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メタデータ	言語: English 出版者: 公開日: 2010-02-16 キーワード (Ja): キーワード (En): 作成者: ラドル, ケネス メールアドレス: 所属:
URL	<a href="https://doi.org/10.15021/00004390">https://doi.org/10.15021/00004390</a>

## Rural Reforms and Household Economies in the Dike-Pond Area of the Zhujiang Delta, China

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### INTRODUCTION

Since April, 1979, following the official adoption of economic reforms passed by the third plenum of the Eleventh Central Committee of the Communist Party, in December, 1978, China has gradually begun to create a mixed economic system in which collectivist and household enterprises co-exist within a socialist framework. Economic reforms first began in the countryside, where, in essence, they decollectivized many agricultural practises, via a responsibility system transformed from *de facto* to *de jure* the status of the individual household as the fundamental rural economic unit, and removed the controls that prevented households from fully marketing their surplus production [RUDDLE 1985; RUDDLE *et al.* n.d.].

As a consequence of those reforms most places in rural China now practise some form of responsibility system, with land and production responsibility contracted either to the household or to the production team. In the economically more advanced provinces more than 90 percent of the farmers employ the household responsibility system [DELFS 1984].

Economically the rural reforms have been highly successful. During the period 1979–83 the value of agricultural production grew at an average annual rate of 7.9 percent, compared with 3.2 percent during the preceding 25 years. Further, rural incomes more than doubled in current prices during the same period. Average rural per capita net income increased by 98.5 percent during

Table 1. Per Capita Rural Incomes  
(Current prices)

(U.S.) \$ (% share)	1978	1981	1983
+250	0	3.2	11.9
150–250	2.4	19.4	34.5
100–150	15.0	34.8	32.9
50–100	49.3	37.9	19.3
0–50	33.3	4.7	1.4
Average annual income	67.8	113.4	157.3

After LI and ZHANG [1984], converted from Rmb and rounded.

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the period 1978–1983, an average annual growth rate of 14.7 percent (Table 1) [LI and ZHANG 1984]. As a consequence the total value of agricultural and sideline products sold on the free market throughout China reached U.S.\$ 46.8 billion in 1983. This was 58 percent greater than in 1978, when the reforms began. In addition, 24 million “specialist households” which concentrate on the production of a single commodity, such as pigs or cotton cloth, have emerged since the reforms.

### AGRO-ECOSYSTEMS AND IMPLEMENTATION OF RURAL REFORMS IN THE ZHUJIANG DELTA

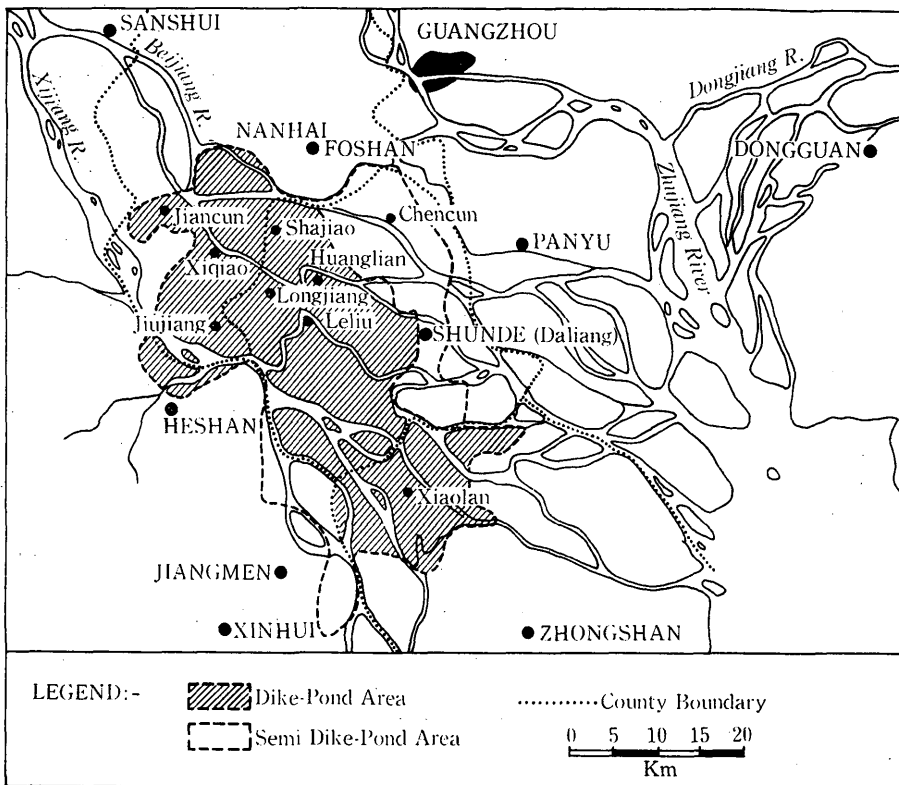
In the Zhujiang Delta of South China an old established and elaborate integrated system of intensive agriculture and the polyculture of carps and other freshwater fishes, which has evolved over the last two millenia, is operated on a geographic and economic scale unmatched elsewhere in the world [RUDDLE 1985; RUDDLE *et al.* 1983; RUDDLE *et al.* n.d.]. This system has been developed over an area of 800 km<sup>2</sup> and supports an estimated population of 1.2 million persons. The system is best developed in the central part of the delta, south of the city of Guangzhou, where it focuses principally on Shunde County and parts of the neighboring counties (Figure 1).

The system is composed of three essential components: fish ponds, mulberry dikes and sugar cane dikes. The ecological heart of this dike-pond system is the fish pond, which is devoted mainly to the polyculture of Cyprinids, the so-called Major or Chinese carps.<sup>1)</sup> Each species has distinct feeding habits and occupies a different niche. Traditionally the ponds were sanitized with quicklime and teaseed cake,<sup>2)</sup> and fertilized to promote the growth of plankton with human, pig and silkworm excrement. The traditionally used fish feeds are Elephant grass (*Pennisetum purpureum*) and sugar refinery waste. Vegetable waste from household kitchens and the crop dikes is also an occasionally used traditional fish feed. Until recently, naturally-occurring fry (“seed fish”) were obtained from local rivers, raised to fingerling size in special ponds operated by the brigade, and then reared to marketable size in the production ponds of each production team.

A range of linked agricultural sub-systems functions on the dikes that surround each pond. In Leliu Commune of Shunde County mulberry (*Morus atropurpurea*), which is inextricably linked with silkworm-rearing (*Bombyx mori*),

1) These are the Grass carp (*Ctenopharyngodon idellus*), Silver carp (*Hypophthalmichthys molitrix*), Bighead carp (*Aristichthys nobilis*), Black or Snail carp (*Mylopharyngodon piceus*), Mud carp (*Cirrhinus molitorella*) and Common carp (*Cyprinus carpio*).

2) Teaseed cake is produced from the crushed seeds of the oil-tea camellia (*Camellia oleosa*). It is composed of 7–8 percent saponin, a hemolytic toxin that kills unwanted, naturally-occurring fish, frog eggs, tadpoles, snails and various aquatic insects that either predate on the stocked fish, are vectors of fish diseases or compete with the fish for feed.



(After RUDDLE *et al.* 1983)

**Figure 1.** Location of the Dike-Pond System in the Zhujiang Delta

and sugar cane (*Saccharum officinarum*) are the main crops cultivated. A wide range of vegetables together with bananas and some fruits is also cultivated [RUDDLE 1985; RUDDLE *et al.* 1983; RUDDLE *et al.* n.d.].

The individual components of the dike-pond system are tightly linked together by energy and materials cycles: plant and animal wastes feed the fish and fertilize the pond; organically rich mud is dug from the pond bottom and spread three times a year as a fertilizer over the dikes; and throughout the year runoff from the dikes gradually returns the mud to the pond bottom, where its nutrients are restored. Apart from natural processes of dissipation, energy and materials are removed from the system only in such economically useful forms such as the fish, silkworm cocoons, sugar cane, vegetables and pigs sent to market [RUDDLE *et al.* n.d.].

Gradually, however, this traditional tight recycling within the dike-pond system is being supplemented by an import of energy and materials from outside sources. This is particularly evident for the pond component, where, increasingly,

the chemical prophylactic dipterex is replacing quicklime and tea-seed cake, and factory-produced concentrated fish feeds are supplanting sugar refinery waste. Nowadays, too, all ponds are stocked with fingerlings reared from fry produced in a hatchery operated by the commune, since, for economic reasons, brigade-level production has been discontinued.

Also in the late-1970s, coinciding approximately with the announcement of the nationwide rural reforms that introduced the household responsibility system and the free market, Guangdong Province was granted considerable autonomy for economic policy-making. In combination both these events led to major socio-economic changes throughout the Zhujiang Delta. Unlike many other parts of China, in the Zhujiang Delta during the period 1979–1983 the household responsibility system was put into operation within the long-established three-tiered communal system of commune, brigade and production team. In this relatively wealthy and highly specialized region of commercial agriculture the adoption of the household responsibility system has been slower than in less commercialized and poorer regions, and local variations in the rate of introduction of the new system are closely related to land use patterns and crop requirements.

