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NEW RICE TECHNOLOGY, INTRAREGIONAL MIGRATIONS AND INSTITUTIONAL INNOVATION IN THE PHILIPPINES

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NEW RICE TECHNOLOGY, INTRARURAL MIGRATION, AND INSTITUTIONAL INNOVATION IN THE PHILIPPINES[1]

ABSTRACT

Accentuation of interregional disparity is a major problem associated with *Green Revolution* technology in the tropics. Diffusion of modern rice varieties has been largely limited to irrigated areas. Nonirrigated upland and floodwater areas have not usually benefitted from the new technology.

New rice technology has caused labor migration from unfavored to favored areas, and employment and income generated by the new technology have affected the population in unfavored areas.

Labor migration caused by the introduction of new technology often requires new forms of labor contracts. New contractual arrangements can reduce disequilibria created by new technology.

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NEW RICE TECHNOLOGY, INTRARURAL MIGRATION, AND INSTITUTIONAL INNOVATION IN THE PHILIPPINES

Accentuation of interregional disparity is a major problem that has been associated with *Green Revolution* technology in the tropics since the late 1960s (Ruttan 1977). Diffusion of semidwarf rice varieties (MV) has been mainly limited to irrigated areas and nonirrigated upland and floodwater areas have benefitted little from the new technology (Barker 1978). New rice technology has induced labor migration from unfavored to favored areas, and employment and income generated by the new technology have indirectly affected the population in unfavored areas. The labor migration induced by the introduction of new technology often requires new forms of labor contracts. New contractual arrangements may be considered institutional innovations to reduce disequilibria created by the new technology.

This paper analyzes the complex interrelationship of technology, migration, and institutions through a case study of the diffusion process of new rice technology in Laguna Province, Philippines. Laguna is uniquely suited for analysis because: 1) of dramatic MV diffusion; 2) the province has a well-irrigated lowland rice belt along Laguna Lake and uplands where new rice technology has had little impact; and 3) labor migration from uplands to lowlands has been associated with major changes in labor contracts for rice weeding and harvesting. First, we review technology diffusion and associated changes in labor demand in the lowland area. Second, the labor migration pattern corresponding to differential impacts of new technology is summarized. Third, changes in labor contracts associated with the new technology and labor migration are analyzed.

New rice technology and labor demand

The so-called green revolution began in 1967 when IRRI released IR8. Diffusion of new rice technology was extremely rapid in the lowland rice area of Laguna (Table 1). In 1970, 3 years after IR8 was released, about 96% of rice farmers had adopted MV. By 1975 adoption was 100%. Average nitrogen fertilizer input per hectare increased from less than 20 kg in 1966 to about 80 kg in 1975, and average rice yield rose sharply. Rapid diffusion of new rice technology was helped by the proximity of IRRI and the University of the Philippines College of Agriculture in Los Baños, and well-developed irrigation systems in this area.

Table 1. Changes in rice technology and labor use in the lowland rice area of Laguna, Philippines, 1966-81 wet seasons.[a]

	1966	1970	1975	1978	1981[b]
MV adopters (%)	0	96	100	100	100
Nitrogen input (kg/ha)	17	59	81	77	67
Yield (t/ha)	2.5	3.5	3.7	4.0	4.6
Labor input (days/ha)					
Land preparation	19	11	11	9	10
% hired labor	21	45	57	71	52
Transplanting	10	11	11	10	11
% hired labor	98	99	100	98	95
Weeding	11	19	32	27	22
% hired labor	19	63	81	82	85
Other crop care	10	16	22	12	19
% hired labor	9	16	51	22	18
Harvesting and threshing	36	37	36	28	31
% hired labor	100	96	98	97	95
Total	86	94	112	86	93
% hired labor	60	70	80	79	72

[a]Based on The Laguna Survey, 1st-5th rounds, conducted by the Department of Agricultural Economics, International Rice Research Institute. [b]Observations from the municipalities of Bay and Calauan are excluded from aggregation to keep consistency with earlier samples.

Until 1975 MV diffusion increased labor demand for rice production. Labor input for land preparation declined because more hand tractors were being used but it was more than compensated for by a sharp increase in labor used for weeding and other crop care. (Barker and Cordova [1978] provide a more detailed documentation of the effects of new rice technology on labor demand.) After 1975 labor input per hectare declined and labor-saving practices, such as the use of herbicide and threshing machines, were introduced in response to increases in wage rates due to the expanded labor demand for industrial and service activities in western Laguna, adjacent to Metro Manila (Smith and Gascon 1979).

