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REPORT ON PRELIMINARY RESULTS OF CROSS-SITE COMPARISONS

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A collaborative study among researchers in the Cropping Systems Network was planned in October 1978 for the purpose of identifying major factors that influence Cropping Systems at sites in the Network. By comparison of various measures of hypothesized determinants and associated systems will gain insight into principles for designs of new cropping patterns for various agro-economic conditions. From December 1978 to October 1979 the Economics Committee of the Working Group constructed a schedule of standard information describing determinants and resultant cropping systems.

The schedule was distributed throughout the Network in February 1979. "The information schedule for site description and cross-site comparison represents researchers' best judgements about what factors affect cropping systems and what measures of them are sufficient when assessing their relative importance," (Report of Cropping Systems Working Group, 1977, pp. 20). Information regarding 15 Philippine sites and two sites in Thailand shown in Appendix Table 1, has been received and tabulated. The information is incomplete and estimates of the various parameters are preliminary. Appendix Tables 2 through 10 reflect a proposed uniform tabulation of the cross-site data. Because of the earlier availability of the Philippine data, certain partial summarization and analyses proceeded, and are reported in the following discussion. It is clear however that a more effective analysis may be conducted employing cross-site data from the network.

We hypothesized that different agro-climatic conditions are associated with different cropping systems. As an alternative hypothesis we were quite interested in any cases where similar cropping systems are found in quite different agro-climatic regimes, what overriding features might bring about such similarities. We also hypothesized that within given agro-climatic conditions, socio-economic factors such as farm size, farm power base, wage rates and other factors might bring about differentiation in cropping systems.

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Methodology

In accordance with the objectives, a survey of 15 farms in each of 12 barrios in 4 Philippine provinces was conducted. The four provinces, Zambales, Cagayan, Ilocos Norte, and Leyte, fall in different agroclimatic zones defined by Oldeman and Suardi (1976) and Manalo (1977). In each province, municipalities were chosen where substantial areas of rainfed lowland rice was grown. Villages were selected to include those with diverse soil texture, topography, and access to markets. Once the villages were chosen, fifteen farmers in each village were randomly chosen as respondents. A questionnaire was used to gather information on (a) whole farm characteristics such as farm size, number of parcels, cropping patterns, household characteristics, etc., and (b) input-output data for the largest parcel where dominant cropping pattern of the village was grown. The "dominant" pattern was earlier identified in an interview of the village captain. Where more than one cropping pattern was widely adopted, information on such patterns was also obtained. Data was gathered between January and July 1979 for the 1978-79 crop year.

Farm environment

Ilocos Norte and Zambales are relatively dry areas as compared to Cagayan and Tacloban. Soil texture varies in the locations. In Ilocos the soils tend to be slightly alkaline, but elsewhere they are slightly acidic. Two villages in Ilocos Norte, Rayuray and San Lorenzo have a flat topography while two villages, Nanguyudan and Pasil, have a gently rolling landscape. In Zambales, Inhobol and Sitio Bunga are gently rolling while Amungan and Sta. Rita are flat (Table 1).

The farming systems in the four sites is generally characterized as semi-subsistence, small sized farms with rainfed rice-based cropping systems (Table 2). Farm sizes range from .8 ha in Ilocos Norte to 2.6 ha in Cagayan.

Farmers in Ilocos Norte, Zambales and Cagayan, sell less than 40% of what they produce indicating that production for subsis tence is extremely important (Table 2). Farmers in Tacloban are commercialized because of the substantial income they derive from coconuts planted on lands other than the rice lands. More than 50% of what farmers produce is sold in the market.

A subsistence farmer is one who consumes a majority of his production (Wharton, 1969). The ratio of production sold to total production can be used to identify farmers' subsistence orientation. Subsistence farmers' decisions simultaneously take account of both farm and home considerations. Heavy dependence upon own farm for consumption may dominate the commercial considerations and economic behaviour.

Influence of the physical environment on cropping patterns

A single rice crop is grown each year at all locations. The possibility of sequential cropping of a non-rice crop is determined primarily by the soil moisture. The soil moisture is determined by the nature of the rainfall pattern, soil texture, length of rainy season, management techniques and availability of supplementary irrigation. Supplementary irrigation in this study refers to water management on individual farms using pumps and diversion of streams. Lowland rice is considered to require about 200 mm per month of water and upland crops from 100 to 200 mm per month.