In areas of fish and rice cultivation, for example, the three-tier organization remains predominant in making such major decisions as the strict scheduling of the phases of the cropping cycle and in setting quotas. For fish, a highly perishable commodity, firm delivery dates and precise quantities to be supplied are specified in the production contract. Where rice is the dominant crop production team responsibility has been retained, since it is feared that devolution of responsibility to the individual household in areas of extremely high population density would lead to the fragmentation of ricefields, a decline in yields and major infrastructural and administrative problems [RUDDLE 1985; RUDDLE *et al.* n.d.]. Nevertheless, as a consequence of the rural reforms individual households in the Zhujiang Delta now enjoy considerable freedom in deciding how to allocate their own capital, labor and management resources, and since 1980 the formal relationship concerning productive activities between the production team and the individual household has changed dramatically.

The First Production Team of the Nanshui Brigade, Leliu Commune, on which this study focuses, implemented the household responsibility system on a trial basis in 1978, when 7 percent of the team's fish pond area was contracted to individual households. By 1981, 70 percent of the ponds had been contracted in that fashion. Since the results of the experiment with the ponds were so successful, in 1982 all the sugar cane and mulberry dikes were farmed under household contracts, and all silkworm production had been converted to the new system [unpub. stats., Procurement and Records Office, Nanshui Brigade, 1983]. By 1984 all the production team's land was contracted to individual households. As a consequence of adopting the new system, productivity and household incomes

have risen considerably. Household activity schedules and labor inputs have also become more flexible.

## THE FUNCTIONING OF THE HOUSEHOLD RESPONSIBILITY SYSTEM

Implementation of the household responsibility system in the First Production Team of the Nanshui Brigade began with the formation of an informal committee composed of the two team leaders plus several representatives of farmers engaged in the different sub-systems of the dike-pond system. Since the committee is informal and functions only within the production team, it has no fixed period of operation and no strict legal terms of reference. Its function is to advise the formal quota-fixing and other decision-making processes that operate at the brigade level. The committee has four main advisory functions:—

- (i) To determine the dike and pond quality types;
- (ii) To establish minimum productivity levels;
- (iii) To implement and supervise the allocation process; and
- (iv) To negotiate contract periods with individual households.

### (i) THE DETERMINATION OF DIKE AND POND QUALITY

Through long experience all households are familiar with the quality and productive capacity of each pond and dike belonging to the team. Decisions on quality and minimum productivity levels are therefore perceived of as being easily reached.

Two quality-productivity classes are distinguished in this team, based on the following criteria:

- (a) Fish ponds close to the village and therefore highly fertilized through the regular application of human and animal excrement and household waste;
- (b) Ponds further from the village and therefore less highly and regularly fertilized; and
- (c) and (d) Since dike soil fertility depends on that of the adjacent ponds, owing to the quality of the pond mud applied to them, those closer to the village are more fertile than distant dikes.

### (ii) FIXING PRODUCTIVITY LEVELS

Again, through long experience, consensus is easily reached among the team members on this subject. The committee fixes the minimum fish yield of each pond, a quota of fish that must be sold to the team at a uniform “public price”, as well as a minimum monetary quota (“bid price”) that a contracting household must guarantee through its tender to pay to the team from the free market sale of production beyond the quota (*vide infra*). It also establishes the production rate for sugar cane from a specific dike and the silkworm cocoon production rate

based on the quantity of mulberry leaves available from a specific dike area.

(iii) THE ALLOCATION PROCESS

Different processes are employed to allocate dikes and ponds. Dike for mulberry and sugar cane cultivation is allocated by a two-step process. First, the household heads wishing to cultivate these crops draw lots to decide on the quality of land they will receive. Based on that the first quality dikes are then divided among the households entitled to them, apportioned according to household size. The area allocated is based on the "number of mouths to be fed," rather than on the size of the household labor force available. Second quality land is then apportioned in the same fashion. A straightforward formula is applied. If, for example, only two households one having 7 members and the other three are to be allocated first class dike, then 70 percent of the area would be allocated to the first household and the remainder to the second.

Ponds are allocated by calling for separate public tenders for each pond. In its tender a household wishing to operate a pond must specify the amount of fish it will produce from a specific pond during the contract period. The basic minimum quantity of fish established by the committee for each pond must be guaranteed to fulfill the quota for the production team established by the brigade. Any excess beyond that figure belongs to the producing household, which can sell it privately on the free market and at the prevailing and uncontrolled price. In addition, in its public tender a household must guarantee to give the production team a specific amount of money ("bid price") derived from this private sale of the surplus fish. Since there is normally no problem in meeting minimum fish production quota for each pond, it is the amount of cash from the private sales that a household guarantees to give the team that determines whether a tender is accepted.

(iv) NEGOTIATING CONTRACT PERIODS

Contract periods for this team vary from 1-5 years and are negotiated by the committee and individual households based on the time required to maximize productivity from a particular pond or dike. For example, usufruct to a mulberry dike newly replanted by a household will be contracted for a longer period than will an older planting, so that the household may obtain full benefit from its large investment of replanting labor [RUDDLE 1985]. Contract periods are generally negotiated to coincide with the full production cycle of the dominant crop on a particular dike.

**Contract Provisions**

In the Nanshui Brigade contracts between the production team and households are straightforward yet comprehensive. Those for mulberry cultivation, for example, contain eleven basic clauses:-

- (1) mulberry dikes are to be distributed according to household size and labor force;
- (2) The silkworm cocoon quota is to be determined by the area of mulberry dike contracted;
- (3) The household must follow the mulberry crop management plan established by the production team;
- (4) The production team will sell to the household a portion of the total amount of hybrid seedlings required for planting;
- (5) The production team will sell to the household an amount of fertilizer appropriate to its mulberry dike area;
- (6) The perimeter of the mulberry dike may be planted to bananas, spaced 2.5–3 m apart;
- (7) Pond mud must be spread over the dike three times a year, in two “thin” and one “thick” applications;
- (8) The household is eligible for a \$1.6 (U.S.) subsidy for the “rational interplanting” of other crops with its mulberry;
- (9) The household is eligible for a \$2.7 (U.S.) subsidy to purchase the tools required for silkworm-raising for every \$53.7 (U.S.) worth of cocoons produced;
- (10) All silkworm excrement produced by the household’s stock belongs to the household; and
- (11) On expiration of the contract period mulberry plants are to be left *in situ* and weeds eradicated from the dike.

The contract system as operated in the Nanshui Brigade is relatively simple. It establishes levels of productivity and the economic relationship between the contracting household and the production team. It allows for households to establish flexible schedules, all within the agronomic constraints of the crops and crop cycle, while adhering to the team’s management plans for each crop. It also affords scope for individual households to improve their economic situation via free market sales (*e.g.*, of bananas).

The contract also provides for the ecological maintenance of the dike-pond system in terms of both pond and dike quality (fertility levels). This is ensured since the mulberry farmer, for example, is legally required to spread pond mud over his land three times a year. Moreover, because of the fast ecological cycling of materials through the dike-pond system, it is impossible for a contractor to capitalize on the inherent fertility of a pond without making the requisite inputs, since the ecological value of the inputs only lasts for one year (*i.e.*, the pond water is changed annually and the fertile pond mud will be entirely excavated for use on the dikes during the course of a year). Peer pressure acts as a further insurance, for in such a small, tightknit community prying eyes are everywhere and the shirker is quickly taken to task.



## THE CONTRACTING HOUSEHOLD AND THE DIKE-POND SYSTEM

The traditional dike-pond system of the central Zhujiang Delta is now undergoing simultaneously two distinct, comprehensive and continuously deepening changes. In terms of the social organization of production, during the last eight years there has occurred a profound change from a collectivist to a household system of dike-pond management. Hitherto all ponds and dikes within a production team were managed uniformly, whereas now, in response to the new socio-economic conditions, the details of management vary among households. This is, of course, a response to the circumstances of individual household that affect their physical and financial capacity of supply different inputs at different rates, as well as of differing perceptions of the comparative worth of traditional and modern inputs.

The second main change was the institution, as an integral part of the rural reforms, of the free marketing of production beyond established quotas. This has resulted in differential rates of return on household labor, and thus of differences in the ability of individual households to raise capital for investment in the dike-pond system. It has also deepened the differences in the details of dike-pond management practises.

In a previous article [RUDDLE 1985] I have analyzed the labor demand of and supply to the dike-pond system of the Zhujiang Delta under both the collectivized economy and the household responsibility system. With reference to dike-pond capitalization and management, the rate of economic return on labor and household economies, the emerging differences among households as a consequence of the rural reforms are examined in this article for the First Production Team of the Nanshui Brigade, Leliu Commune. Emphasis is placed on the fish pond, since this constitutes the ecological core of the entire dike-pond system. Data were derived from four households, and for continuity and comparison the same households as were analyzed previously are also utilized here [RUDDLE 1985]. The interviews were conducted in August 1983 and all economic data are for 1982, the last complete financial year prior to the time of the interview and the mid-point in the transition from a collectivist economy to the household responsibility system.

In that production team land use is distributed as follows: fish ponds 9.97 ha, sugar cane 6.2 ha, mulberry 2.84 ha, miscellaneous crops 0.66 ha, "dry land" crops 0.92 ha, private plots 0.59 ha, lotus pool 0.26 ha, and bananas 0.13 ha [RUDDLE 1985].

