Precision Farming: A New Concept

Where it comes to providing staple food for huge numbers of people, no soil on Earth is more precious than that of the Indo-Gangetic Plains, lying between the tropical heart of the Indian subcontinent and the foothills of the Himalayas.

Here, 13.5 million hectares of land grow rice in the wet season and wheat in the dry winter season. In large part, it is a modern, mechanized farming system using recently developed, high-yielding varieties of both rice and wheat. A staggering one billion people depend on its output for their staple grain.

Since 1985, however, grain production from the Indo-Gangetic Plains has stagnated and there have been signs of declining productivity. This has prompted the questions: Is the intensively irrigated rice-wheat cropping system, in its existing state, basically unsustainable, and is the ecosystem beginning to degrade under the cropping pressure?

A large team of scientists says "no" to both questions, provided the farmers learn to be more efficient.

But the threat of declining productivity in such a vital area has drawn together researchers from the national agricultural research and extension systems of India, Pakistan, Nepal, and Bangladesh and scientists from international agricultural research centers such as IRRI, CIMMYT, ICRISAT, IWMI, and CIP and other institutions such as Cornell University, in the United States.

Glimpse of the Future

After several years of intensive study, under the umbrella of the Rice-Wheat Consortium for the Indo-Gangetic Plains, scientists have begun teaching farmers new agronomic techniques and crop management methods. These bring practical science to the farmers' fields and demand, in the process, that farmers learn new knowledge-intensive technologies. It is a glimpse of the future of agriculture across the entire Asian region. The scientists call it "precision farming," or "conservation farming," and their results so far suggest that it will increase crop productivity, reduce the costs of crop production, boost farmers' income, and maintain the quality of the farming system.

According to IRRI soil nutritionist Dr. J.K. Ladha, the sites showed evidence from some long-term experiments that soil nutrients had become depleted because of years of intensive cropping. Evidence also showed changes in the soil that reduced the availability of nutrients to the plants. On top of this, the inappropriate use of fertilizers was widespread.

"We found that soil nutrient characteristics varied, not only between regions and between farms, but from plot to plot," Dr. Ladha says. "There was no recognition of this, and fertilizer regimes were more or less general for entire regions or districts. Many farmers saw nitrogenous fertilizer as something that would boost their yields, regardless of whether the crop required it or not. Some farmers were putting on too much—sometimes 25 or 40 percent more than the recommendations, and this excessive use of nitrogenous fertilizer was threatening to pollute both the air and the water."

The range of measures being introduced to the rice-wheat system include laser-guided leveling of rice fields to save water; direct seeding of rice to cut the costs of crop establishment, save irrigation costs, and save labor; and incorporation of crop residues into the soil to improve fertility and protect the environment by retaining carbon and providing better conditions for the growth of microscopic life. There is also balanced nutrient management, and that's the most complex measure.

Under the precision-farming system, farmers are taught "field-specific nutrient management." They learn how to test their fields themselves for levels of the nutrients nitrogen, potassium, and phosphorus. Then, according to what they find, they apply enough potassium and phosphorus to avoid its depletion by another crop, and apply nitrogen throughout the growth of the crop according to the demand of the plants. This demand is measured by using leaf color charts that indicate the nitrogen level in the leaves of the plants. When the leaves turn a little yellow, they need more nitrogen.

The research teams have also conducted successful experiments with deep placement of nitrogen fertilizer tablets or briquettes, and with controlled-release fertilizers. They've concluded that both procedures are capable of reducing farmers' applications of nitrogenous fertilizer by up to 30 percent.

Rice on Dry Raised Beds

The researchers have also been experimenting with the cultivation of rice crops on raised irrigated beds, rather than in puddled soils with standing water, and this has achieved a water savings of around 40 percent. As well, it has integrated rice production more comfortably with the soil conditions needed by the following wheat crop.

Dr. Ladha acknowledges that poor farmers with low productivity will find it hard to adopt the new knowledge-intensive technologies over the coming ten years. "But these are the kind of people who need more of our help. They've been overlooked in the past. In Nepal, for instance, with good technical support, they can easily double their rice production."

Conclusions to date suggest that, by adopting field-specific nutrient management practices, farmers can increase their income by US$35 per hectare per crop in the first year, but by $50 per hectare per crop in the second year.

"Precision technologies that conserve resources have an enormous potential for increasing yields and nutrient efficiency in rice cultivation," Dr. Ladha says. "What's more, productivity improves over time, due to both a learning effect and a gradual improvement in soil fertility."

The research team is continuing its intensive monitoring of the rice-wheat ecosystem, further refining its understanding of soil, water, and nutrient processes, and continuing to fine-tune its advice to farmers on nutrient levels in various soils and the measures necessary to make continued intensive cultivation sustainable.