

Impacts of the Production Responsibility System on the Development of Freshwater Pond Fish Culture in China*

PINGSUN LEUNG and YUNG C. SHANG

*Department of Agricultural and Resource Economics
University of Hawaii
Honolulu, Hawaii, U.S.A.*

GUANSHUN CHEN

*Fisheries Economics Research Division
Center for Freshwater Fisheries Research
Chinese Academy of Fisheries Science
Wuxi, Jiangsu Province, China*

SULONG MA

*Fisheries Economics Research Division
Heilongjiang Aquatic Bureau
Harbin, Heilongjiang, China*

Abstract

Fisheries production in China has increased tremendously from one million tonnes in 1951 to over 12 million tonnes in 1990. Increases in aquaculture production and the implementation of the production contract responsibility system in 1978 have been identified as two key factors contributing to this rapid growth. In 1990, freshwater aquaculture accounted for about 36% of total fisheries production. The fastest growing component of freshwater aquaculture production is pond fish culture. This paper traces the development of freshwater pond fish culture since the economic re-form. Economic, social and technological factors affecting national and regional development trends are examined. Discussions are based largely on recent field visits by the authors to fish farms in various parts of China, and several case studies.

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Introduction

Economic reforms in China and its open-door policy in the late 1970s advanced the restructuring of the institutional system in the fisheries industry. This resulted in dramatic increases in fisheries output. The total output of aquatic products in 1990 was 12.37 million tonnes, making China one of the three largest producers in the world (State Aquatic Bureau [a]). The fastest growth has been in freshwater fisheries where total output increased almost five-fold from 1.12 million t in 1979, the first year of the economic reform, to 5.25 million t in 1990 (State Aquatic Bureau [b]). The average annual rate of growth during the 11 years was 15.12%, while, the total output of aquatic products increased by 2.87 times, growing at an annual rate of 10.07%.

The most notable development in freshwater fisheries has been the rapid growth of freshwater pond culture. From 1979 to 1990, the total area for pond fish farming increased by an average of 60,122 ha per year, from 753,993 ha to 1,415,333 ha (see Table 1). The output from pond fish farming grew 18.02% per year, from 0.54 million t in 1979 to 3.37 million t in 1990. Average yield per

Table 1. Development of pond fish farming in China, 1979-90.

Year	Freshwater fishery production			Fish farming pond area (⁰ 000 ha)	Yield of pond fish farming (kg·ha ⁻¹)
	Total (t)	Pond (t)	% Pond (%)		
1979	1,115,875	544,691	48.8	754.0	722.4
1980	1,239,947	620,528	50.0	821.5	755.3
1981	1,373,474	718,961	52.3	847.6	848.2
1982	1,562,000	870,948	55.8	918.8	947.9
1983	1,840,775	1,030,775	56.0	964.9	1,068.2
1984	2,249,707	1,322,082	58.8	1,070.6	1,234.9
1985	2,854,315	1,749,364	61.3	1,257.6	1,391.0
1986	3,481,743	2,193,795	63.0	1,335.4	1,642.8
1987	4,071,506	2,617,978	64.3	1,394.4	1,877.5
1988	4,551,914	2,933,786	64.5	1,421.3	2,064.1
1989	4,904,600	3,143,900	64.1	1,411.3	2,227.6
1990	5,250,000	3,370,500	64.2	1,415.3	2,381.4
Annual % increase	15.12	18.02	5.89	11.50	

Source: State Aquatic Bureau (b).

hectare increased at an annual rate of 11.50%, from 722 to 2,381 kg. While pond fish farming utilized only 36.91% of the total freshwater culture area of 3.83 million ha in 1990, the output amounted to 75.57% of the total output of freshwater fish farming - including fish culture in ponds, reservoirs, lakes, rivers and rice paddies - which was 4.46 million t (State Aquatic Bureau [b]). China leads the world in freshwater fish production, providing about one-third of total world production. In 1990, about 64.20% of the total output of 5.25 million t of Chinese freshwater fisheries came from pond fish farming (State Aquatic Bureau [b]). Pond fish farming plays an important role in Chinese freshwater fisheries as it provides a source of much-needed protein.

Biotechnically, pond fish farming is a closed production process. However, viewing the output of fish farming as a marketable commodity, its production involves ecological, social, economic, technological, informational and managerial aspects. China has a long history of pond fish farming, primarily in the polyculture of the four main species of carp: common carp, grass carp, silver carp and big-head carp. The polyculture technique also extends to black carp, Chinese bream, blunt-snout bream, tilapia, mud carp and crucian carp. This unique polyculture technique has made China the world's leader in freshwater fish farming, although the development of freshwater pond fish farming was slow from the 1950s to the 1970s. Output from pond fish farming was 3 million t in the 1950s, 4.5 million t in the 1960s and over 7 million t in the 1970s. It is believed that production then was far less than what the market could absorb. During the 1980s, pond fish farming output was over 14.8 million t, more than the combined output of the past three decades.

This rapid development can be attributed to the adoption of advanced technology, expanded utilization of existing bodies of water for freshwater fish farming, and government support in establishing centers for fish farming. However, the most important factor has been the implementation of the production contract responsibility system in which individuals and households contract directly with the state and remuneration is linked to output. This major change in the institutional arrangement of pond fish farming created tremendous internal adjustments within the production relationships of freshwater pond fisheries. As a result, fisheries production increased dramatically.

The rapid development of China's fisheries, especially freshwater pond fish farming, created a new era for the rural areas where transformation into a market economy is continuously taking place. Freshwater pond fish farming has become a way of achieving prosperity through industrious work by the rural community. Its development, however, must take place under existing conditions in China where there is a large population with little cultivated land, insufficient grain and food supply, and a low level of animal protein consumption. Hence, fish farming technologies and techniques must save on land, feed and energy. An analysis of the impacts of the production contract responsibility system which has played an important role in stimulating pond fish farming in China is therefore of theoretical and practical importance.

