Institutional Reform in Two Irrigation Districts in North China: A Case Study from Hebei Province[1]

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INTRODUCTION

CHINA HAS INCREASED its total irrigated area from 16 million hectare (ha) at the founding of the People's Republic of China to 48 million ha in 1992. Twenty-one million ha of this growth has been due to the construction of 5,363 large- and medium-scale irrigation districts (which have areas over 667 ha), during these 32 years. The rest of the growth has occurred mainly through the development of small-scale irrigation and extension of previously existing irrigation systems. One half of the cultivated land in China is irrigated. The irrigated area produces 65 percent of China's food grains, 75 percent of its cash crops and 90 percent of its vegetables (Chen and Ji 1994). Rainfall in China varies from 200 millimeters (mm) in the arid northwest to 1,600 mm in the humid southeast. Despite great diversity of physical environment, overall, China has a considerable shortage of water relative to its high demand. Water demand is increasing rapidly due to vast population pressure and rising needs for water for household and industrial uses and agriculture. The average annual supply of water per person in China is 2,700 cubic meters (m^3). This is only 25 percent of the international average water supply per person (Ibid).

Similar to other developing countries, China invested heavily in constructing new irrigation projects from the 1950s through the 1970s. Unlike most other countries, a large part of this construction was done by mass labor of farmers, usually unpaid. Much of it was done, especially during the Great Leap Forward, without the benefit of modern engineering expertise. Similar to other developing countries, the 1980s brought a decline of central government revenues available for the irrigation sector, and the emphasis on construction of new irrigation systems shifted to a focus on improving the management and local sustainability of irrigation systems.

Similar to situations in other developing countries, at a time when irrigation management is being transferred to local levels, competition for water between farmers and between sectors (i.e., agricultural, industrial and domestic) is rising dramatically. This creates a dual challenge for China: "how to make irrigation rise to the level of efficiency and responsiveness required by the increasing demand and competition?" and "how to make irrigation management sustainable through local resources and organizational capacities, with minimal dependence on the government?"

During the period of rapid irrigation expansion, from the 1950s to the 1970s, agricultural production and irrigation management were collectivized. The post-Mao reforms introduced by Deng Xiao Ping from the early 1980s introduced a chain of policies which reduced the dependence of irrigation districts on the government and encouraged local financial and managerial self-reliance. The rising pressures for local financial viability, higher efficiency and transferable water rights has resulted in considerable buying and selling of water by irrigation districts, extensive use of professional irrigation management contracting firms, and emerging experiments with irrigation asset valuation and stock share holding arrangements (Jiang and Yang 1994; Mei 1994).

Since the mid-1980s, there has been a world wide trend to transfer authority for irrigation management and financing from government agencies to local organizations, especially water users associations. Irrigation management transfer takes many forms in different countries but the overall commonality is a reduction of the role of the government and a corresponding expansion in the role of farmers and non-governmental organizations in irrigation management (Vermillion 1992). This paper examines how national policy reforms of the 1980s have been translated into local institutional arrangements and managerial practices in two medium-scale irrigation districts on the North China Plain. Data are used from a case study on Nanyao and Bayi irrigation districts which are located in Hebei Province.

Nanyao and Bayi irrigation districts (ID) are located in Pingshan and Yuanshi counties, respectively, in the Shijiazhuang Prefecture in Southwestern Hebei Province, about 280 kilometers (km) south of Beijing (Figure 1). Annual average rainfall in the area is 500 to 600 mm. The two districts are located in areas with slightly hilly or flat topography. There are seven irrigation districts in the two counties with areas exceeding 667 ha and a total of 76 small reservoirs

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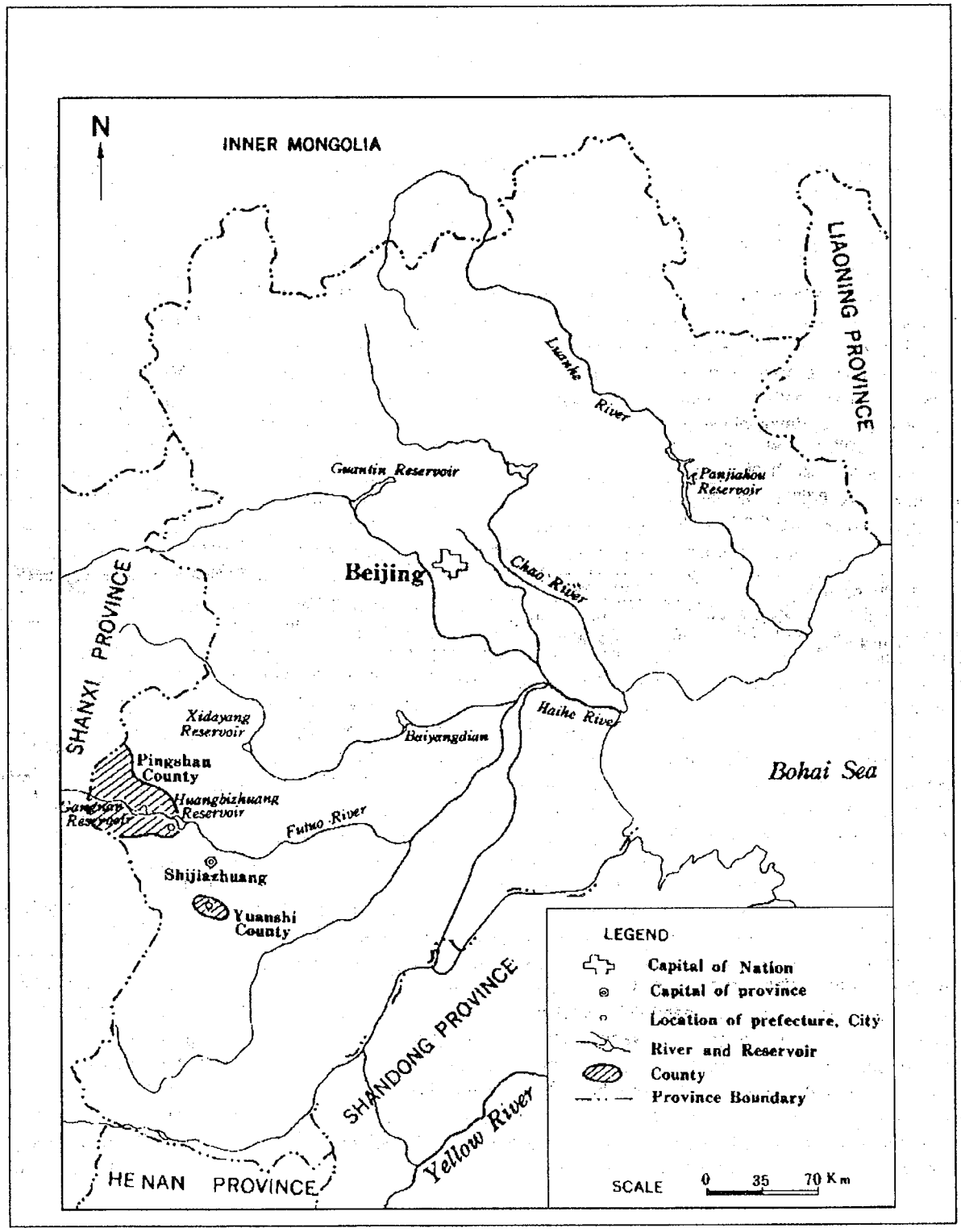
Figure 1. Hebei Province, showing the location of Pingshan and Yuanshi counties.