From 1966 to 1975 not only total labor input per hectare but also percent of hired labor increased sharply (Table 1). Although hired labor had always been used for transplanting and harvesting/threshing, the hired labor ratio for land preparation and weeding increased after the introduction of MV. Causes and effects of these increases varied, however.

Dependence on hired labor for land preparation grew because custom tractor work increased

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and payments to tractor-cum-driver accrued to the income of rich farmers who owned tractors. In contrast, labor hired for weeding (mostly done manually with rotary weeders) became a major income source for landless laborers. Increased fertilizer application and use of young seedlings associated with MV adoption increased weed population. Using young seedlings made it difficult to control weeds by flooding fields because of the danger of drowning them in the early growth stage. A large amount of weeding is needed to be completed in a short time. Because the family needed help, new employment opportunities for landless laborers (and marginal farmers) became available.

New rice technology and demographic change

Although new rice technology increased labor demand in the lowland rice belt in Laguna, technology and therefore, employment, have remained stagnant in upland areas, especially in the hilly coconut belt at the foot of Mt. Banahaw south of Laguna.

Differential employment growth induced labor migration from upland to lowland areas (Fig. 1). Average annual population growth from 1970 to 1980 was higher than 2.5% in rice belt municipalities along Laguna Lake, but lower than 2.5% in uplands away from the coast. The difference seems to be because of migration between the two regions. (Increased labor demand for industrial and service activities was a significant *pull* factor for the west coast of the lake. However, the east coast remained largely agricultural, and increased labor demand was generated by the development of irrigation and new technology.)

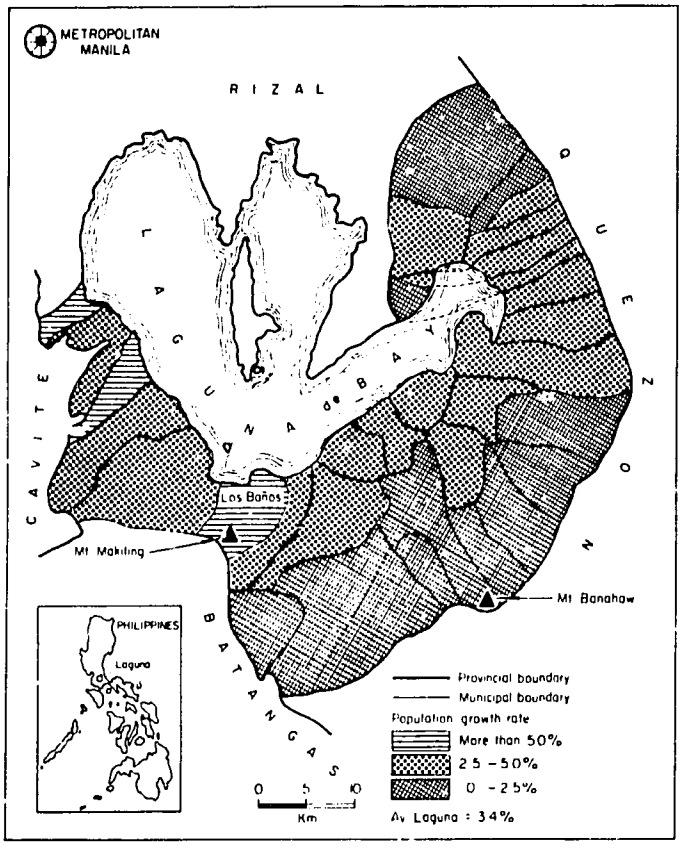

Fig. 1. Average annual population growth rates by municipality in the Province of Laguna, 1970 to 1980. Source: Population Census.

Additional evidence of migration from upland to irrigated lowland is found in survey data collected over many years from a village on the southeast coast of Laguna Lake. Village socioeconomic conditions are discussed in detail by Hayami and associates (1978) and Hayami and Kikuchi (1981, Chap. 5). Annual natural population growth in the village was about 3.5% during the past 2 decades, about equal the total population growth rate in Laguna Province. However, total population growth rate was about 1% higher than the provincial average because of social increase (Table 2).

Migrations into and out of the village are shown in Table 3. The village had major net in-migration from the upland areas but a net out-migration to urban areas during the past 2 decades.

During the 1960s most in-migrants settled in the village as farmers. However, when new rice technology spread during the 1970s most in-migrants were landless laborers attracted by increased employment opportunities. On the other

Table 2. Changes in the population growth rate (%) in a lowland rice village in Laguna, Philippines, 1961-80.