Background of Pond Fish Farming

Compared to other forms of freshwater fish farming, pond fish farming is less affected by natural factors. Economic profits are controllable (i.e., the more input, the more output). It is suited to many areas, and production areas can be in the same location where consumption takes place. These are some of the reasons why its development can be so rapid. Pond fish farming is so popular that it can be found in coastal provinces, the upper Yangtze River area, and in underdeveloped regions such as the cold northwest and northeast provinces. In 1988, the provinces of Guangdong, Jiangsu, Hubei, Hunan and Zhejiang and the City of Shanghai together produced more than 70% of the national output from pond fish farming. In northern China where water is in short supply, the total area for pond fish farming increased by 104.5% to 42,673 ha in 1988 as compared to 1979. Even in northeast China where the weather is extremely cold, the area for pond fish farming increased by 256% to 90,887 ha in 1988 from 1979 (Guan and Chen 1990).

Most existing ponds for fish farming make use of low-lying areas or flood land ill-suited for planting or grazing, as well as small reservoirs less than 7 ha. Common carp, grass carp, silver carp and bighead carp, China's four major traditional fish farming species, along with Chinese bream, blunt-snout bream, crucian carp and

black carp are the main species used. They are polycultured in the same water according to their eating habits and characteristics. Polyculture applies the concept that a mixed stock of selected fish species, with complementary or minimal interfering feeding habits and different ecological requirements, can efficiently utilize the resources of a pond's different ecological niches. Various polyculture systems have been practiced in different regions of China to suit the local economic, environmental and cultural conditions. The proper choice of species and their stocking rates, and the appropriate management schemes depend on factors such as availability of fingerlings and feeds, pond conditions and market demand. The most common system is to stock fingerlings in the ponds in spring, then harvest in fall. Other systems are the rotational harvesting and stocking schemes, as well as the multiple-grade conveyor scheme. In all systems, ponds are usually dried and cleaned during the winter season. These various forms of polyculture have been practiced traditionally in China for many years. Many of the traditional systems have been improved and are still practiced today.

The three major commodity fish-producing regions in China are the Lake Tai region of Jiangsu Province, the Hang-Jia-Hu region of Zhejiang Province and the Pearl River Delta of Guangdong Province. Production from pond fish farming in these three regions is 12,000-15,000 kg per ha, and profit is 15,000-22,500 yuan per ha (US\$ 1 = 5.1 yuan in 1993). In the Lake Dongting and Lake Baoyang areas where Hunan, Hubei and Jiangxi Provinces are located, output per ha is 6,000-9,000 kg, and profit per ha is 9,000-12,000 yuan. In the low-output areas of northwest, northeast and northern China, production per ha is 4,500-7,500 kg and profit per ha is 7,500-10,500 yuan. Basically, the input-output ratio (total cost to total revenue) is roughly 1 to 2 in all cases.

The economics of pond fish farming is two to four times better than agriculture (Chen and Ma 1989). Although some fisheries institutes have demonstrated that high-input production practices can give twice as much output as commonly practiced production models, most producers strive for maximum economic efficiency, and so prefer a production model that uses moderate economic inputs coupled with appropriate technology. Because of increasing consumer demand for freshwater fisheries products, profits from pond fish farming are relatively higher than for other agricultural activities. Pond fish farming has become an effective way for China's peasants

to achieve prosperity through industrious work during the reform. It has the advantages of requiring only a small area, being easy to control, having a quick turnover, and giving high output, good profit and stable production.

The Emergence of the Production Contract Responsibility System in Fisheries

Despite differences in approaches to production, the fisheries industry operates under the same general institutional arrangements and economic management systems as the larger agricultural industry. Before 1978, prior to the economic reform, the rural public ownership economy (i.e., the people's commune system) put undue emphasis on centralized unity. As a result, management and administration were weakly linked. There were no major improvements or breakthroughs in the implementation of the reward distribution according to work performance and the establishment of the responsibility system. Individual farmers had no production quotas, and in distribution, the equalitarian policy was carried out regardless of productivity, as expressed in general by the saying, "everybody eating from the same big pot of rice." This suppressed farmer productivity and the long-term growth of agricultural and fisheries production. For instance, the output of freshwater fish farming increased by only 7.16% annually from 117,193 t in 1951 to 813,320 t in 1979. In those 28 years, it increased less than 700,000 t or roughly 25,000 t per year.

Due to the slow progress of social productivity, the Chinese Communist Party (CPC) 11th Congress' 3rd plenary session held in December of 1978, declared that the country should direct its attention and resources to modernization. In particular, it adopted a policy of speeding up agricultural development by adjusting production relationships and rural policy. In September 1979, the CPC 11th Congress' 4th plenary session passed a resolution on several issues regarding agricultural development. The major points were (1) to respect and guarantee the autonomous authority of production teams, and (2) to legalize contracted economic undertakings with the contract responsibility system where remuneration should be linked to output.

In 2 September 1980, the Communist Party Central Committee issued a document to further strengthen and improve the agricultural production responsibility system, and to approve the various production responsibility systems that had existed in the rural community since 1979 (State Statistical Bureau 1982). The document pointed out that:

The contract responsibility system with remuneration linked to output is the system that distributes the different tasks according to the specialization of the work force coordinated under the unified management of the production team. Those who are good at agriculture are individually contracted cultivated land according to his or her ability, and those who are good at forestry, animal husbandry, side-line production, industry and commerce are individually contracted respective specialization according to his or her ability. Each operation in the production process can be contracted to a group, an individual or a household whichever form is beneficial with respect to production advantage and/or ease of management. Production above or below the contracted level will be rewarded or penalized accordingly. The detailed agreement should be spelled out clearly in the form of a contract and will remain effective for the period as agreed.

