LABOR SUPPLY AND DEMAND IN A COMPLEX SYSTEM : INTEGRATED AGRICULTURE-AQUACULTURE IN THE ZHUJIANG DELTA, CHINA

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INTRODUCTION

Since integrated systems of agriculture and aquaculture are still not well-known scientifically their structure, functions and management, although an ancient, widespread and enduring practise in many parts of South and East Asia, have been little appreciated outside the region until relatively recently. Such systems are based on livestock, fowl, and fish husbandry in combination with a range of seasonally rotated crops. Small numbers of pigs and ducks, together with the fish, provide the household with animal protein and often a small cash income, while aquatic macrophytes, crop residues and kitchen leftovers feed the livestock. The manure of the livestock, together with systematically collected human excrement, where culturally acceptable, is then used to fertilize the fish pond, and eventually the cultivated field. Such diversified and integrated systems have sustained small-scale farm households for centuries. In the more sophisticated variants nutrients and energy are continuously cycled, little is wasted, and an ecological balance is preserved.

Almost without exception the academic and applied evaluation of such traditional and sophisticated resource systems has been neglected.[1)] As a consequence, few data are available on integrated systems, virtually nothing is known of the techniques and technologies used, and data on levels of productivity and farm economy are seriously deficient, if available at all.

Traditional Asian integrated systems of aquaculture and agriculture remain in large measure based on the empirical wisdom of many generations of local farmers, and for the most part the scientific bases for system integration remain to be properly ascertained. Virtually all attempts to improve the scientific

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1) A resource system is a combination of human, biotic and abiotic elements that provides for the flow of human utilities. It consists of the entire chain of events via which a component of the general environment is perceived as a resource and passes from its source through procurement, prossessing and technological transformation to the creation and delivery of an end product that satisfies a perceived human need. For an elaboration see RUDDLE and GRANDSTAFF [1978], GRANDSTAFF *et al.* [1980] and RUDDLE and RONDINELLI [1983].

understanding of integrated agro-ecosystems have concentrated on extremely detailed micro-studies of various biological, physical, technological and economic aspects—such as the nature of the animal waste linkage between livestock and fish from the perspective of fertilizing the pond and feeding the fish—particularly as they concern polycultural pond systems. There has been little attempt to relate these detailed studies to the larger scale relationships such as those between the pond and the dike, or those between the pond-dike system and the general environment within which the integrated resource system functions.

As Furtado [1980] has observed, the constraints inhibiting a fuller scientific understanding of integrated agro-ecosystems lie as much in the social as in the natural sciences. The major factors that affect the performance of integrated systems—energy, materials, spatio-temporal considerations and information diversity—are not, as a whole, well-known, and the socio-economic aspects of such systems, which are complex and little understood, are in particularly urgent need of detailed analysis.

This article thus has two straightforward objectives, one general and the other specific. The first is to provide a detailed analysis of the labor demand of one large-scale system of integrated agriculture and aquaculture, the dike-pond system of the Zhujiang Delta of South China, thereby contributing to the improvement of the understanding of a socio-economic aspect of such systems.

The second and more important and specific objective is to assess the labor absorption capacity of the system, since given the extreme rural population density of the region the system has been frequently characterized as having a high labor demand and therefore of being a critical generator of rural employment [Luo *et al.* 1980; Zhong 1979]. Although that might be the case, until now no supporting evidence has been produced, and casual observation at particular times of the year suggested that under-employment even among operators of the system was commonplace. The main object of this paper is therefore to define the seasonal rates of labor absorption by the dike-pond system at the aggregate level of the lowest administrative unit (the production team, a now historical unit, following the local government reforms of 1983), as well as to assess how these phenomena vary among households in one team as a consequence of the recently implemented household responsibility system.

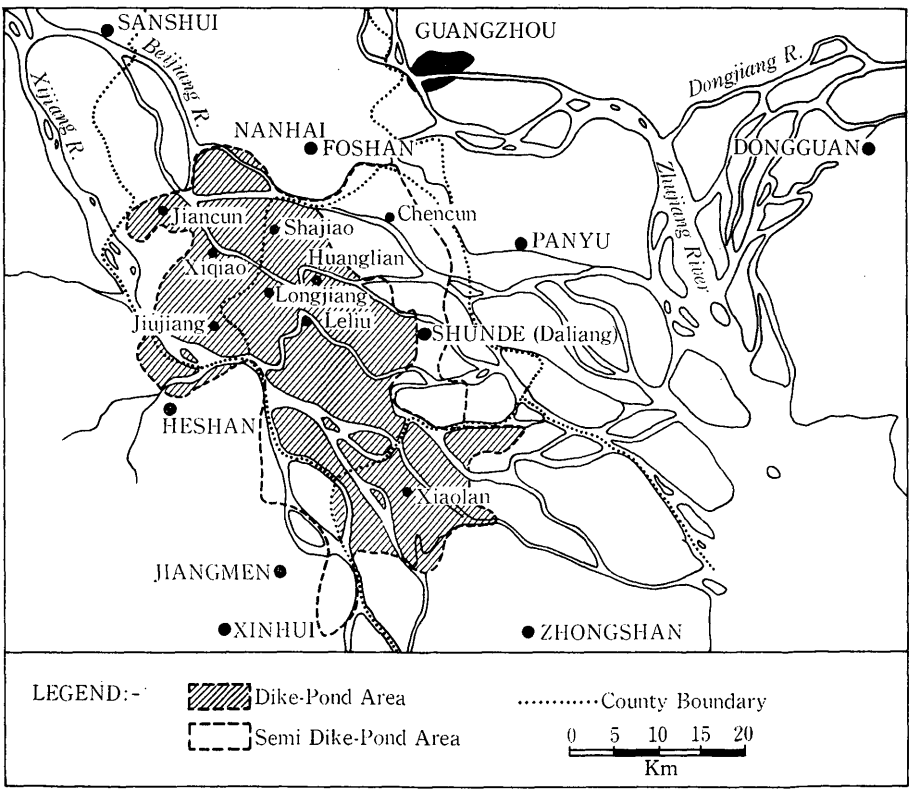
THE INTEGRATED DIKE-POND SYSTEM OF THE ZHUJIANG DELTA

Integrated farming is an ancient practise in China and one that has become more refined as a consequence of agricultural and rural development policies implemented since the foundation of the People's Republic, in 1949. Although based on solid economic and ecological principles, in the Chinese case the fundamental motives for the further development of integrated systems are the

need to maximize productivity per unit of land; the national policy of diversified self-reliance in food and basic raw materials production; and the philosophy that the by-product (waste) from one resource use must, wherever possible, become an input into another use of resources.

In the Zhujiang Delta 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 *et al.* 1983; RUDDLE *et al.* n.d.] (Photo 1). This integrated system has been developed over an area of 800 km^2 and supports an estimated population of 1.2 million persons. The system is best developed in the central part of the delta, where it focuses principally on Shunde County together with parts of neighboring Nanhai, Zhongshan, Xinhui and Heshan counties (Fig. 1).

The core of the system is composed of three essential components: fish ponds, mulberry dikes and sugarcane dikes. These three elements dominate the land use pattern where the system has developed best. Of a total of 80,520 ha of



(After RUDDLE *et al.* 1983)

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

cultivated land in the dike-pond area, 73 percent, or 58,780 ha, are devoted to these three land uses: 28,116 ha (34.9 percent) in fish ponds, 9,900 ha (12.3 percent) under mulberry and 20,764 ha (25.6 percent) planted to sugar cane.[2] The system contains at first sight an extremely complex range of matter and energy linkages among pond, dike, and the general environment (Fig. 2). In reality, however, these components are amenable to relatively easy integration.

At the heart of the system is the pond. To produce or maintain a fish pond, soil is excavated and used to build or repair the dikes that delimit it. Prior to being filled with water, the pond is prepared for fish cultivation by clearing, sanitizing and fertilizing. The required inputs are quicklime and tea-seed cake, which derive from the general environment, and organic manure, which is procured from the animal husbandry sub-system on the dike.

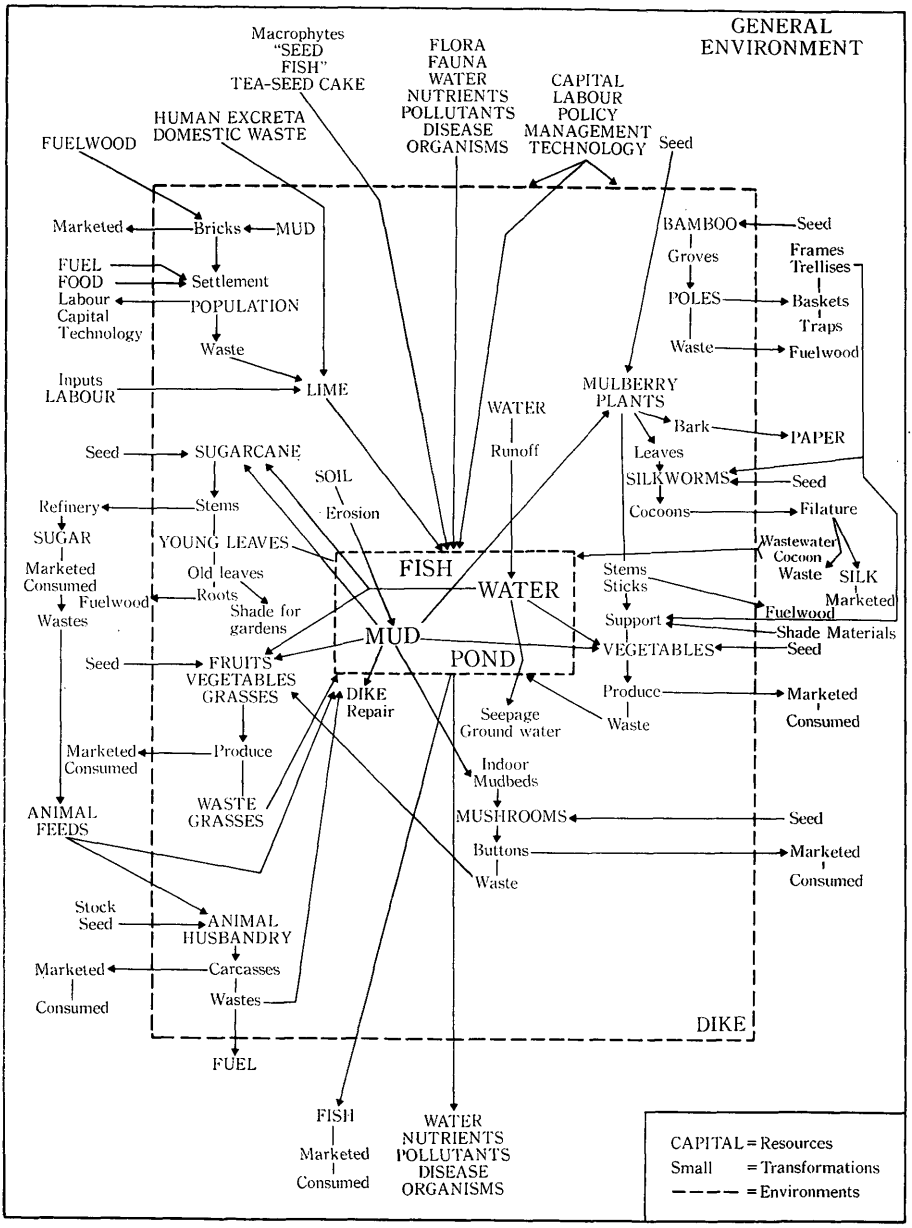
Under natural conditions, soil and organic materials gradually refill the pond through the processes of dike erosion. But this is interrupted 2–3 times a year when organically enriched mud is dug from the pond bottom and used to fertilize and build-up the upper surface of the dike. Pond mud is also used to make mud-beds for mushroom cultivation on the floor of the silkworm shed in winter, when silkworms cannot be raised.

The pond is then filled with river water, which bears nutrients, pollutants, fauna, flora and disease organisms. Water also enters directly as rain as well as through run-off from the dike. Water, enriched with additional nutrients and bearing pollutants, fauna, flora and disease organisms, leaves the pond in controlled discharges via the pond drainage outlet. Water is also lost through evaporation and transpiration, and via seepage into the dike, as well as being removed at regular intervals for the irrigation of crops planted on the dike.

Fish are then stocked in the pond. Apart from a few specialized instances of eel culture and initial experiments with Indian carps, together with the inclusion of Bream (*Megalobrama amblycephala*) and Tilapia (*Oreochromis niloticus*), all fish ponds in Shunde County are devoted to the culture of Cyprinids, the so-called Major or Chinese carps. 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*). Each species has distinct feeding habits and each occupies a different level in the pond water column.

Some fish of marketable size are consumed locally but most enter the market; 70 percent of the fish produced in Shunde County, for example, are sold live, mostly to Guangzhou, Hong Kong and Macao (Photo 2). Fish sales contribute the largest source of income to the region's agricultural sector, the Zhujiang Delta yielding 90,000 t/yr of fish (1979), or 50 percent of the total production of Guangdong Province, and 80 percent of the nation's live fish exports [unpub.

