Development and Adoption of Dryland Cropping Technologies in Hebei Province of Northern China

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Reform of China's agriculture, with the adoption of the household responsibility system that started in 1979, initially resulted in high growth of agricultural output. From 1978 to 1984, agricultural output grew at an annual rate of 7.6 percent but it declined to 4 percent from 1984 to 1988. A number of hypotheses have been proposed to explain the decline: worsening terms of trade, the completion of the household responsibility system reforms, adverse weather, differential changes in technological progress between agriculture and industry, and removal of industrial production constraints (Huang 1998). The decline in output growth raised food security concerns within China.

In 1986, the Canadian International Development Agency (CIDA) was approached by the Chinese Ministry of Foreign Economic Relations to provide technical assistance on dryland farming to the Hebei provincial agricultural research academy. The Hebei Academy of Agricultural and Forestry Sciences (HAAFS) is the provincial agricultural research institution of Hebei province. At the time, less than 10% of HAAFS personnel were trained to a Master's degree level or higher. Agriculture was changing and there was a recognition by HAAFS that it needed to increase its human capital to be able to provide appropriate agricultural technologies to farmers in the province.

The Hebei-CIDA Dryland Project[1] was initiated in 1991 after an evaluation of the needs and capabilities of HAAFS and availability of appropriate Canadian expertise. The five-year project had the goal of increasing production in the Hebei Lowland Plain by developing and transferring ecologically-sound dryland technology to improve water-use efficiency and crop yields. The Chinese Ministry of Agriculture was responsible for managing the project in China, including provision of monitoring and evaluation services. It was expected the project would produce improved crop management practices, cultivars, tillage practices, and increased research capabilities of the HAAFS research personnel. In 1996 the project was renewed for another five years.

The main objective of this paper is to review the participation and role of agricultural economists in this agricultural research development project in rural China. Although a project of this nature inevitably encounters some difficulties, progress was made in the understanding of several socio-economic issues. The problems that spurred the project are discussed. An important component of the overall project was development of a detailed farm level questionnaire which was administered to a random sample of rural households in three different years. This allowed socio-economic analyses of changes in agricultural practices as well as the changing roles of labour use and decision making in the rural areas. An overview of the questionnaire is discussed and general results of selected socio-economic studies are presented. Successes and difficulties in technology adoption are discussed. The final section contains an assessment of the role of agricultural economists in the agricultural research programs in this development project with a focus on lessons learned.

HEBEI LOWLAND PLAIN AGRICULTURE

Hebei is a province in northern China (Figure 1). The Hebei Lowland Plain is located south of Beijing and north of the Yellow river with the city of Hengshui being central to the area. Generally, two crops per year are grown. The climate is semiarid monsoon with an average of 505 mm of yearly precipitation, of which 68% falls from June through August (summer crop season) and only 16% from December through May. Winter wheat and summer corn are the dominant crops. Approximately 50% of wheat production in this region is used by the producing households for personal consumption or carried as inventory to guard against future crop failures. Nearly all winter wheat is irrigated because the winter crop season corresponds with the low precipitation period. Summer crops grown, in addition to corn, are soybeans, millet, and vegetables. Some land is cropped once per year in long-season crops such as cotton. Where irrigation water is unavailable, the land is cropped only during the spring-summer season.

A major concern in this wheat and corn growing region of China is adequate total production for the region, nearby major cities, and other deficit regions. Historically China has emphasised the production of a self-sufficient quantity of grains and fibre with farmers delivering minimum quotas to the state. Food supply has remained a national concern due to the high (and growing) population and increased quality demands resulting from higher disposable incomes.