This reform policy achieved quick results. In a short time, many rural areas had established various forms of the system. This led to tremendous growth in overall agricultural productivity which, in turn, strengthened the rural economy. Table 2 shows that the outputs of major agricultural products in 1989 increased drastically compared to those in 1978 prior to the reform.

The contract responsibility system with remuneration linked to output in agriculture replaced the highly-centralized and unified collective system with a new arrangement that combines unified management and a high degree of decentralization. Thus, it blends the advantages of unified collective management and the enthusiasm of individual or household production and management. This is a major reform under the prerequisite of a collective ownership system of production. Its main purpose is to adjust production relations within the collective economy, combine the factors of production,

Table 2. Comparison of outputs of major agricultural products in 1978 and 1989.

Major agricultural products	1978 (million t)	1989 (million t)	% increase 1978-89 (%)
Grain	304.75	407.45	33.6
Cotton	2.17	3.79	74.8
Oil crop	5.22	12.91	147.4
Rapeseed	2.38	5.44	128.8
Jute and Ambarly hemp	1.09	1.33	22.2
Flue-cured tobacco	1.05	2.41	128.8
Silkworm cocoon	0.23	0.49	115.8
Tea	0.27	0.54	101.4
Fruits	6.57	18.37	179.6
Poultry	8.56	23.38	171.8
Aquatic products	4.66	11.48	146.7

Sources: State Statistical Bureau 1982, 1989.

particularly labor, as well as directly link productivity to material reward in order to stimulate labor's production initiative.

The responsibility system seeks to effectively combine the responsibility, rights and interests of all parties involved. To elaborate, the responsibility of the contractor should be determined, the right of the contractor should be assigned and the interest of the contractor should be rewarded. The responsibility of the contractor is determined in terms of production quota or imposed mandatory purchase, production cost, profit, tax and deduction for services rendered by the collective. The contractor is assigned the right to control all means of production, manage land resources and arrange production activities according to the pre-determined responsibility. The interest of the contractor is rewarded using various systems of bonus and penalty according to the level of fulfillment of the pre-determined responsibility. This system promotes the contractor's concern about the level of production since he or she is rewarded accordingly. Because the contract responsibility system with remuneration linked to output is in accordance with the general characteristics of China's agriculture and based on sound economic principles, it has had far-reaching impacts.

Arable land in China has declined to 0.088 ha per capita (State Statistical Bureau 1989). Surplus labor resulting from a fast-growing population with limited land has long been a problem in China, affecting the stability of the social structure and long-term economic

development. After the institutional reform in agriculture, surplus labor was absorbed in production activities to satisfy the increased demand for agricultural and sideline products. The fisheries sector is no different from the general agricultural sector in this respect. Developing the fisheries sector not only stimulates the market and provides an adequate supply for consumers, but helps align the fisheries production structure, increase farmers' income, and stabilize and strengthen the collective economy. On 17 October 1982, the Chinese government issued a report demanding the rapid development of the fisheries sector by utilizing available water surface and related resources. In 1985 it issued another executive order to develop the fisheries industry.

The success of the contract responsibility system in agriculture gave the Chinese great hope for fisheries. From 1980 on, the system was tried out in pond fish farming in various regions, with good results. Because of its unique features, the system was accepted by the vast majority of fisheries producers from the beginning. According to some experts, the contract responsibility system contributed 60% of the increase in China's fisheries production during 1978-85 (Zhou 1988). Table 1 presents the development of pond fish farming in 1979-90.

The Establishment of the Contract Responsibility System in Freshwater Fisheries

At the beginning of the rural economic reform, those provinces with many inland water resources, such as Zhejiang, Jiangsu and Hunan, formulated a series of policies based on local conditions, to develop fisheries resources. The underlying principles of these policies are as follows:

1. The person assigned the right to use a body of water will operate, invest and benefit. The right to use a body of water is licensed by the county or local government. It remains unchanged for a long period of time and is protected by law.

2. Waters owned by the state can be developed by the state or jointly by the state and community. If the waters are collectively owned, they can be developed by the community's production team or jointly with the state. In either case, individuals or groups can

rent, contract and become shareholders to develop waters for fisheries production. For waters that cross production or collective boundaries, the various parties involved are advised to coordinate in order to consolidate agriculture and fisheries production, or production can be jointly organized and operated by a higher level administration.

3. For fisheries production, individual farmers are encouraged to utilize non-contiguous waters not suited for development by the collective. Farmers may convert their family plots and areas around their living quarters into fishponds. In both cases, output from fish farming belongs to the individual farmers and they are guaranteed use of these areas for a long time.

4. Once the waters for fish farming have been determined, they must be fully utilized. Failing to do so within a certain period of time will result in fines. The fines will go into a special fund for freshwater fisheries development.

The establishment and implementation of these principles have generated farmers' interest in fish farming. In 1988, the total waters for freshwater fish farming reached 3,894,973 ha or 69.03% of the total possible fish farming waters. In 1979, only 48.50% of possible waters were utilized for fish farming (Fisheries Economics Research Division, unpubl. data). In the meantime, the responsibility system was set up and improved gradually along with the determination of fish farming operating rights.

The contract responsibility system with remuneration linked to output in fisheries takes different forms depending on the nature of the different types of fish farming and on the socioeconomic conditions of the locality. It encourages those institutes and individuals possessing the technology, funds, fry and waters to contract, rent, transfer, become shareholders, jointly operate and hire labor to develop fish farming regardless of region, ownership and institutes. The state, collective and individual can together develop fish farming. The contract responsibility system encourages the development of long-term economic objectives in order to avoid over-exploitation of the resources in the short-term. This allows accumulation of funds for long-term capital investment and labor development. The system also extends from production to science, technology and management with the establishment of technology-contract, technology-promotion responsibility and management's target systems. The system is further protected by law.