Period	Natural Rate: Birth (1)	Natural Rate: Death (2)	Natural Rate: Net (1)-(2)=(3)	Social rate (4)	Total (3) + (4)
1961-70	4.7	1.4	3.3	0.9	4.2
1971-80	4.5	0.8	3.7	0.7	4.4

Table 3. Net in-migration (no. of persons) to a lowland rice village in Laguna, Philippines, 1961-80.

	Rural[a]: Lowland rice area	Rural[a]: Upland area	Urban	Total
1961-70				
Farmers	+ 2	+ 21	- 6	+ 17
Landless laborers	+ 2	+ 8	+ 3	+ 13
Total	+ 4	+ 29	- 3	+ 30
1971-80				
Farmers[b]	- 23	- 17	- 19	- 59
Landless laborers	+ 13	+ 73	+ 8	+ 94
Total	- 10	+ 56	- 11	+ 35

[a]Lowland rice area stands for other rice growing villages in the lowland rice belt. Upland area includes depressed fishing villages. [b]Include white collar workers such as village schoolteachers.

hand, farmers' children with better education migrated out to urban centers.

Correspondingly, percent of landless workers in the population increased sharply. In 1965 about 70% of the village households were farm operators. Landless laborer households increased to about 50% by 1975 and exceeded 60% in 1980. (This sharp increase resulted not only from labor migration but also from the rapid population increase within the village.)

Table 4. Changes in percentage of farmers adopting the gama contract in the lowland rice area in Laguna.

Year	Sample survey for Laguna[a]	Full enumeration survey of one village[b]
1960	n. a.	3
1965	n. a.	22
1970	28	45
1975	85	80
1978	77	85
1981	90	85

[a]Based on the Laguna Survey, 2d-5th rounds, conducted by the Department of Agricultural Economics, International Rice Research Institute. n.a. = data not available. [b]Based on our intensive survey.

New rice technology and labor contract

Diffusion of new rice technology and intrarural migration are associated with the development of a new labor contract for harvesting and weeding.

The rice harvesting system traditionally practiced in the Laguna lowland rice belt is called *hunusan*. Hunusan is a contract in which a farmer sets a harvest day and anyone can participate. Harvesters receive a share of threshed rice ranging from one-fourth to one-ninth, but traditionally one-sixth is most common.

As new rice technology has been adopted, hunusan has been replaced by a new contract arrangement called *gama*. Gama is an output-sharing contract similar to hunusan but only the workers who weeded fields without receiving wages participate in the harvest. In this system workers weed fields for the right to participate in harvesting and to receive a share of rice. From the late 1960s to the mid-1970s the gama system spread rapidly, and parallel to MV diffusion (compare Table 4 with Table 1). (The gama system is called *iwihan* or *nangingiwihan* in the uplands. Similar systems are found in Iloilo [*sagod*], Camarines Sur [*agui-agui*], and Pampanga [*atorga*] [Ledesma 1982, Morooka et al 1979, Bautista 1979]. See also Hayami and Kikuchi (1980c).

We hypothesize that hunusan was replaced by gama because of the following developments. In earlier years when labor was scarce and rice yield per hectare was low, the traditional one-sixth share for harvesters would then have been close to a market wage rate which could approximate the marginal productivity of harvesting labor. However, as yield level increased while increased labor supply kept the wage rate stable, the one-sixth share became substantially larger than the prevailing wage rate. The gama system was introduced as an innovation to reduce the gap between marginal labor productivity and harvesters' share.

To test the hypothesis that gama represents an instrument to equate the harvesters' output share with marginal labor productivity, an imputation was made of the wage rate per hour of labor applied to harvesting and weeding under the gama contract. Results show a strong similarity between imputed wage rate and market wage rate (Table 5).

Why was gama chosen from among alternative methods of reducing harvesters' wage rate? Wage rate can be reduced by lowering the share rate under the hunusan system or by replacing hunusan with daily wage workers. The gama system reduces risk and transaction cost in hiring labor. It incorporates a mechanism to reduce laborers' shirking, since an incentive for employees to do more conscientious weeding is provided through output sharing. Although labor normally is abundant, it can be difficult for a farmer to find enough daily wage workers at the right harvest time. The gama system guarantees, by contract, labor availability at harvest. The gama system is also more secure for the employee because it reduces the risk of finding employment in the narrow labor market.