Irrigation water for winter wheat is in short supply in the region, with surface water being used to the point where little or no in-stream flow remains in the rivers. At the same time, large urban centres (Beijing and Tianjin, for example) have been increasing their demands for water. Good quality deep groundwater is being used for irrigation at a rate faster than recharge. Shallow groundwater is present, but it is highly saline and cannot be used alone for irrigation. Soil is also subject to erosion and reduced quality. The condition of soil and water resources has raised

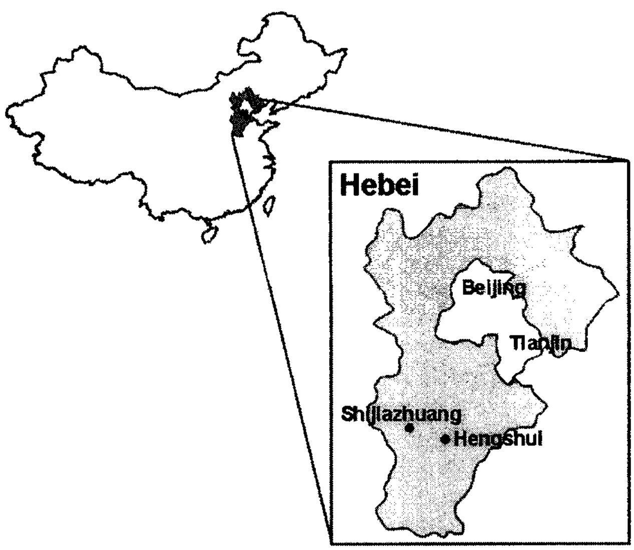

Fig. 1. Hebei Province and the major cities.

concerns about long-term productivity in this region.

Although per capita incomes have been rising in China with the gradual conversion to a market economy, farm incomes have remained low in the Hebei Lowland Plain[2]. In 1993, about 40% of households had at least one family member with off-farm employment. Depending on the off-farm profession, annual income in this part of China ranged from 600 to 4000 yuan (US$ 70 to 470) per employed person. Opportunities are limited for off-farm employment to absorb surplus farm labour.

Farm size is small: arable land has been allocated to households based on household size with each individual receiving about 0.17 hectares. Allocations differ slightly by village, depending on land area and population but most family farms range in size from 0.25 to 1.0 hectare. Small land holdings result in high per unit equipment investment if the farm mechanizes, even with the smaller sized equipment used in China. The land allocation is not always in a contiguous block because land quality is factored into the allocation. Field efficiencies are low because of many small disjointed fields.

One means of increasing production and improving farm incomes is to increase productivity. New technologies expand the production possibilities frontier and allow greater quantities to be produced with similar or reduced inputs. However, increased allocative efficiency may be as important in increasing productivity and income as increased technical efficiency. In the absence of price signals, or prices that generally do not reflect market realities, inefficient selections of commodity and input combinations can be expected to be common practice.

ECONOMIC ISSUES

Opening of the economy to market forces required changes in decision making by newly private household enterprises. However, formal education levels are low[3] and rural peasants and extension advisors had little experience or training in making profit maximizing decisions. Most agricultural researchers and extension agents have recommended ways to maximize production (rather than profitability) of traditional crops. Researchers tend to be frustrated by the relatively slow rate of adoption of new technologies.

Economists have long studied the reasons for slow rates of technology adoption. In general, the reasons include lack of perceived profitability, risk aversion, resource constraints, and insufficient knowledge (e.g., Feder et al 1982). Soon after the CIDA-Hebei Dryland Project was initiated, it became obvious that there was a need for socio-economic training and research in addition to the biological training and research[4]. With China moving towards a market economy, farmers (and those advising them) would have to learn the role of price signals and various household production and resource constraints on decision making rather than aim for arbitrary production targets. New technological developments need to have economic benefits as well as agronomic benefits before producers can be expected to adopt them. Instead of relying on objectives that involved maximizing yields, water use efficiency, or other physical measures, it became necessary to consider economic and environmental criteria in setting research priorities.

The transformation in thinking can be illustrated by examining how the goals of the CIDA-Hebei Dryland Project changed from the first to the second phases. During the first phase (1991-96), the goal was to increase agricultural production in the Hebei Lowland Plain. The science activities of the Hebei-CIDA Dryland Project included: improve crop management strategies through improved irrigation water conveyance and application technologies; development of cropping systems that conserve water and soil resources; improve wheat cultivars through selection of adapted cultivars; development of cultivars with improved water use efficiency; improve tillage practices through evaluation, modification, and fabrication of farm equipment; and develop improved tillage practices. During the second phase (1996-2001), the goal was to improve rural well being through sustainable and profitable agriculture by the development and transfer of ecologically-sound dryland technology. The expected output included the development of sustainable production systems and the determination of socio-economic impacts.