2) Throughout this article all data have been converted from local units and extrapolated at the following rates: 1 *mu*=0.066 ha; 1.97 *yuan* Rmb= 1 (U.S.) (Aug., 1983); 1 *jin*=0.5 kg.



(After RUDDLE *et al.* 1983)

Fig 2. Energy and Matter Linkages in the Dike-Pond System

stats., Foshan Pref.].

A range of linked sub-systems functions on the dike. Mulberry (*Morus atropurpurea*) and sugar cane (*Saccharum officinarum*) are the main cropping sub-

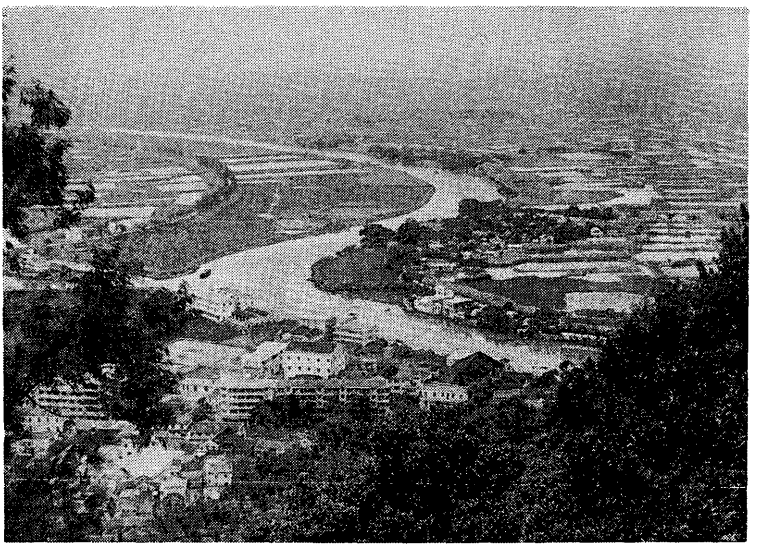


Photo 1. This tract of dikes and ponds developed several centuries ago in Xiqiao Commune, Nanhai County typifies the mature landscape of the old established dike-pond system.

systems. Mulberry is planted on the dikes and fertilized with pond mud and irrigated by hand with nutrient-rich pond water. The principal objective of mulberry cultivation is to produce leaves used as forage by silkworms (*Bombyx mori*). Mulberry bark is also harvested for making paper, and after pruning the

Photo 2. The bustling Fish Purchasing Station of Leliu Commune, Shunde County, is one point from which live fish from the region's ponds are sent to Guangzhou and exported directly to Hong Kong and Macau.

branches are used as sticks to support climbing vegetables, or as fuelwood.

Inextricably bound-up with the mulberry sub-system is silkworm-rearing. Silkworms are reared in special sheds in the settlement and sent to the filature in the nearby urban center for the production of yarn, much of which enters international commerce. Waste water together with cocoon waste and dead larvae is returned from the filature and used to enrich the pond and feed the fish. Silkworm excrement admixed with the remains of mulberry leaves is removed from the rearing sheds and used in the pond as fish feed.

During the off-season for silkworm-rearing mushrooms (*Agaricus campestris*) are cultivated on mud-beds, prepared from pond mud, on the floor of the silkworm rearing shed, using spores obtained from the general environment. Some mushrooms are consumed locally but most are marketed fresh, bottled or canned. After the final crop has been harvested the nutrient-rich mud-bed on which the mushrooms are raised is used to fertilize those sections of the dike on which vegetables, fruit trees and grasses are cultivated.

Vegetable and grass production is a fundamental component of the dike-pond system, providing both essential food for the fish and vegetables for home consumption and marketing. These crops are also fertilized with pond mud and used mushroom mud-beds, and irrigated manually with pond water. In early spring, before the mulberry shrubs come into leaf, mulberry dikes are interplanted with soy bean (*Glycine max*), mung bean (*Phaseolus aureus*), taro (*Colocasia antiquorum*), peanut (*Arachis hypogaea*), and other vegetable crops. These are harvested in May and June. Along the edge of the dike bananas, plantains and fruit trees are cultivated. In summer and autumn, melons and gourds are planted at the very edge of the dike and trained on bamboo trellises that hang over the pond. In addition to making maximum use of the limited space available for cultivation this practise also shades the pond water and prevents excessively high temperatures that would endanger the fish.

Each November, after the last harvest of mulberry leaves, the dikes are interplanted with an assortment of vegetables, mostly leafy greens, which provide two harvests. For feeding fish Elephant grass (*Pennisetum purpureum*) is planted on all available spare land, including the dike slopes, roadsides, around settlements and along watercourses, as are maize (*Zea mays*), sorghum (*Sorghum* spp.), and sweet potato (*Ipomoea batatas*). To feed fish and pigs, aquatic plants such as duckweed, water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*) are cultivated in canals, rivulets and associated water bodies. Small groves of bamboo are also a fundamental part of the system and provide poles for construction and materials used to fabricate baskets, traps, screens, trellises and frames which are the basic tools in other sub-systems. Bamboo waste is also used as fuel.

Sugar cane, some of which is either annually or biennially rotated with mulberry, is also an essential sub-system in the dike-pond complex. The principal product is refined sugar, but ancillary products are young leaves fed to the fish

and pigs, old leaves used to shade crops, for roofing thatch, and for fuel, and roots used as fuel. Refinery wastes are returned to the system in the form of animal and fish feed.

Pigs, raised mainly to provide manure but also for meat and ancillary products, are kept in sties constructed on the dike. Young stock are either obtained from the general environment or bred locally. External inputs to the sub-system consist principally of feedstuffs from the sugar refinery as well as occasional medicines and similar requirements. The concentrated feed requirements of pigs are met by feeding weaned piglets a diet of greens, particularly aquatic macrophytes such as water hyacinth, sugar cane tops, and other vegetable waste. Pigs are regarded as "walking fertilizer factories" and their faeces and urine is the essential fertilizer of the fish pond. Water buffalo dung, mixed with coal dust and dried, is also used as fuel.

Apart from rice the basic food and shelter needs of the human settlements in the dike-pond district are met from the system itself. Local food sufficiency assures a balanced diet. Fuel needs are largely met from waste products; and bamboo, and dike mud, used to manufacture unglazed tiles and bricks, provide the principal materials for housing and furnishings. Other basic social and physical needs are satisfied within the commune. In addition to providing fundamental inputs into the dike-pond system in the form of capital, management skills, labor and technology—in conjunction with the higher order organized social units—human settlements provide excrement, urine, and other household wastes that form the principal organic inputs into the fish pond.

LABOR REQUIREMENTS OF THE SYSTEM

A total of 905.2 man-days/yr is required to operate a composite hectare composed of the four basic components of the dike-pond system.[3] This is equivalent to the full-time annual labor input of 3 workers. By component, mulberry dike operations require 1510 man-days/ha/yr, or the input of 5 workers; those for sugar cane need 1199 man-days/ha/yr, or the input of 4 workers; the pond requires 536 man-days/ha/yr, or the input equivalent of 1.7 workers; and silkworm-rearing requires 375 man-days/ha of mulberry/yr, or the input equivalent of 1.2 workers (Table 1).

The total annual input of labor to the dike-pond system is depicted on a monthly basis in Fig. 3, by the percentage of the total annual input per crop. The components are provided in Table 1 and by task complex in Table 2. Peak

3) The number of man-days is calculated on the basis of 305 days of full-time labor a year. For convenience, monthly labor demand has therefore been calculated based on 25.4 workdays per month.

This composite figure is derived as follows: 0.25 (Mulberry [1510.2]+Sugar cane [1199.3]+Pond [536.0]+Silkworms [375.2]).

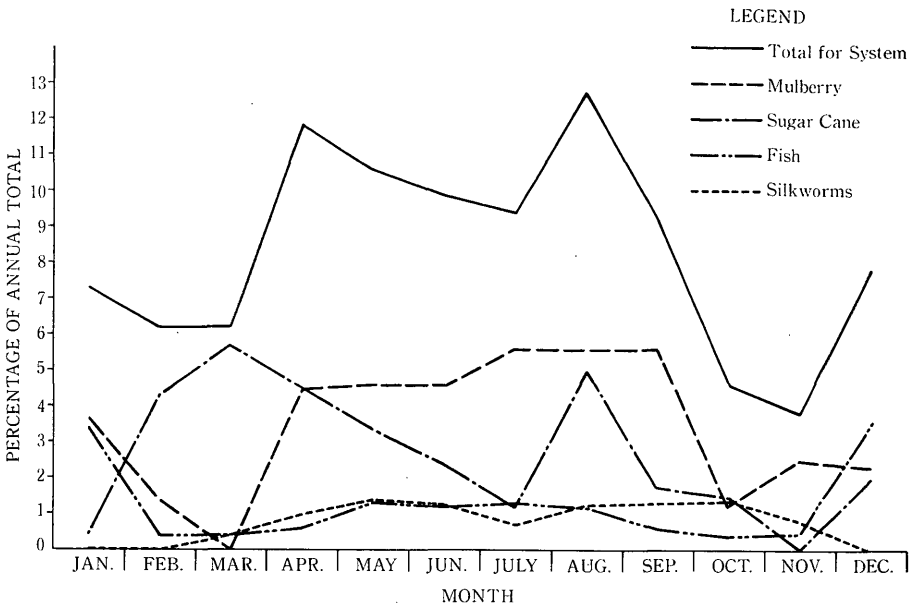


Fig 3. Annual Distribution by Crop of Labor Input to the Dike-Pond System (% of Man-day/Month/Crop)

labor demand occurs in the 6 summer and autumn months (according to lunar reckoning), from April until September. During this period 63.9 percent of the total labor requirement is input to the system. The months with highest demand are April and August, when 11.8 percent and 13 percent of total annual labor inputs are made, respectively. July and September, with 9.4 and 9.2 percent, respectively, have the lowest labor demand during the period.

The second major season of high labor demand occurs during the period December–March (*i.e.*, lunar late-winter until the end of spring), in no month of which do requirements fall below 6 percent of the total annual input. Early-winter is the relatively slack period, with only 4.6 and 3.9 percent of the total annual labor input being made in October and November, respectively. Peak labor demands vary by crop. This has an important temporal bearing on the recruitment of labor, as will be discussed below for each crop.

Labor Input to the Fish Pond

Labor input to the fish cultivation sub-system peaks markedly during the period from mid-December to mid-January, when 47.3 percent of the total annual input is made (Fig. 3). For the remainder of the year labor inputs remain relatively low, except from May through August, when they reach 8.9, 7.2, 8.9 and 7.2 percent of the annual total, for the respective four months. In each of

Table 1. Total Monthly Labor Requirements
(Man-days/Hectare)

CALENDAR	SYSTEM COMPONENT	MAN-DAYS	PERCENTAGE OF ANNUAL TOTAL
JANUARY	Mulberry dike	132.5	3.7
	Sugar cane dike	7.8	0.2
	Fish pond	124.5	3.4
	Silkworms	—	—
	Month total	264.8	7.3
FEBRUARY	Mulberry dike	49.2	1.4
	Sugar cane dike	159.1	4.3
	Fish pond	14.7	0.4
	Silkworms	—	—
	Month total	223.0	6.2
MARCH	Mulberry dike	—	—
	Sugar cane dike	205.6	5.7
	Fish pond	14.7	0.4
	Silkworms	7.6	0.2
	Month total	227.9	6.2
APRIL	Mulberry dike	162.1	4.5
	Sugar cane dike	205.6	5.7
	Fish pond	23.5	0.6
	Silkworms	37.6	1.0
	Month total	428.8	11.8
MAY	Mulberry dike	169.6	4.6
	Sugar cane dike	114.4	3.2
	Fish pond	47.5	1.3
	Silkworms	54.0	1.4
	Month total	385.5	10.6
JUNE	Mulberry dike	169.6	4.6
	Sugar cane dike	87.4	2.4
	Fish pond	38.7	1.1
	Silkworms	48.0	1.3
	Month total	343.7	9.9
JULY	Mulberry dike	202.9	5.6
	Sugar cane dike	46.5	1.2
	Fish pond	47.0	1.3
	Silkworms	48.0	1.3
	Month total	344.9	9.4
AUGUST	Mulberry dike	203.1	5.6
	Sugar cane dike	182.8	5.0
	Fish pond	38.7	1.1
	Silkworms	48.0	1.3
	Month total	472.6	13.0

CALENDAR	SYSTEM COMPONENT	MAN-DAYS	PERCENTAGE OF ANNUAL TOTAL
SEPT.	Mulberry dike	203.0	5.6
	Sugar cane dike	61.6	1.7
	Fish pond	23.5	0.6
	Silkworms	48.0	1.3
	Month total	336.1	9.2
OCTOBER	Mulberry dike	44.0	1.2
	Sugar cane dike	52.7	1.5
	Fish pond	14.7	0.4
	Silkworms	54.0	1.4
	Month total	165.4	4.6
NOV.	Mulberry dike	90.9	2.5
	Sugar cane dike	—	—
	Fish pond	19.1	0.5
	Silkworms	30.0	0.8
	Month total	140.0	3.9
DEC.	Mulberry dike	83.3	2.3
	Sugar cane dike	75.8	2.0
	Fish pond	128.9	3.5
	Silkworms	—	—
	Month total	288.0	7.9
TOTALS	Mulberry dike	1510.2	43.7
	Sugar cane dike	1199.3	30.0
	Fish pond	536.0	15.5
	Silkworms	375.2	10.8
	Annual total	3620.7	100.0

these four months extra labor is necessary for draining excess pond water during the rainy season, and in May, July and August for harvesting.