### HOUSEHOLD NO. 1 (HH 1)

#### Land, Pond and Input Resources of Household

This small household, consisting of two adult workers who operate the

dike-pond system in their spare time plus three dependents [RUDDLE 1985], has contracted for only a 0.33 ha fish pond.<sup>3)</sup> It also has a private plot of 0.0059 ha. All farming activities conducted by this household are geared to fulfilling the requirements of its pond (Fig. 2). The private plot and the banks of the pond are planted exclusively to Elephant grass, used as fish feed. In 1982 2.5 t of Elephant grass was put into the pond, 1.5 t from the private plot (254 t/ha) and 1 t from the pond perimeter (Table 2). The household raises 14–15 pigs/yr, principally to supply excrement for its pond. When of marketable size pigs are sold on the free market. Together with human excrement and urine, as well as kitchen and field waste, these two items comprise the inputs to the fish pond

GENERAL ENVIRONMENT

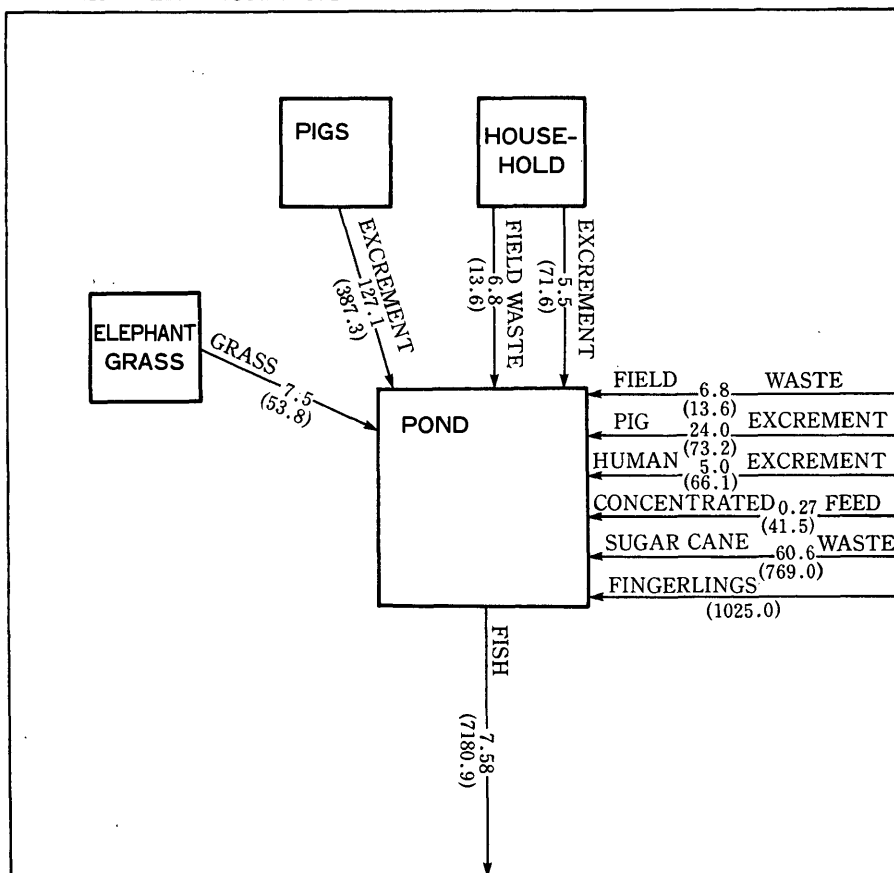


Figure 2. Inputs and Outputs of the Dike-Pond System of HH 1 (Rates in t/ha and (\$U.S./ha); arrowhead indicates flow direction.)

3) In this article all data have been converted from local units and extrapolated as follows: 1 mu=0.066 ha; 1 jin=0.5 kg; and 1 yuan Rmb=0.5076 \$ U.S. (Sept., 1983).

supplied by HH 1 itself.<sup>4)</sup>

Since this household is too small to produce itself all the inputs necessary for even a small pond of 0.33 ha, additional material must be obtained from outside

Table 2. Supply of Inputs to Household Fish Ponds

Input	Extrapolated Application Rate (t/ha/yr)	Actual Application Rates					
		Produced by Household			Supplied Externally		
		(t)	(\$)	(%)	(t)	(\$)	(%)
<b>HOUSEHOLD 1</b>							
Elephant grass	7.58	2.50	50.76	100.0	0.00	0.00	0.0
Pig excrement	151.50	42.00	127.92	84.0	8.00	24.36	16.0
Human excrement	10.60	1.84	24.24	52.5	1.66	21.94	47.5
Kitchen and field waste	13.60	2.25	0.76	50.0	2.25	0.76	50.0
Sugar cane waste	60.60	0.00	0.00	0.0	20.00	253.80	100.0
Concentrates	0.27	0.00	0.00	0.0	0.09	13.70	100.0
Fingerlings	—	0.00	0.00	0.0	—	338.41	100.0
TOTALS	—	—	203.68	—	—	652.97	—
<b>HOUSEHOLD 2</b>							
Elephant grass	12.60	2.50	50.76	100.0	0.00	0.00	0.0
Pig excrement	113.60	22.50	101.52	100.0	0.00	0.00	0.0
Human excrement	25.60	5.07	66.98	100.0	0.00	0.00	0.0
Silkworm waste	8.30	1.66	42.26	100.0	0.00	0.00	0.0
Sugar cane waste	25.20	0.00	0.00	0.0	5.00	50.76	100.0
Concentrates	8.83	0.00	0.00	0.0	1.75	507.61	100.0
Fingerlings	—	0.00	0.00	0.0	—	203.05	100.0
TOTALS	—	—	261.52	—	—	761.42	—
<b>HOUSEHOLD 3</b>							
Elephant grass	25.25	2.50	50.76	100.0	0.00	0.00	0.0
Pig excrement	229.50	22.72	45.68	100.0	0.00	0.00	0.0
Human excrement	30.10	2.98	39.26	100.0	0.00	0.00	0.0
Concentrates	10.10	0.00	0.00	0.0	1.00	152.28	100.0
Fingerlings	—	0.00	0.00	0.0	—	101.52	100.0
TOTALS	—	—	135.71	—	—	253.80	—
<b>HOUSEHOLD 4</b>							
Elephant grass	28.40	3.75	76.14	100.0	0.00	0.00	0.0
Pig excrement	34.09	4.50	13.71	100.0	0.00	0.00	0.0
Human excrement	34.84	4.60	61.04	100.0	0.00	0.00	0.0
Fingerlings	—	0.00	0.00	0.0	—	135.36	100.0
Dipterex	15.15(kg)	0.00	0.00	0.0	2.00(kg)	3.55	100.0
Teaseed cake	60.60(kg)	0.00	0.00	0.0	8.00(kg)	0.73	100.0
TOTALS	—	—	150.89	—	—	139.64	—

the household and the production team, but still from within the dike-pond system. In 1982 the inputs supplied by the household were supplemented by 8 t of purchased pig excrement (16 percent of the total), 1.66 t of human excrement (47.4 percent) and 2.25 t of kitchen and field waste (50 percent).

This household also uses sugar cane waste and concentrated feed, acquired from outside the dike-pond system. The former is obtained from a refinery in the commune that processes sugar cane from the dike-pond system, and the latter, although produced in the commune, is prepared from raw materials from other parts of China. In 1982, 20 t (60.6 t/ha/yr) of sugar waste, and 0.09 t (0.27 t/ha/yr) of concentrated feed were used.

### Household Expenditures for the Fish Pond

In 1982 this household had a total cash expenditure of \$1760 for its pond. Of this, \$1107 (63 percent) was paid to the production team as the "bid price" for the pond contract. The remaining cash outlay was for the purchase of pond inputs. Of these, the two main costs were \$338 for fingerlings (19 percent of expenses) and \$254 for sugar cane waste (14 percent). Other expenditures were \$24 (1.3 percent) and \$21 (1.1 percent) for additional pig and human excrement, respectively, \$0.76 for additional kitchen and field waste, and \$13.7 (0.8 percent) for concentrated feed.

Of the total material inputs made to the pond, 23.8 percent (by value) were generated by the household itself. These entailed an opportunity cost of \$204. The inputs comprised all the Elephant grass (\$51), 84 percent of the pig excrement (\$127), 52.5 percent of the human excrement (\$24) and 50 percent of the field and kitchen waste (\$0.76) (Table 2).

### Pond Production and Rate of Return

The 0.33 ha pond of HH 1 produced 2.53 t of fish in 1982 (7.67 t/ha/yr) (Fig. 2).<sup>5)</sup> To fulfill the quota established for this pond, 0.74 t (29 percent) of the fish was sold to the brigade at the mandatory price of 0.498 \$/kg. This yielded an income of \$368.5 from the entire pond. The balance of 1786.8 kg was then sold at the prevailing free market price of 1.12 \$/kg.<sup>6)</sup> This provided an income of \$2001.2. The total income of HH 1 from fish production in 1982 was \$2369.7, and the net profit yielded by the pond was \$406 (1848 \$/ha) (Table 3).<sup>7)</sup>

4) Based on data supplied by the Biogas Research Unit of Xinbu Brigade, Leliu Commune, the following annual rates by age group have been assumed for human excrement and urine production: 0-7 yrs, 175 kg; 8-15yrs, 350 kg; 16+yrs, 700 kg. Data from the same Unit give 2.7 t/yr per animal as the average production of pig excrement.

