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NEW RICE TECHNOLOGY AND LABOR ABSORPTION COMPARATIVE HISTORIES OF TWO PHILIPPINE RICE VILLAGES

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NEW RICE TECHNOLOGY AND LABOR ABSORPTION: COMPARATIVE HISTORIES OF TWO PHILIPPINE RICE VILLAGES[1]

ABSTRACT

Two villages with contrasting histories of agricultural and demographic evolution were studied to identify the impact of technological changes in agriculture on employment opportunities.

Irrigation development helped absorb additional labor force into agriculture. When new rice technology based on modern rice varieties was introduced in irrigated areas, agricultural employment opportunities increased. Labor needs not only absorbed the rapidly increasing labor force in the rice farming sector, but also attracted migrants from less productive agricultural areas and the urban sector.

Therefore, new rice technology not only supported the agricultural labor force but also reduced the urban poverty.

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NEW RICE TECHNOLOGY AND LABOR ABSORPTION: COMPARATIVE HISTORIES OF TWO PHILIPPINE RICE VILLAGES[1]

One of the most important roles of agriculture in densely populated developing countries is to provide employment opportunities for an ever increasing labor force. Although steady growth in the nonagricultural sector would gradually reduce agriculture's employment role, the current high rate of population growth will make it important to increase agricultural employment for the foreseeable future. How far this role can be fulfilled depends on the labor absorption power of agriculture, which depends on the type and rate of technological change in the agricultural sector. This paper examines the process in which agricultural technology and rural village populations interact depending upon the labor-absorbing capacity of agriculture. The population adaptation process of two contrasting villages is examined by reconstructing village history with special reference to demographic evolution and agricultural change.

DATA COLLECTION AND STUDY SITES

Two villages in two major Philippine rice growing provinces were chosen for the comparative study: one in Laguna Province, henceforth called *Laguna Village*, and another in Iloilo Province, hereafter called *Iloilo Village*.

The data used were collected in field surveys as part of broader projects during June 1980-June 1982 in Laguna Village and March 1979-March 1982 in Iloilo Village.

Historical changes in population were compiled using family reconstruction, a method developed in historical demography. Instead of using parish church records, however, this study reconstructed families using demographic data on birth, death, marriage, and migration of all households that once existed, and existed in the villages at the time of our surveys. We obtained necessary information by interviewing members of all existing households and aged persons in the villages.

Laguna Village has been studied repeatedly since 1966 (Umehara 1967, Hayami et al 1978, Hayami and Kikuchi 1981). Although each study had a different objective, all of them provide basic information about the village, including population, household characteristics, and agricultural production. We used these data to cross-check historical changes documented in our survey. No similar benchmark information was available for Iloilo Village. We tried, in addition to interviews, to trace the history of home lots and farm lots to make the family reconstruction as accurate as possible.

The irrigated lowland rice belt in Laguna Province, which provides the southern coast of the Laguna de Bay in Southern Luzon, is the most productive rice growing area in the Philippines. The lowland strip along the lake elevates to coconut and upland areas in Laguna and the surrounding provinces. Rice production in Laguna has experienced a high level of technological development partly because of well-developed irrigation systems. Roads and highway networks provide relatively easy access to urban centers from most villages in Laguna, including Laguna Village, which is in a town about 90 km southeast of Manila.

Iloilo is one of the four provinces of Panay Island, about 500 km south of Manila. One-third of the province is a coastal plain where rainfed lowlands form a large rice growing area. Maize, tobacco, and vegetables are grown in the lowlands before and after the rice crop and in uplands during the wet season. Although Iloilo has a large port, the nonagricultural urban sector in the province is too small to directly influence rural areas, as compared to the Metro Manila influence on Laguna Village. Iloilo Village is at the northwestern edge of the rice plain and is surrounded by hills on the west.

Some basic statistics for the two villages are given in Table 1. The exact date of village settlement for both villages is unknown. Information gathered by reconstructing families in the villages shows the earliest settlers came to Laguna Village in the 1880s and to Iloilo Village in the mid-19th century. Iloilo Village, reflecting earlier settlement, had more population than Laguna Village in 1920. However, the two villages had similar land-man ratio, which suggests comparable initial conditions as a rainfed-lowland-based rice village.

CHRONOLOGY OF POPULATION CHANGES

Average annual population growth rate for the study period (1920-80) was 4.5% in Laguna Village and 2.7% in Iloilo Village (Table 2). The national average for the same period was 2.6%. Population growth, however, has experienced large cyclical fluctuations depending on changes in natural and social population increases (Fig. 1).

Natural population growth

Death rates declined steadily in both villages except during World War II. Death rate in Laguna Village declined from more than 2% in 1920 to less than 1% in the late 1970s. In Iloilo Village it went from 2% in 1945 to 0.5% in the late 1970s.

Birth rates have fluctuated more over time. In Laguna Village, peak birth rates occurred about every 20 years – in the 1920s, the 1940s, and the 1950s. After the 1950s peak, birth rates remained high (more than 4%) and a small peak occurred in the late 1970s.