Males 20–39 years-of-age make a major heavy labor input into fish pond tasks during a 30-day period from mid-December to mid-January, when the annual maintenance of ponds is undertaken and when the ponds are re-filled with water and re-stocked with fingerlings. This task complex requires a labor input of almost 220 man-days/ha (Table 3).

Routine management of the ponds requires a total annual input of 271.9 man-days/ha during the 10-month period February through December. The average annual daily manpower input required for collecting fish feed, dumping it in the pond, checking water conditions and removing waste from around the perimeter of the pond is 0.9 man-days/ha. Since the tasks involved are relatively light they can be performed easily by teenagers or older persons of either sex, hence there is no labor constraint.

Draining excess water from the ponds after periods of especially heavy rainfall is, however, done by the stronger males aged 20–39. Performance of this task

Table 2. Composition by Task Complex of Monthly Labor Input
(Man-days/Hectare)

CALENDAR	SYSTEM COMPONENT	TASK COMPLEX AND LABOR INPUT
JANUARY	Mulberry dike	Dike preparation (83.3), Planting (49.2)
	Sugar cane dike	Breaking clods (7.8)
	Fish pond	Feeding and Edge clearance (14.7), Annual maintenance (109.8)
FEBRUARY	Mulberry dike	Dike preparation (49.2)
	Sugar cane dike	Making rows and drains (45.4), Seed preparation (37.9), Planting and harvesting (75.8)
	Fish pond	Feeding and Edge clearance (14.7)
MARCH	Sugar cane dike	Weeding (8.6), Slurry-spreading (45.5), Planting and harvesting (151.5)
	Fish pond	Feeding and Edge clearance (14.7)
	Silkworms	Preparation (7.6)
APRIL	Mulberry dike	1st Harvest (37.9), Weeding (121.2), Fertilizing (3.0)
	Sugar cane dike	Weeding (8.6), Slurry-spreading (45.5), Planting and harvesting (151.5)
	Fish pond	Harvesting (8.8), Feeding and Edge clearance (14.7)
	Silkworms	Preparation (7.6), 1st Harvest (30.0)
MAY	Mulberry dike	2nd Harvest (45.4), Weeding (121.2), Fertilizing (3.0)
	Sugar cane dike	Weeding (8.6), Planting and harvesting (75.8), Shoot removal (30.3)
	Fish pond	Draining excess water (24), Harvesting (8.8), Feeding and clearance (14.7)
	Silkworms	1st Harvest (30), 2nd Harvest (24)
JUNE	Mulberry dike	3rd Harvest (45.4), Weeding (121.2), Fertilizing (3.0)
	Sugar cane dike	Mud-spreading (75.8), Weeding (8.6), Fertilizing (3.0)
	Fish pond	Draining excess water (24), Feeding and clearance (14.7)
	Silkworms	2nd Harvest (24), 3rd Harvest (24)
JULY	Mulberry dike	4th Harvest and bud-removal (45.4), Weeding (121.2), Fertilizing (6.1), Mud-spreading (30.3)
	Sugar cane dike	Weeding (8.6), Irrigation (7.6), Shoot-removal (30.3)
	Fish pond	Harvesting (8.8), Draining excess water (24), Feeding and Edge clearance (14.7)

CALENDAR	SYSTEM COMPONENT	TASK COMPLEX AND LABOR INPUT
	Silkworms	3rd Harvest (24), 4th Harvest (24)
AUGUST	Mulberry dike	5th Harvest (75.7), Weeding (121.2), Fertilizing (6.1)
	Sugar cane dike	Weeding (8.6), Shoot removal (30.3), Irrigation (22.7), Soil-heaping (45.4), Mud-spreading (75.8)
	Fish pond	Draining excess water (24), Feeding and edge clearance (14.7)
	Silkworms	4th Harvest (24), 5th Harvest (24)
SEPT.	Mulberry dike	6th Harvest (45.4), Weeding (121.2), Fertilizing (6.1), Mud-spreading (30.3)
	Sugar cane dike	Weeding (8.6), Irrigation (22.7), Shoot removal (30.3)
	Fish pond	Harvesting (8.8), Feeding and edge clearance (14.7)
	Silkworms	5th Harvest (24), 6th Harvest (24)
OCT.	Mulberry dike	7th Harvest (37.9), Fertilizing (6.1)
	Sugar cane dike	Shoot removal (30.3), Irrigation (22.7)
	Fish pond	Feeding and edge clearance (14.7)
	Silkworms	6th Harvest (24), 7th Harvest (30)
NOV.	Mulberry dike	Mud-spreading (30.3), Preparation for over-wintering (60.6)
	Fish pond	Harvesting (4.4), Feeding and edge clearance (14.7)
	Silkworms	7th Harvest (30)
DECEMBER	Mulberry dike	Dike preparation (83.3)
	Sugar cane dike	Tillage (75.8)
	Fish pond	Harvesting (4.4), Feeding (14.7), Annual maintenance (109.8)

requires an average *per annum* of 7 percent of the labor input into this task complex, or some 40 man-days/ha/yr, concentrated in the May–August rainy season and during the passage of typhoons.

A total of 43.9 man-days/ha is required to perform the heavy tasks involved in harvesting fish. This labor input is required five times a year and each harvest requires an input of 9 man-days/ha. This labor has to be recruited once each in April, May, mid-July, mid-September and November–December (Photo 3). Since the entire pond area was not harvested on one single day, but rather spread over 10–15 days at each period, the provision of labor presented no problem.

Table 3. Labor Input to the Fishpond Sub-system
(Man-day/hectare for one cycle)

TASK COMPLEX AND TASK	CALENDAR	INPUT	%
ANNUAL POND MAINTENANCE			
Levelling bottom Checking dikes Fertilization Applying prophylactics	mid-12/mid-1	212.1	
Re-filling and stocking	mid-1	7.6	
Sub-total	—	219.7	41.0
ROUTINE MANAGEMENT			
Feeding	all year		
Clearing dike-edge	1–11	271.9	
Draining excess water	5–8		
Daily checking	all year		
Sub-total	—	271.9	50.7
HARVESTING			
Draining ponds Removing fish Counting fingerlings Transferring fingerlings	4, 5, mid-7, mid-9, 11–12	43.9	
Sub-total	—	43.9	8.1
TOTAL LABOR INPUT PER HECTARE		536.0	99.8*

(* Sum not 100 owing to rounding Tables 3–6)

Labor Input to the Sugar Cane Dike

The cultivation of sugar cane is the second most labor-intensive component of the dike-pond system, and requires an input of 1199 man-day/ha/yr, or 30 percent of the total input to the system (Table 1). Labor requirements for sugar cane reach a peak during the period February through May, when the dike preparation, planting and harvesting task complexes are performed. During this period 57 percent of the total annual labor input for sugar cane cultivation is made (Fig. 3). A second labor peak occurs when the performance of numerous different annual management tasks coincides in August (Table 2). In that month 15 percent of the labor inputs are made to the sugar cane dike.

Tilling the dike for planting sugar cane begins in late-December (Table 4). Generally this heavy task is performed by men of less than 40 years-of-age, and requires 76 man-days/ha of labor. Some two weeks after tilling the sun-dried clods of soil are broken-up by the same men or by women of the same age group. This task consumes a further 8 man-days/ha. Together these three land

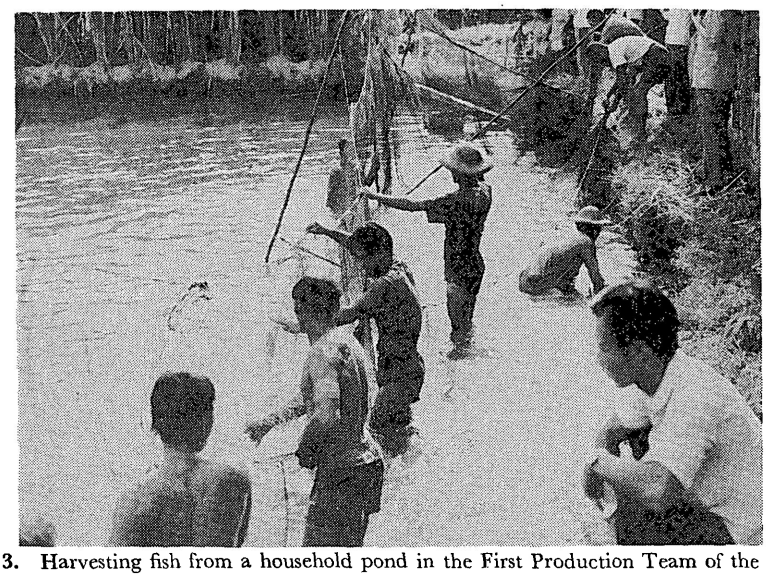


Photo 3. Harvesting fish from a household pond in the First Production Team of the Nanshui Brigade. This heavy task is undertaken reciprocally by younger men.

preparation tasks require almost 129 man-days/ha of labor input. Concurrently, one woman procures and prepares the planting stock. This job requires about 23 man-days/ha of dike to be planted.

The three tasks of planting, irrigation (if the soil is too dry) and fertilizing with household waste are performed at the same time, and, in total, require

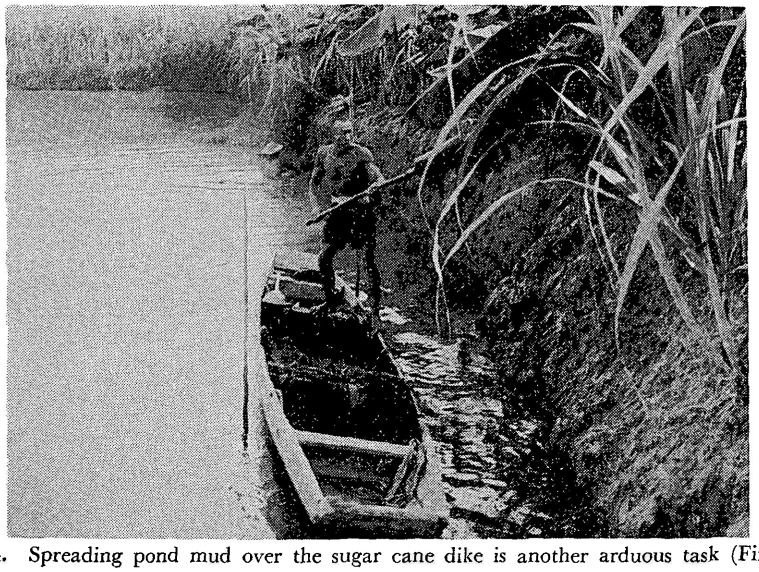


Photo 4. Spreading pond mud over the sugar cane dike is another arduous task (First Production Team, Nanshui County).

Table 4. Labor Input to the Sugar Cane Sub-system
(Man-days/hectare for one cycle)

TASK COMPLEX AND TASK	CALENDAR	INPUT	%
DIKE PREPARATION			
Tillage	late-12	76.0	
Break-up	early-1	8.0	
Rows and drains	early-2	45.5	
Sub-total	—	129.2	10.7
SEED PREPARATION			
Procurement	early-2	22.7	
Sanitizing	early-2	15.2	
Sub-total	—	37.9	3.1
PLANTING			
Fertilizing }			
Irrigating }	mid-2/mid-5	76.0	
Planting }			
Sub-total	—	76.0	6.3
MANAGEMENT			
Irrigation	10 times/yr	76.0	
Slurry-spreading	mid-3 & late-4	91.0	
Mud-spreading	early-6 & late-8	151.6	
Weeding	3–9 (1x/mo)	60.6	
Soil-heaping	late-8	46.0	
Shoot-removal	5–10 (1x/mo)	152.0	
Sub-total	—	577.2	48.1
HARVESTING	mid-2/mid-5	379.0	
Sub-total	—	379.0	31.6
TOTAL LABOR INPUT PER HECTARE		1199.3	99.8

76 man-days/ha. This task complex is coordinated with the labor requirement for harvesting of mature cane, which is performed during the same period.

Irrigation and mud-spreading during the growing period are heavy tasks that are performed mainly by men less than 40 years old (Photo 4). Together these tasks absorb 318 man-days/ha.[4)]

Weeding of sugar cane is done by women in the 20–39 years age group, who provide an aggregate of some 61 days of labor for the task. These same women

4) This figure does not include the 10–12 additional applications of irrigation water in years with a stong autumn drought. These would add a further 76–91 man-days to the labor requirement.

also devote 46 days/ha to heaping-up the soil around the base of the plants. Each month, from the second soil-heaping until late-October, older women remove the internode shoots from the cane. This requires a total labor input of 152 days/ha.

Harvesting is performed by both men and women. It requires some 379 days/ha of labor input.