(Table 1). Pingshan County has 1,886 irrigation wells; Yuanshi has 3,358 wells. Both Nanyao and Bayi ID have numerous tubewells located within their irrigation design areas.

Table 1. Irrigation data for Pingshan and Yuanshi counties, Hebei Province.

Item	County	
	Pingshan	Yuanshi
Total cultivated land (10^4ha)	3.05	3.59
Effective irrigation area (10^4ha)	15,608	26,200
Percentage of cultivated land irrigated (%)	50.96	70.96
Number of irrigation districts more than 666.7 ha in area	6	1
Total area of irrigation districts whose irrigation area is more than 666.7 ha (10^4ha)	14,700	5,400
Total irrigation wells	1,886	3,358
Number of reservoirs	42	34
Capacity (10^4m^3)	162,697	9,700
Water supply quantity to agriculture (10^4m^3)	27,097	14,365

Source: Year book of Hebei Water Conservancy Department in 1992.

Nanyao ID was constructed in 1958, diverting water from the Yie He River. Annual total discharge varies from 10.4 to 59 million m^3. Its irrigation design area is 3,333 ha. It includes six townships and 42 villages located in two counties. Bayi ID was constructed in 1961 and receives water from Bayi and Gangnan reservoirs. Annual total discharge varies from 10.4 to 34 million m^3. Its design area is 5,633 ha. It includes eight townships and 45 villages, all in the Yuanshi County.

ORGANIZATION OF IRRIGATION UNDER THE COLLECTIVES

Before the Peoples' Communes were dismantled in 1983 (Shue 1984), they were at the top of a three-level arrangement for organizing agricultural production and distribution and irrigation development and management. Communes were generally the size of townships and consisted of 10 to 15 production brigades. A brigade generally consisted of several production teams which were the basic units for organizing agricultural production. Teams consisted of 10 to 20 households. Payments to farmers in cash and goods were made on the basis of the amount of work points farmers earned through their farm labor and attendance at communal work activities, including irrigation construction and maintenance.

Irrigation development and management was directed by county level water resources (or "conservancy") bureaus, under the Ministry of Water Resources. At the irrigation system level, bureau staff coordinated irrigation management with the aid of labor assignments made by the commune. During the 1950s, 60s, and 70s, about two-thirds of government funds allocated to the water sector were for construction and one-third were for operations (Gitomer,

forthcoming). Subsidies from both central and provincial funds and from the communes supported the management of irrigation systems. General labor on irrigation systems was paid by communes in work points. Irrigation managers were salaried officials of the county water resources bureau. The costs of irrigation O&M not paid by commune revenues was generally funded by the Ministry of Water Resources.

POLICY AND INSTITUTIONAL REFORM

Change at the National Level

As a result of considerable inefficiencies and declining central government revenues available for investment in rural development, the production responsibility system (PRS) replaced the Peoples' Communes in the early 1980s. Under the PRS, households were allocated long-term leases on farm land and were free to organize their own production and marketing and retain profits. With the advent of the PRS government subsidies for irrigation construction declined by over 60 percent from 3.49 billion yuan (Yu) in 1979 to 1.3 billion yuan in 1981 (Gitomer, forthcoming). Between 1979 and 1985, government irrigation construction investment declined as a percent of gross domestic product from 0.87 percent to 0.21 percent. This precipitous decline in government subsidies to the local level, combined with a disruption of the communal organization of irrigation maintenance, leading to a 2 percent net decline in the total irrigated area in China between 1979 and 1985 from 45 to 44.04 million ha, respectively. During the early 1980s there were widespread reports of chaos, water conflicts and rapid deterioration of irrigation infrastructure.

Alarmed at these trends, in the early 1980s the government began introducing a series of reforms, starting with relatively modest measures and moving to progressively more fundamental changes. The first reform was the work post responsibility system introduced in the early 1980s. This was an attempt to introduce a system of incentives to water resources bureau officials to improve their work productivity. Monetary bonuses and penalties were introduced in annual work performance evaluations amounting to 20 percent or more of base salaries. Nickum (1985) notes, however, that this modest reform tended to amount to only, "a threat to withhold a small amount of nominally discretionary wages for poor attendance." The county water resources bureaus remained intact with the demise of the communes. After decollectivization the Ministry of Water Resources added a lower tier below the county level, the water resources stations which were created to replace production brigade functions at the township level. Village irrigation management groups (VIMG) were created at the village level following the demise of the multi-functional production teams. These were to be under the jurisdiction of village governments but were managed and financed independently from the village government.

Two more far-reaching reforms were introduced through national regulations, both of which were decreed in 1985. These were: 1) the national Regulation on water fees and 2) the State Council Regulation on Diversified Sideline Enterprises. The regulation on water fees stated the principle that revenues for operation and maintenance (O&M) of irrigation districts should come mainly from fees collected from water users. The precise level of fees should be determined at the system level according to the local cost of O&M. However, central and provincial governments continue to place ceilings on the maximum level of fees which can be charged to farmers. Even assuming 100 percent collection rates, fees generally did not provide for the full cost of O&M, let alone for rehabilitation and capital replacement costs. The water fee regulation supported development of a widespread tri-partite system of resource mobilization. This included a fixed area fee (based on the area irrigated by a farmer), a volumetric fee (based on an estimate of the amount of water diverted into a farmer's field), and an annual labor contribution for system maintenance. The latter is not a minor input. Chen and Ji (1994) estimate that contributed farmer labor constitutes more than one-third of the total value of resources invested in existing irrigation districts. While the introduction of volumetric fee assessment is spreading, it is not universal since measurement is frequently difficult and costly. Irrigation fees cannot legally be used for purposes other than operation and maintenance for the system from which they are collected.