5) Production figures for the individual species cultivated were not recorded by any of the households interviewed.

6) These quota and free market prices are applied to all households.

7) Net profit (*i.e.*, return on labor) equals total income less cash costs and opportunity costs.

**Table 3.** Economic Balance Sheet of Household Pond Production

HH No.	Costs (\$)					
	Cash		Opportunity		Total	
	<i>mu</i>	ha	<i>mu</i>	ha	<i>mu</i>	ha
1	351.9	5333.2	40.7	617.2	392.6	5950.4
2	342.1	5183.5	87.2	1320.7	429.3	6504.2
3	257.0	3893.9	90.4	1370.0	347.4	5263.9
4	184.7	2798.5	75.4	1143.1	260.1	3940.9
	Income (\$)					
	Quota Sales		Free Market Sales		Total Sales	
	<i>mu</i>	ha	<i>mu</i>	ha	<i>mu</i>	ha
1	73.7	1116.6	400.2	6064.2	473.9	7180.9
2	73.7	1116.6	394.2	5973.3	467.9	7090.0
3	66.6	1009.6	355.9	5392.4	422.5	6401.4
4	73.5	1113.6	226.2	3427.9	299.7	4541.5
	Net Profit					
	<i>mu</i>	ha				
1	122.0	1847.7				
2	38.6	585.8				
3	75.1	1137.5				
4	39.6	600.6				

### The Household Economy

The 1982 economy of HH 1 is summarised in Table 4. This small household is somewhat atypical in that the "farm" component of its economy is essentially as a lucrative, spare-time sideline. Of a total income of \$1340, 54.5 percent or \$731, consists of the two salaries of the son and daughter-in-law of the household head, neither of which is derived from the dike-pond system.

Nevertheless, the 45.4 percent of the annual income derived from the dike-pond is of major importance to the economy of HH 1. The \$406 derived from fish sales represents 30.3 percent of the total household income, and the \$203 earned by pig sales—essentially a bonus, since they are fed on waste produced by the system and their principal function is to supply waste to the system—constitutes slightly in excess of 15 percent.

The principal expenses incurred, other than those for pond inputs, are also described in Table 4.<sup>8)</sup> The main outlay is for daily foodstuffs other than those

8) Owing to abnormally high medical and hospitalization expenses incurred for the youngest child that year, they must also be regarded as atypical, since these items together, at \$310, accounted for about 30 percent of the 1982 expenditures of this household.

**Table 4.** Annual Income, Expenditures and Savings of HH 1  
(U.S.\$)

Item	Amount	% of income/ expenditure	
<b>sources of income</b>			
Net profit on fish sales	406		30.3
Net profit on pig sales	203		15.1
Son's salary	487		36.3
Daughter-in-law's salary	243		18.2
<b>TOTAL</b>	<b>1340</b>		<b>99.9*</b>
<b>expenditures</b>			
Food	365.4	(27.2)	35.2
Chinese New Year	162.4	(12.1)	15.6
Consumer durables	142.1	(10.6)	13.7
Clothing	55.8	(4.1)	5.3
Hospitalization	106.6	(7.9)	10.3
Medicines	203.4	(15.1)	19.6
<b>TOTAL</b>	<b>1035.7</b>	<b>(77.0)*</b>	<b>99.7*</b>
<b>savings</b>	<b>305</b>	<b>(22.7)</b>	<b>—</b>

\* Computation and currency conversion rounding error

( ) Percentage of income

produced by the household. At \$365 (approximately \$1/day) this item accounted for 35 percent of household expenditures. The second largest was for special foods and ritual requisites needed to celebrate Chinese New Year, the highpoint in the annual cycle of the Chinese family. This item absorbed \$162, or nearly 16 percent of the annual household expenditure.<sup>9)</sup> Consumer durables, now avidly sought throughout the region, accounted for \$142, or almost 14 percent of total expenditures and \$55, 5 percent, was spent on clothing.

About \$305, or some 23 percent, of the net annual income was saved in 1982. Savings and the amount spent on consumer durables would have been greater were it not for abnormal medical bills.

## HOUSEHOLD NO. 2 (HH 2)

Far more complex and representative of the dike-pond system than those of HH 1 are the family farming operations and ancillary occupations of HH 2. This is a large, 9-member household only three members of which are fully

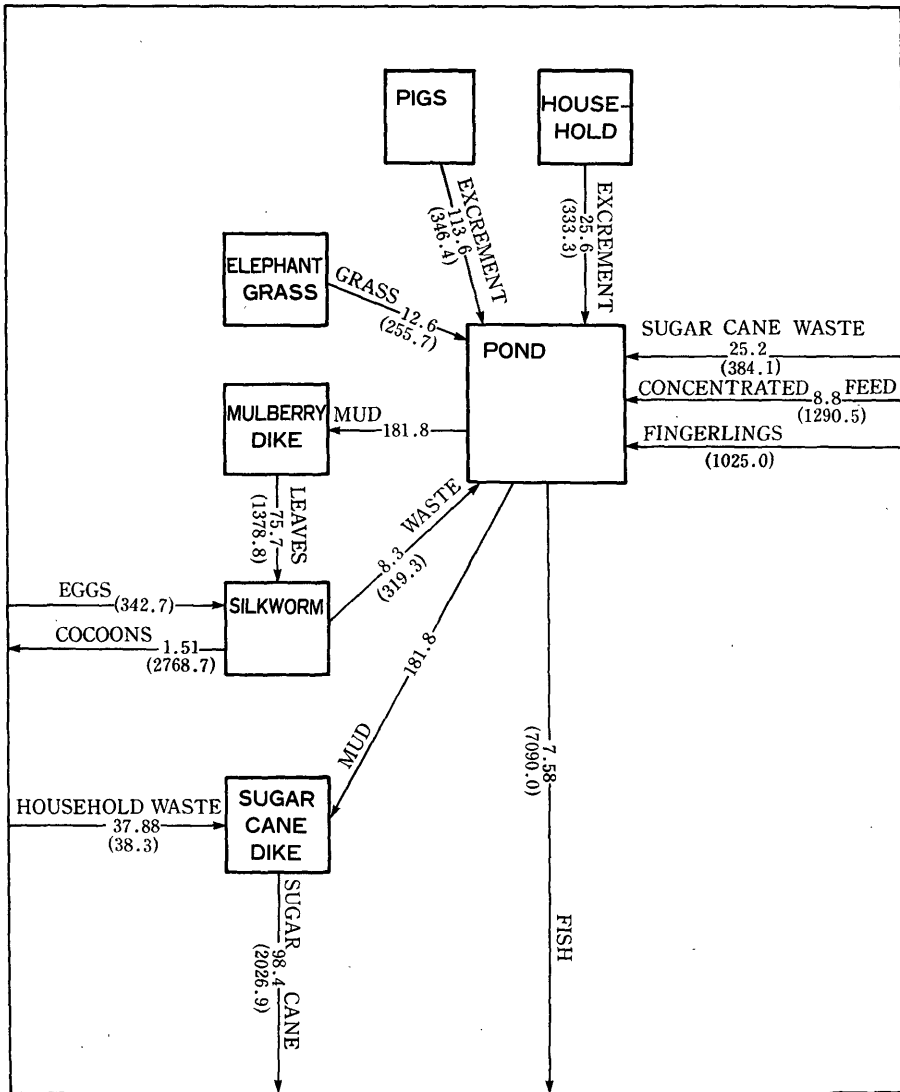
9) Costs for celebrations other than the New Year might also be included, although none were specifically mentioned by the informant (the daughter-in-law), unlike the informants in other households.

involved in the dike-pond system. The members of HH 2 perform a varied range of economic activities both directly related to and quite separate from the dike-pond system. Three other adults work full-time as laborers outside the system and there are three dependents [RUDDLE 1985].

**Land, Pond and Input Resources of the Household**

The area contracted to this household is fully representative of the dike-pond system

GENERAL ENVIRONMENT



**Figure 3.** Inputs and Outputs of the Dike-Pond System of HH 2 (Rates in t/ha and (\$ U.S./ha); arrowhead indicates flow direction.)

system since it operates all the essential components of the system and all are linked by material, energy and labor flows (Fig. 3). The total dike-pond area of HH 2 is 0.515 ha, of which 0.198 ha (38.5 percent) is pond, 0.165 ha (32 percent) under sugar cane, 0.132 ha (25.6 percent) planted to mulberry and 0.02 ha (3.9 percent) is the private plot.

This household is large enough to supply from its own activities all pond inputs except sugar cane waste, concentrated feed and fingerlings (Table 2). Twelve pigs are reared each year on the private plot, mainly to supply excrement for the pond. They produce 22.5 t/yr of excrement, all of which is input to the pond (at 113.6 t/ha/yr). The entire 5.07 t/yr of human excrement produced by HH 2 also goes into the pond (at 25.6 t/ha/yr). The 1.66 t/yr of silkworm excrement and mulberry leaf waste from the household's silkworms is also put into the pond (at 8.38 t/ha/yr). No kitchen and field waste is applied to this pond. Two-and-a-half tons of Elephant grass, cultivated around the perimeter of the pond, is used as fish feed (at 12.6 t/ha/yr). No additional quantities of these inputs are purchased.