In contrast, Iloilo Village birth rates declined steadily from about 5% to 2.6% after a 1960 peak similar to the

Table 1. Selected statistics for two Philippine villages, 1920, 1950, and 1980.[a]

		Laguna Village			Iloilo Village		
		1920	1950	1980	1920	1950	1980
Population		51	204	706	125*	349	627
Household:	Farmer	9	37	46	25	52	96
	Landless farm worker	–	7	71	–	...	11
	Others[b]	–	–	9	–	...	12
	Total	9	44	126	25	58	119
Farmland (ha):[c]	Irrigated lowland	–	–	85	–	–	–
	Rainfed lowland	36*	89*	–	88*	113*	113
	Upland	–	–	–	...	...	28
	Total	36	89	85	88	113	141
	(Per farm)	4.0	2.4	1.8	3.5	2.2	1.5
	(Per capita)	0.7	0.4	0.1	0.7	0.3	0.2
% of farmland tenanted		...	98	98	...	...	90
Multiple cropping ratio		1.0	1.0*	2.0	1.0	1.0*	1.9
Rice yield (t/ha per year)[d]		...	2.2	4.0	...	...	2.9
Land productivity (t/ha per year)[d]		...	2.2	8.0	...	...	3.2
Household income (t/year):[d]	Farmer	...	...	11.9	...	...	5.3
	Landless	...	...	5.0	...	...	1.6
	Average	...	...	7.6	...	...	5.1
Gini-ratio:	Size distribution of farmland[e]	...	0.46[f]	0.77	...	...	0.31
	Size distribution of household income	...	...	0.42	...	...	0.31

[a]Figures with asterisk are rough estimates. An ellipsis (. . .) indicates data not available and a dash (–) indicates no data. [b]Retired and nonfarm households. [c]Area cultivated by village farmers. [d]Value terms converted into paddy rice equivalent using farm-gate paddy price. [e]Size distribution of operational holdings. [f]As of 1960.

Table 2. Changes in population growth rates in two Philippine villages, 1920-80.[a]

	Natural increase			Social increase			Total
	Birth	Death	Net	In	Out	Net	
Laguna Village							
1920-80	4.9	1.6	3.3	2.5	1.3	1.2	4.5
1920-40	4.8	2.3	2.5	2.8	0.5	2.3	4.8
1950-80	5.1	1.1	4.0	2.2	2.0	0.2	4.2
1940-45	5.0	2.1	2.9	4.1	0.3	3.8	6.7
1945-50	3.8	1.5	2.3	1.8	1.7	0.1	2.4
1950-55	5.7	0.8	4.9	1.1	2.1	–1.0	3.9
1955-60	6.1	1.2	4.9	0.7	1.3	–0.6	4.3
1960-65	4.8	1.3	3.5	2.2	0.7	1.5	5.0
1965-70	4.6	1.5	3.1	2.1	1.8	0.3	3.4
1970-75	4.3	0.7	3.6	4.2	2.6	1.6	5.2
1975-80	4.6	0.9	3.7	3.1	3.2	–0.1	3.6
Iloilo Village							
1920-80	...	...	...	...	...	...	2.7
1950-80	3.7	0.7	3.0	1.0	2.0	–1.0	2.0
1945-50	4.6	1.8	2.8	1.8	0.7	1.1	3.9
1950-55	3.6	1.0	2.6	0.3	1.7	–1.4	1.2
1955-60	4.4	0.6	3.8	1.0	2.4	–1.4	2.4
1960-65	5.1	0.8	4.3	1.2	0.6	0.6	4.9
1965-70	3.3	0.6	2.7	1.3	1.2	0.1	2.8
1970-75	3.1	0.6	2.5	0.9	2.0	–1.1	1.4
1975-80	2.6	0.5	2.1	1.3	3.8	–2.5	–0.4

[a]Average per year (%) for the years shown.

1950s peak in Laguna Village. The 1970s peak has not been observed. As a result, average birth rate for 1950-80 was more than 1% higher in Laguna Village.

These contrasting trends in birth rates have resulted mainly from different patterns in social population changes. The 1980 Iloilo Village population pyramid shows that one-half of the population of child-bearing age had migrated out of the village, whereas Laguna Village has a wide pyramid base distance confirming a high natural reproduction rate (Fig. 2).

Social population growth

Large fluctuations are observed in the rates of social population increase in both villages. Although natural growth rate affects total population growth, changes in social increase rate largely determine the patterns of cyclical movements in total population growth over time. Marginal population adjustments occur mainly through migration.

Although absolute in-migration, out-migration, and net-migration rates differ substantially, six common migration phases can be identified in the two villages by cyclical movements of net migration rate. Laguna Village has two subphases.

Phase I. Before 1950. In-migration declined steadily toward 1950 for both villages, except for the first subphase of Laguna Village in which the rate rose suddenly because of an inflow of evacuees during World War II. Out-migration was negligible in both villages, except for the second subphase of Laguna Village in which demobilization of the war evacuees occurred immediately after the war. As a result, net migration rates were positive and corresponded with in-migration rates, except for the second Laguna subphase.

Phase II. 1950-60. Net migration rate was negative for both villages because out-migration rate increased and in-migration remained stagnant at a low level.