Labor Input to the Mulberry Dike

Cultivation of the mulberry dike is the most labor-intensive component of the dike-pond system. With a labor requirement of 1510 man-days/ha/yr, the mulberry dike absorbs almost 44 percent of the total input to the system. Labor requirements remain uniformally high during the period April through September (Fig. 3), when those for leaf harvesting are added to the demands of routine management. During this 6-month period 1110 man-days/ha, or 73 percent of the total labor input to the mulberry component is made (Table 5). A secondary labor peak occurs in January, when the dike is prepared for planting. Only residual labor inputs for tasks not completed in February are made in March.

Most tasks involved in the mulberry nursery are performed by young women, but those requiring expert management, such as pest control, are done by experienced farmers of about 40 years-of-age. Total labor input for the mulberry nursery amounts to about 909 man-days/ha/yr.

Transplanting, levelling the drainage canals and fertilizing with urea are done in February and March by men and women less than 40 years-old. These tasks require nearly 100 man-days/ha of labor. Manual irrigation of the transplanted bushes, which is done concurrently with transplanting, consumes a further 45 man-days/ha of labor.

Management of the mulberry dike during the growing period is undertaken by the same group of people who performed the preceding tasks. Altogether weeding after each of the first six leaf harvests requires slightly in excess of 720 man-days/ha of labor on the better dikes, whereas on those of inferior quality, in terms of the rate of weed infestation, the task requires a considerably higher input. Pest control, if necessary, is performed concurrently with weeding.

Two applications of pond mud slurry and one of relatively dry pond mud are spread over the mulberry dike. They each require 30 man-days of labor input.

The light but frequent work of harvesting mulberry leaves to feed silkworms is performed by young women in their late-teens or early-twenties (Photo 5). This job is done at least 7 and not infrequently 8 times a year between April and November. Since the size of the harvest varies during the season, labor inputs also vary accordingly, from a low of 38 man-days/ha for the first harvest to a high of 75 for the fifth.

If necessary old mulberry bushes are up-rooted after the final leaf harvest.

Table 5. Labor Input to the Mulberry Sub-system
(Man-day/hectare for one cycle)

TASK COMPLEX AND TASK	CALENDAR	INPUT	%
NURSERY MANAGEMENT	late-3/late-4	909.1	
Sub-total	—	909.1*	
DIKE PREPARATION			
Tillage }	early-12/late-1	60.6	
Break-up }		45.4	
Rows and drains }		30.3	
Fertilizing }		30.3	
Sub-total	—	166.6	11.0
PLANTING			
Planting }	late-1/early-2	75.7	
Flatten drains }		15.1	
Fertilizing }		7.5	
Sub-total	—	98.3	6.5
MANAGEMENT AND HARVESTING			
1st Harvest	4	37.8	
Weeding	4	121.2	
Fertilizing	4	3.0	
2nd Harvest	5	45.5	
Weeding	5	121.2	
Fertilizing	5	3.0	
3rd Harvest	6	45.5	
Weeding	6	121.2	
Fertilizing	6	3.0	
Fourth Harvest }	7}	45.5	
Bud-removal }	7}		
Weeding	7	121.2	
Fertilizing (twice)	7	6.1	
Mud-spreading	7	30.3	
Fifth Harvest	8	75.6	
Weeding	8	121.2	
Fertilizing (twice)	8	6.1	
Sixth Harvest	9	45.5	
Weeding	9	121.2	
Fertilizing (twice)	9	6.1	
Mud-spreading	9	30.3	
Seventh Harvest	10	37.8	
Fertilizing (twice)	10	6.1	
Mud-spreading	11	30.3	
Sub-total	—	1184.7	78.4
OVER-WINTERING			
Tieing tips	11	30.3	
Pruning	11	30.3	

TASK COMPLEX AND TASK	CALENDAR	INPUT	%
Sub-total	—	60.6	4.0
REMOVAL FOR REPLANTING	11-12	75.8*	
Sub-total	—	75.8*	99.9
TOTAL LABOR INPUT PER HECTARE*			

*Total labor input assumes a case where neither a nursery is prepared nor old plants removed for replanting; where heavy winter interplanting of vegetables does not occur; that the usual 7 and not the exceptional 8 leaf harvests are taken; and that the dike is of good quality, so that only the minimum weeding inputs are required. Sub-totals denoted by an asterisk are not, therefore, included in the total input.

This job requires 45–75 man-days/ha of labor input. At that time, too, the mulberry dike is prepared for over-wintering and interplanting of vegetables.[5] For this the tips of the branches of the younger bushes are tied together. This job consumes 30 man-days/ha. Older bushes are either pruned or have their branches lashed-down. This task is more labor-intensive and requires 30–76 man-days/ha to perform.

Labor Input to Silkworm-Rearing

Silkworm-rearing requires the least labor input of any component of the dike-pond system, with 375 man-days/ha of mulberry/yr, or 11 percent of total input to the system being devoted to it. Further, most of the tasks are light and are performed by a highly-skilled, older and experienced specialist assisted by younger women who are still basically trainees (Photo 6).

Activities are essentially concentrated between April and November, with preparatory tasks being performed in March (Fig. 3). Preparation of the rearing

5) Since the vegetable sub-system is only a relatively minor component of the land use of the small area studied in detail it became, perforce, only a minor topic in the overall research project. Further, given the small, fragmented, intensively interplanted and frequently changing crop assemblages on the beds of the crop dikes, it would have been disproportionately time-consuming to record the detailed input of labor by task for each crop. Moreover, this would have been impossible without assigning an observer to record the daily jobs done and the time taken for each on the vegetable dike for an entire year, since none of the informants had any idea of the vegetable yields per unit area or of the time required to accomplish the various minute tasks involved. One might have done better by recording labor input by individual planting bed, but the resultant data would have had little ecological or economic value since they could not have been reconciled with either the relative distribution of energy and matter inputs or with labor input per crop or economic rate of return per crop, under conditions of interplanting.

Bananas, often regarded as a vegetable in this area, are grown along the edge of the mulberry and other dikes. All the tasks involved in their cultivation require a labor input of 1515 man-days/ha/yr. (This figure assumes replanting a new area rather than just the routine management of established plants.)

Photo 5. Seven and sometimes eight times a year women perform the light task of stripping mulberry leaves to feed silkworms (First Production Team, Nanshui Brigade).

shed and equipment, done in March, requires some 15 man-days/ha of mulberry, or 4.0 percent of total silkworm-related labor inputs (Table 6 and Photo 7).

Thereafter the principal labor-consuming task is the daily feeding of the worms during their growth period. This task absorbs about 65 percent of the total labor input per crop. Total labor input rates per harvest vary, ranging from

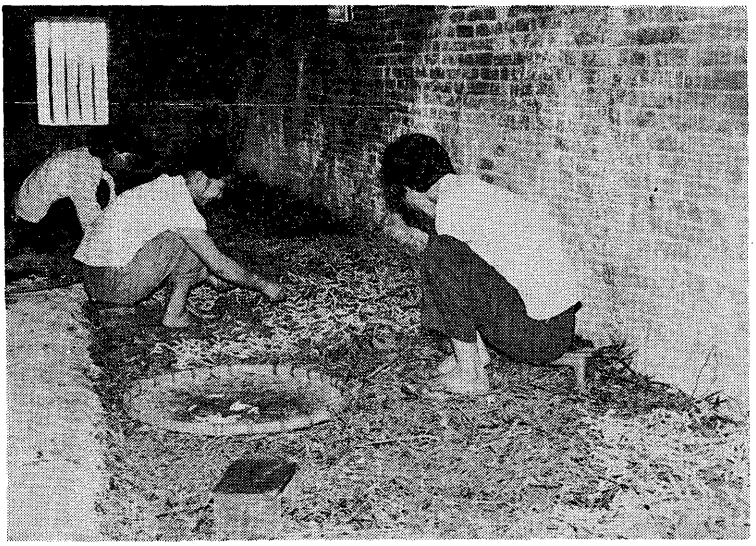


Photo 6. Young women of the First Production Team, Nanshui Brigade selecting silkworms for cocoon-spinning.

Photo 7. Between stocking periods an older specialist disinfects then washes the silkworm-rearing trays in the irrigation canal (First Production Team, Nanshui Brigade).

a high of 60 man-days/ha of mulberry for the first and seventh harvest to 48 for the five others.

LABOR INPUT BY THE FIRST PRODUCTION TEAM, NANSHUI BRIGADE

By the late-1960s the local level formal administrative system of China had assumed the familiar three-tier form of People's Commune, Production Brigade, and Production Team. Nevertheless, the household remained the smallest single unit of Chinese rural social organization and the one in which the *de facto* use and management of privately owned resources, such as small garden plots and domestic animals, was vested.

The production team, the basic agricultural production and accounting unit in most communes, generally consists of 20–30 households. Prior to the implementation of the recent rural reforms (*vide infra*) in it was vested the ownership of all agricultural implements other than those privately owned. Since basic local production decisions are made at this level, the production team is also the smallest unit in the national planning process.

Intermediate is the production brigade, which serves largely as a planning and administrative unit. It undertakes productive activities too large for the production team, such as constructing and maintaining drainage and irrigation systems, or land reclamation and improvement schemes. Brigades also operate agro-industries, farm machinery repair shops and the like, as well as schools and

Table 6. Labor Input to the Silkworm Sub-system
(Man-days/hectare of mulberry dike for one cycle)

TASK COMPLEX AND TASK	CALENDAR	INPUT	%
EQUIPMENT PREPARATION (a)	3-4	15.2	
Sub-total	—	15.2	4.0
REARING (1st harvest)			
Placing worms on trays	4-5	0.8	
Feeding (b)	4-5	39.5	
Removing waste (c)	4-5	4.7	
Collecting worms (d)	4-5	7.5	
Collecting cocoons (e)	4-5	7.5	
Sub-total	—	60.0	17.3
REARING (2nd harvest)	5-6	48.0	
Sub-total	—	48.0	12.7
REARING (3rd harvest)	6-7	48.0	
Sub-total	—	48.0	12.7
REARING (4th harvest)	7-8	48.0	
Sub-total	—	48.0	12.7
REARING (5th harvest)	8-9	48.0	
Sub-total	—	48.0	12.7
REARING (6th harvest)	9-10	48.0	
Sub-total	—	48.0	12.7
REARING (7th harvest)	10-11	60.0	16.0
Sub-total	—	60.0	
TOTAL LABOR INPUT PER HECTARE		375.2	100.8

(a) This task consists of repairing, cleaning and sanitizing the rearing shed and the equipment; (b) feeding is done 6 times/day and requires some 3.0 hrs/ha each time. Worms of harvests 1 and 7 are fed for 18 days and 2–6 for 13 days; (c) Waste is removed from the rearing trays every second day, *i.e.*, 9 times for harvests 1 and 7 and 7 times for harvests 2–6. Each removal requires a labor input of about 3.0 hrs/ha; (d) includes placement on cocoon spinning trays; (e) includes transporting to Cocoon Purchasing Center.

health stations.

The highest unit in the local organization is the people's commune. It undertakes activities too large for the other levels and also performs higher order administrative, economic, social and political functions.

The Leliu Commune labor force of approximately 36,000 persons is organized into 29 brigades and 257 production teams. The latter range in size from 150–500 members and, although basically comprehensive in organization had, until the recent reforms, specialized groups such as those for fish pond operations, mulberry cultivation, and the like. The labor force is supported by various other specialized teams, including, *inter alia*, those for physical construction, transport and machinery repair and maintenance. Other teams work in the complementary small-scale manufacturing sector of the commune economy, producing goods for both use within the commune and for sale elsewhere. Special teams composed of children and old people watch for signs of pest infestation in the fields, and implement appropriate control measures.

In this section the operation of the dike-pond system is discussed via an analysis of labor inputs formerly required, under the old administrative system, to operate the area allocated to the First Production Team of the Nanshui Brigade, Leliu Commune, Shunde County.

In terms of land use, the small tract belonging to the First Production Team of the Nanshui Brigade exemplifies the dike-pond system (Fig. 4; Table 7). Of the total of 21.58 ha that belongs to this team, 19.67 ha or 91.14 percent is devoted to the components of the dike-pond system: 9.97 ha (46.2 percent) are in fish ponds, 6.2 ha (28.7 percent) are under sugar cane, 2.84 ha (13.1 percent) are planted to mulberry, and 0.66 ha (3.1 percent), classed as "miscellaneous dikes," is under Elephant grass and maize.

Only 1.9 ha (8.8 percent) are not tightly linked to the dike-pond system. Of this amount 0.92 ha (4.3 percent) is classified as under "dry land" crops (principally vegetables, peanuts, sweet potatoes and maize); 0.59 ha (2.7 percent)

Table 7. Land Use of the First Production Team, Nanshui Brigade, Leliu Commune, Shunde County

LAND USE CATEGORY	AREA (ha)	DISTRIBUTION (%)
FISH PONDS	9.97	46.2
SUGAR CANE	6.2	28.7
MULBERRY	2.84	13.1
MISCELLANEOUS DIKES[1)]	0.66	3.1
DRY LAND[2)]	0.92	4.3
PRIVATE PLOTS	0.59	2.7
LOTUS POOL	0.26	1.2
BANANAS	0.13	0.6
TOTAL	21.57	99.9*

1) Devoted to Elephant grass and maize production.

2) Under vegetables, peanuts, sweet potatoes and maize.

