Agricultural Research and Extension: Lessons from China

Through a succession of three projects, the World Bank helped China to improve the capacity of its agricultural universities and key research institutes and to develop ties with the global research community. As important, the projects helped China establish working links, first between the university and research communities, and then between research and extension services to bring useful technologies to farmers. The key to the projects' success was their phased approach: projects were sequenced to build and expand on the achievements of earlier activities and relied on pilot efforts to determine the best model for strengthening extension work at county and farm levels.

China's project phasing demonstrated the benefits of first focusing on technology generation before heavily investing in extension services. As a vehicle for delivering information, extension services are unlikely to be cost-effective without a strong inflow of technology useful to farmers. A recent OED audit* of the World Bank-supported Second Agricultural Research Project highlights lessons for future programming.

Background

China's national agricultural research system is the largest publicly funded and administered research system in the world. About 60,000 researchers and technicians work in about 400 research institutes and 70 agricultural universities throughout China. Despite years of political upheaval the system contributed significantly to the country's agricultural productivity. Technological improvements, particularly of high-yielding rice and wheat varieties, accounted for an estimated 20 percent of growth in production between 1965 and 1989.

Nevertheless, isolation from international research and the institutional disruptions brought on by the Great Leap Forward and the Cultural Revolution took an enormous toll. When World Bank support of China's agricultural sector began in the early 1980s, the country's agricultural research system was suffering from outdated technology and equipment, poorly trained researchers and teachers, and few if any connecting links between education, research, and extension.

But given China's shrinking arable land base and vast and still growing population, the country increasingly had to rely on raising agricultural intensity to increase production. And increased agricultural intensity meant greater reliance on a modern research system and on agrotechnical extension services capable of quickly communicating new technologies to farmers.

Bank support of China's national agricultural research and extension system followed a two-pronged approach: strengthening research to expedite the output of technology, followed by activities to strengthen extension and the links among research, extension, and farmers.

Project goals and approach

The first of the three projects supported by the Bank, the Agricultural Education and Research Project, focused on modernizing and strengthening the capacities of 11 universities and 7 key research institutes. That project also initiated the first links to international research and financed the agricultural research study, which identified the principal areas needing further support and formed the basis for the design of the second project.

The $59 million Second Agricultural Research Project, approved in

*Performance audit report, "China: Second Agricultural Research Project," Report No. 15220, December 1995. Performance audit reports are available to Bank executive directors and staff. They can be ordered from the Bank's Internal Documents Unit and from Regional Information Service Centers.
Box 1: Research institutions and output of technology

| Agricultural Crops Basic Research Center—Wheat, rice, soybean, and corn varieties |
| Aquatic Products Research Center—Assessment of fish populations of northern seas and breeding technology for carp |
| Grassland Research Center—Monitoring and forecasting systems, grassland productivity |
| Veterinary Research Center—Development and production of new vaccines |
| Xinjiang Special Products Research Center—Post-harvest technology, fruit production technology |
| Cotton, Wheat and Corn Research Center—Cotton varieties (eight new varieties produced), wheat and cotton farming systems |
| Potato Research Center—Post-harvest technology, potato varieties |
| Arid and Semi-Arid Research Center—Wheat varieties, goat production, soil conservation |
| Forestry Resources Monitoring Center—Remote sensing, development of guidelines for regeneration of natural forest |
| Water Conservancy Information Center—Water conservancy database, weather forecasting system |
| Tropical Crops Library and Information Center—Chinese and foreign languages collection, database |
| Meteorology Observation Center—UHF Doppler radar for wind measurement |
| Water Conservancy Research Center—Irregular wave generator |
| Nanjing Hydraulic Research Center—High-quality testing methodologies and testing equipment |
| Northwest Hydrological Training Center—Training |

1984 and closed in 1992, focused on improving research and extension. It was designed to modernize physical facilities for research, develop cadres of highly trained research scientists, strengthen research planning and programming, and improve communication of research results to farmers. The project's goals were twofold: first, to expand and improve the capacities of 15 national research centers in six different agroecological zones. The research centers were chosen for their demonstrated potential for contributing to new technologies and for their ability to become training centers in major agricultural disciplines.