Table 5. Comparison of the imputed wage rate of harvesting labor and the market wage rate in the lowland rice area of Laguna, Philippines, 1970-81 wet seasons (The Laguna Survey, 2d-5th rounds, conducted by the Department of Agricultural Economics, International Rice Research Institute).

	1970	1975	1978	1981
Number of gama work days per hectare:				
(1) Weeding[a]	13.3	27.4	19.3	16.5
(2) Harvesting and threshing[b]	27.2	29.2	26.5	29.2
(3) Total	40.5	56.6	45.8	45.7
Output share of harvesters:				
(4) Quantity in rough rice (kg/ha)[c]	419	493	514	594
Imputed wage rate (kg/day)				
Hunusan (4) ÷ (2)	15.4	16.9	19.4	20.3
Gama (4) ÷ (3)	10.3	8.7	11.2	13.0
Market wage rate (kg/day)[d]	10.0	8.4	11.2	13.1

[a]Includes replanting done by gama workers. [b]Harvesting and threshing labor days worked by hired laborers. [c]Actual output share paid to harvesters. [d]In terms of rough rice equivalent.

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More importantly, the gama contract is more congruent with traditional moral principles, such as mutual help and income sharing, in village communities, and causes less social friction. Farmer employers could have lowered real harvesting wage rates by reducing the output share or by employing laborers with a fixed daily wage contract from the market. However, the cost arising from resistance to a change in long-established village custom would have been substantial. In one instance where farmers abandoned the system and reduced the harvesters' share, the laborers became angry and their crop was destroyed during the night (Kikuchi and Hayami 1980b).

Although adopting gama reduces the wage rate, it increases employment and earnings of landless laborers because it reduces risk and transaction costs in hiring labor and facilitates substitution of hired labor for farmers' family labor for tasks that do not require education and skill (Roumasset and Smith 1981). It is a reasonable inference that the diffusion of gama encouraged migration of farmers' family members from lowland areas to urban occupations and of landless laborers from the uplands to lowland areas (Table 3). Another basic factor underlying the substitution of hired labor for family labor was the income effect to increase farmers'disutility with drudgery in agricultural production. Farmers in the lowland rice belt were mostly tenant operators. However, their tenancy right was strongly protected and land rent was fixed at a low level by the land reform programs. Therefore, they could capture a major income gain from the increased productivity due to the adoption of new rice technology (see Kikuchi and Hayami 1980a,b).

Intrarural migration and diffusion of gama contract

We have identified the gama contract as an innovation to reduce disequilibrium between the market wage rate under the time-rate contract and the implicit wage rate under the output-share contract, which was created by new rice technology. Gama also facilitated intrarural labor migration, thereby reducing disequilibrium in the rates of return to labor between uplands and lowland irrigated areas.

Typically, laborers from the upland areas first migrate to lowland rice villages as seasonal harvesters. Gama contracts assure them of employment and income, and reduce seasonal migration risks. Later, when they find the income under gama contract sufficient and stable for subsistence, they begin to settle permanently in the rice villages.

The gama concept probably originated in the uplands and was brought to the lowland rice belt by migrant laborers. We have found that many villages in the hilly area at the foot of Mt. Banahaw, south of Laguna, practiced gama long before new rice technology (see Appendix).

Surveys conducted from 1978 to 1982 were used to map the geographical distribution of villages where gama was traditionally practiced even before World War II, and those that adopted gama when new rice technology was introduced (Fig. 2). Traditional gama villages are clustered in southern hills and new gama villages are in the lowland rice belt. (The two new villages within the hilly area in Figure 2 are located at a relatively low elevation and have large, flat rice paddy fields.)

Why was the gama contract traditionally practiced in the hills before modern rice technology? It may have been encouraged by the unique topography in the hills. The rice terraces on the hills are undulated. With minor efforts to modify natural water flows, they can be irrigated, and weeding can effectively raise rice yields. In contrast, on the flat lowland plain, water control was difficult until major national irrigation systems were developed. Until then, rice fields were deeply flooded and weeding was rare. Most farmers in the lowland villages reported that they adopted the system when irrigation systems were developed.

Although the undulated topography is likely to have encouraged the early adoption of gama in the hilly area, there may be other sociological and anthropological reasons. The hills were settled earlier than the lowland because they had less malaria than the marshy coastal plain. Population pressure had traditionally been stronger in the hills. Social change in hill communities caused by growing population pressure on limited land resources during the early, less commercialized period could have been what Geertz (1970) called *involution* and *shared poverty* in work and income-sharing systems.