* Rounding error.

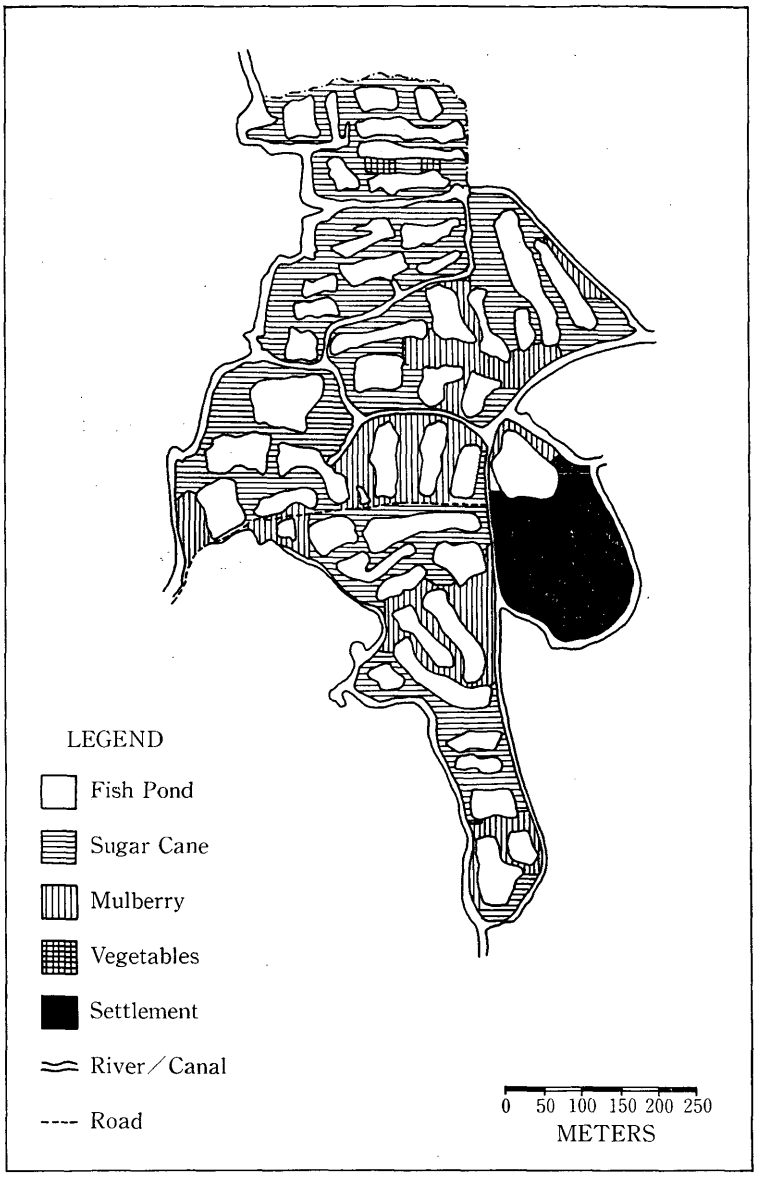


Fig 4. Land Utilization by the First Production Team, Nanshui Brigade

is allocated as private plots for household use and is devoted mostly to vegetable production; 0.26 ha (1.2 percent) is a pool for lotus cultivation; and 0.13 ha (0.6 percent) is under bananas.

The population structure and labor force characteristics of the First Production Team of the Nanshui Brigade are typical of those of most other teams in

Table 8. Population Characteristics and Labor Division in the First Production Team, Nanshui Brigade

AGE GROUP	TOTAL	%	NO. MALE	NO. FEMALE	WORK PERFORMED	
					MALE	FEMALE
0-14	100	32.15	48	52	PS, S	PS, S
15-19	32	10.28	15	17	FP, S, SW	M, RW, S, SW
20-24	33	10.61	16	17	FP, SW	FP, RW
25-29	29	9.32	15	14	//	RW, SC
30-34	26	8.36	11	15	//	V
35-39	16	5.14	6	10	//	OW
40-44	12	3.85	3	9	SC	//
45-49	10	3.21	5	5	SC	M, SC
50-54	16	5.14	7	9	OSL	//
55-59	9	2.89	4	5	//	R
60+	28	9.00	13	15	R	//
TOTAL	311	100.00	143	168	—	—

WORK KEY:
FP=Fish pond, M=Mulberry, OSL=Outside side work, OW=Outside work, PS=Pre-school, R=Retired, RW=Roadwork, S=School, SW=Silkworm, SC=Sugar cane, V=Vegetables.
SOURCE: Unpublished data from the Nanshui Brigade Procurement and Records Office.

Leliu Commune. This medium-size team has a total population of 311 persons (August, 1983), composed of 143 males and 168 females, divided among 58 households (Table 8).

Of this population, 57.64 percent is economically active on a full-time basis, and the dependent population (*i.e.*, pre-schoolers, children still attending school and retired persons) is large, at 42.4 percent, although many such people are engaged part-time in productive activities. The bulk of the directly productive labor is performed by both males and females of 15–49 years-of-age, with the 50–60 years age groups essentially being in transition from full-time labor to retirement.

The 178 full-time workers in the team, which includes 96 females, were, until the rural reforms started, allocated among the sub-systems of the dike-pond system as follows: 42 to mulberry cultivation and sericulture; 31 to sugar cane production; 52 to fish pond activities; and the remaining 53 to brigade and commune industries, transport, administration and other essential activities.

LABOR SUPPLY

Division of Labor

Children younger than 7 years-of-age spend most of their time either at play in the alleyways of the village, under the supervision of retired persons, or in the

Brigade's kindergarten. Such young children generally lack both the fundamental knowledge and skills as well as the physical strength to undertake even the simplest of production tasks.

Both boys and girls aged 7–15 are in school most of the time, and some boys continue until their nineteenth birthday. But both before and after school hours and during the holidays children from about the age of eight regularly assist in field and pond work and with domestic chores.

They begin their participation in productive labor with the least mentally and physically demanding tasks, such as sweeping-up twigs and leaves blown down by typhoons, for use as domestic fuel, and the collection of fish food and feeding the fish. They are taught the more complicated, but still not too difficult, jobs of monitoring pond water quality via the visual inspection of fish surfacing behavior, to assess dissolved oxygen conditions in the early morning, and after periods of heavy rain to check on pond water levels. They also gradually begin to undertake some of the heavier and more skilled tasks such as weeding, cutting, carrying and drying sugar cane leaves for fuel, picking mulberry leaves and feeding silkworms, and the like.

Tasks such as those are not inherently complex and are usually mastered with little effort after instruction by an adult family member. Thus by the age of 15 a child will normally have performed most of the basic and lighter tasks on many occasions, either filling-in for a sick or absent relative or neighbor, or as a part-time member of a household production unit or, until five years ago, as a member of one of the specialized work groups into which a production team was organized. Only rarely will persons less than 20 years-of-age have performed the physically demanding tasks involved in routine and annual pond maintenance, mud-spreading, or such relatively skilled tasks as crop fertilization. Only when they become full-time members of the work force are they taught, and do they perform, such tasks regularly.

The physically demanding tasks involved in the fish pond sub-system and the skilled activities demanded by silkworm-rearing are performed mostly by men aged 20 to 39 years. Males 40–49 years old mostly undertake the labor of sugar cane and vegetable cultivation. Most men 50–59 years-of-age generally hand-over the heavy and intensive work involved in the four main sub-systems to the younger males, although they continue to participate during periods of intensive labor demand and during emergencies. Mostly, these men devote themselves to "sideline" production, such as fishing and shrimping in the rivers and irrigation canals (Photo 8), small boat construction or river transport. Although men officially retire at the age of 60, they invariably continue to engage occasionally either in the lighter tasks of the main productive activities or in sideline pursuits, as the household economy warrants. But on any given day many men in their mid-sixties stay around the village doing such odd jobs as repairing agricultural or fishing tools, or tending a small stall in the free market along the main alleyway.

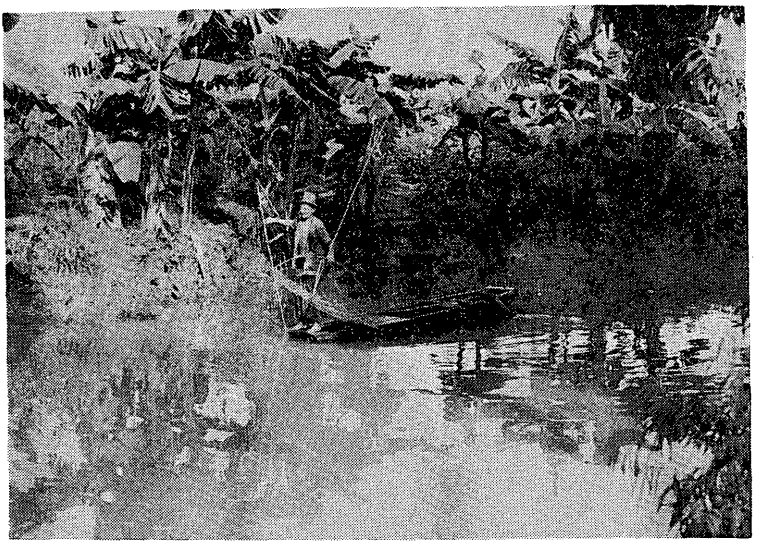


Photo 8. An old man shrimping with a stick-held lift-net in an irrigation canal of the First Production Team, Nanshui Brigade.

After leaving school the more skillful young women work in the mulberry and silkworm sub-systems, where they are involved in all the lighter tasks of mulberry cultivation and most of the tasks of silkworm-rearing. Others work at such odd jobs as road maintenance, brick- and tile-making or house-building. Women between the ages of 20 and 49 undertake a considerable proportion of the culti-

Photo 9. Manual irrigation of cowpeas (*Vigna sinensis*) is performed several times per day during the autumn drought period (First Production Team, Nanshui Brigade).

vation labor, particularly the lighter tasks (Photo 9), and, to a lesser extent, fish pond work as well as the heavier household chores. With increasing age, women perform lighter fieldwork and household chores, and, although officially pensioned-off at 55, older widows assist generally around their oldest son's house, doing much if not all of the cooking, light housework and the supervision of the younger children—thereby releasing the mother for field labor—as well as tending small market stalls and doing a myriad of other minor miscellaneous tasks.

The Working Day

The length of the working day, which varies according to season, is 10 hours in spring, summer and autumn and 8 in winter. According to the lunar calendar used by Cantonese farmers, January–March is spring, April–June is summer, July–September is autumn and October–December is winter. A typical daily schedule of work and other activities is given in Table 9.

Team Labor Inputs to the Fish pond

At the level of the production team, with 9.97 ha of fish ponds, the sub-system had a total annual labor demand of 5344 man-days. The annual maintenance task complex required the provision of 2190.2 man-days of labor, or the work of 86 men during the 30-day period in December–January. Routine management tasks of the production team's pond area required the provision of 2710.2 man-days/yr of labor. Thus for the team's ponds this task complex required the full-time labor of 9 persons/yr. Harvesting required 88 man-days.

Team Labor Inputs to the Sugar Cane Dike

The 6.2 ha that the production team had under sugar cane had a total annual labor demand of 7436 man-days. By task complex this required the

Table 9. Typical Schedule of Work and Other Activities

(1)	SPRING-SUMMER-AUTUMN	
	04:00	Rise
	04:00–04:30	Prepare feed for fish and stock, check pond
	04:30–05:00	Eat breakfast at food stall
	06:00–11:00	Dike and pond work
	11:00–14:30	Eat lunch at home and rest
	14:30–19:30	Dike and pond work
(2)	WINTER	
	07:00	Rise
	07:00–07:30	Prepare feed for fish and stock, check pond
	07:30–08:00	Eat breakfast at food stall
	08:00–11:30	Dike and pond work
	11:30–13:30	Eat lunch at home and rest
	13:30–18:00	Dike and pond work

supply of close to 800 days for dike preparation, 235 for seed preparation, 470 for planting, 3750 for management during the growing period, and 2350 for harvesting.

Many tasks in the cultivation of sugar cane are undertaken by both men and women working together. Principally these were for planting and harvesting, which, since they were performed at the same season, demanded a large labor force. The team had to muster 470 man-days for planting and 2348 for harvesting. During the 3-month period from mid-February to mid-May a total of 2818 man-days of labor was required to perform simultaneously the tasks of planting and harvesting. In other words, a minimum of 31 people had to work full-time on the sugar cane dikes during that period.

The heaviest tasks in sugar cane cultivation are undertaken by men of less than 40 years-of-age, supplemented in times of severe labor demand by younger women. Thus such stronger men were required to supply 471 man-days of labor in the second-half of December to till the sugar cane dike and a further 282 in early-February to construct the planting rows and drains. The heaviest tasks of management during the crop growth cycle are also performed by these same men. Thus the production team had to recruit their labor exclusively for irrigation and slurry- and mud-spreading. These tasks required 471 and 1504 man-days *per annum*, respectively. In total, therefore, men in the less than 40 year-old age category had to supply 2728 man-days/yr for sugar cane cultivation.

