Conservation Agriculture in South Asia

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The rice-wheat cropping system occupies nearly 13.5 million hectares in the Indo-Gangetic plains, or nearly a fourth of the total geographic area of South Asia. It provides food and employment for millions of people in Asia. Given the enormous importance of this cropping system, the CGIAR strongly supports the Rice-Wheat Consortium (RWC), which is an eco-regional program led by the national agricultural research and extension systems of Bangladesh, India, Nepal and Pakistan, and is convened and facilitated by CIMMYT.

The Consortium's goal is to maintain food security and improve the livelihoods of farmers dependent on rice-wheat cropping systems by promoting the principles of conservation agriculture and by developing technologies that help conserve natural resources and use them efficiently. The RWC has promoted several such technologies for tillage and for establishment of rice, wheat and other crops. By December 2005, more than 3 million hectares in the Indo-Gangetic Plain were covered with zero-till or drastically reduced till wheat. This contributed to more timely planting of wheat and other crops, helped make it possible to produce more food at lower cost, enhanced the efficiency of natural resource use and provided other significant environmental benefits.

The technologies being promoted include no-till or drastically reduced-till, raised-bed planting, surface seeding, and direct dry seeding or transplanting of rice in unpuddled conditions. In addition, laser land leveling is being promoted to improve water productivity and achieve more efficient use of fertilizer nutrients (especially N), by means of techniques such as leaf color charts, GreenSeeker crop sensor technology and single deep placement of N fertilizer in rice and wheat. The packaging and dissemination of resource-conserving technologies are based on the concept of integrated crop management, which is important for improving agricultural productivity, input-use efficiency and farmers' incomes. Efforts are also being made to target different technologies in complex rice agroecologies of the eastern Gangetic plains, using remotely sensed satellite databases.

Through farmer participatory research, the RWC is perfecting double no-till systems for flat- and raised-bed planting in rice-wheat systems that have contrasting edaphic requirements. Major challenges in the coming years will be to enable no-till production of direct dry-seeded rice, using agronomic practices developed for wheat and other upland crops, and to devise strategies for adapting the rice-wheat system to climate change. Research on these issues centers on a set of innovations that take into account the principles and practices of conservation agriculture, including use of the second-generation multi-crop seed drills (double disk drills, the Happy seeder, Turbo-seeder, rotary disk drills and punch planters).

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Their design makes it possible to place seeds and fertilizers at appropriate line-spacing and soil depths in the presence of loose and anchored crop residues. In addition, co-planting of *Sesbania* (referred to as "brown manuring") with direct-seeded rice and growing short-duration legumes, such as mungbean and cowpea in the sugarcane-wheat system, are being encouraged to provide surface cover for soils with requiring additional irrigation water. Crop residues are retained as mulch rather than incorporated into the soils. These practices result in water savings and moderate crop canopy temperatures, and they improve soil health at the field and farm levels in the irrigation commands.

Zero-till and raised-bed planting systems significantly improve wheat productivity, as compared with conventional tillage. It has also been observed that raised-bed planting in precisely leveled fields is conducive to diversification through inter-cropping systems, such as sugarcane + wheat, wheat + mint and maize + potato/redbeets/fababean/green peas or other high-value vegetable crops. Replacement of long-duration pigeonpea with the extra-short-duration pigeonpea cultivar ICPL 88039 enables farmers to clear their fields early for planting of zero-till wheat, thereby doubling cropping intensity.

A further possibility for maximizing farm profits and productivity is to integrate crop with livestock production. Dual-purpose wheat and quality protein maize have been introduced to enhance green fodder availability and grain nutrition quality, and thus improve livestock productivity. These strategies obviate the need for diverting arable lands to only fodder production. Dual-purpose wheat and maize provide green biomass, varying from 6 to 10 t/ha, valued at about US$150 to $200, with some yield penalty on the grains. Green fodder helps meet fodder shortages and improves livestock productivity.

Climates change appears to pose a significant threat to the food security of nations in the region. Long-term data suggest that wheat productivity has declined since the 2000-2001 winter cropping season, and this decline has been associated with a rise in the minimal temperature by 3^{o}-4^{o}C at the grain-filling period. The RWC is therefore actively involved in developing strategies to both adapt to and mitigate climate change. For example, raised-bed planting (with narrow and wider beds) can help adapt nutrient management and irrigation practices to climate change. Results of on-farm trials indicate that, although productivity is always greater with zero-till than with conventionally tilled-wheat, it is lower than with the bed planted crop. To adapt to climate change in the eastern Gangetic Plains of India, Nepal and Bangladesh, wheat should possibly be replaced with maize or *boro* rice during the winter season. Winter maize in this region gives average yields of more than 6.5 t/ha, compared to 2.5 to 3.5 t/ha for winter wheat.

Partners in the RWC will actively share the results of their research on the potential of resource-conserving technologies to improve crop and water productivity. In addition, the Consortium will move forward in its work on the double no-till system (in which crop residues are retained on the surface), with the objective of developing a conservation agriculture production system.