All other pond inputs are purchased. Five tons of sugar cane waste is supplied (at 25.2 t/ha/yr) and 1.75 t of concentrated feed is used (at 8.8 t/ha/yr). Fingerlings are also purchased from the brigade.

Apart from the application of mud dug from its own pond, household waste is the only input made to the 0.165 ha of sugar cane dike contracted by HH 2. The entire annual supply of 6.25 t is purchased and applied to the dike at a rate of 37.88 t/ha/yr.

Inputs for the mulberry dike, which has not been replanted since the implementation of the household responsibility system, are limited to pond mud and fertilizer. The latter is obtained free of charge from the production team. The 0.132 ha of mulberry dike contracted to HH 2 yields 3.0 t/yr of leaves. HH 2 meets the entire silkworm feed requirements from its own mulberry dike. Sixteen sheets of silkworm eggs, the other principal input required for silkworm production, are purchased from the commune.

The 0.02 ha private plot allocated to HH 2 is planted to bananas and vegetables. All vegetables are consumed by the household whereas most of the bananas are sold on the free market.

### **Household Expenditures for System Inputs**

As exemplified by HH 2, input costs are relatively low in the traditional form of this highly integrated dike-pond system, where the waste outputs of one component constitute inputs for others. Only now that the dike-pond system is becoming more open are large cash expenses being incurred for inputs.

In 1982 the total cash outlay by HH 2 for its pond was \$1026.3. Of this, \$264.9 (25 percent) was the bid price for the contract and \$761.4 was for material inputs (Table 2). The largest expense, \$507.6 (50 percent), was for concentrated



feed. Fingerlings cost \$203 (20 percent) and sugar cane waste \$50.8 (5 percent). An opportunity cost of \$261.5 was incurred on the four principal pond inputs (*i.e.*, for Elephant grass, pig excrement, human excrement and silkworm waste).

Expenses for purchased inputs for the dike components of the system were relatively minor. Household waste, the only purchased input made to the sugar cane dike, cost 1.01 \$/t. This household applied 6.25 t at a total cost of \$6.3 (38.3 \$/ha/yr). No purchased inputs were made in 1982 to the mulberry dike, but \$22.6 was spent for 16 sheets of silkworm eggs.

### Pond Production and Rate of Return

The 0.198 ha pond of HH 2 yielded 1.5 t of fish in 1982 (7.58 t/ha/yr). Quota sales of 0.44 t (about 30 percent of the total production) produced an income of \$221, and the balance sold on the free market produced \$1182.7. The total income from fish production in this household was \$1403.7. The net profit earned on the pond was therefore \$116 (Table 5).

### Production and Rate of Return of the Sugar Cane Dike

This household contracted for 0.165 ha of sugar cane dike, from which it

Table 5. Annual Income, Expenditures and Savings of HH 2  
(U.S.\$)

Item	Amount	% of income/ expenditure	
<b>sources of income</b>			
Net profit on fish sales	166.0		3.9
Net profit on cocoon sales	407.0		13.6
Net profit on sugar cane sales	328.0		11.0
Net profit on pig sales	152.2		5.1
Net profit on banana sales	152.2		5.1
First son's salary	761.4		25.5
Fourth son's salary	761.4		25.5
Daughter-in-law's salary	304.5		10.2
<b>TOTAL</b>	<b>2982.7</b>		<b>99.9*</b>
<b>expenditures</b>			
Food and consumer items	1827.4	(61.3)	68.3
Chinese New Year	507.6	(17.0)	19.0
Clothing	203.0	(6.8)	7.6
Consumer durables	137.0	(4.5)	5.1
<b>TOTAL</b>	<b>2675.1</b>	<b>(89.6)*</b>	<b>100.0</b>
<b>savings</b>	<b>307.7</b>	<b>(10.3)*</b>	<b>—</b>

\* Computation and currency conversion rounding errors

( ) Percentage of income

**Table 6.** Economic Balance Sheet of the Dike Component of HH 2

Item	\$/mu	\$/ha
(1) <b>sugar cane</b>		
Cash costs	2.53	38.33
Opportunity costs	0.00	0.00
<b>Total costs</b>	<b>2.53</b>	<b>38.33</b>
Income	133.77	2026.92
Net profit	131.24	1988.59
(2) <b>mulberry-silkworms</b>		
Cash costs	11.40	342.70
<b>Total costs</b>	<b>11.40</b>	<b>342.70</b>
Income from cocoons	182.74	2768.70
Net profit	171.34	2426.09
Total costs for dike component	13.93	381.03
Total income from dike component	316.51	4795.71
Total net profit on dike component	302.58	4414.68

produced 16.25 t of cane in 1982 (98.49 t/ha/yr). With that of all other households in the production team the sugar cane from HH 2 was sold to the local refinery at a controlled price of 20.58 \$/t. This yielded an income of \$334.4 (\$2026.9/ha/yr).

At \$6.3 (\$38.3/ha/yr), expenses incurred for purchased inputs to the sugar cane dike were minimal. Thus HH 2 made a net profit of \$328 (\$1988.5/ha/yr) on the sugar cane component of its dike-pond operation (Table 6).

### Production and Rate of Return of the Mulberry Dike and Silkworm Component

HH 2 operates a 0.132 ha tract of mulberry dike, the leaf production of which is consumed entirely by the household's silkworms. Although the principal objective is to produce leaves, an important secondary product is silkworm excrement and mulberry leaf waste for the pond.<sup>10)</sup>

HH 2 produces 10.0 t of leaves (75.8 t/ha/yr). This, in turn, converts into 0.2 t of silkworm cocoons (1.51 t cocoons/ha of mulberry/yr).<sup>11)</sup> In addition, 1.67 t of waste is produced annually by the 8 crops of silkworms reared. This has an opportunity cost of \$42.26.

Five crops of multivoltine worms are raised. Each requires a total of 0.3 t

10) This objective has now less important for many households since concentrated fish feeds became locally available.

11) This is a valid extrapolation, since in the Zhujiang Delta cocoon production potential is reckoned empirically in terms of mulberry area.

of mulberry leaves and yields 0.153 t of waste for pond use. Three crops of bivoltine worms are also raised. Each requires 1.0 t of leaves and produces 0.3 t of waste.

Income from cocoon sales averages \$45.7 per harvest, or \$365.5 for the year. Since \$42 is saved by not having to purchase silkworm waste for the pond, in HH 2 the total value of silkworm-raising \$407/yr. The household's mulberry leaf production is thus worth 41 \$/t (\$3088.73/ha/yr) (Table 6 and Fig. 3).

### Private Plot Yields

The 0.02 ha private plot of HH 2 is used to satisfy the household's vegetable requirements and to produce bananas for sale. Production rates were not determined. A dozen pigs are also raised for excrement production and sold on the free market each year. They are fed with kitchen and field waste from the household (which in HH 2 is not applied directly to the pond).

For the integrated dike-pond system operated by HH 2, total costs (cash and opportunity) were \$1316.7 and total income was \$2408.1. The net profit in 1982 was therefore \$1091.4 (4677 \$/ha).

### The Household Economy

The economy of HH 2 is summarised in Table 5. Noteworthy is that the three full-time wage earners together generate 61.3 percent of the household's total annual income. Further, if the 9.5 percent of the household income derived from the sales of bananas and pigs is subtracted, the dike-pond system generates only 28.5 percent of the income of HH 2. In this household the three dike-pond components contribute almost equally to the total income: pond 12 percent, sugar cane 11 percent and mulberry-silkworm 10 percent.

As in HH 1, food is the principal item of expenditure in HH 2. Together with other daily consumer items, food accounts for 68 percent of all household expenditures and absorbs 57 percent of the total income. Expenses for Chinese New Year celebration comprise the second largest item in the budget, although in this case this item included the expenses of birthdays and other celebrations. Relatively minor items in the budget of HH 2 are clothing and consumer durables. The former accounted for 7 percent of income or 5 percent of expenses and the latter for 4 and 5 percent, respectively. In this household almost 10 percent of the income (\$307.7) was saved in 1982.

### HOUSEHOLD NO. 3 (HH 3)

Another relatively simple dike-pond operation is conducted by the small HH 3. Although the dike-pond area contracted is also small, unlike HH 1 this household operates the complete range of dike-pond activities, except silkworm-raising. Like HH 1, in this one, too, the dike-pond is operated part-

time, since its two "able-bodied" members have other full-time occupations. Four dependents comprise the remaining members of this household.

**Land, Pond and Input Resources of the Household**

As in HH 2, this household's dike-pond operations are representative of the system in that they constitute the full assemblage of linked, complementary components (Fig. 4). The total area contracted for amounts to 0.245 ha. In addition, the household has an allocated 0.01 ha private plot. The contracted area comprises 0.146 ha of dike, 0.106 ha (72.6 percent) of which is under sugar cane and 0.04 ha (27.4 percent) planted to mulberry. The pond area is 0.099 ha.