The lighter tasks of sugar cane cultivation were performed by women and older and younger males, supplemented as required by the stronger men when they were not required for other, heavier tasks. Thus women mainly provided the almost 50 days of labor needed to break-up the clods after sun-drying. Preparation of the planting material was usually done entirely by women, who provided 235 days for the purpose. Similarly, soil heaping, weeding and shoot-removal was also done by women who provided an aggregate of 1603 days of labor for these tasks. Thus the women were primarily responsible for providing a total of almost 1890 days of labor for these tasks for each cycle of sugar cane cultivation.

Team Labor Inputs to the Mulberry Dike

The 2.84 ha of mulberry dike cultivated by the production team had a labor demand of 4289 man-days/yr, or the full-time labor of 14 persons. This assumes that neither a nursery is prepared nor older plants removed for re-planting; that heavy winter interplanting does not occur and therefore that only the tips of the mulberry bushes are tied rather than the plants being lashed down; that 7 rather than the exceptional 8 leaf harvests are taken; and that the dike is of good quality so that only minimal labor inputs for weeding are required. Were these additional tasks to be performed the annual labor requirement would rise by 1105 man-days/ha to a total of 2615 man-days/ha, or to 7427 for the area that the Production Team had under mulberry. Correspondingly, the number of

Table 10. Monthly Labor Input of the Production Team

		MAN-DAYS	NO. OF WORKERS
JANUARY	Mulberry dike	376.3	14.8
	Sugar cane dike	48.3	1.9
	Fish pond	1241.3	48.8
	Silkworms	—	—
	Month total	1665.9	65.6
FEBRUARY	Mulberry dike	139.7	5.5
	Sugar cane dike	986.4	38.8
	Fish pond	146.6	5.7
	Silkworms	—	—
	Month total	1272.88	50.1
MARCH	Mulberry dike	—	—
	Sugar cane dike	1274.7	50.2
	Fish pond	146.6	5.7
	Silkworms	21.5	0.8
	Month total	1442.8	56.8
APRIL	Mulberry dike	460.3	18.1
	Sugar cane dike	1274.7	50.1
	Fish pond	234.3	9.2
	Silkworms	106.7	4.2
	Month total	2076.0	81.7
MAY	Mulberry dike	481.6	18.9
	Sugar cane dike	709.2	27.9
	Fish pond	473.6	18.7
	Silkworms	153.3	6.0
	Month total	1817.7	71.56
JUNE	Mulberry dike	481.6	18.9
	Sugar cane dike	541.8	21.3
	Fish pond	385.8	15.1
	Silkworms	136.3	5.3
	Month total	1545.5	60.8
JULY	Mulberry dike	576.2	22.6
	Sugar cane dike	288.3	11.3
	Fish pond	473.6	18.6
	Silkworms	136.3	5.3
	Month total	1474.4	58.0
AUGUST	Mulberry dike	576.8	22.7
	Sugar cane dike	1133.3	44.5
	Fish pond	385.8	15.1
	Silkworms	136.3	5.3
	Month total	2232.2	87.8
SEPT.	Mulberry dike	576.8	22.7
	Sugar cane dike	381.9	15.0
	Fish pond	234.3	9.2
	Silkworms	136.3	5.3
	Month total	1329.3	52.3

		MAN-DAYS	NO. OF WORKERS
OCTOBER	Mulberry dike	124.9	4.9
	Sugar cane dike	326.7	12.9
	Fish pond	146.6	5.8
	Silkworms	153.3	6.0
	Month total	751.5	29.5
NOV.	Mulberry dike	258.2	10.2
	Sugar cane dike	—	—
	Fish pond	190.4	7.4
	Silkworms	85.2	3.3
	Month total	533.8	21.0
DEC.	Mulberry dike	236.5	9.3
	Sugar cane dike	469.9	18.5
	Fish pond	1285.1	50.6
	Silkworms	—	—
	Month total	1991.5	78.3
TOTALS	Mulberry dike	4288.9	14.0
	Sugar cane dike	7435.2	24.9
	Fish pond	5344.0	17.5
	Silkworms	1065.2	3.4
TOTAL ANNUAL DEMAND		18133.3	60.0

full-time workers required would have risen to 24.[6]

LABOR REQUIREMENTS AND SUPPLY

The operation of the dike-pond area of 9.97 ha that was assigned to the First Production Team of the Nanshui Brigade had a total labor demand of 18133 man-days/yr, *i.e.*, it required the annual full-time labor of 60 workers. By sub-system, mulberry dikes required 4289 man-days/yr, or the labor of 14 workers; sugar cane dikes required 7435 man-days/yr, or the labor of 25 persons; fish ponds required 5344 man-days/yr, or the labor of 17 workers; and silkworm-rearing required 1065 man-days/yr, or the labor of 3 persons (Table 10).

The monthly labor demand of the Production Team's dike-pond area is shown in Table 10 and Fig. 5. The maximum labor input, 2076 man-days, was made in April, when 82 full-time workers were required. The lowest input, 534 man-days, was made in November, when 21 workers were required to operate the system. The average monthly labor demand of the system was 1511 man-days, which required an average of 59 full-time workers.

From this it is apparent that the system demanded the full-time labor input of

6) Per hectare an additional 75.7 man-days are required for lashing; 75.7 for the removal of old bushes; 43.9 for the eighth leaf harvest plus two additional applications of urea; and 909.9 for all the nursery bed tasks.

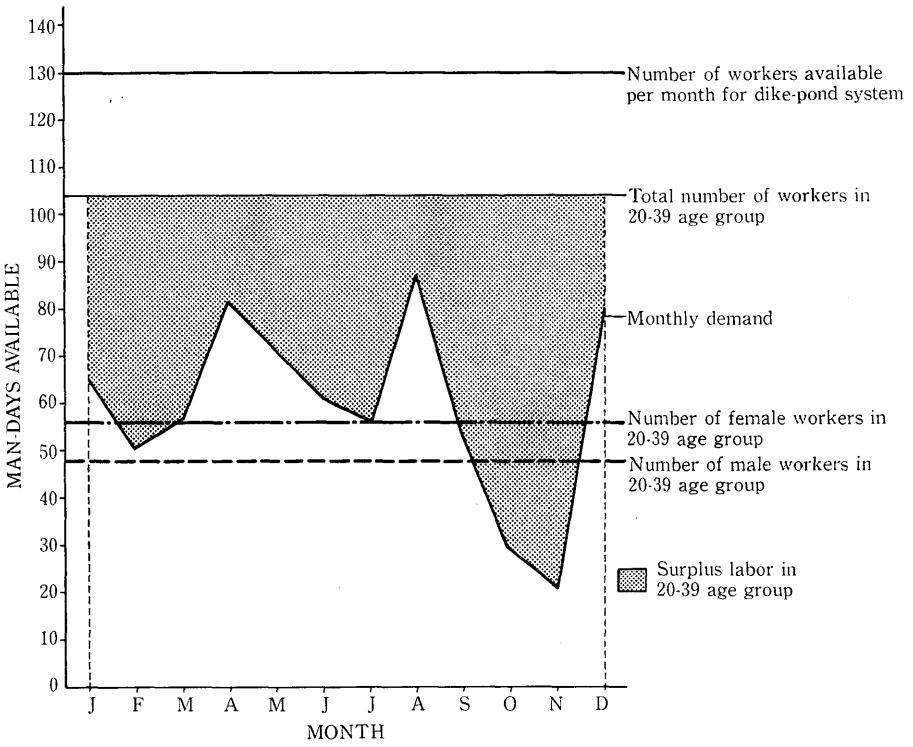


Fig 5. Monthly Labor Availability and Labor Demand of the Dike-Pond System of the First Production Team, Nanshui Brigade

far fewer workers than were potentially available in the production team to operate it. The potential full-time labor supply of 48 men in the 20–39 years age group alone amounted to 14628 man-days/yr, and that of the 56 women in same age group was 17064 man-days/yr. Thus this age group alone could potentially provide 31692 man-days/yr to the dike-pond system. In other words, on a yearly basis the area of dike-pond operated by the First Production Team could absorb only 57 percent of the potential full-time labor available in the 20–39 year-old age group alone.

This characteristic of the system becomes particularly marked in the relatively slack early- and mid-winter season. In November, for example, the system absorbed only 534, or 20 percent, of the 2641 man-days potentially available from the total 20–39 year-old age group. On the other hand in April, August and December, the peak months for labor demand, the system absorbed 79, 85 and 76 percent of the potential labor of this group, respectively (Fig. 6 and Table 11).

For simplicity, the 20–39 years age group has been used in the foregoing to

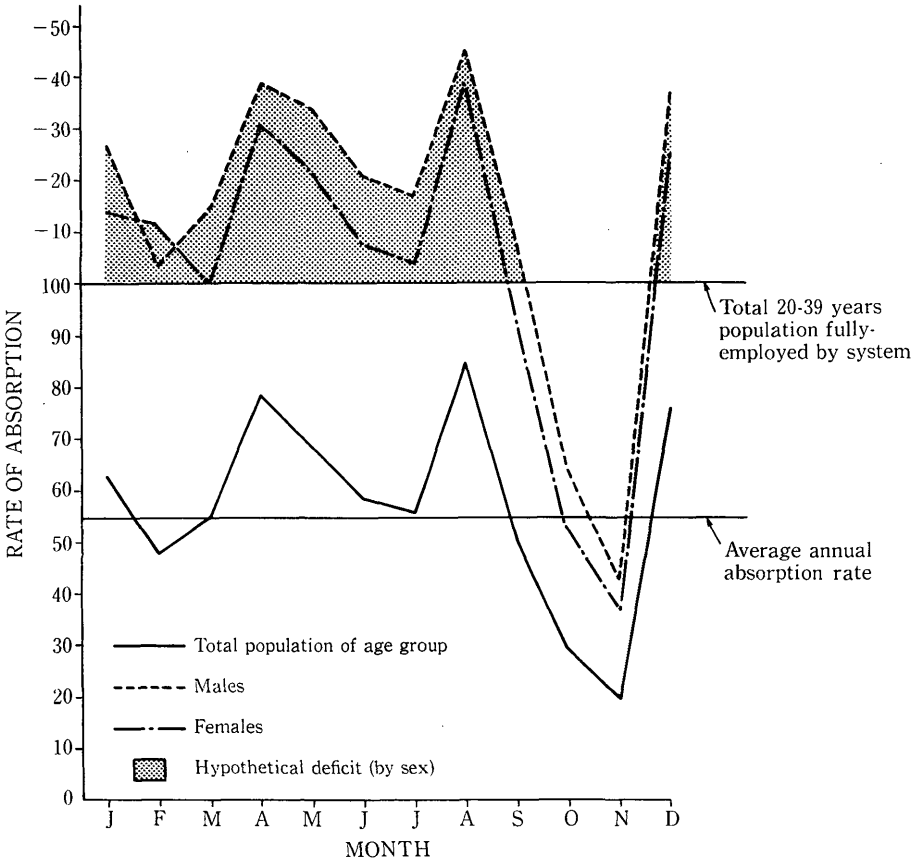


Fig 6. Labor Absorption Capacity of the Dike-Pond System for the 20–39 Year Age Group

exemplify that condition.[7] As has been demonstrated above, persons younger than 20 years-of-age and those older than 39 years were also employed in the system, hence the manpower base was broader than modelled and the absorption capacity of the system correspondingly less. However, it is important to realize that the bulk of the labor input to the system, and especially that for the heavier tasks, is performed by both men and women of the 20–39 year-old group.

Given the full-time employment capacity of the dike-pond system *per se*, the important employment generating function of the general environment is immediately apparent, in terms, *inter alia*, of building, managing and maintaining physical and social infrastructures and marketing, in particular.

Since the basic elements of the dike-pond system can absorb only slightly

7) Although only the core elements of the system have been considered here—the sugar cane and mulberry dikes, fish pond and silkworm-rearing—other agricultural activities are relatively insignificant in the production team studied. At most they would absorb the full-time labor of only an additional 5 persons.

Table 11. Labor Absorption Capacity of the Dike-Pond System for the 20–39 Years Age Group

MONTH	DEMAND	POTENTIAL SUPPLY			ABSORPTION RATE		
	Man-days	Total	Male	Female	Total	Male	Female
JAN	1666	2641	1219	1422	63	−27	−15
FEB	1273	〃	〃	〃	48	−04	−11
MAR	1443	〃	〃	〃	55	−15	100
APR	2076	〃	〃	〃	79	−39	−31
MAY	1818	〃	〃	〃	69	−32	−22
JUN	1546	〃	〃	〃	59	−21	−08
JUL	1474	〃	〃	〃	56	−17	−04
AUG	2232	〃	〃	〃	85	−45	−39
SEP	1329	〃	〃	〃	50	−08	93
OCT	752	〃	〃	〃	29	62	53
NOV	534	〃	〃	〃	20	43	38
DEC	1991	〃	〃	〃	76	−38	−29

over half the available labor, under the household responsibility system implemented by the recent rural reforms families have greater flexibility to adjust the details of their allocation of labor both within and outside the system. This is the topic of the next section.

