CIMMYT
CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAÍZ Y TRIGO
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

Rice Wheat

The Rice-Wheat Consortium for the Indo-Gangetic Plains[1]

Highlights 2001-2003

Farmers Take up Zero-Tillage

Farmers in the Indo-Gangetic Plains are rapidly adopting zero-tillage for sowing wheat after rice. From next to nothing a few years ago, zero-tillage area surpassed 200,000 hectares in 2001 (Figure 1), with farmers in possession of almost 4,000 zero-tillage planter implements made by 32 manufacturers (Figure 2). The RWC expects adoption to exceed one million hectares in the next few years, as local manufacturers meet the demand for machinery and more farmers are exposed to the technology and its benefits. The quickened uptake is simple to explain: zero-tillage allows farmers to produce more, more cheaply, and with significant savings in water, soil quality, and inputs. The drudgery of agriculture is also reduced. Net benefits in India and Pakistan average about US$150 per hectare, through higher yields and lower land preparation costs that are a fraction of those for conventional tillage. Surveys in adoption areas show that even resource-poor farmers without tractors found zero-tillage beneficial enough to contract someone to plant their fields.

A report by an independent agency in Australia on a project to disseminate zero-tillage in northwest India calculated a return of US$238 million on the project's original cost of US$1.3 million, assuming that the project led farmers to adopt zero-tillage three years sooner than they would have otherwise. The report also projects gains of $1,800 million, in net present value terms, for the Indian economy from the adoption of zero-tillage, over the next 30 years.

Other conservation agriculture techniques promoted by the RWC are finding favor with farmers. These include seeders for 2-wheel hand tractors (483 ha planted with 250 farmers with 57 seeders in 16 districts of the eastern Indo-Gangetic Plains), bed planting (4,700 ha planted with 210 bed makers cum planters with 397 farmers in 73 districts) and surface seeding (almost 11,000 ha and 31,000 farmers in 12 districts).

[1] The RWC is a partnership between the national agricultural research systems of Bangladesh, India, Nepal and Pakistan; several international centers of the CGIAR (CIMMYT, IRRI, ICRISAT, CIP and IWMI) and various advanced international institutions (Cornell University, IAC, Wageningen, IACR, Rothamsted, CABI-UK, and Melbourne University) aimed at sustainably increasing the productivity of rice-wheat systems in South Asia, thereby conserving natural resources, improving livelihoods, and reducing poverty.

Zero-till and other RCT area coverage in RWC countries of the IGP in the 2001-02 & -2002-03 season.

States/theme	Districts		Area (ha) coverage		Number of drills		Number of farmers@	
Zero-tillage	**2001-02**	**2002-03**	**2001-02**	**2002-03**	**2001-02**	**2002-03**	**2001-02**	**2002-03**
Uttar Pradesh (West)	11	22	11,800	40,900	33	270	7,300	16,500
Uttar Pradesh (East)	16	18	820	3,670	20	55	700	2,800
Bihar	8	10	380	1,000	14	64	1,000	1,700
Haryana	10	10	97,166	275,000	2,150	9,700	15,000	52,000
Punjab India	8	13	20,000	50,000	70	450*	3000	8,000
Pakistan Punjab	16	16	78,408	189,980	1604	3604	10,281	26,574
Pakistan Sind/ Baluch	2	3	132	397	2	8	11	32
Nepal Tarai	6	6	32	76	8	12	35	70
Bangladesh	3	3?	4	10?	5	7?	5	10?
Total	80	101	208,742	561,033	3,906	14,170	37,332	107.686
2-wheel HT seeders								
Nepal Tarai	6		120		12		100	
Bangladesh	10		363		45		150	
Total	16		483		57		250	
Bed Planting								
Uttar Pradesh (West)	11	16	1,330	2,840*	23	65	200	780
Uttar Pradesh (East)	16	16	50	126	10	27	10	34
Bihar	8	8	4	125*	5	21	10	125
Haryana	11	11	1,000	400	17	22	50	35
Punjab India	12	12	1,000	1700	11	17	50	73
Pakistan Punjab	9	9	1,312	1750	31	47	64	80
Nepal	3	3	5	27	5	7	8	21
Bangladesh	3	3	5	25	3	5	5	23
Total	73	78	4,706	6,993	105	211	397	1171
Surface seeding								
Bangladesh	5	5	10,000[2]	10,000[3]	--	-	30,000	30,000
Nepal	4	2	223	457	--	-	132	262
Eastern India	3	4	500	560	--	-	1000	1,050
Total	12	11	10,723	11,117	--	-	31,132	31,312

[2] Frequency depends on seeding conditions; estimates of last WRC survey indicated up to 10,000 ha when conditions were favorable. * Area under intercrops and vegetable crops. @ - estimated area.
[3] Frequency depends on seeding conditions; estimates of last WRC survey indicated up to 10,000 ha when conditions were favorable.