Summary and conclusion

This paper discussed the process by which differential impact of new rice technology on upland and irrigated lowland areas has induced intrarural labor migration in Laguna Province, Philippines. Labor flowed in a direction to reduce interregional income disparity created by the new technology. Laborers migrating from upland to lowland rice areas were attracted mainly by increased employment opportunities in rice production, especially in weeding.

Migration was facilitated by the diffusion of a new contractual arrangement called gama. This

Appendix. Diffusion of sample villages (barrio) by change in the harvesting contract in Laguna and Quezon, based on surveys in Feb 1978, Sep 1980, Jan 1981, Aug 1981, and Sep 1982.

Province	Municipality	Barrio	Type of barrio[a]	Topography[b]	Irrigation[c]	Harvesting system[d]			Year of survey
						Old	New	Year of change	
Laguna	San Pedro	Landayan	R	FP	*, 2x (na)	H (3/20)	G (3/20)	1965	Feb 1978
	Biñan	San Antonio	R	FP	*, 2x (na)	H (3/20)	G (3/20)	1970	Feb 1978
		Canlalay	R	FP	*, 2x (na)	H (3/20)	G (3/20)	1971	Feb 1978
	Cabuyao	Sala	R	FP	*, 2x (na)	H (1/6)	G (1/6)	1967	Feb 1978
	Calamba	Parian	R	FP	*, 2x (na)	H (1/7)	G (1/7)	1971	Feb 1978
	Los Baños	San Antonio	R	FP	*, 2x (na)	H (1/6)	G (1/5)	1974	Feb 1978
	Bay	Maitim	R	FP	*, 2x (na)	H (1/6)	G (1/6)	1956	Feb 1978
	Calauan	Masiit	R	FP	*, 2x (na)	H (1/7)	G (1/7)	1962	Feb 1978
		Dayap	S	FP	*, 2x (1958)	H (1/6)	G (1/6)	1950's	Aug 1981
		Lamot II	R	FP	*, 2x (na)	H (1/6)	G (1/6)	1958	Sep 1982
	Pila	Labuin	R	FP	*, 2x (1958)	H (1/6)	G (1/6)	1964	Feb 1978
		Tubuan	R	FP	*, 2x (1958)	H (1/6)	G (1/6)	1960	Sep 1980
		Masico	C	FP	*, 2x (1958)	H (1/6)	G (1/6)	1960's	Sep 1980
	Pagsanjan	Biñan	R	FP	*, 2x (1950's)	H (1/5)	G (1/5)	1960's	Aug 1981
		Cabanbanan	C	FP	*, 2x (1967)	H (1/5)	G (1/5)	1968	Aug 1981
	Magdalena	Buenavista	C	FP	na, na (na)	H (1/5)	G (1/5)	1965	Aug 1981
		Salasad	C	FP	**, 2x (NC)	H (1/5)	G (1/5)	1965	Aug 1981
		Burlungan	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Aug 1981
	Majayjay	Pangil	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Aug 1981
	Rizal	Pook	C	ST	na, na (na)	G (1/5)	G (1/5)	NC	Jan 1981
	Liliw	Daniw	C	FP	na, na (na)	H (na)	G (na)	1960	Sep 1980
		Tuy Baanan	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Sep 1980
	Nagcarlan	Wacat	R	FP	*, 2x (1958)	H (1/6)	G (1/6)	1950's	Aug 1981
		Sibulan	C	FP	*, 2x (na)	H (1/6)	G (1/6)	1960	Sep 1980
		Sta. Lucia	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Sep 1980
		Bankuro	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Sep 1980
		Palayan	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Jan 1981
		Talangan	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Sep 1980
		Taytay	C	ST	**, 2x (NC)	G (1/4)	G (2/9)	1980	Aug 1981
	San Pablo	Ilog	C	ST	**, 2x (NC)	G (1/4)	G (1/5)	1973	Aug 1981
		San Diego	C	ST	**, 2x (NC)	G (1/4)	G (1/5)	1975	Aug 1981
		Sta. Maria	R	FP	*, 2x (NC)	H (1/7)	G (1/7)	1965	Sep 1982
		San Isidro	R	FP	*, 2x (NC)	H (1/6)	G (1/6)	1970	Sep 1982
Laguna	Luisiana	San Antonio	C	ST	R, 1x (NC)	G (1/5)	G (1/5)	NC	Sep 1982
Quezon	Lucban	Piis	C	HT	R, 1x (NC)	H (1/5)	H (1/5)	NC	Sep 1982
		Aban	C	HT	R, 1x (NC)	G (1/4)	G (1/4)	NC	Sep 1982
	Sampaloc	Bataan	C	ST	**, 2x (NC)	G (1/5)	G (1/5)	NC	Sep 1982
		San Isidro	C	ST	**, 2x (NC)	G (1/5)	G (2/9)	1973	Sep 1982
	Tayabas	Dapdap	C	HT	R, 1x (NC)	G (1/4)	G (1/4)	NC	Sep 1982
		Camaysa	C	HT	**, 2x (NC)	G (1/5)	G (1/4)	1975	Sep 1982
		Bagyo	C	HT	na, na (na)	G (1/5)	G (1/4)	1975	Sep 1982
		Wakas	C	HT	**, 2x (NC)	H (1/5)	G (1/5)	1955	Sep 1982
	Tiaong	Bulakin	C	FP	**, 2x (NC)	H (1/6)	G (1/6)	1967	Sep 1982
	San Antonio	Pulo	R	FP	**, 2x (NC)	H (1/5)	G (1/5)	1968	Aug 1981
	Pagbilao	Binahaan	C	FP	**, 2x (1965)	G (1/4)	G (1/5)	1970	Sep 1982