HOUSEHOLD VARIATION IN LABOR SUPPLY AND SYSTEM DEMAND

Since December, 1978, following the third plenum of the Eleventh Central Committee of the Chinese Communist Party, there has occurred a progressive repudiation of the notion of a highly collectivized society, and China has gradually moved toward the creation of a mixed economy. The program of economic reform began first in the countryside (following the official adoption of the reforms in April, 1979). In brief, the rural reforms have decollectivized agriculture, transformed from *de facto* to *de jure* the status of the individual family as the fundamental rural economic unit, and have removed the controls that prevented households from freely marketing their surplus production.

The rural reforms legitimized a spontaneous and illegal isolated process of decollectivization as, for example, had occurred in 1977 in Jinyu Commune, Guanghan County of Sichuan Province, where fields had been secretly divided among the production teams. That practise was condoned as an experiment in the following year. Now, some eight years later, most places in rural China practise some form of the responsibility system, via which land and production responsibility is contracted either to the household or to the production team. In the economically more advanced provinces in excess of 90 percent of farmers

employ the household responsibility system [DELFS 1984].

The rural reforms have been spectacularly 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 [LI and ZHANG 1984]. As a consequence of these reforms, agricultural and sideline products sold on the free market nationwide totalled U.S.$ 46.8 billion in 1983. This was 58 percent greater than in 1978, when the reforms began.

At about the same time as the rural reforms were announced, Guangdong Province was granted considerable local autonomy to devise its own economic policies. As a consequence of both of these events considerable although varied socio-economic changes have occurred throughout the Zhujiang Delta.

In the delta region, at least during the five years from 1979 to 1983, the three-tiered communal system was not apparently weakened to any significant degree. There, rather, the household responsibility system has been operationalized *within* that structure. This is to be expected since the multifaceted and interlocking system that was, in general, perceived of as beneficial had been gradually assembled over three decades to organize a highly complex commercial cropping system.

In the relatively wealthy Zhujiang Delta region, which is highly specialized in the production of commercial crops, the adoption of the household responsibility system appears to have been slower than in less commercialized and poorer regions. In the delta local variations in the rate of introduction of the new system are closely related to land use patterns, as is reflected in the clauses and phrasing of the individual contracts for the different crops [RUDDLE *et al.* n.d.].

Although households now have considerable freedom in decision-making for the allocation of their own resources, the role of the three-tier organization remains predominant in the centralized making of major decisions that control such operations as the strict scheduling of the phases of the cropping cycle and quota levels. For example, for fish, a highly perishable commodity, firm delivery dates and precise quantities to be supplied are specified in the production contract.

In areas where rice production is of major importance, however, the household responsibility system has taken little hold and the older system of production team responsibility has been retained. For the most part the new system has not been implemented since the emergence of overly fragmented ricefields in an area of extremely high population density, with production levels declining as a consequence, is viewed as a distinct possibility were the new system to be implemented for rice production.

Although the basic structure of the social organization of agricultural production remains essentially the three-tiered form of commune, brigade and production team, since the late-1970s, with the introduction of the household responsibility system of farming, a dramatic organizational change has occurred at the household level, the smallest unit of Chinese social organization.

In Shunde County the organizations and functions of the higher order elements of the structure remain essentially the same as described above, with production quotas governing the relationships at all levels from the region to the production team. This hierarchical structure of quota-setting has not been changed. Since 1980, however, a dramatic change has taken place in the formal relationship concerning productive activities between the production team and the individual household [RUDDLE n.d.].

The First Production Team of the Nanshui Brigade started the contract system in 1978, when 7 percent of the team's fish pond area was contracted to households on a trial basis. By 1981, 70 percent of the ponds had been contracted, and, since the results of the experiment were regarded as being so successful, in 1982 all the sugar cane and mulberry dikes were farmed under household contracts, and all silkworm-rearing production had been converted to the new system. By 1984 it was planned to have all of the production team's land contracted in this manner [unpub. stats., Procurement and Records Office, Nanshui Brigade, 1983].

The contract system has been enthusiastically accepted by farm households, since not only does it permit a hitherto unaccustomed degree of flexibility in arranging household activity schedules and labor inputs and allow wider private ownership of productive assets, such as tools and equipment, but, more importantly, productivity has risen dramatically as has the *per capita* income of the team members. The material signs of this new-found affluence pervade the countryside of Leliu Commune.

Detailed variations at the micro-level within the dike-pond system, that is now in transition from a collectivist to an individual household form of social organization of production, are examined in this section based on data derived from intensive interviews conducted with informants in four households, or 7 percent of the total in the First Production Team of the Nanshui Brigade. The interviews were conducted in August, 1983 and the data derived therefrom were for 1982, the last complete financial year prior to the time of interview.

HOUSEHOLD NO. 1 (HH 1)

One of the simplest and smallest household dike-pond operations in this production team is conducted by HH 1. Since the incomes of the two working adults in this family do not depend directly on the dike-pond system and the household is relatively small (Table 12)—as is its food requirements and capacity to supply operational labor to the system—this household could contract for only a relatively small area of dike-pond.

HH 1 has contracted for only a 0.33 ha fish pond. It also has a private plot of 0.0059 ha. All farming activities conducted by this household are geared to

Table 12. Composition and Occupations of Household No. 1

RELATIONSHIP TO HEAD	AGE	FULL-TIME OCCUPATION	PART-TIME OCCUPATION
Householder	71	Retired	None
Son	33	Shipyard laborer	Family farm
Daughter-in-law	31	School cook	Ditto
Grand-son	7	School pupil	None
Grand-son	2	Crêche	Ditto

fulfilling the requirements of its pond.

Household Composition and Occupations

In this family the 31 year-old daughter-in-law of the household head provides most of the labor for the dike-pond. A full-time cook in the brigade school, she performs the household's dike-pond operations as a part-time activity, assisted occasionally by her husband and eldest son. Her husband, the 33 year-old son of the house, is a shipyard laborer in the city of Guangzhou. He is at home for as aggregate of only 1.5 mo/yr, during which he works on the household's pond and private plot.

Three dependents comprise the remaining members of HH 1. The oldest, the 71-year-old household head, is a retired widower who too old and infirm to work the dike-pond system. He assists with light household chores and minor tasks. The other two are grandsons of the household head; a 7-year-old primary school pupil and a 2-year-old infant who attends the brigade crêche.

Labor Requirements and Supply

This 0.33 ha pond requires a total labor input of 177 man-days/yr, or 58 percent of the full-time annual labor of one person. Of this, 72 days, or 41 percent, is for the heavy tasks of annual pond maintenance.

Tasks demanding such hard physical labor are routinely performed by rural Chinese women, and those in HH 1 are done mostly by the daughter-in-law of the householder early in the morning and in the evening before and after her daily full-time job and household chores. Year-round she puts in an average of 4 hours/day of labor to the dike-pond system. When the she is too busy and her husband away in Guangzhou, her 7-year-old son does the simple task of checking on pond oxygen levels, by observing fish behavior. Her husband also works at these tasks when he is free from his city job. He does full-time dike-pond work for a total of about 45 days/yr, and attempts to schedule vacations to coincide with periods of heavy labor demand.

Routine management of this pond requires an aggregate annual labor input of 90 man-days, or 51 percent of the total. The main job is the daily cutting of Elephant grass and dumping it into the pond.

Fish harvesting in HH 1 requires an annual total of 15 man-days of labor input, or 3 days for each of the five harvests. Since a group of men from households that have contracted ponds cooperate reciprocally to harvest fish, the householder's son tries to schedule vacations for both his own harvests and when he must reciprocate.

This household is potentially able to muster 268 man-days/yr of labor to operate its pond. The householder's son is free from his shipyard laborer's job for 45 days/yr; the 59 days/yr of school holidays plus the 4 hrs/day put in by his wife, which is equivalent to 146 man-days/yr, provides a total of 205 days/yr; and their son can provide the 30 min/day (or 5 percent of one man-day) usually given to observing pond conditions, the equivalent of 18 man-days/year.[8]

The total potential pond labor supply of HH 1 is 268 man-days/yr, enough to satisfy the annual demand of 177 man-days. But owing to the son's absence from home, synchronizing supply with demand when the heavy annual pond maintenance tasks must be performed is potentially problematical.

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 large, 9-member household performs a varied range of economic activities both directly related to and quite separate from the dike-pond system (Table 13).

The area contracted to this household is fully representative of the dike-pond system since it operates all the essential components of the system, all of which are linked by material, energy and labor flows. 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

Table 13. Composition and Occupations of Household No. 2

RELATIONSHIP TO HEAD	AGE	FULL-TIME OCCUPATION	PART-TIME OCCUPATION
Householder	63	Silkworms	Fish pond
Wife	60	Silkworms	Ditto
First son	34	Factory Laborer	Ditto
Daughter-in-law	32	Brickworks Labor	General farm work
Fourth son	27	River transport	Ditto
Fifth son	19	General farm work	House-building
Grand-daughter	10	School pupil	Pig-raising
Grand-son	8	School pupil	None
Grand-daughter	5	School pupil	Ditto

8) School vacations amount to 59 days/yr (47 for summer vacation [July 15–August 31], 2 for Western New Year and 10 for Chinese New Year).

sugar cane, 0.132 ha (25.6 percent) planted to mulberry and 0.02 ha (3.9 percent) is the private plot.

Household Composition and Occupations

Only three adult members of HH 2 are fully involved in the dike-pond system. The 63-year-old male head of the household and his 60-year-old wife are specialists who rear silkworms. Part-time they both work on their contracted pond. Their 19-year-old fifth son is the only other full-time worker on the contracted land of this family. Not specialized in any particular dike-pond activity, because of his youth he mainly undertakes the heaviest tasks. In his spare time he builds houses.[9)]

The first and fourth sons reside in the household. The former, 34-years-of-age and married, is a full-time laborer in the brigade food-processing factory. In his spare time he assists with pond work. The unmarried fourth son is 27-years-of-age. With a group of age-mates he purchased a boat and works full-time as a transport contractor on the local waterways. Part-time he does general work on the household's dike-pond.

The wife and three children of the oldest son of the householder also reside in the household. The 32-year-old-wife is a full-time laborer in the brick-and-tile works of the production team. Part-time she undertakes general work on the household land. All the grand-children attend school full-time. The oldest, a girl of 10, assists in pig-raising during her free hours. The two small boys, 8- and 5-years-of-age, are regarded as being still too young to do any productive household labor. (Although in many cases 8-year-olds do simple tasks.)

Labor Requirements and Supply

The 0.198 ha fish pond contracted by this household has a labor demand of 106 man-day/year, or 34 percent of a full-time laborer's annual work. Of this total, 43 man-days, (14 percent) are required to perform annual maintenance tasks, 54 (17 percent of total labor input) are required for routine management throughout the year, and 9 (or 3 percent of the total) for harvesting.

The 0.165 ha of sugar cane dike worked by HH 2 requires an annual labor input of 198 man-days, or 64 percent of one full-time laborer's annual work input. Of this, 21 days is performed by the men for dike preparation, 6 by the women to prepare the planting stock, 13 by men and women for planting, 95 by men and women for management and 63 by men and women for harvesting. During the busy February–May planting and harvesting season this household must supply 90 man-days of labor, or 45 percent of the total input to this crop.

9) There is a large pent-up demand throughout the Zhujiang Delta for modernized family housing. This is now being fulfilled as a result of the larger amounts of savings and disposable income engendered by the recent rural reforms [RUDDLE n.d.; RUDDLE *et al.*, n.d.].

The 0.132 ha of mulberry dike cultivated by this household requires a labor input of 199 man-days/yr, or 65 percent of a full-time laborer's total annual labor input.[10)]

In early-December and late-January 22 man-days are required for the heavy tasks of dike preparation. Tillage, the construction of planting rows and drains, and fertilizing, the heaviest of these tasks, require 16 man-days of labor. This is mostly provided by the fifth son. The 6 days required to break-up the sun-dried clods, a relatively light task, is provided by any of the three sons and the daughter-in-law in their spare time. Planting and related tasks are performed in late-January and early-February by the same persons, who provide 13 days of labor for the purpose.

Management and harvesting is divided among the women and men of the household. Leaf harvesting and weeding, tasks performed monthly between April and November, are done mainly by the wife and daughter-in-law, assisted occasionally by the older grand-daughter. Labor for leaf harvesting, which includes removal of the terminal bud coincident with the fourth harvest, varies among the harvests, but in HH 2 requires an aggregate input of 44 days during the silkworm-rearing season. Weeding requires 96 days of labor throughout the growing season. Fertilization by broadcasting urea is done for each leaf harvest by the fifth son and requires a total of 4.4 days of labor over the entire season.

The heavy labor involved in spreading pond mud over the mulberry dike is performed by the son. The three applications together require a total labor input of 12 days.

The final task in the mulberry cultivation cycle is preparation for interplanting winter vegetables. The light tasks involved are performed by anyone who has time available, and require 8 days of labor.

All the tasks involved in raising silkworms for one season require 375 man-days of labor input per hectare of the mulberry. With 0.132 ha under mulberry, this household must supply 49 man-days of labor per season for silkworm-raising.

The total labor demand of the dike-pond system operated by this household is 552 man-days/yr. This is equivalent to 1.8 years of full-time labor input. Labor demand for heavy work performed by the younger males peaks in December–January, when all the annual pond maintenance and dike preparation tasks must be performed.