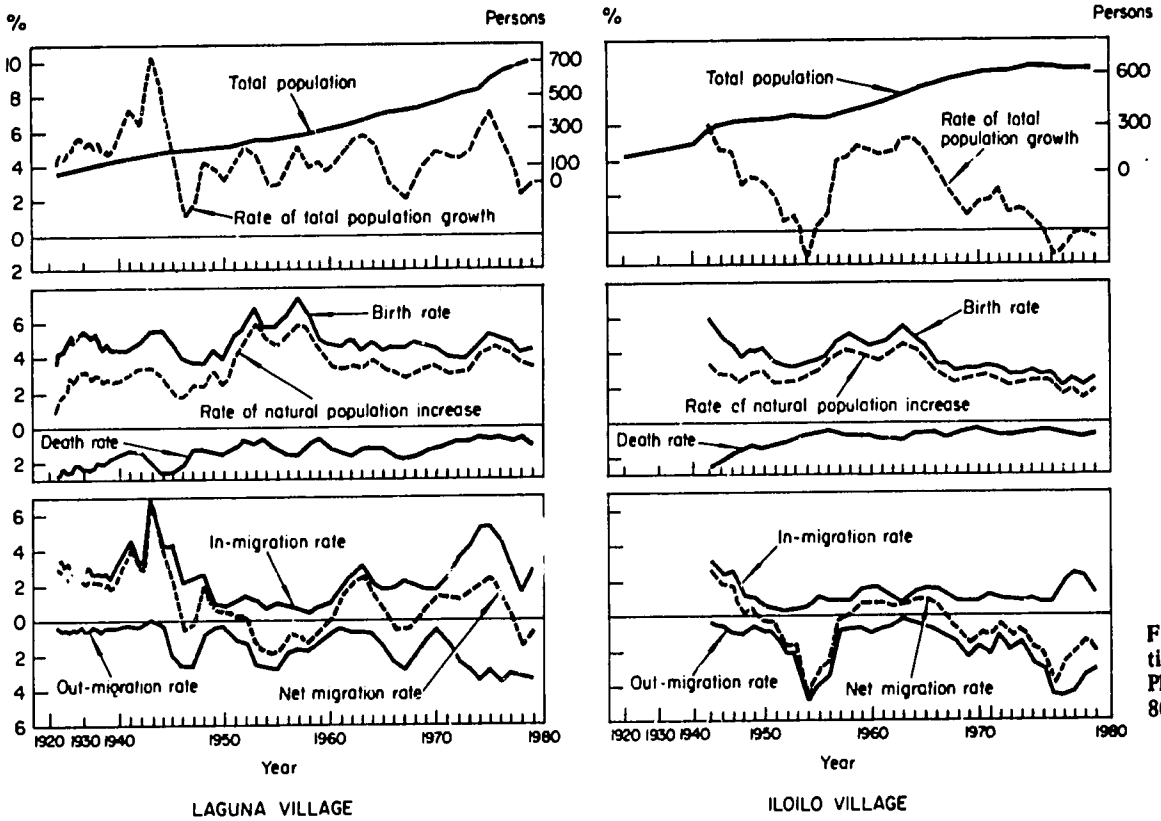
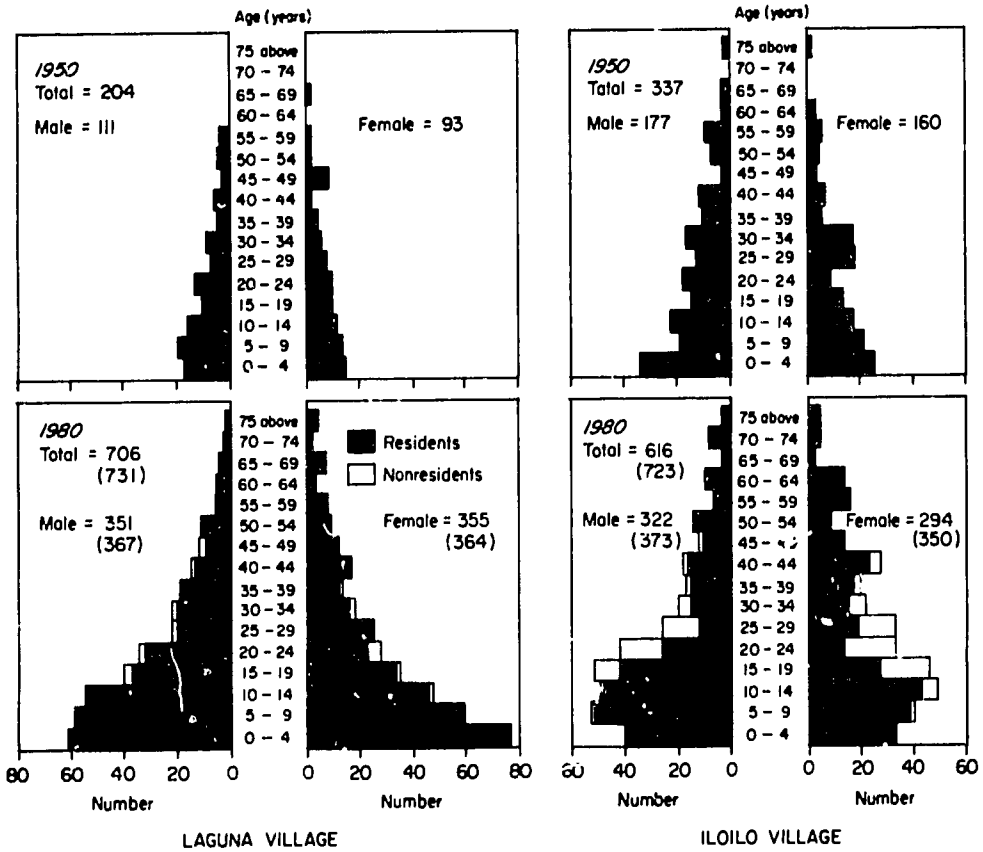


Fig. 1. Changes in population growth rates in two Philippine villages, 1920-80.

Fig. 2. Age distribution of village population in two Philippine villages, 1950-80.



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Phase III. 1960-65. In-migration rates jumped and out-migration was low for the two villages during this phase, resulting in positive net migration rates.