The Various Forms of the Contract Responsibility System in Pond Fish Farming

As described earlier, the contract responsibility system is implemented in various forms to suit the socioeconomic conditions of the different regions in China. Its major forms in pond fish farming are described below.

1. THE HOUSEHOLD CONTRACT RESPONSIBILITY SYSTEM

The farm household, which is the basic unit, makes a contract with the collective that owns the water and pond area to operate a certain part of the area. The contract specifies a fixed amount of output to be produced (target output) based on and determined by the productivity of the pond and water areas during the past three years. The target output is used to determine the amount of output to be turned over to the collective, or to assess the so-called contract fee. Both forms of payment can be viewed as a rental fee paid to the collective for use of the water and pond areas. The output of the household is handled in one of two ways: (1) the contracted output is handled by the collective, while the excess is handled by the individual household; or (2) the entire output is handled by the farm household. In general, the collective does not pay for production costs. The profit (or loss) of the contractor (farm household) is determined as the residual after deducting production costs and the value of the contracted output or contract fee from the total revenues. The contract fee ranges from 1,500 to 4,500 yuan per ha, except in some remote areas where it can be less than 1,500 yuan. The contract fee includes deductions for social welfare and collective savings, land and agricultural taxes, a pond cleaning fee and depreciation.

This system directly links the work of the households to their interest and makes full use of supplementary labor within the households. It is particularly suited to small and scattered pond and water areas within agricultural villages. It is the major form of the rural fish farming contract responsibility system. In 1988, the 369,000 contracted households produced 694,000 t of fish which comprised 23.6% of the total output from pond fish farming (Fisheries Economics Research Division, unpubl. data). A problem of the

system, however, is the difficulty of determining the level of the contracted output. If the estimate is too high or low, it may cause an imbalance in the distribution of profits between the collective and individual.

2. THE MULTIPLE HOUSEHOLD CONTRACT RESPONSIBILITY SYSTEM

The basic contracting unit of this system comprises several households, usually not more than 20. The group is formed voluntarily. Capital is raised almost entirely within the households involved, but occasionally funds are partially provided by the collective. After a fixed sum prescribed in the contract is remitted to the collective, the remainder is distributed to the households according to their labor input and invested capital. Details of the contract are determined jointly by the contractor (group of households) and the collective, or through a bidding process.

The system allows concentrated pond areas to use advanced technology, and combines labor and capital resources. However, more management is required to avoid uneven distribution of profits and underutilization of technology.

3. A SYSTEM OF COLLECTIVE MANAGEMENT, CONTRACTING INDIVIDUAL LABOR WITH A REWARD/PENALTY SCHEME

This system consists of two levels of contracting. First, the village or township government initiates a general contract with the collective fish farm. Then the head of the collective farm negotiates another detailed contract with the individual employees of the farm to implement the general contract. The contract determines the distribution of profits or losses to the individual employees according to their productivity, and takes full consideration of the village's social fund accumulation, and the farm's needs for further development. The system maximizes employee productivity and allows long-term development of the fish farm.

For example, the Dongshan township government in Wu County of Jiangsu Province contracted a local fish farm with a production target value of 550,000 yuan and 150,000 yuan profit for 1986-88 (Tang 1989). For production value over the target, 30% would go to the township government, 30% to the farm's development fund, and 40% to the employees as a bonus. Based on the past

three year's production values, the target was to remain unchanged for the next three years. The specifics of the contract were detailed as follows: (1) Each individual employee was assigned 0.67 ha of pond area. (2) The target output was determined by each individual pond. The average target output for the entire farm was 4,285 kg per 0.67 ha of pond area with the following breakdown: 1,605 kg grass carp, 600 kg Chinese bream, 1,155 kg silver carp and big-head carp, 550 kg common carp, 275 kg white crucian carp and 100 kg local crucian carp. (3) Concentrated pellet feed was allocated according to a feed conversion ratio of 3 to 1. (4) The employee was paid 700 yuan for completion of the contracted output. For the amount exceeding the contracted output, 80% was distributed as a bonus to the employees and the remaining 20% was kept by the farm. If the output was below the target, the employees had to compensate for the value of the unfulfilled output. With implementation of the contract system, the farm's revenue and profit increased 5-17% annually (Tang 1989).

4. A SYSTEM OF COLLECTIVE MANAGEMENT, CONTRACTING A PRODUCTION TEAM WITH A REWARD/PENALTY SCHEME

In regions where the collective structure is strong and fish farming techniques are more advanced, system 3 described above evolved from contracting individual labor to contracting a production team. The change takes advantage of the increased mechanization in fish farming which requires coordination of individual labor. Water and pond area, output, revenue, cost and profit are determined in terms of the production team instead of individual labor. If the output exceeds the contracted amount, a bonus is given; if the output is below the contracted amount, a penalty is imposed. Responsibility, interests and rights of the production team as well as its members are clearly defined. However, the system requires a high level of management particularly in determining the various elements of the contract.

For example, in Hejiang Village of the City of Wuxi in Jiangsu Province, one of China's more productive fish farming regions, four village-run fish farms and one fish farming village have been implementing this system since the early 1980s (Xue and Sun 1989). The average output per ha reached over 15,000 kg in over 260 ha of fishponds. Labor productivity increased from 692 kg in 1978 to

3,452 kg in 1987. In the same period, fisheries revenue per labor increased from 581 to 4,455 yuan, and profit per labor from 241 to 4,301 yuan; labor for fish farming declined by 45.8%, the ratio of grow-out ponds to total pond area increased from 63.6 to 86.3%, and production cost as a function of revenue decreased by 0.8%. Table 3 provides a summary of the development of pond fish farming in Hejiang Village from 1980 to 1987.