In this household an aggregate of 87 man-days must be supplied for pond maintenance and dike tilling plus associated activities at that time. The bulk of the work is undertaken by the fifth son, assisted by his two brothers and sister-in-law in their spare time. This is the most concentrated period of heavy labor input during the annual cycle of the dike-pond system. Thereafter, although brief

10) Were the additional tasks to be performed (*vide supra*), labor requirements would increase to 345 man-days/year, or the equivalent of the full-time labor of slightly more than one person.

periods of intense labor are required, such as for spreading pond mud over the dikes or for fish harvesting, most of the work performed repeatedly throughout the year is relatively light and can be done when labor is available.

The capacity of this large household to supply labor to its dike-pond operation far exceeds the required input of 552 man-days/yr. The aggregate potential input capacity of the 6 younger adult members is 1830 man-days/yr, of which this household's dike-pond operation can absorb only 30 percent. Thus chronic under-employment of family labor has been overcome by having three members fully employed outside the system. Nevertheless, there remains an excess labor capacity in this household, which can potentially supply a further 1278 man-days/yr to the system or to other economic activities.[11]

HOUSEHOLD NO. 3 (HH 3)

Another relatively simple dike-pond operation is conducted by the small HH 3. Although the area contracted is small, unlike HH 1 this household operates the complete range of dike-pond activities, except silkworm-rearing. Like HH 1, in this one also the dike-pond in operated part-time, since its two "able-bodied" members have other full-time occupations.

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. 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.

Household Composition and Occupations

The 36-year-old male head of HH 3 is employed full-time as the Finance Officer of the production team. His 34-year-old wife is a full-time laborer in the production team's brick-and-tile factory. Both work on their dikes and pond only during their spare time. In this they are assisted part-time by their two young sons, both of whom are school pupils (Table 14).

Two female dependents comprise the remaining of the members of this household. One is the 60-year-old mother of the household head. She is retired and assists the family by doing all the housework. The 6-year-old daughter attends the team's kindergarten, and performs no productive labor.

Labor Requirements and Supply

The dike-pond operation of this household has a total annual labor demand

11) This total has been calculated as follows: householder 305 days, his wife 305 days, first and fourth sons and daughter-in-law 156.5 days each (60 free days plus 3 hrs/day for 305 days), and the fifth son 305 days.

Table 14. Composition and Occupations of Household No. 3

RELATIONSHIP TO HEAD	AGE	FULL-TIME OCCUPATION	PART-TIME OCCUPATION
Householder	36	Official	Family farm
Wife	34	Brickworks Laborer	Ditto
Mother	60	Retired	Housework
First son	13	School	Family farm
Second son	11	Ditto	Ditto
Daughter	6	Kindergarten	None

of 252 man-days/yr. It is operated in their spare time by two adults and a young son. The householder and his wife can each supply 151 man-days/yr to the system, for a total of 302 man-days/yr, or slightly in excess of the requirements of the system.[12] A potential scheduling difficulty for performing the heavy pond maintenance and dike preparation activities is overcome by both adults taking vacation from their full-time jobs to perform the tasks together.

The 0.099 ha fish pond contracted by this household requires a labor input of 53 man-days/year, or 17 percent of a single laborer's full-time work input. Annual pond maintenance tasks require an input of 21 man-days (39 percent of the total), routine maintenance needs 27 man-days (50 percent) and harvesting 4 man-days (7 percent).

The 0.116 ha planted to sugar cane requires a labor input of 142.4 man-days/yr, or 45 percent of a full-time laborer's annual work. Of this total, 14 days are for dike preparation, 4 for seed preparation, 8 for planting, 70 for crop management and 43 for harvesting. In the February–May busy season 63 days must be supplied for the planting and harvesting tasks.

The 0.04 ha of mulberry dike cultivated requires 60 man-days/yr of labor

Table 15. Composition and Occupations of Household No. 4

RELATIONSHIP TO HEAD	AGE	FULL-TIME OCCUPATION	PART-TIME OCCUPATION
Householder	51	Family farm	Administration
Wife	45	Ditto	Housework
Mother	82	Retired	None
Son	15	School pupil	Family farm
First daughter	21	Silkworms Laborer	Ditto
Second daughter	18	Brickworks Laborer	Ditto
Third daughter	12	School pupil	Ditto
Fourth daughter	9	Ditto	Ditto

12) Based on each having 60 days/yr free from their full-time jobs plus each providing 3 hrs/day for 305 days.

input, or 19 percent of a full-time laborer's annual work. Of the total, 7 days are required for dike preparation, 4 for planting, 13 for leaf harvesting, 29 for weeding, 1 for broadcasting urea fertilizer (*i.e.*, about an hour each time), 4 for mud-spreading and 2 to prepare for over-wintering.

HOUSEHOLD NO. 4 (HH 4)

The dike-pond area contracted by this household is 0.548 ha. Of this, 0.132 ha (24.0 percent) is the fish pond, 0.119 ha (21.7 percent) is dike planted to mulberry and 0.297 ha (54.1 percent) is under sugar cane. Bananas are cultivated along dikes and together with sugar cane on the 0.09 ha private plot.

Household Composition and Occupations

With the exception of the retired 82-year-old mother of the household head, all members of this household are involved in dike-pond operations at least part-time (Table 15). The 51-year-old head of HH 4 devotes 60 percent of his working time to household farm work. The remainder is spent as the Administrator of the production team. His 45-year-old wife works full-time on the farm and, with the assistance of her four daughters, also performs all the household tasks.

Three of this householder's five children, the 15-year-old son, the 12-year-old third daughter and the 9-year-old fourth daughter, are full-time school pupils. In their spare time all assist with farm work. The two oldest daughters, 21 and 18-years-old, are fully employed outside the household's dike-pond operation. The former works as a laborer in the silkworm group of the production team and the latter is a laborer in the team's brick-and-tile factory.

Labor Requirements and Supply

The dike-pond area of this household has a total labor demand of 725 man-day/yr. The household's capacity to provide labor to the system is far in excess of this requirement since the potential labor supply from the "able-bodied" adults alone amounts to 1220 man-day/yr, assuming that they all provided a full-time labor input of 305 days.[13] Thus to fully realize the income-earning potential of the household some members are fully employed outside the dike-pond system, and the head of the household devotes only 60 percent of his time to it. Nevertheless, the labor supply potential of this household still exceeds system requirements, since its members can together supply at least 942 man-days/yr of labor.[14]

To operate this household's 0.132 ha pond requires a total annual input of

13) That is, the head of the household, his wife and two oldest daughters.

14) Calculated on the following basis: Household head (60 percent full-time) provides 183 man-days/yr; his wife provides 305; and first and second daughters plus the son each provide 151.5 man-days/yr (60 days/yr free from full-time work plus 3 hrs/day for 305 days/yr).

70 man-days of labor. This is equivalent to 23 percent of a full-time laborer's total annual working time. Of this total, 29 man-days (41 percent) are required for annual maintenance tasks, 36 (51 percent) for routine maintenance, and 6 (8.5 percent) for harvesting.

This household cultivates 0.387 ha of sugar cane, including that grown on its 0.09 ha private plot, which requires a total labor input of 464 man-days/yr, or the full-time work of 1.5 laborers for one year. Dike preparation requires 49 days; 15 are needed for seed preparation; 29 for planting; 234 for crop management; and 147 for harvesting. In the February–May period 211 man-days must be supplied.

HH 4 cultivates 0.119 ha of mulberry dike, which requires an annual labor input of 180 days, or 59 percent of the total annual labor input of a full-time worker. Labor inputs are distributed as follows: 19.8 days for dike preparation; 11.7 for planting; 141 for harvesting and management; and 7.2 for preparations for over-wintering. Of the tasks performed by this household during the silkworm-rearing season, 39.7 man-days are required for leaf-harvesting, 86.5 for weeding, 4.0 for broadcasting urea, and 10.8 for spreading pond mud.

CONCLUSION

As is to be anticipated in a traditional system in transition from a collectivist to an individual household responsibility system, details of dike-pond management vary among households. This is, of course, a response to individual household circumstances that affect the physical and financial capacity to supply different inputs to the system at different rates, as well as differing perceptions with regard to the comparative worth of traditional and modern inputs.

As demonstrated for the production team as a whole, although inherently labour intensive the dike-pond system has a relatively weak labour absorption capacity under the conditions of the population density of the Zhujiang Delta. This is also apparent at the individual household level.

Household economies are heavily dependent on jobs secured outside the direct operation of the dike-pond system. In all four households more than half the annual income is derived from work outside the system [RUDDLE, n.d.]. Of a total of 28 persons in these sample households, nine (32 percent) work full-time outside the dike-pond system. However, eight of them—all except the son of the householder in HH 1, who works as a shipyard laborer in Guangzhou—hold jobs that depend indirectly on the system.

Although those jobs are not directly related to the operation of the dike-pond system, they are linked to its success and continuous productivity. Thus two persons, the school cook (HH 1) and the brigade finance officer (HH 3), together with the part-time production team administrator (HH 4) are employed in the

social infrastructure of the system; three women (one each in HHs 2, 3 and 4), who are full-time laborers in the brigade's brick-and-tile works plus the son of HH 2, a part-time house-builder, are involved with the physical infrastructure of the system; the son of HH 2 who operates a river boat depends heavily on the transport of products from and inputs to the system to make a living; and another son of HH 2, employed in the brigade's food processing factory, together with a daughter from HH 4, a silkworm laborer for the production team, process outputs from the system.

Despite that external employment, the dike-pond system still remains overmanned at the household level. In some instances this is marginal, as in the case of HH 3, where only 16 percent of the available man-days are not utilized by the system. In HH 2, on the other hand, 70 percent of the available man-days are not applied to the system. In HH 1 and HH 4 the capacity to supply manpower exceeds the requirements of the system by 34 and 23 percent, respectively.

Yet from one perspective much of this surplus manpower may be construed as more apparent than real, since it is derived from annual aggegation of holidays, days off and the spare time available to household members after completion of their principal labor. On the other hand, after decades of frugal living and low incomes individual households are eager to take advantage of the variety of income-generating opportunities now available to them as a result of the implementation of the household responsibility system and its related free market. Thus there exists a huge pent-up demand for consumer goods and services as well as for the cash needed to acquire them.

As a consequence, most spare time hours are put to economic use. Thus although there may be enough employment generated by the system and by outside jobs to employ full-time "able-bodied" workers for 10 hrs/day–305 days/yr, there is a huge demand for income-earning opportunities to absorb the surplus hours and days created by spare time. In this sense, then, the aggregate man-days surplus represent more a demand for opportunities to earn additional, part-time incomes.

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中国，珠江デルタにおける農業と養殖漁業との複合システム
——労働力の需給関係を中心として——

ケネス・ラドル

南アジアと東アジアの各地には，農業と養殖漁業とを生態学的に巧みに結びつけた，はなはだユニークな循環システムが，かなり広範囲にわたって古くから普及していた。それにもかかわらず，このシステムの科学的考察は，まだ不充分にしか試みられていない。とりわけ，人間生態学と社会科学の諸分野における研究の立ちおくれが著しい。

このような状況のもとで，この論文は次の2点を当面の目的として書かれたものである。すなわち，第一は，中国南部珠江デルタの池塘（養魚池）施設のような，高度に統合されたシステムにおける労働力の需要に関して詳細な分析を施すこと，第二は，その労働力の季節的需給率に基づいて，この複合システムによる地域労働力の総体的な吸収能力を測定すること，以上の2点である。この目的に沿って，広東省順徳県南水郷の第一生産隊に属する4所帯（全所帯の7パーセントに相当）をサンプルに選び，同生産隊の労働力の需給が総量的に分析された。

この調査の結果，珠江デルタの伝統的な地塘システムが吸収し得る労働力が，案外に低水準にとどまっていることが分かり，したがって個々の所帯にとっては，池塘システム以外に雇用を確保することが，家計の安定のために必須条件である，という結論に達した。すなわち，南水郷第一生産隊に配当された池塘は，総計9.97ヘクタールで，その操業に要する年間労働力は，延べ18,133人日と算定された。これは，60人のフルタイム労務者を動員した場合の年間労働力に相当する。ところが，同生産隊が抱えるフルタイム労働力の実勢は，20歳から39歳までの年齢層に限ってみても，104人，つまり年間延べ31,692人日に達する。したがって，同生産隊の池塘システムは，この年齢層の実質労働力の57パーセントしか吸収できないわけである。所帯レベルで労働力の吸収率をみてみると，高いところで83パーセント（所帯 No. 3）から，低いところで30パーセント（所帯 No. 2）というように幅があった。そしてサンプル所帯の人員の32パーセントが，池塘操業以外の職種にフルタイムで就業していた。

本稿が依拠した野外調査は，1980年1月から1983年12月までの間に筆者が実施した，珠江デルタの池塘システムに関する大規模な研究の一部をなすものである。そのうち，労働力の需給関係に関する実地調査は，1981年の9～10月，および1983年の8～9月の前後2回，各数週間にわたって行なわれた。この研究プロジェクトは，中国科学院（広州地理研究所）と国連大学（東京）との財政的協同援助のもとに，筆者の主導による共同研究として実施されたものである。