Phase IV. 1965-70. In-migration rate remained almost constant at the Phase III level, but out-migration rate increased. Consequently, both villages again experienced negative net migration.

Phase V. 1970-75. In Laguna Village, net migration rate continued to be positive. In-migration rose to an unprecedented level except for the war subphase. In Iloilo Village, net migration rate was negative, but stabilized at around -1% because the increasing out-migration trend halted.

Phase VI. 1975-80. Out-migration rate increased to 3-4% in both villages, causing a negative net migration rate in Laguna Village and an increasing negative net migration in Iloilo Village.

Specific migration patterns characterize these phases of social population changes.

In Laguna Village, two phases before 1960 were characterized by rural-to-rural migration with a large net population inflow (Table 3). Most in-migrants came from surrounding upland areas to the village as members of farmer households. This rural-to-rural migration pattern prevailed throughout the 1960s. Two migration flows occurred in Phase V. First, rural-to-rural migration flow was dichotomized into an outflow from the village farmer class and a large inflow from outside rural areas, especially from the upland area, to the landless worker class. Second, urban-to-rural migration flow increased with a substantial net inflow to the village landless class.

Phase VI is characterized by a dual migration pattern. Rural-to-rural migration with a large net inflow from the upland area to the lowest village class continued and landless worker households increased tremendously toward 1980 in Laguna Village, partly because of the large inflow in the 1970s (Table 1). On the other hand, rural-to-urban migration flow increased sharply. Most out-migrants were from the upper farmer class in the village. Many out-migrants to the urban sector were wealthy farmers' children with higher education who found jobs in factories and offices. The number of circular migrants who found temporary jobs in urban centers, often as construction workers, also increased significantly (see Stretton 1981, Kikuchi et al 1982).

The Iloilo Village migration pattern was similar to that of Laguna Village until 1950 – people came to the village from surrounding upland areas. In Phase II, a large outflow of population occurred. Most out-migrants went to Mindanao, about 500 km from the village, where they were given 5-ha farms through a government resettlement program. However, a large number of these out-migrants returned to the village in the early 1960s because of production, health, and security problems in the settlement area. This return migration from Mindanao characterized Phase III. Phase IV through Phase VI was characterized by rural-to-urban migration of village youths who sought urban sector employment opportunities. This exodus of village youths was the major factor responsible for the declining birth rate since the mid-1960s. Throughout all phases the migration of landless workers from and to Iloilo Village was of minor importance.

Table 3. Balance of in-migrants and out-migrants by status before and after migration in two Philippine villages.[a]

Status in the village \ Status outside the village	Laguna Village				Iloilo Village			
	Rural		Urban	Total	Rural		Urban	Total
	Lowland area	Upland area			Lowland area	Upland area		
Before 1961[b]								
Farmer	+ 3	+42	- 2	+43	- 7	-19	-13	-39
Landless	+ 9	+ 2		+11	+ 2	+ 4		+ 6
Total	+12	+44	- 2	+54	- 5	-15	-13	-33
1961-70								
Farmer	+ 2	+21	- 6	+17	- 3	+34	-28	+ 3
Landless	+ 2	+ 8	+ 3	+13		+ 7	+ 2	+ 9
Total	+ 4	+29	- 3	+30	- 3	+41	-26	+12
1971-75								
Farmer	- 5	-12	- 3	-20	- 2	+11	-44	-35
Landless	+12	+31	+15	+58	+ 1	+ 2	- 2	+ 1
Total	+ 7	+19	+12	+38	- 1	+13	-46	-34
1976-80								
Farmer	-18	- 5	-32	-55	+ 1	-18	-59	-76
Landless	+ 1	+42	- 7	+36	+ 5	+ 2	- 9	- 2
Total	-17	+37	-39	-19	+ 6	-16	-68	-78

[a]Number of in-migrants less number of out-migrants. Excludes in-migrants who came to the villages as residents with non-farm occupations.
[b]For Laguna Village, 1920-60; for Iloilo Village, 1945-60.

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CHANGES IN AGRICULTURE AND EMPLOYMENT

In the previous section we showed that village population growth was not smooth but was subject to large cyclical fluctuations caused mainly by population migration. In this section, we examine historical changes in agriculture and employment in the two villages.

Technological and institutional changes in agriculture

Major incidences in village agriculture since settlement for the two villages are listed in Table 4. Both villages were settled in the later half of the 19th century. Settlement was an unorganized process in which people from adjacent areas moved in gradually as rice fields opened. The villagers practiced extensive rainfed rice farming that required only labor to prepare land, establish the crop, and harvest. Village settlement based on opening new rice fields ended by the late 1940s in both villages. After the land frontier virtually closed in the late 1940s, agricultural evolution in the villages diverged sharply.

Laguna Village. Rainfed rice farming dramatically changed in Laguna Village when a national irrigation system extended to the area in 1958. Irrigation made double-cropping of rice possible in all the village rice fields, thereby doubling rice crop area per unit of physical area (Table 1). A rice monoculture pattern has been established. In the early 1960s, hand tractor use, fertilizer application, and weeding by rotary weeder were introduced.

Another major change in rice farming was the introduction of modern semidwarf rice varieties (MV) in the late 1960s. By 1974, MV diffusion had reached nearly 100%. MV adoption had a strong impact on cultural practices: fertilizer use was intensified, chemical application became more common, weeding was increased substantially using both rotary and hand weeding, and straight row planting was adopted by all farmers. As a result of new technology, average annual rice yield per hectare in the village increased from 2 t in 1956 to 8 t in 1980.