Irrigation districts often had underutilized assets and resources which had potential economic value. There was generally a gap between the level of resources which could be raised by the irrigation fees (because of political reluctance to require farmers to pay for the full cost of irrigation service), and the actual costs of operation and maintenance. By 1988 it was official policy that no central or provincial government funds could be used for regular O&M in irrigation districts. By the 1980s salaries of irrigation district officials were dropping in real terms below alternative employment opportunities in rural China. Many skilled staff were leaving the service due to low salaries and poor working and housing facilities in irrigation districts. In order to bridge the gap between the limited revenue which could be raised from fees and the amount needed for O&M and to boost salaries and facilities for irrigation workers, the government introduced the concept of diversified sideline enterprises into the irrigation sector. Irrigation districts were encouraged to develop sideline enterprises to raise additional revenue from the profits of businesses to cross-subsidize the costs of irrigation management. Such enterprises developed gradually during the late 1980s and early 1990s, first beginning with underutilized existing assets such as reservoirs (for sale of water outside the district,

fisheries, recreation, tourism) and reservoir bunds and reserved lands (for tea, orange and tree plantations). Later, sideline enterprises spread to all sorts of businesses, from bottling and food processing to restaurants, construction contracting, bicycle repair shops, petrol stations, production of shirt collars, and so on. Although income from sideline enterprises is growing it still generally provides a small percentage of the total resources invested in irrigation.

The Water Law enacted in 1988 introduced a water extraction permit system, new authority to apply sanctions against water use violations at local levels, and procedures for mediating water disputes. The Law establishes measurable water rights and facilitates the allocation of water between sectors through buying and selling. However, implementation of the new Law has proceeded slowly. By 1993 only 11 provinces or autonomous regions had passed implementing regulations for the Law.

These broad national policy reforms were partly the result of a combination of financial and managerial pressure at the national level and "a process of experimentation and trial and error" at the local level (Gitomer 1994, 1). They have resulted in a variety of organizational arrangements throughout China at the level of irrigation districts. What the reforms have in common is an evolution towards local financial and managerial autonomy (both vertical and horizontal). The tri-partite irrigation fee (area and volumetric fee plus an annual labor duty), diversified local financing and village irrigation management groups have resulted in irrigation districts which are increasingly multi-functional and multi-organizational entities with extensive inter-organizational linkages for cross-subsidies and joint accountability. Irrigation districts are also increasingly managed by small, locally contracted "irrigation management firms" which receive multi-year contracts from villages or irrigation districts, depending on the level of management involved (Svendsen and Vermillion 1992).

Organizational Changes in Nanyao and Bayi Districts

Under the commune system, operation and maintenance of the districts was handled first by water conservancy groups, created in 1964. These were soon absorbed financially and managerially by the collectives and later, villages. Irrigation staff interviewed in this study reported that under the commune system, responsibility was often confused and coordination was difficult because irrigation matters were handled by busy multi-functional production brigades and later, by village committees. Irrigation district staff had little authority relative to the communes. When the production responsibility system replaced the collectives, water resource stations and village committees replaced brigades and production teams, respectively. Water conflicts and system deterioration increased dramatically in Nanyao and Bayi ID during the transition period after the collapse of communes but before the new reforms of village irrigation management groups (VIMG), the new system of irrigation fees and sideline enterprises began to be adopted locally. These were phased in during the mid-1980s in Bayi ID, and the late 1980s and early 1990s in Nanyao ID.

At present, Nanyao ID in Pingshan County, the top two levels of canals are managed by the irrigation district and the third and lower-level canals are now managed by VIMGs. Nanyao ID has five levels of canals (as do most districts in both counties). The district office has two tiers, the main office and four sections which are subdivisions of the system (Figure 2). Nanyao ID has 30 staff plus 5 temporary workers. All receive their total salaries from the water charge. There are four geographic sections and three managerial sections supervised by the district office, canal measurement, engineering and irrigation, and financial and administrative. Nanyao has 40 village irrigation management groups (VIMG). Nanyao ID has not yet developed any sideline enterprises under a "Diversified Management Division."

Bayi ID Office has three tiers, the main office, which oversees the entire system and operates the reservoir, five technical and administrative units, and below them, four sections, which manage the main and branch canals and liaise with VIMGs (Figure 3). Bayi ID (including the reservoir) has a total of 67 staff, 20 of which have temporary status. Thirty-two staff are performing water management functions (12 are engineers) and 35 are in the "Diversified Management Division," producing revenues from sideline enterprises. All 32 staff in the Irrigation Management Division (IMD) are ID employees and receive all of their salaries and pensions from Bay ID, not the county water conservancy bureau. None of the staff are civil servants under the water conservancy bureau. Hence the irrigation district is an independent public utility, not part of the government bureaucracy. Bayi ID has four levels (including VIMG) in contrast to Nanyao's three levels. It has five technical and administrative offices which in turn supervise the Irrigation Management and Diversified Management Divisions. It incorporates 45 VIMGs.

In both districts, functions of the section level staff are to: 1) adjust gates along the main canal (gates along branches are operated by VIMGs);

Figure 2. Organizational Chart for Nanyao Irrigation District, Pingshan County, Hebei Province.

