-wheat cropping systems occupy 13.5 million hectares in the Indo-Gangetic Plains of South Asia and provide food security and livelihoods for millions of farmers and workers. The Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC) is an eco-regional program of the Consultative Group on International Agricultural Research (CGIAR) that combines natural resource management with production development and involves the national agricultural research systems of Bangladesh, India, Nepal and Pakistan, several CGIAR centers (CIMMYT, IRRI, ICRISAT, IWMI and CIP), and various advanced institutions.

A CGIAR eco-regional program is a combination of natural resource management, production (extension) in a defined geographical area with site specific socio-economic and policy environments.



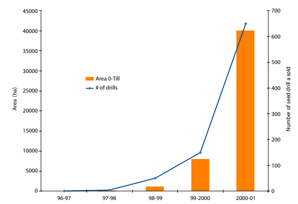
For 10 years the RWC has promoted several resource-conserving technologies for the region's rice-wheat farming rotations. This poster documents the recent, rapid adoption of zero-tillage for sowing wheat in Haryana State, northwest India. Zero-tillage here means direct seeding of wheat into rice residues immediately following rice harvest. This is done using a relatively inexpensive (US$400), locally-manufactured seed drill. The drill carries a series of inverted-T opener tines, like those on a seed drill imported from New Zealand to Pantnagar University in 1988, and is adapted for use with the four-wheel tractors common in the region.

Haryana and the Rice-Wheat Rotation

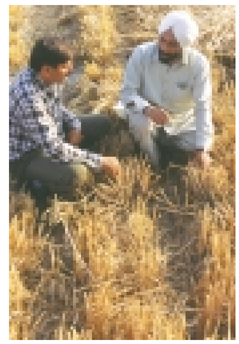
Haryana has a semiarid subtropical climate with distinct rainy (June-September) and dry (October-May) seasons and a maximum mean precipitation of 500 mm per year, making irrigation from canals and tubewells necessary for intensive, rice-wheat cropping. Pre-sprouted rice seedlings are transplanted into flooded, puddled soils in June/July. Wheat sowing follows rice harvest in October-November. An average 6-8 tractor passes are required to prepare the soil for wheat, under conventional practices. The rice-wheat rotation is practiced on approximately 580,000 ha in the state.

Rapid Adoption of Zero-tillage

In the past three years, adoption of zero-tillage in northwest India has accelerated. The new practice will be used on at least 40,000 ha in Haryana in 2000-01, calculated conservatively from zero-tillage drill ownership. The rapid adoption stems both from the practice's virtues (see table) and the RWC's approach, which involved first helping farmers experiment directly with the practice and then acting quickly on their feedback.



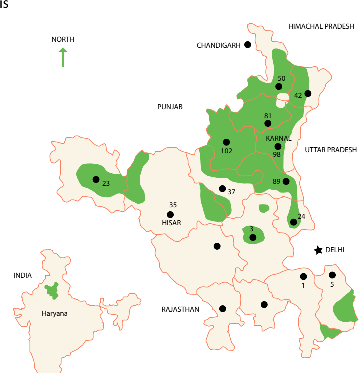
Sales of zero-tillage drills have increased significantly in Haryana since 1997. Each drill can service approximately 80 ha per season, allowing a rough estimation of the area under the practice.



Scientists in the RWC are working to help farmers manage rice and wheat residues, which can amount to as much as 10 t/ha/yr, producing some 13 t of carbon dioxide when burned. Eliminating burning would mitigate local pollution, reduce health hazards, and increase soil organic matter.

Benefits of zero-tillage over conventional tillage for sowing wheat after rice in Haryana, India. Earlier sowing improves wheat yields by allowing the crop to mature before hot, pre-monsoon temperatures, which shrivel grain, and can open "space" in the system for other crops. The time savings permits farmers to engage in other profitable activities. Reduced tillage also saves on tractor and implement repairs and maintenance.

Item	Farmers' perceptions	Researchers' findings
Sowing.	Wheat sowing earlier by 5-8 days (small-to-medium farms) to 2 weeks (large farms).	On an average, wheat sowing can be advanced by 5-15 days.
Fuel savings.	Not available.	An average 60 L diesel per ha.
Cost of cultivation.	US$42-92 per ha.	US$37-62 per ha.
Plant population.	Seed germination improved 20-30%.	13.5% more plants in zero-tillage fields.
Weed infestation.	20% less germination and weaker weeds.	43% fewer weeds in zero-till fields.
Irrigation.	Saves 30-50% water in the first irrigation and 15-20% in subsequent irrigations.	36% less water used, on average.
Rice stem borer infestation.	Less, due to less stubble sprouting.	Winter coolness impairs sprouting and thus borer development. Beneficial insects in stubble help control borers.
Rice stubble.	Decayed faster.	Decayed faster.
Fertilizer use efficiency.	High.	Improved due to placement.
Wheat yields.	Higher than under conventional system.	420-530 more kg per ha.



Rice-wheat zones in Haryana, India. (The numbers indicate area in '000 hectares.)

Environmental Benefits

If eventually used on even half of Haryana's rice-wheat area, zero-tillage would reduce diesel use by 17.4 million liters. Using a conversion factor of 2.6 kg CO_2 per liter of diesel burned, this would represent a reduction of more than 25,000 tons each year in CO_2 emissions. Because zero-tillage takes immediate advantage of residual moisture from the previous rice crop, as well as cutting down on subsequent irrigation, water use is reduced by about 10 cm-hectares, or approximately 1 million liters per ha.

Additional Improvements Needed

1. New varieties (both wheat and rice) that will grow well under zero-till and on beds.
2. Some way to manage the large amounts of residues produced in rice-wheat rotations, besides burning them. Options include developing systems to plant into residue, bailing and removal, and use of microbial sprays that speed decomposition.
3. Land leveling to improve the efficiency of water use.
4. More and better machinery. Zero-till drills, for example, are currently manufactured mostly in the Punjab and must be shipped to faraway places such as Haryana. Also, current drills get plugged or do not always sow seed at uniform depths.

The RWC is also promoting the planting of wheat, rice and other crops on top of a ridge and furrow system. Known as "bed planting", this practice was introduced after Indian scientists visited the CIMMYT program in Mexico and learned about this technique, pioneered by northern Mexican farmers. This system is being promoted mainly for the benefits that accrue from water savings (50% over conventional tillage), but also in areas where grassy weeds are a problem, since this system allows mechanical weeding and a reduction in costly herbicide applications. Bed planting also allows for fertilizer placement, both basal and topdress, and increased efficiency of these inputs.

Suggested Reading

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