Environmental Benefits

Zero-tillage cuts greenhouse gas emissions and reduces the need to use of herbicides and pesticides. Water is also a major constraint to agriculture in the region and will become dramatically scarcer in the next decade. Afghanistan, Pakistan, and northwest India have recently been affected by severe drought; water tables are declining fast and reservoirs are drying up. A single hectare of wheat sown using zero-tillage requires up to 1 million liters less irrigation water than the same crop grown under conventional tillage. Work is under way to look at water balances across irrigation systems and determine, among other things, if field-level savings from zero-tillage translate into more water available at the command level.

Resource-Conserving Technologies

The RWC studies and promotes a basket of resource-conserving cropping practices—zero-tillage, direct seeding, sowing on raised beds, small-scale mechanization, rotations, among others—helping farmers to test them and providing follow-up support. These technologies can be (and normally are) adopted partially at first, but provide their maximum benefit when used throughout the cropping system. Thus, building on their success with wheat, Consortium scientists are working with farmers to test resource-conserving alternatives for growing rice: without puddling, on beds, and under zero-tillage. Early results show increased yields and significant savings in water. One farmer in the Indian Punjab who sowed rice on raised soil beds reported yields of 9 tons per hectare—a 17% increase over yields for the crop on the flat—and a 65% water savings.

Bed planting, especially permanent beds, is gaining acceptance, as more farmers receive equipment to experiment and see the benefits for themselves. Data from India suggest that use of permanent beds saves even more water (average 31%) than zero-tillage. The practice also improves yields (24%) across an array of crops, increases input-use efficiency, and cuts costs (see table). Finally, soil physical and biological properties improve under permanent beds.

Data from India showing the benefits of bed planting.

Crops	Yield on beds (t/ha)	Yield on flat (t/ha)	Water savings (% over flat)	Yield increase (% over flat)
Maize	3.27	2.38	35.5	37.4
Urd bean	1.83	1.37	26.9	33.6
Mung bean	1.62	1.33	27.9	21.8
Green Peas	11.91	10.40	32.4	14.5
Wheat	5.12	4.81	26.3	6.4
Rice	5.62	5.29	42.0	6.2
Okra	34.4	29.1	33.3	18.2
Carrot	36.3	28.6	31.8	26.9
Radish	34.7	26.7	29.4	30.0
Cabbage	33.0	27.8	26.8	18.7
Pigeon Pea	2.2	1.5	30.0	46.7
Gram	1.85	1.58	27.3	17.1
Cauliflower	25.9	18.9	36.4	37.0
Average	**--**	**--**	**31.2**	**24.2**

Cropping Diversification and Nutrient Management

The RWC is promoting system diversification—including the addition of crops such as maize, sugarcane, legumes, potatoes, and vegetables—to enhance farmers' incomes and make production more sustainable. In Bihar and eastern parts of the state of Uttar Pradesh and in the eastern Gangetic Plains of Bangladesh , a region characterized by resource-poor, small-scale farmers, maize cropping under zero-tillage during the dry, winter season has proven successful. Dribbling of maize with potato planted on the ridges with an indigenous mechanical planter has been liked by many farmers as it helps improve yield of potato and quality of the tubers beside reducing cost of potato cultivation by US $ 50-100. Intercropped maize subsequently grows very well on the residual fertility in potato fields. Boro[4] rice is being promoted as an additional crop in flood-prone, poorly-drained areas (*Tal lands*[5]) in the East where a single, low-yielding crop of rice is normally grown in monsoon season. Efforts are on to relocate highly productive bor rice crop in irrigated midlands and uplands rice ecologies on the raised beds to save on irrigation water. Chickpea, lentils, pigeonpea mungbean and other legumes are being promoted in "[5]*Chaur and Diara lands*", with improved varieties and management (zero-tillage and beds), to improve the returns. In all cases, research aims to foster diversification to crops that fit local market demands.

The efficiency of use of nitrogen—a major nutrient for high yields and a key natural resource—is low, especially in rice. The RWC, with direct assistance from staff of the International Rice Research Institute (IRRI), is promoting use of leaf color charts to help farmers apply nitrogen fertilizer at the right time and in the amounts really needed. Proper fertilizer placement practices and use of urea super granules are also being promoted. Finally, the RWC is fostering more balanced fertilization, because soils in the region are becoming poor in phosphorus, potassium, and other micronutrients.