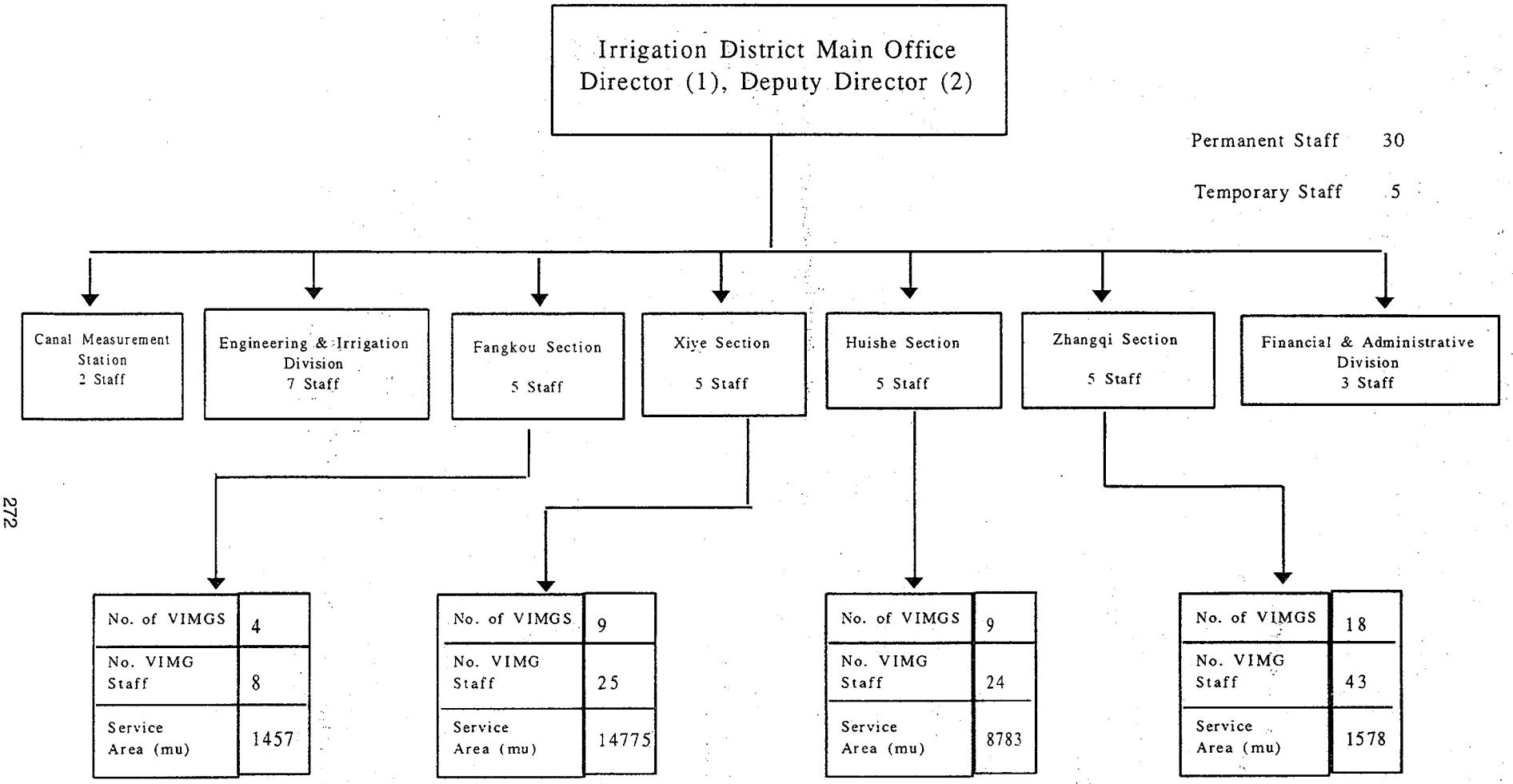
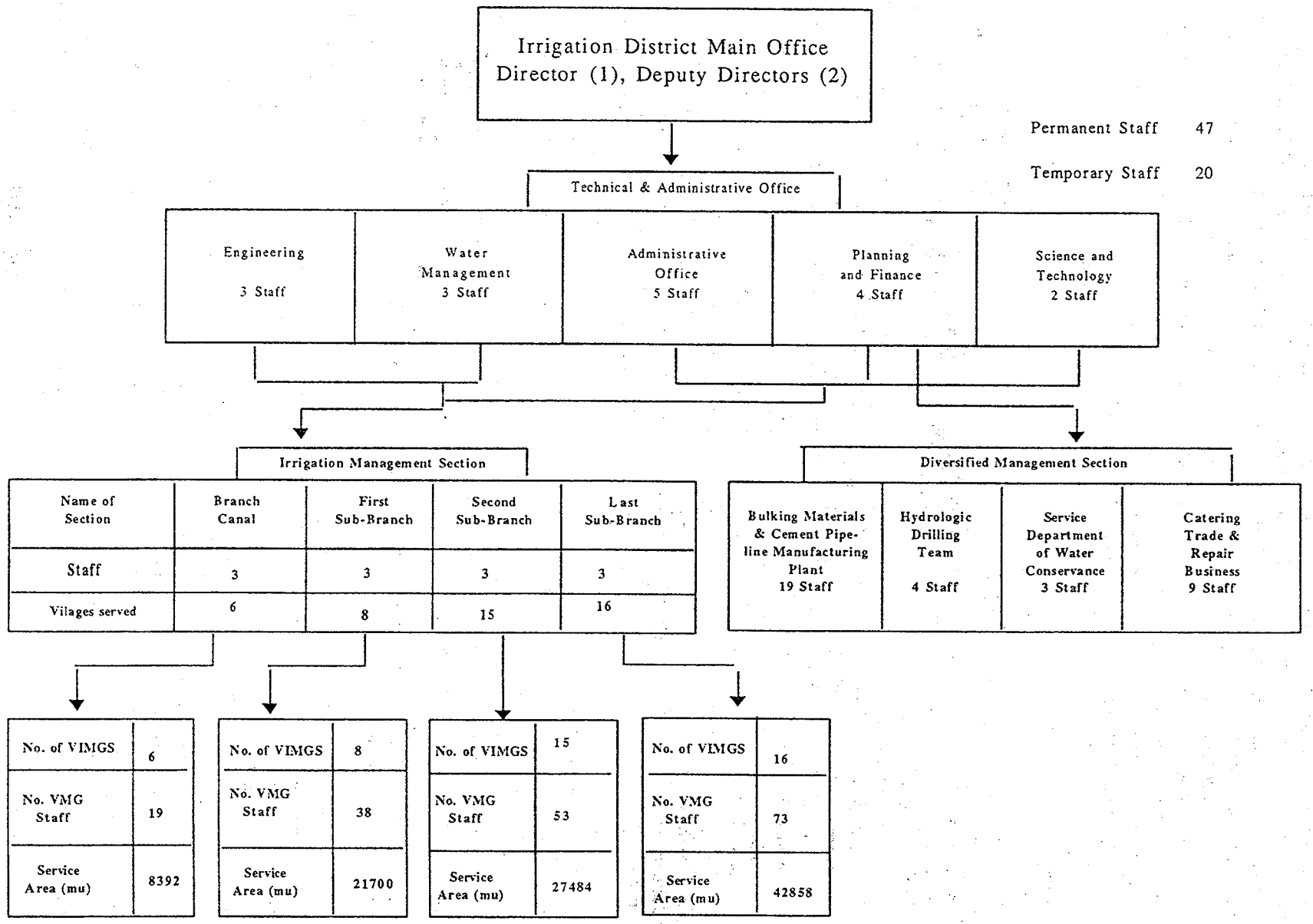


Figure 3. Organizational Chart for Bayi Irrigation District, Yuanshi County, Hebei Province.