Other than the purchase of fingerlings and concentrated fish feed (Table 2), this household generates all pond inputs from its own activities. Apart from the application of pond mud, neither purchased nor household-generated inputs are

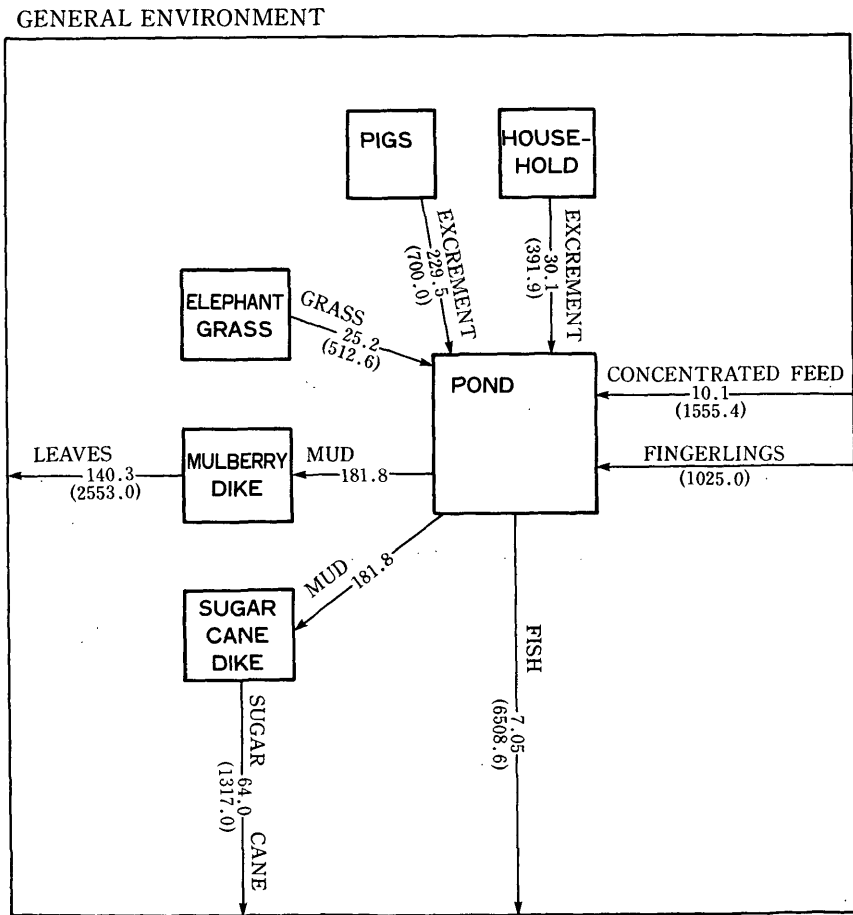


Figure 4. Inputs and Outputs of the Dike-Pond System of HH 3 (Rates in t/ha and (\$ U.S./ha); arrowhead indicates flow direction.)

made to its dikes. Since HH 3 does not rear silkworms there is no purchase of eggs.

Ten pigs are raised *per annum* on the private plot and their total excrement production of 22.72 t is input to the fish pond, (229.5 t/ha/yr). To that is added the household yield of 2.98 t of human excrement (30.1 t/ha/yr). No other waste products are applied to this pond.

The fish are fed with Elephant grass and concentrated feed. The total supply of the former, 2.5 t (25.25 t/ha/yr), is cultivated around the perimeter of the pond. The 1.0 t (10.1 t/ha/yr) of concentrated feed supplied is purchased from the commune factory. As with all other households in this team, fingerlings are purchased from the brigade. No other pond inputs are supplied, and in common with the preceding two households, HH 3 uses no prophylactics in its pond.

### Household Expenditures for System Inputs

In 1982, HH 3 incurred cash costs of \$385.5 for the operation of its pond. Of this, \$132.5 (34 percent) was paid as the bid price and \$253 was spent for pond inputs: \$101 (26 percent) for fingerlings and \$152 (39 percent) concentrates. An opportunity cost of \$135 was incurred on the inputs generated by the household (Table 2). Total costs for the pond thus amounted to \$520.5 (5263.9 \$/ha).

### Pond Production and Rate of Return

This 0.099 ha pond produced 0.7 t of fish (7.05 t/ha/yr) in 1982. Quota obligations were fulfilled by the sale of 0.222 t (31.7 percent), which yielded an income of \$110. The balance sold on the free market for a total of \$533.8. Thus the total income of fish sales was \$644.3, and the net profit was \$123.8 (1137.5 \$/ha) (Table 7).

### Production and Rate of Return of the Dike Component and Private Plot

The remainder of the income of HH 3 from the system was derived from the sale of sugar cane and mulberry leaves to the production team. Since the private plot is entirely planted to sugar cane, the total area under this crop is 0.116 ha. It yielded a total of 7.42 t (64 t/ha/yr), which was sold at 20.58 \$/t and produced an income of \$152 (1317 \$/ha/yr). This was all net profit since no inputs were made to the dike.

The 0.04 ha planted to mulberry yielded 5.6 t of leaves (140.3 t/ha/yr), which was sold at the public price of 18.2 \$/t. This produced a net profit of \$101.5 (2553 \$/ha).

In addition to sugar cane, 10 pigs were produced on the private plot. Excluding the value of their excrement for the pond, they yielded a profit of \$330, since other than kitchen and field waste no inputs were made for them.

Total costs of the integrated dike-pond operation of HH 3 were \$520.5, and income was \$1227.8. The net profit was \$707.3 (2896.6 \$/ha).

**Table 7.** Annual Income, Expenditures and Savings of HH 3  
(U.S.\$)

Item	Amount	% of income/ expenditure	
<b>sources of income</b>			
Net profit on fish sales	123.8		8.1
Net profit on pig sales	329.9		21.7
Net profit on sugar cane sales	152.2		10.0
Net profit on mulberry leaf sales	101.5		6.7
Household head's salary	507.6		33.4
Wife's salary	304.5		20.0
<b>TOTAL</b>	<b>1519.5</b>		<b>99.9*</b>
<b>expenditures</b>			
Food	609.1	(40.0)	68.5
Chinese New Year	152.2	(10.0)	17.1
Consumer durables	50.7	( 3.3)	5.7
Clothing	76.1	( 5.0)	8.5
<b>TOTAL</b>	<b>888.3</b>	<b>(58.3)</b>	<b>99.8*<sub>1</sub></b>
<b>savings</b>	<b>631.4</b>	<b>(41.5)</b>	

\* Computation and currency conversion rounding errors.

( ) Percentage of income.

### The Household Economy

The economy of HH 3 is summarized in Table 7. As in the previous two households, salaries earned outside the dike-pond system play a major role in the budget. In this case those of the household head and his wife combined provide \$812, or 53 percent of the total income. The spare time operation of the dike-pond system added \$645 (24 percent), and pigs provided \$329 (21 percent) of the total income.

Like the previous two households, food is the principal expense incurred. In this case additional food purchased beyond that produced by the household, together with such consumer items as tobacco, matches, candles and the like (specified by the informant as included within this category) required the expenditure of \$609. This was nearly 69 percent of total expenditure and slightly more than one-third of the household's income.

Again, the second largest expense was for the Chinese New Year and other celebrations. This absorbed \$152, or 8 percent of the household income and accounted for 17 percent of expenditure.

Clothing and consumer durables were rather minor items in the budget of HH 3. Only \$76 was spent for the former (5 percent of income and 9 percent of total expenditures), and \$51 (3 percent of income and 5 percent of total expenses) was spent on the purchase of consumer durables.

In all this household spent \$888 or 58 percent of its annual income in 1982. The remaining 42 percent was saved.

**HOUSEHOLD NO 4 (HH 4)**

**Household Composition and Occupations**

All members of this household are involved in dike-pond operations at least part-time. There are also three dependents, and two adults have full-time local employment outside the dike-pond system [RUDDLE 1985].

**Land, Pond and Input Resources of the Household**

The dike-pond area contracted by HH 4 amounts to 0.548 ha. Of this, GENERAL ENVIRONMENT

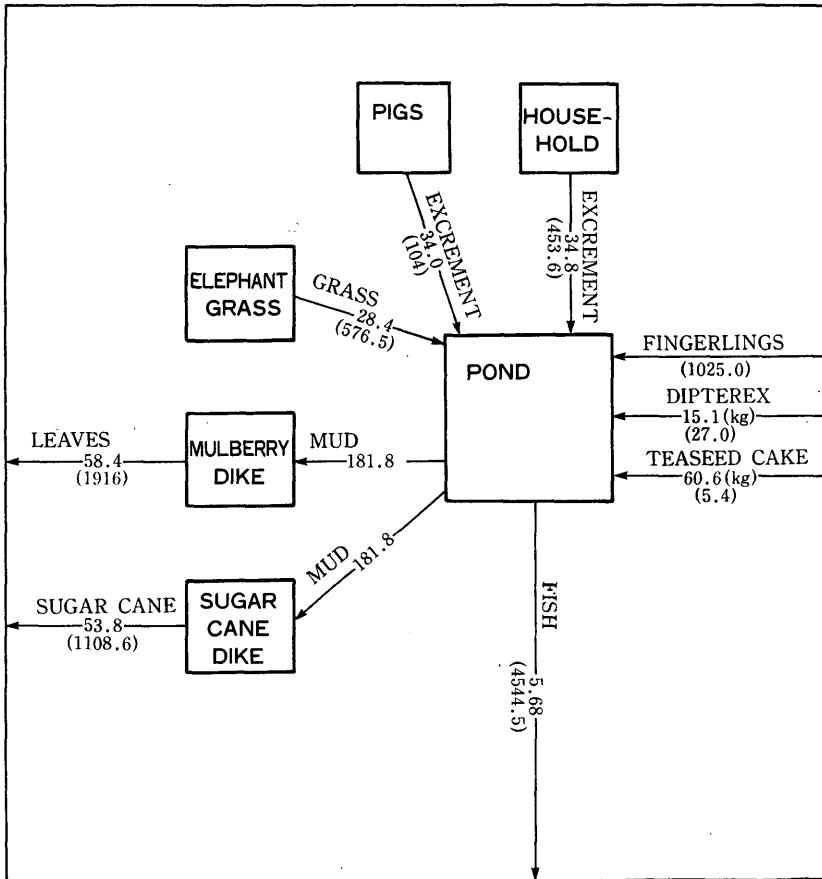


Figure 5. Inputs and Outputs of the Dike-Pond System of HH 4 (Rates in t/ha and (\$U.S./ha); arrowhead indicates flow direction.)