5. A SYSTEM FOR COLLECTIVE FISH FARMING, CONTRACTING THE INDIVIDUAL WITH A FIXED FEE SCHEDULE

The individual contracts or rents part of a collective fish farm for fish production. The contractor bears all production costs and receives all the revenues from fish sales. The individual pays the local government a fixed fee or rent as determined in the contract. The contractor has autonomous authority in production management as well as personnel allocation during the contracting period.

This system is suited to collective farms which are well-equipped. For example, Dongfa Fish Farm, a collective fish farm in Heilongjiang Province's Seldong City, has 40 ponds totaling 34 ha which were contracted to individuals in 1985. The City received 105,000 yuan per year from the individual contractors. The annual amount remained unchanged for five years as specified in the original contract, so the City received a total of 525,000 yuan in the 5-year period. Before 1985, the fish farm never had a profitable year.

In 1988, 95% of 23,465 village-owned fish farms carried out some form of the contract responsibility system (Fisheries Economics

Table 3. Development of pond fish farming in Hejiang Village, 1980-87.

Item	Unit	1980	1982	1985	1986	1987
Pond area	ha	266	266	266	266	262
Grow-out pond area	ha	174	237	232	226	228
Total output	t	2,197.4	3,370.5	3,955.8	4,242.2	4,464.0
Commodity fish output	t	1,533.4	2,353.5	2,615.0	2,805.0	2,945.0
Unit commodity fish output	kg·ha ⁻¹	5,767.5	8,871.0	9,835.5	10,558.5	12,930.0
Revenues	1,000 yuan	2,958.7	4,726.4	8,944.0	10,205.1	12,330.0
Expenses	1,000 yuan	2,130.3	3,542.5	5,488.5	7,292.0	8,661.0
Profit	1,000 yuan	828.4	1,193.9	3,456.2	2,912.9	3,669.0
Expenses/revenues	%	72.0	74.8	61.4	71.4	70.2
Labor	persons	1,332	1,095	905	890	853
Labor productivity	kg/person	1,151.0	2,154.0	2,889.5	3,163.5	3,452.0
Profit per labor	yuan/person	621.9	1,090.3	3,819.0	3,273.0	4,301.0

Source: Xue and Sun 1989.

Research Division, unpubl. data). About 60% of the fish farms were run by collectives and contracted to individuals (system 3), about 10% were run by collectives and contracted to production teams (system 4), and 20-30% were contracted or rented to individuals using a fixed fee schedule (system 5). Few were operated purely based on labor wage or jointly managed by collectives and individuals. Based on actual production practices after the reform, the most favorable forms of the contract responsibility system appear to be collective management, with individual or production team contracting (i.e., systems 3 and 4). Both systems combine unified management with a high degree of decentralization which maintains the enthusiasm of the individuals or production teams.

State-owned fish farms have imitated the responsibility system in their operations. Tasks such as grow-out production, fry cultivation, feed processing, transportation, marketing and others are contracted to individuals, households or production teams. The contracts are in terms of output, revenue, cost and profit targets augmented by a bonus and penalty scheme. Changes in relations between the farm and its employees have resulted in increased farm productivity. For example, since 1979, Baido Fish Farm, a state-owned fish-farm in Wu County of Jiangsu Province, has gone through four different stages in adopting the contract responsibility system (Li and Chen 1986a). It started in 1979 with labor wage as the only incentive. In 1981 it contracted farm activities to large production teams with many individuals (usually more than eight and on average about ten). Then in 1983 it adopted an overall contract responsibility system, i.e., it contracted individuals. Finally, in 1984, the system evolved into contracting small production teams (with an average of three individuals). Each time, the responsibility system was improved and as a result, pond fish output increased by 15 times from 1978 to 1985. The farm reversed its situation from a loss of 8,886 yuan in 1978 to a profit of 162,539 yuan in 1985 (see Table 4).

The contract responsibility system has changed fish farming from a sideline activity to a major industry in the rural areas of China. In 1988, 6,144,000 households were engaged in fish farming, an increase of over 26 times compared to 1978. In 1988 these households farmed 367,200 ha or 9.4% of the total freshwater fish farming areas (Fisheries Economics Research Division, unpubl. data). In areas where per capita arable land is limited, water and

Table 4. Results of the evolution of the contract responsibility system in a state-owned fish farm, 1978-85.

Forms of distribution	Year	Pond area (ha)	Labor (persons)	Output (kg)	Revenue (yuan)	Expenses (yuan)	Profit (yuan)
1. Wage	1978	16.7	33	18,300	32,087	40,973	-8,886
	1979	26.9	32	35,537	57,080	72,745	-15,665
	1980	33.0	50	59,879	94,914	102,409	-7,495
2. Contracting to large production teams	1981	32.9	33	79,061	140,500	129,260	11,240
	1982	34.5	38	138,056	226,700	194,609	32,091
3. Overall responsibility system	1983	34.8	47	207,700	391,480	327,038	64,442
4. Contracting to small production teams	1984	31.5	50	234,692	596,200	502,094	94,106
	1985	34.1	58	292,832	854,673	692,134	162,539

Source: Li and Chen 1986a.

pond areas are treated like farmlands. For example, in the City of Xiantai in Hunan Province, ponds for contracting are classified into three categories according to their equivalent farmland value. The first category of ponds is worth 0.027-0.033 ha of farmland, the second 0.02-0.027 ha of farmland, and the third about 0.013 ha of farmland. The contractor must give a certain amount of grain to the state and pay tax based on the standards of farmland. In this way, peasants regard the ponds as important as crop land, and thus put more labor and investment into fishponds, maintaining them regularly, and increasing their management efforts.