2) maintain the main canal (mainly by planning and coordinating farmer labor); 3) pass announcements from the irrigation district or county water conservancy bureaus to villages (especially informing villages about section-level meetings for scheduling water deliveries between villages); 4) settle disputes between villages over water use (disputes often occur over which village irrigates first); and 5) encourage VIMGs to pay water fees on time.

As part of the reforms begun in the early 1980s, VIMGs were organized in Pingshan and Yuanshi counties to take over direct responsibility for managing irrigation. A VIMG generally has about three to five members, selected by the farmers in a village. VIMGs normally have a head, a deputy (who inspects canals for problems or damages), a treasurer, a head of water fee collection and a head of maintenance. Their duties are to clean canal sections which pass through the village (normally branch canals and below), distribute water among village farmers, collect water charges ("under the supervision of the ID"), ensure proper passage of water through the canals and maintain, organize schedules among farmers for water delivery and protect field-level irrigation facilities of the county water conservancy bureau (WCB). The VIMG head often is also an official on the village committee. Each VIMG staff member has responsibility for coordinating water distribution between roughly 200 households farms.

Irrigation fees

Both Nanyao and Bayi ID are attempting to implement the new system of water fees. Irrigation districts in the two counties each have different water fee levels, according to availability of revenue sources, variable O&M costs and the number of irrigation turns delivered in a year. While Nanyao ID calculates water charges according to its estimate of water volume delivered, the VIMGs translate an otherwise volumetric water fee into an area-based charge levied against individual farmers. The Hebei Province official water charge rate is 3 yuan per 100 m^3 (maximum allowed). Nanyao ID is charging less than the allowed amount because the farmers refuse to pay more than the current rate. The fixed area fee is Yn 7.5 per mu[4] and the volumetric fee is Yn 2.5 per 100 m^3. The amount of the fee is estimated by the district based on village area irrigated. Both components are combined into a single fee, treated as a fixed area fee, at the rate of 15 yuan per mu. This assumes five irrigations per year.

In Nanyao, if the VIMG collects 100 percent of the fee by the end of March, the VIMG retains 5 percent of it. If they collect 10 percent by the end of April, the VIMG retains only 3 percent. If the VIMG collects less than 100 percent by May then the VIMG must pay a fine of an additional 3 percent of the remaining amount uncollected. The entire fee for the year is collected once a year, in February, 10 days before the first irrigation. Fee collection rates for 1993 were 97 percent, 90 percent and 95 percent for each of three sections.

In Bayi the volumetric water fee is 7.11 yuan per 100 m^3. The area fee is 1.5 yuan per mu. Before 1984 the water fee was only a fixed area fee so the use of water was very inefficient. The volumetric water fee was introduced in the mid 1980s, after 1984, as part of the reforms. The Hebei Province standard rate for the volumetric fee was 3.3 yuan per 100 m^3, but since Bayi ID purchases water from the Bayi Reservoir and sometimes from another county (Pingshan) and have more than 100 km of canal to supply this water to the district, they have a higher fee based on the actual higher costs for water. The Bayi Reservoir and ID propose a fee level which is approved by the county government, based on the provincial standard, modified to take into account actual local costs. So there is some slippage between central or provincial standards and what irrigation districts actually charge for water fees. The fee standards seem to be considered more as guidelines than rules.

Diversified Sideline Enterprises

Nanyao ID is in a poorer area than Bayi and it began implementing the reforms later. It has still not developed any sideline enterprises. Its officials state the desire to establish them but report difficulty in raising initial capital and getting organized. Bayi ID's Diversified Management Division was created in 1984. By 1994 it has become highly diversified. It has 11 kinds of sideline business: 1) survey and design of small-scale irrigation projects, 2) fitting of water pipes and taps, 3) repair of farm machinery and irrigation and drainage equipment, 4) well boring and pump installation, 5) building construction, 6) small restaurant, 6) bicycle repair shop, 7) agricultural products store; and the production of 8) cobblestone, 9) cement tile, 10) cement pipe, and 11) talcum powder. Since 1984 Bayi ID has received many prizes and awards from the county, prefecture and province for its successful Diversified Management Division (Wu 1994). Profits from sideline enterprises provide approximately seven percent of the total revenues of the district. The businesses also provide employment for family members of district staff (as well as others) and thereby enhance the standard of living of staff families.

At the level of Hebei Province, in 1992 a total of 450 million yuan (US$52.3 million) gross income was raised province-wide by the Water Conservancy Bureau from diversified sideline enterprises. Sixty-six million yuan (US$7.7

[4]15 mu = 1 hectare.

million) of it was invested in construction and rehabilitation of water projects. These enterprises also provided employment for 13,155 people.

POST-REFORM MANAGEMENT PRACTICES IN NANYAO AND BAYI DISTRICTS

Performance Standards

Under the work post responsibility system, yearly personnel evaluations of district and water conservancey bureau staff are required. For irrigation district staff these include an assessment of water fee collection rates, the quality of maintenance work and water distribution. Both Nanyao and Bayi make annual assessments of staff and district management performance according to the same basic set of eight "economic norms" (or performance standards) promoted by the work post responsibility system. They vary in how they calculate points, bonuses or fines. Assessment is done at the level of individual staff, section offices, divisions and at the district office level. The eight criteria used are: irrigation efficiency, proportion of structures which are functional, balance of income and expenditures, total water use, irrigated area, water use efficiency, irrigation schedule targets and crop yields obtained.