In some villages in Zambales, vegetables and watermelons are planted after rice using water from wells on the farm. Garlic and tobacco are grown after rice in Ilocos Norte where wells and pumps are available on most farms. A double crop of rice in Tacloban is possible for farmers who have access to overflows and diversion of creeks and rainfed canals.

Under rainfed conditions, a farmer's cropping strategies are most likely to be influenced by the variability they have experienced in wet season onset and decline within the locality (Morris 1978). Puddling of the soil for lowland transplanted rice takes place during the first one to two months of the rainy season. Figure 3 shows that in Zambales, the wet months (months with more than 200 mm of rainfall) occur from May to October with the heaviest rainfall occurring in August. Farmers there usually plant rice in July and harvest in October or November. Vegetables, mungbeans, watermelons are usually planted in December and harvested in February using supplementary water from deepwells since this is the dry season. Land in Amungan is relatively flat while topography in Inhobol is rolling, but both have medium soils and both have crops such as mungbean, vegetables and watermelons on substantial areas after rice. Sitio Bunga has a rolling topography and Sta. Rita is flat, but both have a heavy soil. Here, the lands are generally left idle after the harvest of rice Soil texture apparently differentiates the cropping system of these two areas.

Ilocos Norte is the driest of the four sites, having only 3-4 wet months during the year. However, non-rice crops are grown extensively after rice using farm wells and pumps, and various water conservation practices. As shown in Fig. 4, rice is usually planted in July and harvested in November. Immediately after rice is harvested, when the soil is still wet, rice straw and weeds are cut close to the ground. The fields are neither plowed nor harrowed but are immediately mulched with a layer of rice straw to conserve soil moisture, control weeds and to regulate the soil temperature. A dibble or any sharp pointed stick is used for making holes for planting cloves of garlic. Garlic is usually planted in November and harvested 100-140 days after field setting during the months of February and March. During the hot dry months, the growing stage of garlic bulbs, beds are watered 3-4 times.

High yielding upland-adapted, improved varieties of rice (developed at the University of the Philippines)and traditional varieties which have longer stalks are preferred to the short statured IRRI varieties because of the importance of straw for mulching for the crops to be planted after rice.

A week before garlic is harvested, with the mulch still on the ground, some farmers take advantage of the residual moisture by planting mungbeans. Others plant mungbeans or corn after all the garlic is harvested. Mungbeans and corn are drought tolerant, short-maturing and can be grown with low management levels. These are planted in February and harvested in April to May. Mungbean seeds are broadcast on unprepared land.

In Cagayan, farmers usually plant lowland rice in October and harvest in February. The heaviest rains occur in November. A majority of the farmers grow the traditional, long-maturing rice varieties like Raminad and Wagwag because of their better eating qualities. (Fig. 5).

A single crop of rice is usually planted in Tacloban. Planting is in December and harvesting is in March. For those farmers who have access to supplementary irrigation from creeks and canals, a second crop of rice can be planted in July to October. A few farmers plant corn in June and harvest in September. Sweet potato is usually planted in March and harvested in August. These non-rice crops are grown for home consumption only. A majority of the farmers in this site use IRRI varieties of rice.

Dominant cropping patterns

In Zambales, the dominant cropping pattern is rice-fallow. Depending upon the proximity to markets and access to supplementary irrigation, certain other patterns are adopted. Mungbeans, vegetables, and watermelons are grown after rice in villages near the market centers and where farmers can tap water from deep wells. In Cagayan, lands are left idle after rice is harvested. In one village in Cagayan, Gattaran, few farmers can plant mungbeans or plant a second crop of rice (Table 3).

In Ilocos Norte, rice-garlic is the dominant cropping pattern in the four villages. However, the topography appears to exert a significant influence on the cropping patterns adopted. In addition to rice-garlic, rice-tobacco is widespread in two villages with a flat landscape. In these villages, farmers are able to tap ground water fairly easily with deep well water pumps. In Nanguyudan, a slightly rolling area, adoption of rice-garlic is quite low and rice-corn and rice-vegetables occupy significant areas. Here very few farmers are able to use deep water pumps. The topography of Pasil farms is similar to Nanguyudan but many farms are able to obtain supplementary irrigation from the nearby Paoay lake. Where this is possible, farmers grow garlic after rice, when it is not possible, no crop is grown after rice.