It was realized that economic evaluation of new and potential technologies could assist in setting research directions and priorities, as well as helping researchers and scientists to understand the process of adoption and dissemination of profitable new technologies. The main funding agency (CIDA) also required an objective measure of benefits that resulted from the project. A socio-economic component was included in the second phase of the project with the objectives of evaluating the economic benefits of new technologies and determining project impacts.

FARM FAMILY SURVEY

It was considered important for the success of the CIDA-Hebei Dryland Project that appropriate research results be adopted on the farm. This required knowledge of how and why farmers allocate resources within the constraints facing them. While aggregate data on crop and livestock production, input and household purchases, numbers of farmers, areas of land in each crop, etc. were relatively easy to obtain, it was necessary to obtain detailed data on specific farm operations to understand what decisions were being made at the farm level and what influenced those decisions. Thus, it was decided to conduct a randomized survey of farm families and to repeat the survey twice during the tenure of the project to gauge how agricultural production and resource use changed over time.

The survey data were expected to serve multiple purposes. The information could be used as a base to measure changes in production practices and income that resulted from the experimental work at HAAFS. A good set of baseline data would be invaluable when conducting a review of the project upon its completion. The baseline data would also provide information on current production practices and farm structure so that extension activities could be aimed at the appropriate level.

The plan was to administer the questionnaire to a random sample of farm families at three different times: in 1993, 1996 and 1999. It was anticipated this type of longitudinal survey would provide information on trends and production changes taking place. However, it was recognized that a six-year interval between the first and third surveys is too short to provide definitive answers to questions involving the adoption of new technologies since most would require investments in fixed assets.

Agricultural economists from Beijing Agricultural University (BAU) led the development and administration of a farm level questionnaire to obtain baseline data of the farm industry in the area. The socio-economics team at HAAFS consulted with the team at BAU in implementing the survey and assisted in the economic interpretation of research results.

The farm survey was conducted in Dengzhuang township, near the city of Hengshui. Five percent of randomly selected households were surveyed in 15 villages for a total sample of 249. The first survey (baseline) was conducted in 1993 (including the winter wheat area that was planted in 1992). A second survey was conducted in 1996, under the direction of the Hebei Academy of Social Sciences (HASS). A third survey for 1999 data, originally scheduled for late 1999, was completed during the summer of 2000 by HASS.

The questionnaire had six main sections: households; labour and off-farm income; annual crops; fruit trees; livestock; and farm and household labour and decision making activities (Table 1). The household section asked for information on 41 items including land use for annual crops, tree fruits, and forestry; dryland and irrigated land area; inventories of significant farm assets such as tractors, pumps, carts, labour animals; major household assets including televisions, refrigerators, washing machines, and bicycles; and tax and labour obligations to the village.

Table 1. Questionnaires for farm survey: Information categories by section

Household	Labour	Annual Crops	Fruit Trees	Livestock	Decisions
each household	each person	14 crops	5 fruits	7 types	each person
land use	gender	area	area	inventory	annual crops
land type	age	production	tree age	production	fruits
residence	education	sales and use	production	sales	animals
equipment	farm work	income	sales	feed inputs	yard
- farm	off-farm work	inputs	income	- amount	household
- household	- days	- amount	inputs	- cost	decisions
transportation	- income	- cost	- amount	other costs	- crops
village labour	other income	field operations	- cost		- inputs
village taxes		- type	labour		- capital
		- labour	taxes and rent		- family
		- costs	intercropping		
		hired labour	- type		
		straw use	- incom		

The second section of the questionnaire asked for information on labour by each household member. It had 33 items including the relationship to the household head (three generations in a household was common), human capital measures (education and experience), and days of farm and off-farm work. Off-farm work was divided into nine occupational groups.

The third section asked for information on annual crops. It had 71 items per crop including production related aspects such as yield and grain use; inputs including fertilizer, irrigation water, pest control, field operation type, cost, and labour requirements. The fourth section, on tree fruits, asked for 60 items of information including production and sales; inputs including fertilizer, irrigation, plant protection, and labour; and tree fruit taxes and rent. Livestock information was gathered in the fifth section of the questionnaire. It asked for 36 items of information including current year production and sales, grain consumption and purchases, and labour requirements.