Table 2 shows the system of performance measures used in Nanyao ID in 1993. The rating was 96.5 percent of potential. In comparison with problems of advancing siltation and deterioration, this rating lends some support to Nickum's argument (1985) that the water fee assessment system in China is only used in a modest way to remind staff not to shirk duties too much. Performance standards are set for each of these criteria and percentage figures are used to measure levels of achievement relative to that standard. If a staff gets a rating below 60 percent, no annual salary bonus is given and salary is reduced by one grade for that year. This has never happened yet. Apparently as a gesture to increase work incentives, Nanyao recently decided that from 1994 onwards, if a staff is ranked below 79 percent, he gets no bonus and the salary will be reduced by one grade. For scores above 79 percent, the higher the score the higher the bonus. Scores tend to be stable in most years. The overall annual performance rating for Nanyao ID increased from 81 points in 1987 to 96.5 points in 1993. This was likely a combination of some "rating inflation" and real improvements.

Staff grades generally increase according to seniority, promotion and performance ratings according to the guidelines of the National Personnel Ministry. Grade levels determine salary. The Labor Ministry designates base salary levels for all kinds of positions, even in financially independent irrigation districts.

Financial Management

Under the collectives or village committees, general commune or village revenues subsidized routine irrigation costs. Central and provincial level funds are now only available for construction and rehabilitation, on a cost-sharing basis with villages or farmer groups. Financing routine operation and maintenance has always been the responsibility of the irrigation districts and farmers. Officials report that neither Nanyao nor Bayi ID have ever received central government funds for routine operation and maintenance.

While no funds are provided by the government for O&M, between 1988 and 1992 the county water conservancy bureau provided 519,000 yuan (approx. US$85,000) to Bayi ID for canal lining and extension. This amount was one-third of the total expended. As required matching investments, the same amount was invested by both Bayi ID and member villages (mainly in the form of labor), respectively.

In 1992 Nanyao ID's total budget was approximately 365,000 yuan (about US$ 63,000), 350,000 yuan of which was from the collection of current and back accounts for water fees. Expenditures totalled 341,500 yuan, including a 36,500 yuan repayment of its 1991 budget deficit. Nanyao spent 36,500 yuan to purchase supplemental water from the Yie He river. Therefore, Nanyao had a budget surplus in 1992 of approximately 13,500 yuan.

Between 1984 and 1992 Bayi's Diversified Management Division produced 400,000 yuan (approx. US$60,000) in profits. Of this, 260,000 yuan (65%) was submitted to the ID office to finance water management. The other 140,000 yuan (35%) went to salaries and bonuses for staff of the Diversified Management Division, many of whom are spouses of ID staff. In 1992 total revenues from irrigation fees in Bayi ID amounted to 906,000 yuan, while total revenues (i.e., profits) from sideline enterprises amounted to 70,000 yuan. This total income of 976,000 yuan (approx. US$ 168,000) produced a surplus of 258,000 yuan (US$45,000) over total expenditures of 718,000 yuan (US$ 124,000). Purchase of water constituted 360,000 yuan (US$ 64,000) or 52 percent of total expenditures.

In about two-thirds of the villages in Nanyao ID, the VIMG collects water fees from individual farmers, in the other third the villages produce enough off-farm collective income that the village committee pays all of the water fees charged to the village and often also pays for other agricultural taxes, educational fees and village fees. For example, Dong Hui She village has successful collective enterprises, including a brick factory, fertilizer bag production plant and

Table 2. Annual Performance Assessment for Nanyao Irrigation District, 1993.

1) Water Delivery				
Item	Planned (104m3)	Actual (104m3)	Potential points	Points awarded
Total discharge	4500	5600.6	4	4
Irrigation water	2000	2150.6	5	5
Delivery to Yingang canal	1500	3450	3	3
Water delivery days	300 days	307 actual	3	3
Total points			**15**	**15**
2) Irrigated Area				
Irrigated area	273.3	273.3	5	5
Irrigated area x times	12000	14000	5	5
Total points			**10**	**10**
3) Water Use Efficiency (WUE)				
WUE of main canals	0.715	0.715	4	4
WUE of branches	0.82	0.82	4	4
WUE of sub-branches	0.91	0.91	4	4
WUE of whole canal system	0.534	0.534	4	4
Total points			**16**	**16**
4) Irrigation Duty and Efficiency				
Irrigation duty at the head of the main canal (m3/ha)	1522.5	1519.5	3	3
Irrigation duty at the outlet of sub-sub branches (m3/ha)	892.5	892.5	2	2
Irrigation duty in field (m3/ha)	813	811.5	2	2
Annual gross irrigation water per ha	6870	7875	3	3
Irrigation efficiency at the head of main canal (ha/m3/s)	56.7	56.8	3	3
Irrigation efficiency at the outlet of sub-sub branches (ha/m3/s)	96.9	97.1	2	2
Total points			**15**	**15**

(Continued)

Table 2. (Continued)

5) Rate of Functional Structures	Planned (10 m3)	Actual (10 m3)	Potential points	Points awarded
Structures	447	447	4	4
Canals and branches (km/number)	48	48	3	3
Total points			**7**	**7**
6) Maintenance				
Lined canals (km)	10	10	6	4
Silt clearance (km/number)	271/62	271/62	4.5	4.5
Structures maintained (number)	35	35	4.5	4.5
Total points			**15**	**13**
7) Income and Expenditure				
Total income	US $31,395.3	US $38,372.1	5	5
Total expenditures	US $26,744.2	US $36,627.9	5	5
Operating and managing cost	US $20,930.2	US $6,046.5	3	3
Annual maintenance cost	US $5,813.95	US $12,558	3	3
Total points			**16**	**16**
8) Crop Yield Assessment				
Grain	3262.5	3045	2	1
Wheat	4425	4605	2.5	2.5
Cotton	600	585	1.5	1
Total points			**6**	**4.5**

Grand total of potential points = 100
Grand total of points awarded = 96.5

fruit orchard. 80 percent of the factory workers are also farmers from the village. Workers are paid on a piece rate basis. Dong Hui She village paid 100 percent of its water fee by 5 March in 1992 and 93 and thereby received a 5 percent rebate.