Some forms of the joint contract responsibility system are regardless of ownership. One is the so-called "lateral economy joint contract responsibility system" in which technicians from advanced regions, such as Jiangsu and Zhejiang Provinces, are sent to underdeveloped areas with medium or low fish productivity to supervise fish farming. This system is within the general scope of the contract responsibility system with remuneration linked to output. The only difference is the extent of the responsibility and remuneration. In any case, the contract responsibility system with remuneration linked to output has fundamentally changed the old system that fettered productivity in the past. It has stimulated farmer enthusiasm and paved a new path for the development of fisheries in China.

Major Breakthroughs of the Contract Responsibility System in Freshwater Pond Fish Farming

The contract responsibility system replaced the old unitary ownership model with new co-existing models of state ownership, collective ownership, joint economic operation and individual operation. The co-existing nature of the various models is particularly suited to the present conditions of China's fisheries sector for the following reasons: The productive forces in the fisheries sector are multi-level in nature with uneven productivity. The degree of production specialization is not uniform. For instance, the extent of mechanization in freshwater fisheries lags behind that in marine fisheries. So a single large economic entity, such as large state-owned fish-farms, would not help in stimulating development of the entire productive forces. Instead it might hinder its development. However, the various forms of the contract responsibility system provide many alternatives in developing the uneven productive forces in freshwater fisheries. According to official fisheries statistics (State Aquatic Bureau [b]), China's freshwater fish farming output from state-owned fish farms increased about 4.6 times, from 83,077 t in 1979 to 379,397 t in 1988. Meanwhile, the combined output of fish farming from collective and individual farms increased about 4.8 times, from 730,243 to 3,518,077 t. Thus the co-existence of the various models of operation improved the utilization of uneven productive forces in freshwater fisheries and sped up overall development.

After the contract responsibility system became widespread in pond fisheries, major changes were observed: (1) The previous unitary model, with the commune, brigade (the basic unit) and production team, was replaced by a two-tier ownership system of township and village with different levels of management and collective ownership based on fish farms. (2) In areas with a well-developed commodity economy and high fisheries productivity, townships and villages engaged in fish farming established joint enterprises of fishing, manufacturing and commerce based on the local economy and natural environment, for example, a fish farming collective in Hejiang County of Wuxi City organized a joint fisheries-manufacturing-commerce company. (3) Many specialized households contracted collective fish farms to perform various specialized tasks and became another level in the collective economy. (4) With the specialized

households as the core, this new system allowed both capital and fish farming techniques to flow freely and be shared in the collective fish farms.

The various forms of the responsibility system have stimulated competition. The system closely connects farmers' individual interests with production, creating much enthusiasm and initiative. The results are increased production, reduced costs and economic efficiency. From the practical point of view, pond fish farming requires high levels of manual operation. Thus, it is easy to distinguish those who work hard from those who do not. This allows easy assessment of a bonus or penalty. In general, farmers have the incentive to try their best in order to increase farm productivity.

With respect to the structure of the fish farming sector, new developments have emerged. Many joint fishing-manufacturing-commercial enterprises and various specialized services have been established. Specialized service organizations provide various services before production (assistance in raising production capital and providing production information), during production (introduction of advanced production technology, management skills and other technical know-how), and after production (product marketing and commodity information exchange). For instance, in Hanshou County of Hunan Province, the number of specialized service units for pond fish farming increased from 70 in 1983 to 110 in 1987, and service personnel from 550 to 1,500 (Li and Lu 1989). The output of pond fish farming increased from 2,600 t to 10,084 t during the same period. These specialized services have become integral to the pond fisheries economy.

In addition, fish farmers have created many integrated fish farming systems in the practice of pond fisheries. Thus, the change in the structure of the fish farming sector has led to adjustments in the agricultural sector. According to various surveys on integrated fish farming conducted in Zhejiang, Guangdong, Jiangsu, Hunan and Hubei Provinces, China's traditional ways of pond fish farming with mulberry and sugarcane have been substituted gradually by integrated production models of fish-grass, fish-poultry and fish-domestic animals. The changes were made largely to reduce production costs. In simple pond fish farming, feed and fertilizer can make up 40-50% of total production costs. In integrated fish farming for which feed and fertilizer can be produced internally, production costs can be reduced by about 50% (Ma 1989a).

The contract responsibility system has emancipated the productive forces and accelerated technological progress and labor productivity in freshwater fisheries. Because of the implementation of the contract responsibility system, fish farmers have autonomous authority over production and management. As a result, labor productivity and technical efficiency have increased. For example, in traditional fish farming regions of Zhejiang, Jiangsu, Shanghai and Guangdong where the local economy is strong, transportation is convenient, and information exchange is fast, the traditional approach of stocking in spring and harvesting in fall has been replaced by a rotational system to meet the year-round market demand. Fish farmers in these regions have also increased investments to improve the ecological environment of fishponds and maintain their long-term productivity.

Since 1979, Guangdong Province has accumulated over 300 million yuan from foreign investments, bank loans, individual investments and state support for the development of 66,667 ha of intensive fishponds. Bank loans make up 50%, and individual investments make up over 30% of the total accumulated fund. Pumps were installed in ponds with poor water circulation systems. In Jinlui Township of Shende County in Guangdong Province, 2,310 water pumps and 1,457 aerators were installed in the town's 9,750 ponds in 1987. In Nanhai County, the number of installed aerators increased from 20 in 1985 to 4,500 in 1988 (Guangdong Aquatic Bureau 1990). Improvements in the production environment resulted in continuous increases in output. According to official fisheries statistics, from 1979 to 1987, Guangdong Province's freshwater fisheries output increased by 460,000 t, of which 90% came from pond fish farming (Guangdong Statistical Bureau).