Land reform was implemented in the area side by side with MV introduction, and share-tenants became leaseholders (Kikuchi and Hayami 1980, Ledesma 1982). About 70% of the farmland cultivated by village farmers was under share tenancy until 1965. By 1975, the farmland under leasehold tenancy increased to more than 70%, and was followed by an increase in rice yield due to the diffusion of MV technology. Because of fixed rent mandated by land reform regulations, a significant portion of increasing economic rent remained with the leaseholders, and improved their income position in the village (Table 1, also see Kikuchi and Hayami 1980).

Another important institutional change occurred in a labor hiring arrangement for rice harvesting. The traditional open harvesting system in which anyone could participate in harvesting for a share of output was replaced by a new closed system in which harvesting was limited to those who weeded the fields without receiving wages (Barker and Cordova 1978, Kikuchi and Hayami 1980). This new system, called *gama*, has diffused quickly in the village area since MVs were introduced.

In the late 1970s, some labor-saving techniques were introduced in rice farming. Herbicides are used by almost all village farmers, and mechanical threshers have partially replaced the traditional hand threshing in the village.

Iloilo Village. After the lowland land frontier closed in the late 1940s, rice farming in Iloilo Village remained rainfed. Rice farming was intensified only by small improvements such as the use of steel plows instead of wooden plows. Farmers gradually started to cultivate hilly uplands that had been used for grazing water buffalo. Maize was the major crop in these areas. During this time, the landlord's share under share tenancy rose from the traditional one-third (*tresa*) to two-fifths (*quinta*).

Efforts had to be made to intensify land use through multiple cropping. Farmers began to grow upland crops in the lowland areas when local improved rice varieties were introduced around 1960 using a maize-rice-mungbean pattern, and fertilizers and chemicals for rice were introduced. In addition to crops normally grown in the upland areas, other crops such as taro and squash were planted, causing

Table 4. Major technological and institutional changes in agriculture in two Philippine villages since their settlement.

Period	Laguna Village	Iloilo Village
19th century	Settlement began (1880s) with extensive rainfed farming	Settlement began (1850s) with extensive rainfed rice farming
Late 1940s	Land frontier closed	Lowland land frontier closed Upland cultivation began
1950s		Mindanao resettlement project
1958	Irrigation system constructed (complete rice double-cropping)	
Early 1960s	Hand tractor	Local improved rice varieties
	Improved cultural practices (fertilizer, chemical, rotary weeder, dry seedbed)	Land use intensification (multiple cropping of upland crops on lowland)
	Gama system	Improved cultural practices (fertilizer, chemical, hand weeding)
Late 1960s	MV, with further improvement in cultural practices Land reform (Operation Leasehold)	
1973	Credit program (Masagana 99)	Land reform (Operation Leasehold) Masagana 99
Late 1970s	Herbicide	MV, direct seeding, partial double-cropping of rice
	Mechanical thresher	Mechanical thresher

the limited upland land frontier in the village to be exhausted by the end of 1960s.

Land reform was implemented together with a government rice production-credit program called Masagana 99 (M-99) in 1973, which restored the share rent to the traditional one-third level or established lower levels of fixed rent for leaseholders. For most participating farmers, M-99 credit was a one-time injection of cash that was used mainly to convert existing local debts into bank debts.

MVs were introduced as a component of the M-99 program, however, their performance in rainfed fields was no better than that of existing local improved varieties. Farmers started to partially adopt MVs in well-watered lowland areas after 1975 when very early maturing varieties (IR30, IR36), which made double-cropping of rice possible, were introduced. In the late 1970s, about one-third of the lowland in the village was double-cropped. Adoption of direct seeding and mechanical threshing reduced conflicts in farm operation timing caused by adding a second rice crop to the existing multiple cropping system. Unlike Laguna Village, mechanical thresher use reached 100% in 3 years and replaced laborious foot threshing.

Changes in labor requirements in agriculture

Changes in agricultural labor requirements reflect changes in agriculture that have been described (Table 5).

In Laguna Village, improvement in irrigation and adoption of MV technology increased the capacity of rice farms to employ labor. Reduction in labor use caused by labor-saving technological changes such as hand tractor use and dry seedbed methods, were more than compensated for by the increased labor needs for intensive crop care, especially weeding. Total annual labor requirement for the village more than doubled from the 1950s to the 1960s, and increased 20% more by the mid-1970s. However, it started to decline in the late 1970s when farmers started adopting herbicides and mechanical threshers.

Total labor use in rice production in Iloilo Village also increased significantly from the 1950s to 1970. However, because labor use rose mainly through gradual increases in multiple cropping, the rate of increase for the period was much lower than in Laguna Village. In the late 1970s, the labor requirement per hectare per rice crop in Iloilo Village declined because direct seeding and mechanical threshers were adopted, but total village labor use remained at the 1970 level because of further increases in multiple cropping with a second rice crop.

Another sharp contrast in labor use between the two villages is found in changes in the share of hired labor in the total labor requirement for rice production. In both villages, transplanting and harvesting have traditionally been done by hired labor. Therefore, the percentage of hired labor in the total labor requirement for rice was commonly high in the 1950s.

In Laguna Village percentage of hired labor increased to more than 70% toward the mid-1970s. From 1966 to 1976, workdays worked by hired laborers increased more than the total labor requirement because of MV technology introduction, indicating hired labor was substituted for farmers' family labor. This substitution took place because farmers' income position improved due to land reform and MV technology, and a bulk of hired labor was absorbed into weeding operations under the new labor hiring arrangement for weeding and harvesting.