The last section of the questionnaire, with 56 items, was added by HASS in the 1996 and 1999 surveys to obtain information on the role of women and men in labour allocation and decision making, both on the farm and in the household. This is important as the roles of household members have been changing with increased education, off-farm employment opportunities, changing agricultural technologies, and the need to adjust to economic signals.

SOCIO-ECONOMIC RESEARCH

Several members of the Hebei Socio-Economics group were given short term transfers to the Agriculture and Agri-Food Canada Research Centre at Lethbridge, Alberta to work as research fellows for training and experience. Experimental field data from the project and the survey data provided a convenient resource for their training. As part of the training and research program in the CIDA-Hebei Dryland Project, a number of socio-economic studies were conducted. A brief synopsis of five selected studies follows.

Irrigation Systems

The primary sources of water for irrigation in the Hebei Lowland Plain are deep wells which are low yielding. The water table is declining, and energy costs of pumping are high because of the lift (up to 100 m) required. A basin irrigation system is used whereby small basins in the fields are flooded with water delivered by ditches. This causes high losses of water due to seepage. An alternative system of irrigation is to deliver the water by PVC pipes.

The costs of the current and alternative irrigation systems were determined (Chen et al 1995). The alternative irrigation system outlined above reduced water requirements and pumping costs by 27 percent. Repair and maintenance costs were reduced by 16 percent. However, annual fixed costs were 94 percent higher because of the investment required for pipe and installation.

While there would be a net reduction in irrigation costs and water use with the technology, the system is not widely adopted. The capital investment required is high and many villages and farmers are not able or are unwilling to finance the large investment. A system with similar efficiencies but with a lower capital investment must be developed before there would be wide spread adoption of improved irrigation water delivery systems. Work is underway on engineering efficient and low cost water delivery systems.

Crop Returns

Crop returns for 1993 and 1996 were determined for the major crops in the area (Wang and Smith 1996; Sun and Smith 1998). Margins were calculated net of seed, fertilizer, chemical, irrigation, field operation, hired labour, custom harvest, and other miscellaneous costs (Table 2). Net margins on dryland and irrigated land for 1993 and 1996 differ due to differences in yields, prices, and costs.

Across the time period, there were decreasing returns to cotton production and increasing returns to grains. The relative returns among the spring and summer crops indicate that some shifts in production might be expected because of the differences in relative returns. Caution is required in projecting changes with only two years of data. There is a great deal of uncertainty in expected returns because environmental conditions, costs and prices in any year can change the relative profitability of crops.

Production Efficiency

Production efficiency of farms surveyed in 1993 was estimated for five main crops (Yang et al 1997). The estimates (Table 3) indicated that efficiency for winter wheat was on average higher and less variable than for the other four crops. Yields for wheat were also less variable. Wheat is a staple crop and it is expected that producers make every reasonable effort to produce a good crop. Management of wheat, including field preparation and input use, also tends to be very similar across farms.

Cotton yields were highly variable across farms, contributing to a lower efficiency. The relatively low technical efficiencies of corn, soybean, and cotton indicate there is plenty of potential to increase productivity in this region. Identification of the factors contributing to low production efficiency were inconclusive and inconsistent across crops. Age and education had a small positive but generally insignificant effect on efficiency for most crops. Mechanization, measured by the presence of a tractor, reduced efficiency, but the effect was not significant. Off-farm income had no effect on production efficiency.

Nitrogen Fertilizer Rates

A two crop per year winter wheat - corn experiment was used to estimate optimum rates of nitrogen (N) fertilizer application on the two crops and irrigation water use on winter wheat (Yang and Smith 1999). Production response functions were estimated for winter wheat and summer corn. Optimum water for winter wheat exceeded the rates applied by producers. Water

Table 2. Net margins of the major crops, 1993 and 1996.