In the four villages in Tacloban, double rice cropping pattern is important. In this site, rainfall is characterized by frequent rains and in ten months of the year, there is more than 100 mm of rain. Rainfall and year round streams provide ample water for the two crops of rice (Table 4).

Simple resource flow model

An early step in analysis of factors that differentiate farm agro-ecosystems is the construction of a qualitative model of the unit under consideration. In this context, model building involves identifying the inputs and outputs of the system of interest, the subsystems of the system, and the circuitry connecting the subsystems. The next step is to begin to quantify the relationships hypothesized in the qualitative model, and to construct a quantitative model of the system (Hart 1979).

Resource flows within a farm can be illustrated in a single model (Figure 7). This figure shows schematically the resource flows in a farming system. Here the inputs of the farm production activities are cash, labor and power while the outputs are the rice and non-rice crops and livestock products generated from the farm household and various farm enterprises. The household provides family labor to

three main activities, namely off- and non-farm employment, livestock, rice and non-rice cropping activities (cropping systems). The livestock activity in turn, may provide power to the farm activities and provides food to the household as well as cash through livestock sales. Family labor that goes into off- and non-farm employment also generates cash for the household. The cash generated from these activities are either used for household expenses or goes back into the livestock and cropping systems activities. For the cropping system activities and provides food to the household as well as cash through livestock sales. Family labor that goes into off- and non-farm employment also generates cash for the household. The cash generated from these activities are either used for household expenses or goes back into the livestock and cropping systems activities. For the cropping system activities, cash is used for the purchase of material inputs as payment for hired labor and power. For livestock activities, cash may be used for livestock feeds. The levels of intensity of these resources use depends upon the relative needs and priorities of the farmer.

Economic resources and cropping patterns

Land. In general one would think that the rice and non-rice crops would compete for land. However, in the four sites, competition of rice and non-rice crops for land is not important.* In the 4 sites, where sequential planting is done, non-rice crops are grown on lands planted to rice during the period of the year when rice cannot be grown. In Tacloban, a perennial cash crop, coconuts, is commonly found on the farms. However, this is grown on upland areas which are generally not suitable for rice cultivation. Certain non-rice crops are grown after rice; again, during the period of the year when rice cannot be grown.

Across sites, the multiple cropping index shows a negative relationship to average farm size (Table 5) at the two extremes, Ilocos Norte and Cagayan. In Ilocos Norte, despite the fact that the number of wet months is quite low (3-4 wet months) per year, farmers use resource intensive management techniques to grow garlic and other crops after rice in order to derive maximum incomes from their small sized farms. However, in Cagayan, where farms are about three times larger, most of the lands are left fallow after rice even though the number of wet months (5-6 per year) is higher than in Ilocos Norte.

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* This contrasts with the situation in small farms in certain other parts of Asia, for example, in Bengal in the Indian Sub-Continent, in many small farms, rice (the main staple crop) competes with jute (a cash crop) for land.

Cash. Cash in the farm can be generated from various sources including off-farm and non-farm employment, livestock sales, and rice and non-rice sales. Cash generated from these sources is used in the household as well as for purchasing inputs for crop activities.

The four sites show diversity in sources of cash (Table 6). In Ilocos Norte, where farms are generally small, the annual non-rice crops (garlic, tobacco) grown after rice are the major sources of cash. All rice produced is consumed in the household. In Tacloban, non-rice crops (coconuts) is the major source of cash but in this case, the non-rice crop is a perennial crop on lands not suitable to rice cultivation. In Cagayan and Zambales, rice has a dual purpose, it is both a subsistence and a cash crop. Cash generated from rice and non-rice crops and off-farm employment provides substantial cash earnings.

Farmers in two villages in Zambales generate relatively much cash from off- and non-farm employment compared to the other three sites. This may be explained by the proximity of these two villages to urban centers which provide employment opportunities. Farm households may obtain higher income from off-farm work in areas close to such urban centers. However, the proximity to urban centers alone does not sufficiently explain the off- and non-farm employment. The nature of the urban center itself is important. For instance, although the villages in Ilocos Norte are relatively near urban centers with good roads and transportation facilities, income from off and non-farm employment is quite low. On the other hand, Iba, the center of Zambales, is an industrial type of urban center and appears to absorb large amounts of farm labor. Laoag, in Ilocos Norte, a commercial type of urban center, does not provide employment for farm labor to the same extent.