On the other hand, percentage of hired labor in rice production declined continuously from the 1950s to 1980 in Iloilo Village and family labor was substituted for hired labor. The kind of labor operations needed in complex multiple cropping systems made it difficult to use hired laborers. In addition, the income effect, which worked in Laguna Village, hardly existed in Iloilo Village, or if it did, it worked in the opposite direction (compare the average household income in 1980 between the villages as shown in Table 1).

Table 5. Changes in labor use for crop production in two Philippine villages.

Activity	Labor use (workdays/ha per crop) for rice production							
	Laguna Village				Iloilo Village			
	1956[a]	1966[b]	1976	1980	1953[c]	1970	1978	1980
Land preparation	20	19	11	11	15	25	24	27
Crop establishment[d]	17	12	12	12	28	24	14	9
Weeding[e]	5	14	32	18	9	8	8	9
Harvesting and threshing	25	32	38	21	31	37	34	21
Others	4	12	12	12	–	2	2	3
Total	71	89	105	74	83	96	82	69
% hired	58	58	71	81	65	56	45	38
Total village labor use for crop production[f] (1000 workdays/year)	9	21	25	18	9	15	16	15

[a]Data are for 20 rainfed farms in Laguna from de Guzman et al (1958). [b]Data are for 62 irrigated farms in Laguna from Barker and Cordova (1978). [c]Data are based on a survey in a village 20 km from the study village by Quintana (1954). [d]Seedbed preparation/seeding, pulling seedlings, and transplanting. [e]Weeding and replanting. [f]Includes nonrice crops.

Changes in nonfarm employment

Nonfarm employment within both villages has been minimal, although there always have been small nonfarm businesses such as sewing, storekeeping, and buy-and-sell activities.

Changes in nonfarm employment have primarily come from outside the villages, but no specific data are available to show how nonfarm employment changed except for national income statistics (Table 6). The Philippine economy grew rapidly in the 1970s. The net national product (NNP) of the industry and service sectors, in which the village labor force may find employment, increased faster in the late 1970s than during earlier periods. The construction sector, which employed a large inflow of circular migrants from rural areas, grew rapidly during the 1970s. These rapidly growing employment opportunities in nonfarm sectors may have worked as pull factors for the village labor force, even though employment growth rates may not have been as high as NNP growth rates because of possible capital-using biases in the sectors.

INDUCEMENTS TO POPULATION ADJUSTMENT

Two contrasting processes of population adjustment develop from previous sections on historical changes in village population and agriculture.

Technology-induced process

In Laguna Village, the marginal changes in population correspond well to the major developments in village agriculture. A large influx of in-migrants in Phase I was induced by the availability of rice land hitherto unused for agriculture or used very extensively. As the land frontier was exhausted, the in-migration rate declined and finally the net migration rate became negative in Phase II. Extensive rainfed rice farming with a stagnant technology and limited land resources failed to absorb the population, which increased rapidly due to the high natural increase immediately after the war.

After the construction of an irrigation system in 1958, a new wave of in-migrants came to the village in Phase III. The new labor absorption potential created by improved irrigation was the primary inducement of this change. Phase IV, in which net migration rate became negative again, coincided with the period when no dynamic change in rice farming occurred. The rice monoculture pattern had already been well established. Only gradual changes, such as partial adoption of fertilizer and weeding by rotary weeder, happened. Many in-migrants came to the village as members of landless worker households, but more people, mostly from the farmer class, left the village and moved to the urban sector.

The dynamic demographic changes in Phase V corresponded with dynamic changes in rice farming after the introduction of MV technology. There was a huge wave in this phase of in-migrants, most of whom joined the village landless worker class, from the upland areas where there had been no significant changes in technology. The introduction of the new rice technology increased labor demand, especially for weeding, and land reform improved economic and social positions of the farmers in the village, inducing farmers to substitute family labor for hired labor. The open harvesting system was replaced by a new closed system.

These technological and institutional changes in rice farming seem to be congruent with the absorption of large numbers of landless worker migrants into the village. On the other hand, the urban sector grew rapidly from the early 1970s onward. The increasing employment opportunities in this sector may have encouraged out-migration of village farmer class members to the urban sector, consequently establishing a dual migration pattern.

The dual migration pattern became stronger in Phase VI. Although the flow of in-migrants from upland areas to the village landless worker class increased, more people from the farmer and landless worker classes moved to the urban sector.

Thus, evaluation of the six phases of population change shows a technology-induced process of population adjustment. When employment potential existed or increased because of technological changes in village agriculture, additional population was absorbed from outside. When employment potential was exhausted by in-migration and natural population increases, the population was adjusted by out-migration. It is reasonable to hypothesize that marginal changes in population have been induced by changes in employment opportunities which are in turn determined by technological changes in agriculture and by nonfarm sector growth.

Population-induced process

Population adjustments were similar in Iloilo Village and

Table 6. Development in the nonfarm sectors in the Philippine economy, 1960-79 (NEDA 1979, 1980).

Period	GNP (Total)	NNP[a] (Industry + Service)	NNP[b] (Construction)
		Billion ₱[c]	
1960	30.7	18.0	1.2
1965	39.5	22.6	1.7
1970	50.3	28.6	1.6
1975	68.8	38.4	3.1
1978	82.1	46.7	4.9
Average annual growth rate[d]		%	
1960-65	5.6	4.9	11.4
1965-70	4.8	4.9	−2.9
1970-75	6.5	5.8	15.6
1975-79	6.1	6.7	14.9

[a]NNP, total of the industry and service sectors. [b]NNP, total of the construction sector. [c]At 1972 constant prices. The figures are 3-year averages centering the years shown. [d]Averages of annual growth rates of the periods shown.