0.132 ha (24.09 percent) is the pond, 0.119 ha (21.71 percent) is dike planted to mulberry and 0.297 ha (54.19 percent) is dike under sugar cane. Bananas are cultivated along the edges of the dikes and together with sugar cane on the 0.09 ha private plot.

Other than fingerlings and pond prophylactics, which are purchased, all pond inputs are generated by this household (Table 2, Fig. 5). Only three traditional inputs are used in fish production; elephant grass, pig excrement and human excrement. Since HH 4 does not raise silkworms, no waste from that operation is available. Neither sugar cane waste nor concentrated feed is used. Unlike the other three households, however, HH 4 does apply two prophylactics to its pond; the traditionally used teaseed cake and the modern dipterex.

The entire 3.75 t (28.4 t/ha/yr) of Elephant grass supplied to this household's pond is, as usual, cultivated around the pond perimeter. Similarly, the full 4.5 t (34.09 t/ha/yr) of pig excrement and the entire 4.6 t (34.84 t/ha/yr) of human excrement applied to the pond are supplied by the household. Only small amounts of pond prophylactics are used; 8.0 kg of teaseed cake (60.6 kg/ha/yr) and 2.0 kg of dipterex (15.15 kg/ha/yr). Other than pond mud supplied from the household's own pond no inputs are made to the dikes.

### **Household Expenditures for System Inputs**

Cash costs incurred by HH 4 for its dike-pond operation amounted to \$369.6. Of this, \$230 (62 percent) was the bid price. The balance was for material inputs; \$135.3 (36 percent) for fingerlings and \$4.3 for pond prophylactics. An opportunity cost of \$150.8 was incurred for the Elephant grass and human and pig excrement generated by the household. The total operating cost for this pond in 1982 was therefore \$520.

### **Pond Production and Rate of Return**

The 0.132 ha pond contracted by this household produced 0.75 t of fish in 1982 (5.68 t/ha). To meet the quota for this pond, 296 kg (39.47 percent) was sold at the public price. This produced an income of \$147.4. Forty kilograms were consumed by the household (at an opportunity cost of \$19.9) and the balance of 404 kg (54 percent of the total yield) was sold on the free market. This yielded an income of \$452.4. HH 4 thus obtained a total income from fish sales of \$600 (4544.5 \$/ha/yr). Since costs amounted to \$540, the net profit on this household's pond operation was \$80 (Table 8).

### **Production and Rate of Return on the Dike Component and Private Plot**

The balance of this household's income from the dike-pond system is obtained from the sale of sugar cane, mulberry leaves and bananas. The 0.387 ha of dike and private plot planted to sugar cane produces 20.9 t (53.87 t/ha/yr). The entire production was sold to the production team at the fixed price of \$20.58/t



**Table 8.** Annual Income, Expenditures and Savings of HH 4  
(U.S.\$)

Item	Amount	% of income/ expenditure
<b>sources of income</b>		
Net profit on fish sales	80.0	3.4
Net profit on pig sales	30.4	1.3
Net profit on sugar cane sales	430.5	18.3
Net profit on mulberry leaf sales	228.4	9.7
Net profit on banana sales	304.5	13.0
Household head's salary	609.1	26.0
First daughter's salary	406.0	17.3
Second daughter's salary	253.8	10.8
<b>TOTAL</b>	<b>2343.0</b>	<b>99.8*</b>
<b>expenditures</b>		
<b>TOTAL**</b>	1827.5	(73.2)
<b>savings</b>	515.5	(21.3)

\* Computation and currency conversion rounding error

\*\* Informant unable to disaggregate data

( ) Percentage of income

and produced an income of \$430.5 (1108 \$/ha).

The 0.119 ha under mulberry yielded 6.94 t of leaves (58.42 t/ha/yr), which produced an income of \$228 (1916 \$/ha). Bananas planted at the edges of the dikes, and at the borders of the private plot, yielded 1.5 t of fruit, which was sold on the free market for \$305.

Since neither cash nor opportunity costs were incurred in dike cultivation, the total income of \$963 derived from these components together constitutes net profit. The total net profit on the dike-pond operation of HH 4 was \$1023.

### The Household Economy

As with the preceding households, in HH 4 salaries earned outside the dike-pond system constitute a major item in the budget. The two full-time salaries of the first and second daughters plus that earned by the household head together amount to \$1269 and comprise almost 55 percent of the total household income (Table 8).

Slightly less than half the household's income, or \$1054, is derived from the dike-pond system. The bulk of this, 91 percent, is obtained from the sugar cane, mulberry leaves and bananas. The pond yields only 2.5 percent of the total household income. Income from the sale of pigs, kept by this household almost solely as a source of excrement for the pond, constituted only minor source of income, yielding \$30, or just 1.3 percent of the total.

The total expenses of this household amounted to \$1827 in 1982.<sup>12)</sup> Savings for the year were \$495.5, or 21.3 percent of the total income.

### SUMMARY OF THE HOUSEHOLDS

As is to be anticipated in a traditional system undergoing such a profound organizational and economic transition, details of dike-pond management vary among households. This is particularly clear for pond management, which offers a wider scope for selection from a range of inputs than do the dikes. Here variations in household management are compared with respect to the fish ponds. This comparison is limited to ponds only because this component is the ecological key to the dike-pond system and because all four households have contracted fish ponds, whereas all of them do not operate all the other sub-systems, and because variation in the inherent fertility of different dikes was not measured.

#### The Supply of Materials Input to Fish Ponds

The application rate of all excrements combined (pig, human and silkworm) applied to ponds varies considerably, from a high of 259 t/ha/yr in HH 3 to a low of 68 t/ha/yr in HH 4 (Table 9). All households fertilize their ponds with human and pig excrement, but only HH 2 (the only one rearing silkworms) uses

**Table 9.** Costs and Rate of Return on Pond Inputs for the Four Households

HH	Cash Costs							
	a: Excrements		b: Feedstuffs		c: Fingerlings	d: Prophylactics		Total
	t/ha	\$/ha	t/ha	\$/ha	\$	kg/ha	\$	\$/ha
1	162	597	82	969	1025	0	0	2591
2	147	1063	46	3876	1025	0	0	5967
3	259	857	35	2050	1025	0	0	3932
4	68	566	28	577	1025	76	32	2200
	Total Opportunity Costs		Net Profit		Fish Yield		Total Conversion Rates	
	\$/ha		\$/ha		t/ha	\$/ha	t/ha	\$/ha
1	613		4590		7.57	7181	32:1	1:2.7
2	1319		1123		7.57	7090	25:1	1:1.2
3	1369		2577		7.05	6509	41:1	1:1.7
4	1141		3403		5.6	4544	17.1:1	1:2.0

"Bid prices" excluded

12) Unfortunately, since records were not kept by this household, this figure cannot be disaggregated.

silkworm excrement in its pond. Apart from HH 1, which purchases 16 and 47.5 percent of its pig and human excrement input, respectively, all households generate their own supplies of these pond fertilizers. Application rates vary and depend on the number and ages of household members and on the number of pigs reared. HH 3 uses the most pig excrement, at 229.5 t/ha/yr, and HH 4 the least, at 34 t/ha/yr. At 34.8 t/ha/yr, HH 4 applies the most human excrement and at 10.6 t/ha/yr HH 1 uses the least.

There is a similar wide range in the rates at which fish feeds are supplied, from 82 t/ha/yr by HH 1 to 28 t/ha/yr by HH 4 (Table 9). Total input costs (including opportunity costs) range from 5967 \$/ha/yr, in HH 2, to 2200 \$/ha/yr in HH 4 (Table 9). All households use Elephant grass as fish feed and in all cases the supply is obtained entirely from dikes contracted by the households or from their private plot, or a combination of both. No Elephant grass is purchased. Application rates vary from 28.4 t/ha/yr by HH 4 to 7.5 t/ha/yr by HH 1 (Table 2).

Only HH 1 uses the inexpensive kitchen and field vegetable waste as fish feed. Half is generated by the household and half purchased. It is applied at a rate of 13.6 t/ha/yr.

HH 1 and HH 2 use sugar cane waste as a fish feed, the former supplying it at a rate of 60.6 t/ha/yr and the latter at 25.2 t/ha/yr. All households except HH 4 provide purchased concentrated feed. HH 2 and HH 3 are heavy users, supplying it at rates of 8.8 and 10.1 t/ha/yr, respectively, whereas at 0.27 t/ha/yr, HH 1 uses an extremely small quantity. Only HH 4 uses pond prophylactics, both of which are purchased. As with all households in this production team, these four purchase their entire supply of fingerlings.