	1993		1996		Yield index	
Crop	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	¥/ha				1993 = 100	
Winter Wheat	720	1095	225	4155	128	127
Summer Corn	2025	2070	390	3090	77	118
Spring Cotton	1920	2025	1095	315	66	235
Spring Soybean	1260	2760	3375	3525	173	86
Summer Soybean	1710	1890	3075	4245	92	110
Spring Millet	1290	1965	2070	1560	96	46

Table 3. Production efficiency for five main crops

	Efficiency		Yield	
Crop	(%)	CV[a]	(kg/ha)	CV
Winter Wheat	73	17	4027	21
Summer Corn	55	26	4230	40
Spring Cotton	61	33	923	73
Spring Soybean	45	52	1185	55
Summer Soybean	58	25	1800	35

[a] Coefficient of variation for production efficiency and yield, respectively.

supplies were limited and producers were unable to apply more irrigation water.

Optimal N rates estimated for winter wheat were about 20 kg/ha (7%) lower than the average rate applied by farmers. Optimal N rates estimated for summer corn were 15 kg/ha (15%) higher than the average rate applied. One possible explanation for this observation is perhaps farmers over-apply N on winter wheat and adjust N down on corn in expectation of N carryover. The rate of N application is relatively close to the estimated optimum rate. However, some producers are applying much higher rates and might be aiming to achieve maximum yields despite the lower profits that would result from these higher rates of applied nitrogen.

Women's Labour Input and Decision Making

Adult women in the sample of rural households were divided into those who reside in traditional linear families (with three or more generations in a single household) and those who are in the newer style nuclear families. Interestingly, more than half of the rural women now reside in nuclear families.

Women in the survey were less educated than were men: almost half the men had more than six years of formal education whereas two-thirds of the women had six years or less of schooling. The women in nuclear families (who tended to be younger) were more highly educated than were those in linear families, except for the daughters-in-law in the latter category.

Women perform about the same amount of farm work as do the men, in addition to their dominant role in housework and child-rearing. Women also actively undertake many of the decisions on the farm; however, men have retained their traditional role of decision maker in key areas, especially those that involve marketing and acquisition of major inputs and capital items.

Men increasingly have been drawn into off-farm activities. More than one-third of the men in the sample worked for an average of about 180 days off the farm whereas less than 10 percent of the women have significant off-farm employment. Although the off-farm activities have increased cash income to the farm units, they also have meant increased responsibilities for women who, for the most part, have remained on the farm and have had to cope with managing their households and farms in a newly market-oriented society.

ADOPTION OF TECHNOLOGIES: SUCCESSES AND DIFFICULTIES

The CIDA-Hebei Dryland Project management team, and HAAFS, wanted to ensure research results would be rapidly adopted by the area's farmers. In the plan for the first phase of the project, several demonstration areas were set up in Hebei province - assuming that these would be the areas of adoption - that could then be compared to the non-adopters outside the demonstration areas. During early years of the project, the paradigm for extension and survey data collection was that there would be two divisible groups for comparison purposes. The emphasis for disseminating the research results was directed to the demonstration areas. It was expected that farmers in the non-target areas would not adopt the new technologies.

Evidence from the study area indicates that farmers readily adopt new cultivars of wheat, soybeans, cotton, and lines of hybrid corn. These technologies require few changes in management practices and investment is low. However, many other technologies have not been readily adopted. One example of non-adoption is reduced tillage systems for planting winter wheat. Corn is commonly planted directly into wheat stubble, but prior to planting winter wheat fields generally are plowed. Experiments indicate that reduced tillage technology has promise, but adoption of this technique with current seeding equipment is not feasible. The large quantity of corn residue and the corn root ball are problematic for current seeders. Equipment designs are being developed and tested to overcome these constraints.

Many other technologies and cropping systems, though seemingly profitable, also are not being adopted quickly. Crop mix, optimum input use, resource conservation, "sustainable" production systems, and mechanization are technologies that appear to be adopted slowly. A number of economic, as well as agronomic, reasons can be posited as to why seemingly beneficial technologies do not get adopted. These include: limited access to information about the technology, insufficient human capital, aversion to risk, inadequate incentives associated with farm tenure, lack of credit, inadequate farm size, chaotic supply of complementary inputs, and inappropriate transportation infrastructure (Feder et al 1982; Klein 1987).