[a]R = rice village, S = sugarcane village, C = coconut village. [b]FP = flat plain, ST = slope, terraced, HT = hilltop, terraced. [c]* = NIA, ** = communal (include natural irrigation) or private, R = rainfed, 2x = 2 crops in a year, 1x = 1 crop in a year. Figures inside the parentheses are the years when irrigation systems were constructed. NC = no change since before World War II, na = data not available. [d]Old system = before the war, New system = after the war. H = hunusan, G = gama. Figures inside parentheses are harvesters' share. na=data not available. NC = no change since before World War II.

system reduced risks in finding employment for migrant laborers, thereby facilitating intrarural labor flow. Because the gama system reduces labor transaction costs for farmer employers, it facilitated the substitution of hired labor for farmers' family labor with better education and higher opportunity costs. As a result, demand for hired labor increased more than demand for total labor for rice production, which further facilitated labor migration from unfavored to favored areas.

Although gama was a new system in the lowland rice belt, it had traditionally been practiced in hilly upland areas. It appears that the gama concept was brought to the lowland rice belt by migrant laborers. The traditional form of contract in the hill communities became an institutional

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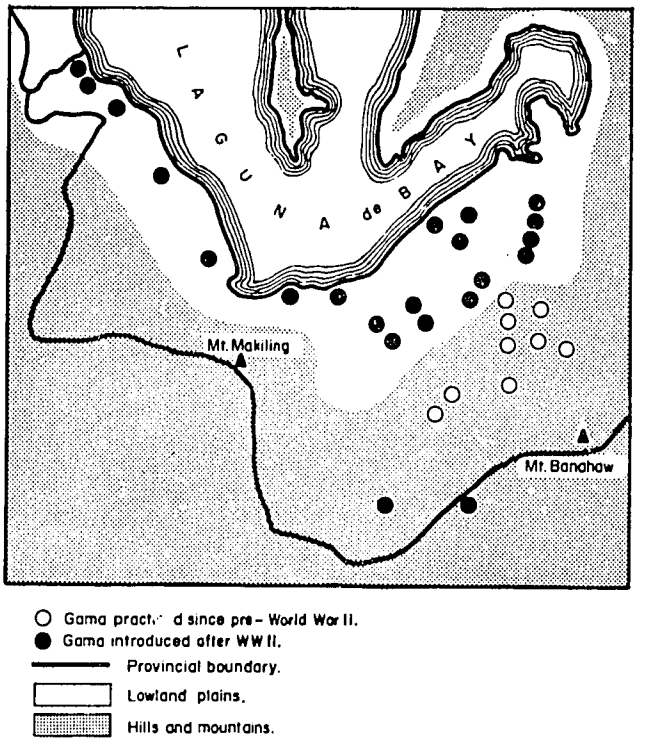

Fig. 2. Distribution of sample villages by period of the adoption of the gama contract in Laguna Province.

instrument to facilitate adjustments in resource allocation for reducing disequilibria created by the new rice technology. This Philippine experience suggests that indigenous community institutions and organizational principles can be utilized successfully for modern rural development.

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