The Bayi ID collects the water fee from farmers, through the VIMGs, three to five days before the village's scheduled water turn. The VIMG broadcasts with megaphones announcements of pending water delivery three to five days in advance, reminding farmers to come and pay their water fee before delivery. Two members of the VIMG wait at a designated location for farmers to come and pay. At least two VIMG staff must together receive water fees. A receipt is issued to farmers upon payment. Normally, 90 percent of the farmers pay the fee in advance of the water delivery. Others still get water but must pay afterwards or they will not be allowed the next water turn until they pay up--but this is reportedly "very rare."

Compensation of VIMG staff is sometimes from the village committee funds and sometimes from a village-levied surcharge on the water fee. Compensation to VIMG staff ranges from 400 to 1,000 yuan between different villages, varying by the size of village irrigated area, amount of work required and differences in wealth between villages. Most villages in Bayi ID have a surcharge on the water fee of about 2 to 5 percent to pay for the cost of compensation for VIMG staff.

Water Management

Nanyao ID normally obtains its full water supply from the Yie He River according to a withdrawal permit. Occasionally, as in 1992, supplemental water is purchased. Bayi ID obtains water from the Bayi Reservoir. Before 1976 the amount of water in the Bayi Reservoir was 3 to 5 million m^3. By purchasing water from other counties by feeder canals, the amount of water in the Reservoir expanded to 35 million m^3 today. Purchased water constitutes 95 percent of the water in the Reservoir today. All imported water directly or indirectly comes from the Yie He ID. Seventeen to 25 million m^3 of water is imported per year into the Bayi Reservoir. Seventeen million m^3 of water was purchased by Bayi ID in 1992. Bayi pays between 100,000 and 200,000 yuan per year to purchase water. The amount varies according to rainfall and how much BID requests, which can depend on how many turns are requested from Bayi and the VIMGs. In both Nanyao and Bayi ID's wheat and corn are the main crops. Farms normally receive five irrigations per year. Water is distributed by the ID to respective VIMGs according to a pre-announced schedule.

All VIMGs are responsible to schedule, manage and record water deliveries within the village area. Deliveries are arranged to irrigate one farm at a time along a given canal, starting from the farm nearest the top end and working downstream. The duration of each turn depends on how long it takes the water to reach the entire field. This varies between 10 minutes to one-half an hour per mu for furrow irrigated wheat. A member of the VIMG opens and closes canal offtakes for each water turn and records the time of start and finish and assesses the individual volumetric fee on the basis of the actual duration of the turn. If a farmer has not paid the water fee before his scheduled irrigation delivery, the VIMG pays his fee to the district (so that the village-level payment is complete before its scheduled irrigation) and his turn is delayed until he pays. Sometimes water delivery to a village is delayed if the VIMG is late in paying the fee to the ID. Information on volume of water delivery scheduled, schedule dates and times and target fee level assessed to the village are all posted publicly in the village. After the irrigation the information is completed with comparative information on actual schedule and volume of delivery implemented. Actual assessable fee is recorded for comparison with target fee assessment. Adjustments to payments on the basis of actual recorded deliveries, for either adding or reimbursing, are normally made at a meeting of VIMG representatives with irrigation district staff at the end of the cultivation year, usually in December.

In Bayi ID actual discharges are monitored by superiors and compared with targets. Bonuses are given or refused on the basis of the evaluations. The Director of Bayi ID fines staff who do not deliver the right amount of water on time and for the right duration, to branch canals. District staff and a VIMG staff jointly measure actual discharges at the head of each sub-sub-branch canal once a day for the duration of the village's water delivery period. In Nanyao and Bayi, staff gauges, current meters, v-notch and cipoletti weirs and flumes are used to measure water deliveries from the main canal to branch offtake levels. In Bayi water is also measured down to the level of "sub-sub branch" outlets..

Since Bayi ID purchases a considerable amount of water each year it wants to improve water use efficiency. To encourage greater efficiency, Bayi ID gives a small cash bonus to VIMGs for using less water than planned ($\pm$ Yn 10-20). These bonuses are paid from money collected from fines ID gives to some villages who waste water. (Sometimes a village does not prepare all its land or repair or clean channels properly, so they need and request more water than planned.)

The irrigation districts generally settle irrigation disputes which are not settled by the VIMGs or which are between villages. Common sanctions for breaking rules, such as taking water out of turn are given a fine (the most common method). Farmers who damage structures are required to repair the structures and pay a fine. Irrigation districts also have the legal right to cut off water delivery to farmers, but this is very rarely used.

In Bayi ID farmers caught illegally opening field offtake gates must pay twice the area and volumetric water fee assessed for that irrigation. The last time this happened was in 1985. For repeated offenses they would pay an extra Yn 200 to Yn 500. For closing cross regulators, farmers would pay double the water fee for the estimated amount of illegal extra water taken, plus an additional Yn 100 to Yn 200. If the farmer refuses to pay, he is sent to the police station. This happened sometimes before 1985, but rarely thereafter, except in 1987 which was a drought year. The district never fines farmers for absence at the time of scheduled delivery; they just move his or her turn to the end of the schedule for the village. For damaging structures, farmers must pay for the repairs and the police give a fine. This last happened in Bayi the winter of 1990.

Maintenance

In Nanyao the average annual unpaid maintenance labor contribution from farmers is about 11 days, 10 days for sub-branch canals, plus normally one day on main or branch canal(s). The actual number of farmer unpaid maintenance labor required varies between villages according to the amount of land served and the length of channels used in the village. In Bayi, maintenance labor requirements for farmers vary between villages but are in the order of 15 to 20 work-days per year. Most of this labor is for maintenance and repair of channels below the main and branch canal levels. Farmers are permitted to substitute a payment in cash for a day of maintenance labor not worked, paid at the rate of a standard day's labor cost.

MANAGEMENT PERFORMANCE IN NANYAO AND BAYI DISTRICTS

Management Efficiency

Farmers in the two districts had mixed perceptions about the effect of de-collectivization on water management. Farmer informants and district officials both reported that reforms under the Economic Contract Responsibility System have had some negative effects on irrigation management. Greater group control under the production team mitigated against wasting water, it permitted both day- and night-time irrigation and ensured that farmers would be present to manage their water turn (rather than be away attending to off-farm business). In recent years disputes often arise because farmers are absent at their scheduled time for water delivery and water is often wasted or taken out of turn by others. However, a group of farmers interviewed in Nanyao ID reported that water use efficiency had improved over the last 10 years after the reforms. Ten years ago it took on the average 60 minutes to irrigate one mu of land. This now takes about 40 minutes. Now that individual farmers and village irrigation management groups must pay fees, there is more pressure against open wasting of water. System wide water use efficiency has been calculated to be approximately 0.53 in Nanyao and 0.72 in Bayi ID. 35.5 percent of the 111 km of main, branch and sub-branch canals are lined in Nanyao. 31.8 percent of the 157 km of main, branch and sub-branch canals in Bayi ID are lined. The larger number of tubewells within Bayi might be part of the reason for the higher estimated efficiency, due to a lower need for surface water in conjunctive areas.