The CIDA-Hebei Dryland Project has evolved with changing requirements. As noted previously, production objectives evolved to include environmental, sustainability, and economic objectives in the second phase of the project. Training was a major focus at the beginning of the project, but after eight years and about 80 fellows having received training in Canada (and many of those completing or taking higher degrees in China), training was reduced. The recognition that sound agronomic and economic technologies need to be disseminated broadly in a timely manner has redirected the project towards increased extension activities. It was anticipated the perceived gap between technology development and adoption by farmers could be reduced with an increased and targeted extension effort. The remaining time in the project (2000-2002) will focus on dissemination of technologies to the region, including neighbouring provinces with similar growing conditions. The project also will be extended one year.

The project has had a number of successful research activities (though most still need to be evaluated by agricultural economists to assess their relative profitability, riskiness, and other socio-economic factors):

1) Direct Seeding – Direct seeding of summer corn following winter wheat now is common in the region.

2) Irrigation Systems – Water delivery systems, timing of applications, and rates of water use to increase the efficiency of irrigation water have been developed.
3) Water Usage – The project team developed models of water use by various crops to increase efficient timing of water use, and developed ways to mix shallow saline water with good quality deep groundwater to increase the supply of irrigation water.
4) Crop Production – New varieties have been developed and now are in general use; intercropping of some crops (e.g., cotton and sweet potatoes) has been tried by area farmers; fertilization rates, minimum tillage and better methods of weed control were determined and are increasingly used by farmers in the region.
5) Biocontrol of Pests – Farmers in the region now are actively using biocontrol methods for bollworms in cotton and there is a commercial interest in using wasps to control some other crop insect pests, especially in tree fruits.
6) Biocontrol of Diseases – Biological controls of plant diseases, such as verticillium wilt, are being developed.
7) Sustainability of Cropping Systems – Scientists have developed more knowledge about the relationship between fertilization levels and leaching of unused nutrients in the soil. In addition, background knowledge on soil microorganisms has been determined.

Most of the Chinese professionals who have participated in the scientific exchange have gained new knowledge of scientific methods and commercial applications. In addition, many Canadian scientists have visited the project sites in China and have contributed to the research program there. While it is difficult to measure the success of training programs, an assessment in the first five-year phase of the project used indices of personal performance appraisals pre and post training and determined a 19% increase in appraisal ratings for those having had training (Jia and Ji 1996).

Like many agricultural development projects, the CIDA-Hebei Dryland Project has had its difficulties. Within HAAFS, the project was one small component of the activities of the entire academy and other priorities could temporarily pull resources away from the project. The main site of research work was at Hengshui, three hours drive from the Academy at Shijiazhuang. One of the institutes of HAAFS also is located in Hengshui, but coordination of experiments and laboratory analyses with institutes in Shijiazhuang was initially difficult. The travel distance and logistics increased the complexities of undertaking field experiments. Some of the research land was "leased" from the local village or farmers and required the cooperation of the local farmers, who initially were unfamiliar with research needs and protocols. Farmer actions may have compromised some results. Timing of field operations and measurements were complicated because of the coordination required among all of the cooperators. Solving many of these problems required changes in management, highlighting the need for management human capital as well as research human capital.

Some research fellows came to Canada with limited levels of science or English and training progress with these fellows was less than expected. Some of those who were trained transferred duties after the training period and some of the benefits of training may have been lost, depending on the area of transfer. However, most individuals continued to work in their field of study and for those who transferred to other duties, the training would still have been a benefit to HAAFS.

THE ROLE OF AGRICULTURAL ECONOMISTS: AN ASSESSMENT

The main purpose of conducting agricultural research is to provide information that will assist farmers in making better production and investment decisions. The benefits from new agricultural technologies can be realized only if they are relevant and profitable for farmers to adopt (Norman et al 1994). A goal of the CIDA-Hebei Dryland Project was to improve rural well-being through development of sustainable and profitable production systems for the Hebei lowland plain. Ecologically-sound dryland technology through improved water-use efficiency, soil and water quality, and farming profitability would be transferred to all farmers in the region.