Laguna Village through Phase II. Extensive rainfed rice farming and open land frontiers in the village attracted people from the surrounding upland areas through Phase I. Population inflow declined as the land frontier was exhausted and many villagers left the village under government resettlement programs in Phase II.

The population adjustment process for the two villages diverged sharply during and after Phase III. Iloilo Village remained a rainfed village, but the possibility of increasing agricultural labor absorption continued to exist, although at a much lower level compared with Laguna Village, where irrigation was being developed. In Iloilo Village intensification of rice farming with the local improved varieties and diversification of crops grown on the limited land resources corresponded to the rapid population growth caused by the high rate of natural increase and the net population inflow in Phase III. It should, however, be noted that the net population inflow in this phase was from two waves of migrants returning from the Mindanao resettlement site. Agricultural intensification was not the cause, but the result of population inflow. In Phase IV, the exodus of village youths to seek jobs in the urban sector began.

The increasing out-migration rate halted in Phase V with two institutional changes in the early 1970s, land reform and the government credit program. However, out-migration remained high and soon began to increase at an accelerated pace despite further increases in multiple cropping. Initially, MVs did not perform well in the rainfed conditions. It was only after the mid-1970s that the farmers started to adopt MVs making it possible to further increase the multiple cropping ratio. Introducing a second rice crop into the multiple cropping system was facilitated by the adoption of labor-saving techniques and the substitution of hired labor for family labor. As a result, overall labor demand increased little in Phase VI, during which out-migration from the village was substantially larger than in the previous phase.

It was possible to increase intensity of rainfed agriculture and farmers pursued this goal after the land frontier disappeared because of increasing population pressure on limited land resources. Thus, the six population phases of Iloilo Village also show another population adjustment process: population-induced process. It is hypothesized that marginal changes in population and changes in village agriculture have been induced by the population increase in the village.

Migration functions

To partially support the hypotheses, we attempted to estimate migration functions for the villages using the data in the previous sections. Estimated results of linear equations relating the migration rates to the independent variables are shown in Table 7. Generally, the regression equations explain well the large fluctuations in the migration rates.

Table 7. Migration regressions with migration rates (%) as dependent variables.[a]

Variable	Laguna Village			Iloilo Village
	In	Out	Net	Net
MANLAND	-1.11 (0.20)	0.25 (0.17)	-1.62 (0.29)	-1.96 (0.66)
IRRIGATION	2.11 (0.48)	-1.38 (0.40)	3.45 (0.62)	
MV·LANDREF	7.84 (1.84)	-1.51 (1.06)	10.38 (2.32)	
GAMA	2.47 (1.68)		0.04 (2.20)	
NONFARM	-2.90 (1.31)	3.26 (1.05)	-3.92 (2.01)	-0.82 (0.95)
DWAR 1	2.14 (0.39)		2.74 (0.50)	
DWAR 2		1.96 (0.41)	-1.50 (0.60)	
DGOVSETP				-2.64 (0.40)
DLV				1.61 (0.46)
Intercept	5.39	-0.82	5.88	5.96
R^2	0.80	0.73	0.81	0.81
D-W d stat.	2.17	0.80	1.68	1.61
F stat.	31.3	25,9	28.2	32.6
D. F.	48	49	47	31

[a]Regression coefficients are reported with standard errors in parentheses. Variable definitions: MANLAND = man-land ratio (persons/ha); IRRIGATION = the ratio of irrigated land area to the total land area; MV·LANDREF = product of MV (ratio of area planted with MV to the total planted area) and LANDREF (ratio of farm land under leasehold tenancy to the total farmland); GAMA = ratio of farmers adopting the gama system to the total farmers; NONFARM = NNP at the 1972 prices, sum of the industry and service sectors (index, 1972 = 1.0); DWAR 1 = 1 for 1941-45; DWAR 2 = 1 for 1945-47; DGOVSETP = 1 for 1951-56 during which the government recruited applicants for the resettlement programs in Mindanao; DLV = 1 for the years after 1960 when local improved rice varieties were introduced.

Three equations were used to estimate in-migration, out-migration, and net-migration rates for Laguna Village. Data were from 55 observations made from 1922 to 1979: 9-year moving averages for 1922-37 and 3-year moving averages for 1941-79. Data for the prewar and war periods were not available for NONFARM. We assumed a constant level: the 1950 level for the prewar period and a level 50% lower than that for the war period.

The regression coefficients of man-land ratio indicate that an increase in population pressure on limited land resources decelerated in-migration and accelerated out-migration. The irrigation development had highly significant impact, opposite of man-land ratio, on the migration rates. The variable constructed by multiplying the ratio of land area planted to MVs by the ratio of land area under leasehold tenancy has significant coefficients in the in-migration and net migration equations, suggesting that a

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large in-migration flow was induced when land reform and MVs were simultaneously introduced. The coefficient of GAMA in the in-migration equation is not significant at conventional significance levels, but is larger than its standard error and has the expected sign, suggesting that the diffusion of the new labor-hiring institution served as an inducement to population inflow. The development in the nonfarm sectors had a two-way impact on migration flow: it reduced village population inflow and it facilitated population outflow from the village.

Therefore, the results for Laguna Village are highly consistent with our hypothesis.

Only a net migration equation with limited number of explanatory variables was estimated for Iloilo Village. Three-year moving averages for 1946-80 were used. The result seems to support our hypothesis for the village.