Financial Viability

In Nanyao, between 1990 and 1993, total district income increased from approximately 160,000 yuan to 330,000 yuan, an increase of 106 percent. Nanyao however, is not building up a reserve fund. It covers a deficit in one year from next year's water fee collection. It collects the previous year's unpaid fees along with those of the current year. An official in Nanyao ID reported that they have no incentive or ability to create a reserve fund by increasing the water fee (even though the government regulation encourages it), because they expect the government to eventually pay for rehabilitation when it becomes seriously needed.

Over the last several years Bayi ID has had a surplus of income over expenditures each year, which is allocated three ways: 1) 50 percent for a reserve fund for rehabilitation or improvements, 2) 30 percent for staff "welfare" and housing conditions, and 3) 20 percent for staff bonuses. Between 1990 and 1993, total district income increased from 550,000 yuan to 976,000, an increase of 77 percent. The financial viability of both districts appears to be gradually improving as a result of the reforms, especially in Bayi.

The average annual income of farmers 10 years ago was less than 300 yuan. Now it is about 600 yuan per year. Crop yields have increased but the prices have stayed about the same, so there has been only a slight real increase in net income from farming over the last 10 years. Gitomer (1994) reports that in 1985 national-level average annual per capita rural income was less than 400 yuan. He notes that since 1985 there has been no growth in average rural per capita income in real terms. This seems to indicate that the ability of farmers to pay more of the real costs for irrigation has not improved significantly over the last decade. Ability of farmers to pay can vary widely between areas.

Nanyao ID is in a less productive area than Bayi ID. In 1993 Nanyao ID had average combined wheat and corn yields of 7,650 kg/ha compared to a much higher average yield level in Bayi of 12,120 kg/ha.

ID officials and VIMG representatives reported that under the old commune system it was easier to collect the water fee; they always collected 100 percent of it, although the fee was very low. In recent years collection is often late and the rate doesn't always reach 100 percent. The average water fee collection rate in Pingshan County is about 70 to 80 percent. The water fee covers the salaries of ID staff and small maintenance costs. Only 5 percent of the fee goes to the county water conservancy bureau. Farmers dissatisfied with the irrigation service sometimes refuse to pay the water fee. 1992 was the first year Nanyao had ever collected 100 percent of the water fee from the VIMGs before the season. The 1991 collection rate was about 70 percent. By 27 September 1993, Nanyao ID had collected about 85 to 90 percent of the 1993 irrigation fee.

An official in the Pingshan Water Conservancy Bureau noted that the best option for financing sustainable physical structures was to encourage sideline enterprises and hope for future government assistance for rehabilitation, because the farmers cannot bear any additional water charge increase or labor requirements.

Physical Sustainability

According to ID officials, essential structures in all seven irrigation districts in Pingshan County are deteriorating, since revenue and labor inputs only cover district staff salaries and small maintenance activities. After the reforms many farmers have developed highly diversified livelihood strategies which compete with labor for irrigation maintenance. It was easier for the collective production teams to mobilize maintenance labor. Despite problems of rising siltation of canals in both districts, farmers interviewed expressed the opinion that the rate of deterioration was less now than it was 10 years ago. Plans were being discussed between farmers and district officials in both Nanyao and Bayi to perform special large-scale maintenance activities to repair and de-silt main and branch canals through the use of mass labor. It is clear that periodic heavy maintenance or rehabilitation will be needed in both systems. It is not clear whether this can be achieved solely through local resources. There are no indications as yet that deterioration is leading to a shrinkage in the irrigated area of either system. Irrigated area continues to rise gradually. This is partly due to the spread of tubewells within the design areas of both systems. The increasing dependence of the systems on conjunctive use of both surface and groundwater irrigation is cause for concern for the long-term sustainability of irrigated area, however, since the underground water table is dropping at a rate of 1.1 meter per year.

CONCLUSION

National level policy reforms promoting local financial and managerial self-reliance are being adopted, although in a somewhat variable manner, at the level of Nanyao and Bayi Irrigation Districts. Nanyao ID is a smaller system in a less productive area relative to Bayi. Nanyao ID has also been slower in introducing the volumetric water fees and creating village irrigation management groups. It has still not developed sideline enterprises. Bayi ID started its first sideline enterprises in 1982. Nanyao ID has a relatively abundant, river-based supply of water and has often been in water surplus. Bayi ID on the other hand is in a water deficit situation and must purchase large amounts of water each year. This dependence on water purchasing, together with the apparent greater ability of farmers to pay (due to higher productivity), may be the driving influences for development of sideline enterprises in Bayi and greater concern about improving water use efficiency. Both Nanyao and Bayi IDs have implemented numerous rules and practices which create various financial incentives and accountability mechanisms aimed at enhancing water use efficiency and the transparency of financial accounting and water delivery.

It is apparent that the reforms are producing more viable local management of irrigation. They provide reasonably clear delineation of responsibilities, water rights and linkage between rights to water and paying for it. Where sideline enterprises have developed they are helping to stem the flow of skilled staff out of the irrigation sector by improving facilities and standards of living for families of irrigation district staff and water resources officials.

Farmers must pay the water fee in advance in order to receive water. If they do not in fact receive water their fee is refunded. Within limits, farmers may pay a higher level of fee to receive more water. In Bayi ID, this appears to be a powerful mechanism which achieves an impressive level of performance of water and financial management. The village acts as a mediating guarantor to see that these rules apply to the individual farmer. This appears to be resulting in gradual enhancement of self-reliance of irrigation districts. However, as indicated in Nanyao ID, it is apparent that some irrigation districts in less favorably endowed areas may be in need of external technical and financial support services to implement volumetric water delivery, fee assessment and diversified sideline enterprises.

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