Second, the project was to pilot a new model for extension through support of ten recently formed county-level agrotechnical extension centers (ATECs). The ATECs consolidated in one center previously separate agricultural support services. Through integration of services, the new model aimed at maximizing the efficient use of resources and improving technical advice and training to farmers. If properly implemented, the new extension centers, which were being established in each of China's 2,300 counties, promised to expedite the transfer of new technology to millions of farm households. And they would ensure that information on technical problems confronting farmers would be relayed back to the research institutes for solution.

The ongoing third project is concentrating on further strengthening extension services and the links between research and extension.

Findings from the second project

The project was largely implemented as designed and at lower cost than expected, due in part to savings on contingency allowances and the devaluation of the yuan. Except for overseas technical assistance, all key targets were met or exceeded. The 15 institutes were rehabilitated and equipped with modern scientific instruments, and with extra funds accrued through the devaluation of the yuan, the project expanded its overseas and local training programs, extending many of the scholarships for advanced studies overseas.

In two areas, project design and implementation proved weak: First, some of the equipment purchased under the project was underutilized. It was either inappropriate for the needs of the centers or was received before trainees had returned from abroad to operate it. Although the project had a technical assistance component, a provision to recruit technical advisers to oversee the selection, use, and maintenance of sophisticated scientific equipment was not part of it. Second, government extension of training scholarships delayed the return of trainees needed to start new research programs (and operate the new equipment). But the trainees' low return rate did not have as great an adverse effect as might have been expected because junior scientists sustained the output of technology. In this respect, the local training component provided greater immediate benefits, with most trainees returning to their posts as scheduled.

Despite these shortcomings, the project contributed significantly to modernizing China's national research and extension system.

Basic research

With improved facilities and better trained staff, the number of research programs increased markedly in the research centers assisted, from 334 in 1985 to 641 in 1990. The programs produced important results. (See Box 1 for types of technology produced.) The Cotton, Wheat, and Corn Research Center now houses some of the most advanced instruments of any cotton research laboratory.

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in the world. The center released eight new cotton varieties, and research on new wheat and cotton cultivation techniques enabled farmers in the coastal plain to increase productivity through intercropping. For livestock, researchers introduced a new method for mass producing low-cost vaccine against equine infectious anemia, with potential for exporting the vaccine to the United States and Latin America.

Improved library facilities and short overseas visits helped Chinese scientists reestablish links to the global scientific community after years of isolation. China now has several international cooperative research programs, including programs with Japan, the United States, and the Consultative Group for International Agricultural Research. The research emanating from the agricultural institutes and universities is also gaining international recognition as evidenced by the greater number of articles accepted in international scientific journals, from 11 in 1985 to 34 in 1990.

**Extension and adaptive research: the ATEC model**

In the late 1970s, China shifted from the cooperative to the individual household as the key unit in economic decisionmaking. Farmers' plots were small, often no bigger than 0.1 hectare. To increase yields, they needed access to more sophisticated technology that was suitable for their location and farming circumstances. The ATECs provided such a vehicle, and the ten pilot centers helped establish the model as an effective structure for transferring technology in China's changed agricultural environment.

With project support, the pilot centers acquired the facilities and gained the knowledge base to become actively involved in basic field and adaptive research and farmer training. Over the seven years' life of the project, the centers extended 840 technologies to farmers cultivating almost 9 million hectares. In one center alone (the County Huaxian Agrotechnique Popularizing Center) extension staff successfully transferred 230 new agricultural technologies to farmers, whose wide adoption of the methods increased the county's agricultural output significantly. Average yields of grain crops increased from 3,683 kg/ha in 1983 to 4,884 kg/ha in 1994.

Academic staff from the universities and scientists from the research centers actively participated in many of the centers' programs, such as training lead farmers, supervising adaptive research in demonstration villages, and taking part in annual production planning sessions. (See Box 2.) Each ATEC had an extension committee comprising members from the local extension and research communities and chaired by the county political leader. The composition of the committees further strengthened the evolving links, and the participation of the local leader strengthened county government commitment to supporting the centers.