In addition to the simple dummy variables for the government resettlement program and the local improved varieties, two independent variables were included in the analysis, of which only man-land ratio was significant. This suggests that the increasing population pressure on land was the major factor underlying the population adjustment process in Iloilo Village. As population increased, some of the population was pushed out from the village regardless of the outside employment situation.

CONCLUSION

This comparative study of two Philippine villages helps describe the interactions between technological and institutional changes in agriculture and population adjustments in rural areas.

In Laguna Village, the marginal changes in population were induced by changes in resource endowments and changes in agricultural technology and institutions. Waves of in-migrants from the surrounding upland areas were attracted mainly by increased employment opportunities in rice production caused by irrigation development and introduction of MV technology combined with changes in land tenure and labor hiring institutions. This intrarural migration generated by changes in the rice farming area may not only have contributed to reduction of the interregional income disparity created by the technological developments in the rice production but also helped reduce the urban poverty problem. Had there been no technological development in the rice farming areas, large migration flows from upland and rice farming areas would have rushed into urban centers.

Population adjustment in Iloilo Village was unfavorable. The lack of favorable land infrastructure deprived the village of the process followed by Laguna Village. As population growth pressed hard on limited land resources, the farmers made as much effort as possible to realize relatively meager potentials of increasing land use intensity. In rainfed conditions, however, increases in land use intensity were not sufficient to support the increasing population and a large part of the population was pushed to the outside economy.

During the last decade, both villages have become increasingly dependent on the outside economy. Intersectoral migration has become larger. Steady increases in nonfarm sector employment will be crucial in shaping the future demographic adjustment process of the villages. The extremely high rate of natural population increase in Laguna Village may easily cause the adjustment process to become population-induced if the nonfarm sector fails to provide increasing employment and if new agricultural technology fails to develop after the potential of existing MV technology is exhausted. A depression in nonfarm sector employment will increase the population-induced process for Iloilo Village. Both agricultural technology development and employment development in nonfarm sectors are necessary to avoid rural impoverishment under the population-induced adjustment process.

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Appendix 1. Population of Laguna Village, Philippines, 1917-80.

Year	Population at the end of year	Births	Deaths	In-migrants	Out-migrants
1917	43				
1918	47	1	1	4	
1919	49	2	2	2	
1920	51	2	2	2	
1921	55	2	1	3	
1922	55	3	2		1
1923	55	1	2	1	
1924	56	2	2	2	1
1925	58	1		1	
1926	60	3	1		
1927	69	5	1	6	1
1928	71	3	1		
1929	76	5	4	4	
1930	82	7	1		
1931	85	2	2	4	1
1932	90	4	1	2	
1933	92	5	3		
1934	92	3	2	1	2
1935	97	4	1	2	
1936	107	6	3	7	
1937	113	5			
1938	116	3	4	5	1
1939	121	8	2		1
1940	131	6	2	6	
1941	132	3	1		1
1942	149	8	2	11	
1943	156	9	3	1	
1944	177	7	4	18	
1945	181	11	6		1
1946	176	7	4	2	10
1947	183	3	2	9	3
1948	193	10	1	2	1
1949	199	7	4	3	
1950	204	9	3		1
1951	211	8	2	2	1
1952	226	16	2	5	4
1953	238	14	1	2	3
1954	241	16	3	1	11
1955	247	10	1	2	5
1956	258	16	5	4	4
1957	272	23	5		4
1958	286	19	2	1	4
1959	292	11	1	2	6
1960	305	13	3	3	
1961	318	18	6	3	2
1962	334	11	4	11	2
1963	358	20	5	11	2
1964	376	14	3	9	2
1965	389	18	3	2	4
1966	399	17	6	9	10
1967	407	19	8	11	14
1968	415	18	7	6	9
1969	437	21	5	7	1
1970	460	20	4	10	3
1971	478	19	5	6	2
1972	498	17	4	19	12
1973	523	21	3	27	20
1974	548	22	5	17	9
1975	593	31	1	39	24
1976	639	35	6	32	15
1977	646	24	3	9	23
1978	671	34	5	14	18
1979	682	26	4	10	21
1980	706	29	11	34	28

Appendix 2. Population of Iloilo Village, Philippines, 1944-81.

Year	Population at the end of year	Births	Deaths	In-migrants	Out-migrants
1944	277				
1945	283	14	8	2	2
1946	311	19	6	15	0
1947	317	10	4	3	3
1948	322	11	5	4	5
1949	337	16	4	4	1
1950	349	13	3	2	0
1951	350	15	6	0	8
1952	358	9	3	3	1
1953	355	12	2	0	13
1954	358	14	4	1	8
1955	342	12	1	4	31
1956	356	13	1	5	3
1957	368	18	2	0	4
1958	385	19	3	4	3
1959	403	18	3	5	2
1960	423	17	2	8	3
1961	439	19	3	7	7
1962	458	22	6	3	0
1963	484	26	3	4	1
1964	511	29	4	3	1
1965	536	18	2	13	4
1966	556	21	4	7	4
1967	569	17	3	4	5
1968	579	20	6	8	12
1969	586	14	1	2	8
1970	587	20	2	4	21
1971	610	20	3	9	3
1972	617	19	4	7	15
1973	628	19	5	1	4
1974	629	15	3	7	18
1975	644	18	2	6	7
1976	638	21	4	3	26
1977	631	14	1	3	23
1978	615	18	2	6	38
1979	616	9	6	24	26
1980	627	21	5	13	18
1981	613	10	4	2	22

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