In two fishing villages of Wu County in Jiangsu Province, old, shallow ponds of varying sizes were modified into a series of new ponds, each about 0.67 ha in size and 3 m deep. The modified ponds were connected to form a total area of 65.7 ha. Output and profit per ha increased from 3,908 kg and 7,271 yuan (before modification) to 12,510 kg and 20,546 yuan (after modification) (Li and Chen 1986b). The modified ponds are suitable for reasonably intensive polyculture and are well-adapted for mechanization. The modification has provided the foundation for establishing an ecological equilibrium and achieving stable and high yields. Table 5 compares pond productivity before and after the modification.

Table 5. Comparison of fishpond productivity before and after modification in Wu County of Jiangsu Province.

Item	Before modification	After modification	Differences (after-before)
Depth of pond (m)	1.3	2.8	+1.5
Unit stocking (kg-ha ⁻¹)	975	2,100	+1,125
Unit output (kg-ha ⁻¹)	3,908	12,510	+8,603
Revenues (yuan-ha ⁻¹)	11,103	36,903	+25,800
Cost increase after modification (yuan-ha ⁻¹)			
Total cost		12,535	+12,535
Modification cost		675	+675
Fry cost		3,561	+3,561
Feed cost		5,299	+5,291
Others		3,000	+3,000
Unit profit (yuan-ha ⁻¹)	7,271	20,546	+13,265

Source: Li and Chen 1986b.

Basic Issues in Improving and Perfecting the Contract Responsibility System in Freshwater Pond Fish Farming

1. THE LENGTH OF THE CONTRACT PERIOD

At present, it is a serious problem that ponds have not been maintained and repaired for a long time. For example, in the City of Huzhou in Zhejiang Province, many old ponds were modified in 1979-84. However, in recent years, no attention has been paid to cleaning ponds during winter. As a result, ponds have silted up to 9.1 cm, the width of pond dikes has been reduced by 25 cm, the average depth of the ponds decreased by 30 cm, and the amount of silt per mu reached about 256 cubic meters. These problems also exist in other fish farming provinces. The major cause of these problems is the relatively short period (1-3 years) of most contracts, and in some instances the contracts are rotated among households. In these situations, the contracted farmers are not willing to invest to improve production, preferring to maximize short-term benefits. Thus the potential of production cannot be developed to the fullest extent

The length of contracts no doubt affects the stability in the implementation of reform policy. Based on fish farming practices in

recent years, the ideal contract period is at least 5 years. Some areas have adopted a system using a 9-year contract with a provision to revise the contract fee every 3 years. In some remote provinces, the contract period is 10-20 years in order to encourage fish farming. Extending the contract period will help increase investment by fish farmers which, in turn, will improve production conditions and productivity. Even in cases where an extended contract period is not possible, provisions for pond cleaning as well as pond maintenance and repairs, should be spelled out in the contract.

2. THE SIZE OF THE CONTRACT AREA

The size of the water and pond areas contracted for fish farming varies from region to region. For example, in the mid and lower reaches of Yangtze River, the size of the pond contracted to each unit of labor varies as follows: (1) 0.33-0.53 ha for intensive fishponds near the water network with relatively poor levels of mechanization and transportation facilities; (2) about 0.67 ha for intensive fishponds close to the city, with convenient access to fertilizer and feed, a moderate level of mechanization, and relatively good transportation facilities; (3) 0.67-1 ha for intensive fishponds in areas with a high level of mechanization, good transportation facilities, and specialized services such as input procurements and fisheries product marketing; (4) 0.33-0.53 ha for integrated fish-farms practicing integration of grass-planting, livestock and poultry raising and fish farming; and (5) 2-2.67 ha for extensive fish farming in rivers and lakes. The size of the contract area per unit of labor depends not only on the local growing and socioeconomic conditions, but also on factors such as availability of supplemental labor from the individual's household, the technical skill and physical character of the labor, and the workers' enthusiasm. However, it can be difficult to determine for each situation the appropriate size of the contract area per unit of labor. It is suggested that labor productivity, output and profit targets be set above the average in similar localities.

3. THE INTEGRATION OF THE CONTRACT RESPONSIBILITY SYSTEM

The contract responsibility systems with household operation and with collective economy are not substitutable for each other.

Instead, they benefit from each other. In general, the household contract responsibility system in fish farming has undergone three stages of development:

(1) *Single-entity operation stage*. At this early stage, the sole purpose of every fish farming household is simply to achieve adequate food and clothing. The main task of the collective management is to implement the contract system in an orderly manner. It also establishes service organizations to provide necessary fisheries production inputs to the households.

(2) *Expansion and development stage*. The fish farmers have achieved a stable and steady production and income, are capable of accumulating capital, and are able to use their spare time and accumulated capital to invest in other risk-taking ventures such as planting and raising livestock and poultry.

The collective expands the scope of the service organizations, and assists in transferring contracts from one household to another.

(3) *Specialized operation stage*. The fish farmers become more specialized in their operations to increase the economic efficiency of production. They are also ready to compete in the commodity fish market.

The collective management establishes collective enterprises such as fish farms and fish fry farms which are usually too large to be handled by individual households. It perfects the profit distribution and social accumulation systems for social welfare development.

The parallel system of the household operations and the collective economy provides unified management and yet a high degree of decentralization so as to capture maximum labor productivity.

4. THE DISTRIBUTION OF ECONOMIC BENEFITS

Before the reform, the government assessed a sales tax of 8% on aquatic products. In 1985, it abolished the quota system for aquatic products, and prices were determined by the market. Since then, the distribution of economic benefits between the government and the fish farming units is fixed in terms of an agreed amount to be remitted to the government. In general, the contract responsibility system involves simply keeping the remaining profit after remitting an agreed fixed amount to the government and the collective. However, in actual practice, sometimes the target output of the contract is somewhat low, the length of the contract period is too short

and the contract is not binding (without public notary). The low target output translates into an unfair amount remitted to the government. It is suggested that the average local long-term output be used to determine the target output, and that the contract be notarized.