**Linking research with extension**

Project phasing allowed investments in the national extension network to be delayed until work-

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**Box 2: Linking research with extension: some examples**

*The Cotton, Wheat and Corn Research Center at Anyang in Henan Province* serves more than 100 cotton-growing counties. Its technicians train farmers in cotton cultivation, conduct short courses at the institute for senior county officials, provide training films to the ATECs, and supply sufficient breeders' seeds for 200,000 hectares of cotton in two provinces each year. Each research scientist is responsible for providing technical support to three counties and participates in the meetings of the relevant extension committees.

The center bred Zhong-Mian 12 (ZM12), a disease-resistant, high-yielding and high-quality cotton variety. By 1991 ZM12 was being planted on 1.25 million hectares, or 25 percent of the national cotton area infected with Fusarium and Verticillium wilt. The new variety is popular in North China where cotton can be planted in the spring, 4 to 6 weeks prior to the harvest of winter wheat, thus allowing the farmers to harvest two crops a year. The value of ZM12 cotton produced in 1991 was US$200 million equivalent.

*The Institute of Crop Breeding and Cultivation in Beijing* has for many years networked its research results to farmers, who have widely adopted many of its technological outputs, such as its recommendation for planting short-maturity corn after wheat. Some of the research programs conducted by affiliates of the Chinese Academy of Agricultural Research are also being carried out under contract to the ATECs.

*The Weinan City Agricultural Technology Promotion Centre (ATPC) in Shaanxi Province* established a special fund, with contributions from farmers and government, to support 33 agrotechnical promotion organizations in rural towns. Fifteen of the organizations have extension committees, scientific equipment for adaptive research, and demonstration sites. The center supports 37 demonstration villages, which are run by more than 7,000 farmer technicians. ATPC makes extensive use of video technology to extend general scientific knowledge and to promote advanced technology to large audiences. Since 1986, it has extended 20 agricultural technologies within an area of 247,000 hectares. Many of these have been widely adopted.
ing links had been established among universities, research, and extension and the pace of technology generation had accelerated. Although planning and direction of research in China is still very much top-down, the project made important progress in strengthening links among research, extension, and farmers.

**Sustainability**

Extending the capacity of a research system inevitably requires increased recurrent budgetary support. Some research projects develop financing mechanisms such as contract research or special technology funds. But the Second Agricultural Research Project made no such provisions. And with declining government budgets, the research centers face funding problems. But as agricultural surpluses continue to increase, opportunities for commercial activity will also increase and with them possibilities for privatizing parts of agricultural research. Because the county governments fund the ATECs, funding is not as much of an issue for the extension centers as it is for the national research centers.

**Lessons**

- Bank assistance over a series of projects helps build agricultural research capabilities in a logical sequence to maximize the efficiency of investments. The phased approach in China allowed sufficient time for research and extension systems to develop and the links between them to evolve. Moreover, with a focus first on research to expedite technological output, then on extension, project activities ensured that extension centers would have a steady flow of technological output to transfer to farmers.

- A multipurpose extension services center can be a cost-effective and efficient means of delivering agricultural services to farmers. China's ATECs effectively incorporated several separate agricultural support services in a single center. With one ATEC center in each of its 2,300 counties, China's national extension system is evolving into a sophisticated system capable of bringing audiovisual communication technology, farmer training, analytical scientific support, and adaptive research to millions of farming households throughout China. Moreover, the ATEC system has effectively developed vertical links between research, extension, and farmers and is grounded in local ownership through its local government funding and management.

- A sufficient, timely, and reliable recurrent budget for agricultural research is critical for developing new technology. To defray some of the cost, one alternative may be charging user fees through the establishment of a special cess for research to be collected at centralized processing facilities, such as mills and spinning plants. Such user payments also help make the system more accountable for a research agenda geared to client needs. Also, as agricultural surpluses provide increased commercial opportunities, possibilities for privatizing parts of the public research systems will increase. In the meantime, it is important for policymakers and stakeholders to ensure that China's research system is appropriately financed.