In terms of the pond component, the traditional dike-pond system is most strongly adhered to by HH 1, which uses only an insignificant quantity of concentrated feed and depends almost entirely on the use of a full range of traditionally used inputs, with the exception of silkworm waste. Apart from its use of modern prophylactics and the lack of a sugar cane waste input, HH 4 also basically operates its pond according to the traditional system. Elephant grass is the only feed supplied.

HH 2 and HH 3 represent transitional stages. The former loads its pond heavily with the full complement of excrements generated by the system. It also supplies both sugar cane waste and a high rate of concentrated fish feed in addition to the traditionally used Elephant grass. HH 3, on the other hand, has discarded more of the traditional inputs and has substituted concentrated feed entirely for sugar cane waste.

Because of the extremely high relative cost of concentrated fish feeds the traditional system has the highest rate of economic return. HH 1 and HH 4, which make only insignificant and no use of concentrated feed, respectively, have the lowest rate of total input costs and the highest rate of return on their working

capital. For every dollar input, HH 1 has a rate of return of \$2.7 and HH 4 a return of \$2.0. Conversely, HH 2, which has both a high rate of concentrate application, at 8.8 t/ha, and the highest total input costs, at 5967 \$/ha, has the lowest economic rate of return. For every dollar HH 2 expends on pond inputs, \$1.2 is returned. In HH 3 input costs are the second highest, at 3932 \$/ha, and the economic rate of return the second lowest, at \$1.7 for every dollar's worth of inputs supplied.

A different situation emerges, however, when a comparison is made of the efficiency with which each household pond converts the material input to fish (Table 9). Although yielding the highest economic rate of return, the pond of HH 1 is the second least efficient converter of inputs. In that pond total material inputs are converted at a ratio of 32 : 1. The pond contracted by HH 3, in which a high rate of concentrates is added to high rates of traditional inputs, is the least efficient, with a conversion ratio of 41 : 1 [RUDDLE, DENG and LIANG 1986].

The most efficient conversion of materials occurs in the pond of HH 4—the most traditional—where the conversion rate is 17.1 : 1. A relatively efficient overall conversion rate occurs in the pond of HH 2, at 25 : 1. In that pond the excrement loading rate and rate of concentrated feed application is the highest among the four households.

### Household Economies

The Zhujiang Delta has long been known as one of the richest rural regions of China. Ignoring gross family incomes, which are obviously a factor of family size, dependency rates and the ability to secure jobs external to the dike-pond system, the 1982 per capita income distributed among all household residents ranged from a low of \$253 in HH 3 to a high of \$331 for HH 2 (Table 10). Even the lowest figure is far higher than the \$152 (1983) given by LI and ZHANG [1984] as the average per capita rural income in China (Table 1).

However, since dependency ratios are high, ranging from 60 percent in HH 1 to 33 percent in HH 2, these income figures are considerably distorted (Table 10). The more realistic figure of net income per "able-bodied" worker is vastly greater, at \$670, \$497, \$455.8 and \$464.6 (HHs 1–4, respectively).

Also noteworthy is the high rate of savings, which ranges from a low of 10.3 percent of net income in HH 2 to a high of 41.5 percent in HH 3. In part this high rate may be explained by the relative absence of goods and services on which to spend disposable income and partially by purposive saving for the future acquisition of major and expensive consumer durable items as well as for the improvement of housing. That may be inferred from the percentage distribution of household expenditures, in which for every household the rate for consumer durables is low (ranging from 13.7 to 3.3 percent), and from the observation that most households in the production team have already acquired the basic and cheaper durable items, such as portable electric fans, ceiling fans, black-and-

Table 10. Summary of Household Economics

	HH 1	HH 2	HH 3	HH 4
Household size	5	9	6	8
No. of dependents	3	3	3	3
Dependency rate	60	33	50	37.5
Net income (\$)	1340.0	2982.7	1519.5	2323.0
% non-d-p system	54.6	61.3	53.4	54.6
Income per capita (\$)	268.0	331.0	253.2	290.4
Income per worker (\$)	670.0	497.0	455.8	464.6
Expenditures (\$)	1035.7	2675.0	888.1	1827.5
% income spent	77.0	89.7	68.5	73.2
Expend. per cap. (\$)	207.0	297.0	148.0	228.4
Savings rate	22.7	10.3	41.5	21.3
Savings per cap. (\$)	61.0	34.2	105.2	61.9
% spent for food	35.2	61.7	40.0	n.a.
% spent New Year	15.6	17.0	10.0	n.a.
% spent clothing	5.3	6.8	5.0	n.a.
% spent con. dur.	13.7	4.5	3.3	n.a.
Per cap. food exp. (\$)	73.0	203.0	101.5	n.a.
Per cap. NY exp. (\$)	32.4	56.4	25.4	n.a.
Per cap. cloth. exp. (\$)	11.1	22.5	12.6	n.a.
Per cap. con. dur. exp. (\$)	28.4	15.2	8.4	n.a.

white televisions, electric rice cookers, cassette recorders, radios, bicycles, large pieces of furniture, and the like.

Although there is a considerable range in the rate of expenditure, the households show a strong similarity in the percentage distribution of expenditures. Foodstuffs, a category that includes other necessary daily consumer items, are in all cases the principal item of expenditure. This ranges from 61 percent of the expenditures in HH 2 to 35 percent in HH 1. The rate in HH 1 would probably be similar were the son of the householder present full-time and if his wife did not receive some of her meals at the school in which she is the cook.

Cash outlays for Chinese New Year and other village celebrations range from 10 to 17 percent of household expenditures. These expenses are largely for special foodstuffs and reflect both the importance of this family-oriented celebration and the Chinese penchant for feasting.

Expenses for clothing are relatively low, comprising 5-7 percent of family expenditures. This remains essentially a minor item since the everyday clothing of the Cantonese farmer is simple, inexpensive and strictly functional. Relatively little is spent on clothing for special occasions, particularly in the countryside, and that which is purchased is used sparingly and maintained with care.

In many households a large number of consumer durable items has already

been acquired. Thus expenses for consumer durables is a relatively minor item in household budgets while people save for the more expensive and still less widely available items, such as light motor cycles and refrigerators. Improved or new housing is certain to become a major item of expenditure, since the beginnings of a boom in family house construction are everywhere visible in both the rural and urban parts of Shunde County.

#### ACKNOWLEDGEMENTS

The field research on which this article is based forms part of a much broader study of the human ecology of the dike-pond system of the Zhujiang Delta undertaken from January, 1980 until December, 1983. Field investigation of individual household economies and dike-pond management was undertaken for two periods of several weeks in September–October, 1981 and August–September, 1983.

The entire research project was conducted under the joint financial sponsorship of the United Nations University, Tokyo, and the Chinese Academy of Sciences, through the Guangzhou Institute of Geography. It constituted one component of the project on water-land interactive systems conducted by the former Programme on the Use and Management of Natural Resources of the U.N. University and co-ordinated by the author.

In the field a great many persons contributed in innumerable ways to the success of this project. For their enthusiastic support of the research and many other kindnesses my sincere thanks are due to Mr. Lu Huiyuan, Commune Cadre, and Mr. Zhong Qiulin (Procurement and Records Officer, Nanshui Brigade, Leliu Commune), for making available to me detailed economic and management data of the Commune, and in particular those of the First Production Team, Nanshui Brigade.

For the detailed material used in this article I am particularly indebted to those patient householders whom I interviewed at length in the First Production Team of the Nanshui Brigade. I wish to express my appreciation to Mrs. Cao Suyi, Mr. Su Hongjian, Mr. Su Zaoji, Mr. Su Saoqiu and Mr. Cao Xuequin.

Finally, I express my gratitude to Mr. H. Z. Deng and Mr. G. Z. Liang, both staff of the Guangzhou Institute of Geography, for their field assistance and companionship.

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## 中国、珠江デルタ養魚地帯における農業制度 改革と家庭経済の変化

ケネス・ラドル

1979年4月の制度改革による戸別生産請負制と自由市場制の導入にともない、中国の農村経済はいちじるしい変容をとげている。戸別生産請負制のもとで、農家は耕地、養魚池等を一定期間使用する契約を、おおくの場合、生産大隊ととりかわし、その期間中生産物を公定価格で生産隊に供出する義務を負うが、余剰生産物は自由市場で公定価格にとらわれず売ることが可能である。その結果、1979—1983年のあいだに農業総生産は年平均7.9%上昇し、農家収入は倍増した。

本論文ではこの制度的改革が、淡水養殖漁業にもたらした変化を検討している。ここでのべる事例は、珠江デルタ中央部における池塘（養魚池）養魚システムの典型例をしめす広東省順徳県南水の第一生産隊に所属する四世帯を主な対象として、1981—1983年におこなった現地調査にもとづいている。池塘養魚システムの生態学的研究を柱にすえて、養魚池にたいする資本投下、養魚池経営、労力投下にたいする利潤率、家庭経済についての分析をおこない、制度的変化の影響を検討している。

本論文で引用している経済統計は、過去の集団経営方式から戸別生産請負制への移行期をしめすものとして意味をもつ、1982年におけるものである。