The Development of the Contract Responsibility System in Pond Fish Farming

1. The system of specialized services for pond fisheries plays an important role in the continuous and steady development of the pond fish farming economy. The hundreds of thousands of households adopting the contract responsibility system in China's pond fisheries are each unique in their operations. This might not generally fit into the overall integration of fish farming operations and the increase in the level of specialization. Further development in pond fisheries would require a system of specialized services. Most service organizations were former government fisheries agencies; some were established by collectives and individuals.

In major pond fisheries regions of Guangdong Province, three service systems have been established: the fish fry supply system, the feed supply system, and the technology extension system (Guangdong Aquatic Bureau 1990). From 1978 to 1987, the province invested 15.94 million yuan to establish 11 major hatcheries and a network for a fry distribution system. Since 1979, the province invested more than 9 million yuan in 25 fish feed manufacturing plants with annual outputs of 1,000-3,000 t. Sales distribution centers were established to satisfy the many scattered fish farming households. In Nanhai County, for example, 570 retail shops sell feeds, there is a service center for technology extension, and an extension agent is assigned to townships with more than 33.33 ha of fishponds. There are over 1,000 extension agents in the province. In Shunde County, every township has a quarantine station. There are more than 400 quarantine workers in the 220 villages to prevent diseases of grass carp. As a result of these service systems, the province's freshwater fisheries, especially pond fish farming, ranks first in the country. A comprehensive set of service systems not only meets the needs for specialization in pond fish farming, but also

plays an important role in the stable development of pond fish farming.

2. Contractors are encouraged to adopt advanced technology to increase profits. In recent years, because of the rapid increase in pond fish output, the market price for pond fish has been fairly stable and has even decreased slightly. In the meantime, the prices of fisheries supplies, electricity and fuel have generally increased. The situation was more severe in 1988 when China encountered serious inflation. Economic benefits of fish farming were heavily affected. The state needs to control inflation through fiscal and monetary policies; while farmers need to improve the entire production process through better management and advanced technology which reduce production costs and/or increase yield. According to Zhou (1988), from 1978 to 1985, the contribution of technology to fisheries productivity was 31.2% which is lower than that in developed countries where the contribution was over 60% (with agriculture included). In traditional fish farming areas in the middle and lower reaches of the Yangtze River, the contribution of technology to fisheries productivity was 48.44%; while in newly developed areas in the North, the contribution was 23.14% (Ma 1989b). The potential of advanced technology in pond fish farming is great particularly with the help of appropriate public policy.

The global trend in freshwater fish aquaculture development is toward developing land-saving and water-saving technology, developing new feed and improving broodstock quality. China has also adopted land-saving, feed-saving and water-saving technology in its development of pond fish farming. It has gradually standardized fishponds which in turn has improved their ecological conditions. In addition, the introduction of aerators and feed processing machines have improved the productivity of the fishponds. Traditionally, Liaoning Province is one of China's marine fisheries region. However, since 1983 they have invested 13.5 million yuan to construct 8,267 ha of standardized freshwater fishponds in 18 cities and counties. As a result, a fish farm in Honghe District of Shenyang City has achieved over 15,000 kg per ha of output in its 47 ha of fishponds, and received over one million yuan of profit. Fish farm mechanization and fishpond standardization are gradually being adopted throughout the country.

3. The contract responsibility system has promoted the integrated use of water and related resources. Pond fish farming

integrated with domestic animal husbandry and crop planting has been practiced in China for many centuries. It makes full use of human, material and financial inputs as well as natural resources such as water, land and solar energy. It constitutes a production system that is low-input, high-output, economically efficient and provides a high conversion rate of energy. Integrated fish farming is best in protecting the ecological environment, utilizing water and land resources, and in reducing costs. For example, the West Lake Fish Farm in Sheshan Township of Nanjing City has 27.3 ha of fishponds and 8 ha of fodder fields. Fish farming is their main operation. They also raise pigs, poultry and dairy cattle, plant grass and grapes, and produce long rice, tofu products, mixed feed and dairy products. The amount of fish, meat, poultry, milk, eggs and other market products increased from 23 t in 1980 to 184.5 t in 1985 (see Table 6).

4. Improving product quality and the technical level of labor is the key to the continuous development of pond fish farming. The stable increase in output of pond fish farming depends on its market competitiveness, i.e., low input, high output and high economic efficiency. The implementation of the contract responsibility system in rural areas does not necessarily lead to an increase in labor skill and management efficiency. Neglecting the development of technical labor skills will cause difficulties in adoption of new technology, development and utilization of new feeds, performing routine pond cleaning, and improvement of mechanization. Thus, farmers must be trained in the latest technology and management techniques to improve labor quality and technical skills.

Table 6. Output and value of fisheries and sideline products in West Lake Fish Farm, 1980-85.

Year/Unit	1980	1981	1982	1983	1984	1985	Annual % change
Fish output (t)	23.0	34.5	62.0	72.5	163.0	184.5	516
Total revenues ('000 yuan)	40.2	55.4	97.5	149.6	424	651	74.5
Total profits ('000 yuan)	15	7.4	28.7	31.6	12.1	205	68.7
Labor from rural area (yuan/person)	108	118	123	165	195	245	17.8
Labor productivity	1,489	1,584	2,787	3,563	8,151	10,850	48.4
Sideline production* (t)	23	73.7	150.3	203.6	254.6	337	717

*Sideline production includes pork, poultry, milk, milk products and tofu products.

Source: Chen et al. 1986

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