The project management team recognized the need for interdisciplinary and socio-economics research. Narrow, discipline-oriented studies often produce interesting results from a scientific perspective but often fail to consider many of the key biological and economic interactions that affect the farmers' judgements about the usefulness of the new techniques or information. It is common practice to plan new research programs with a disciplinary focus rather than a systems orientation. Implementation of interdisciplinary research activities would require some operational changes because of the cooperation that would be needed among scientists from different institutes within the Academy.

Socio-economics interdisciplinary research activities were more difficult to implement than were the biological experiments because the Academy did not have an established economics unit. Problems with initiating interdisciplinary research in China are not unfamiliar to agricultural economists in Canada (Klein et al 1998) and other developed countries (Young 1995). Although research administrators recognized the need for more economics input into agricultural research programs (as happened in the second phase of the CIDA-Hebei Dryland Project), well-trained agricultural economists with a biological background were not available. As a result most biological research projects have proceeded with minimal involvement of the socio-economics unit. Initiation of work in a different field (like agricultural economics) for a research institution can be fraught with many unforeseen difficulties.

In addition to the separate backgrounds and training among biological and economics researchers, there can be a philosophical divide between economists trained in a policy environment where aggregate analyses dominate and those trained in production economics and farm management where micro-level analyses of specific production technologies is important. The short history of economic research in China has emphasized policy and political science. Farm management is not in the main stream of the profession. Biological scientists also view the economic problem differently (often they think of economics as accounting) and are often more concerned with aggregate analysis and project evaluation than with farm-level analysis of the expected impacts of specific technologies on individual farm operations.

The socio-economics unit at HAAFS is a new unit with different training and skill requirements from biological research, but there was no individual trained in agricultural economists with experience to lead a group of researchers. This required different operational arrangements, such as external advisors from BAU and HASS. External advisors had to deal with differing priorities of the institutions and, when in Beijing, the logistics of travel. Despite some of these difficulties, the unit did make progress in various applied analyses. It is also expected that future progress will be improved because of experience gained and the additional university training some of the individuals in the unit have sought.

The change in project emphasis over the last two years of the project highlights the need for economic input. Extension of technologies should be done only if they are of economic benefit to producers and/or to society as a whole. Information from the farm surveys make it possible to develop benchmark farms that can be used for development of effective extension programs. A set of representative farms should be established, based on the survey data, to evaluate the impacts of technologies on the various types of farms. These model farms can be used for economic experimentation and analyses in conjunction with the efforts to transfer knowledge from the biological research to the farmers in Hebei and surrounding provinces. Farming systems research has become almost standard operating practice in many areas of the world. The CIDA-Hebei Dryland Project incorporated many elements of systems thinking, including an emphasis on problems faced by the farmers, to enhance the extension of scientific knowledge but, so far, has not gone far enough in implementing the concept.

NOTES

[1]CIDA contracted with Agriculture and Agri-Food Canada as the Canadian Executing Agency to deliver the project, and it is managed from the Lethbridge Research Centre.

[2]Computed returns per household from crop production in 1996 were ¥1500 (US$ 180) and off-farm income averaged ¥2600 (US$ 310).

[3]Older farmers have fewer years of schooling than do the younger ones. Household heads, on average, were 41 years of age with 5.5 years of schooling. Household heads less than 40 years of age had an average of 6.9 years of schooling whereas those over 55 years of age had 3.8 years of schooling.

[4]Given the inexperience in the social sciences at HAAFS, an early recommendation had been to hire two agricultural economists trained at the PhD or MSc level, or to second an economist from a university for the project. This recommendation was found to be infeasible so a cooperative arrangement with Beijing Agricultural University (BAU) (now China Agricultural University) was implemented to provide guidance and direction in socio-economics. There were few Ph.D. level trained agricultural economists in the north of China and even fewer, if any, trained in farm management techniques required for farm level technology evaluation. The second phase of the project (1996–2001) includes a cooperative arrangement with the Hebei Academy of Social Sciences (HASS), replacing the agricultural economists at BAU. Cooperation with HASS was beneficial for rural survey work, but analysis of farm-level technologies requiring interdisciplinary activities was not an area in which they had expertise.

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