Implements are the Key

Having enough of the right equipment at the right place and time is the key for success. Critical to the adoption of zero-tillage in rice-wheat systems is the testing and promotion of alternatives—in some cases, special implements or attachments—that allow farmers to sow through the large amounts of residue left on the field after harvest. The RWC is working with local manufacturers and farmers on these and other issues relating to machinery. Now there are more than 50 manufacturers (few years back they were just few) who are providing these

[4] Boro rice is a traditional rice crop of the Eastern GP that grows over the cooler, drier winter months with irrigation. The seedlings are started in November and the main fields planted in February with harvest in May. It is the highest yielding rice crop in rice systems of South Asia because of the cooler temperatures and high radiation receipts

[5] Tal lands low lying depressions that remain flooded for greater part of the year and water leaves very late in the winter season . These depressions are usually connected with the river system and hence flood water vacates the fields gradually for planting crops. The major difference between the *Tal* and *Chaur lands* is are that whereas the former is connected to river system the latter is unconnected and hence the stored water either evaporates , deep percolates or is used by farmers for surface irrigation in nearby fields. Chaurlands become available for planting only in winter season. Diara lands are lands formed through deposition of alluvial sediments by meandering rivers along the banks or as eyelets and are flooded for short times.

equipments in Pakistan and India. A traveling seminar was arranged whereby three local manufacturers visited Australia to get new ideas. Through the exchange of equipment with Bolivia, the RWC helped develop a zero-tillage planting implement that can be drawn by the two-wheel tractors used by smallholder farmers throughout the eastern Indo-Gangetic Plains. Researchers in several countries near India, including Pakistan, have exchanged equipment with specialists in that nation. In the coming wheat season, farmers region-wide will experiment with new prototype equipment for both two- and four-wheel tractors.

New Participants and Products

The RWC continued to expand its membership under the coordination of CIMMYT and the Consortium's Facilitation Unit. One measure of the growing participation was the number of presenters at a technical meeting early this year: 10 from national agricultural research programs and 20 from international centers and advanced research institutes.

The RWC has also developed a web page [http://www.rwc-prism.cgiar.org/rwc/index.asp] that lists major news items, contains many RWC or related publications, and has links to other sites of relevance. (The latter include sites developed by participating national programs, with the help of the RWC Facilitation Unit.) Visitors can also search the site easily for information they require using a search engine placed on the web site called PRISM, developed by the RWC partners.

The RWC has provided funds and assistance to help make geographic information system (GIS) tools available to national program researchers, and has worked with CIMMYT in the development and distribution of CD-based country "Almanacs" that put GIS data and power at the fingertips of all RWC partners and stakeholders. Using remotely sensed data on flood affected areas, drainage relief, and an available databases on appropriate crop cultivars, and targeting the appropriate tillage and crop establishment technologies, the RWC helped the government of Bihar, India, to develop a suitable contingency plan to help resource-poor small and marginal farmers recover following the severe floods of 2002. In October 2002, RWC participants and other experts will gather to discuss ways in which to use modeling to analyze the performance of rice-wheat systems over time and their effects on global warming.

Socioeconomic Analysis

National program specialists conducted surveys to assess the impact of the resource-conserving technologies discussed here on productivity and farmer welfare. Social scientists met to discuss future collaboration in May and to find ways of obtaining funding to pursue this essential component of Consortium work. Key aims cited were to (1) document the diffusion of resource-conserving technologies in South Asia; (2) analyze the technical, economic, social, and institutional factors that affect the farm-level decision to adopt these practices; and (3) assess their impacts on agricultural productivity, the quality of the resource base, farm-level profitability, and the distribution of benefits.

RWC Support

Over the years a consortium of generous partners have supported the RWC, including the following:

- The Asian Development Bank (ADB).
- The Directorate General, International Cooperation of the Government of the Netherlands (DGIS).
- The CGIAR Finance Committee (support obtained with help from the World Bank).
- The Australian Centre for International Agricultural Research (ACIAR).
- The Department for International Development, UK (DFID).
- The International Fund for Agricultural Development (IFAD).
- The United States Agency for International Development (USAID).
- The New Zealand project is funded by NZODA and is in collaboration with Massey University.

National research systems of the participating countries have also provided funding and significant in-kind support for RWC activities, and international centers like CIMMYT and IRRI have drawn on their own unrestricted funds to ensure that work goes forward.

For more information, contact:

Dr. **Raj K. Gupta**
Regional Facilitator
Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC)
CG Centre Block
National Agricultural Science Center (NASC) Complex
DP Shastri Marg, Pusa Campus
New Delhi 110012, India

Email: rwc@cgiar.org
Phone: +91 (11) 582 7432 / 582 2940 +91
Fax: +91 (11) 582 2938