The demand for cash varies depending upon the farmer's needs and priorities. Cash generated from the above activities is either used in the household or in the cropping system activities for purchase of material inputs or as payment for hired labor. In Ilocos Norte, the substantial cash generated from non-rice crops is used for household expenses and for material inputs for rice production, particularly fertilizers. In these farming systems, one of the main goals of a farmer is to provide the subsistence requirements of rice. In order to obtain these requirements from a small area, they apply high levels of material inputs. The average level of nitrogen per hectare in rice production is about 93 kilograms (Table 7).

In Tacloban, even though coconuts generate quite high levels of cash, this cash is not used to increase material inputs (such as fertilizer) in rice cultivation. Very low levels of fertilizer are applied to rice. However, the use of hired labor in rice cultivation is quite high. It appears that farmers tend to use their cash resources for hired labor. The low levels of material inputs may be related to the fact that these farmers can obtain their subsistence rice requirements from their substantially large holdings (about 1.48 ha), without intensive application of fertilizer, herbicides, etc. The average level of nitrogen is only about 29 kg per ha. Herbicide use is rare.

Family and hired labor. Labor is hired for rice production to a fair extent at all sites (Table 8). Family labor in the sites ranges from over 80% in two villages in Ilocos Norte to around 10% in some villages in Tacloban and Cagayan. The degree of hired labor use is the inverse of family labor use. Even in the same site depending upon the availability of family labor the proportion of hired labor varies. In two villages in Ilocos Norte, a very high proportion of hired labor (66.0 and 53.6%, respectively) is used for rice production. In the other two villages, Nanguyudan and Pasil, a very low percentage of hired labor is used (10.4 and 15.3%, respectively).

Also the substantially high cash income derived from coconuts may also explain why farmers tend to use more hired labor in this site. In two villages, the intensity of labor use for rice production is higher than elsewhere. Labor mandays per cultivated hectare in rice in these two villages ranges from 100 to 192 mandays per ha (Table 8). The "gama" contractual labor arrangement may be related to this. A majority of the farmers in this site use IRRI varieties with which weeds seem to be a problem. Herbicides are not commonly used such that a large number of weeders are required. In this "gama" arrangement, the weeders are not immediately paid but they secure the right to harvest and thresh the palay for which they are paid 1/4 to 1/5 of the gross production.

In Cagayan, the high percentage of hired labor use may be explained by the large farm size, cash availability and harvesting and threshing practices. Farms in this site are a relatively large 3.3 hectares and 1.9 hectares in the two villages. A large number of hired laborers is employed especially in harvesting and threshing, a prominent social activity. However, particularly in Camalaniugan the intensity of labor use in mandays per cultivated hectare of rice is very low (66.3 mandays per ha). Farmers also hire tractors for land preparation.

Another important factor which determines the use of hired labor use may be the income-leisure preference of the farmers. As Ruthenberg (1976) points out, much of the work in the farm is both tedious and strenous, so not surprisingly farmers show marked preference to leisure when incomes exceed a certain limit. This has often been demonstrated by the extent to which hired workers are employed to replace family members once incomes have exceeded very modest levels. At low levels of income, farmers have to work more intensively and devote lesser time to leisure. This appears to be the case in Tacloban and Cagayan. In Tacloban, farmers obtain substantial income from coconuts, a less labor intensive activity. Farmers then are able to spend more time in leisure and hire workers to replace family labor. In Cagayan, cash generated from rice is spent for hiring tractors for land preparation thus relieving the farmer in doing such strenous farm operation.

The high percentage of family labor use in the two villages in Ilocos Norte may be explained by the high number of available adult workers per hectare. In Nangyudan there are 3.7 adult workers per ha while in Pasil, there are 5.2 available adult workers per ha. In Tacloban, the number of available adult workers per ha in the four villages ranges from .4 to 2.3. The statistical relationship between available family labor and family labor use was examined using a simple regression model. The percentage of family labor used per hectare was the dependent variable and the total available family woekrs per hectare was the independent variable (Table 9). Results shown in Figure 8 show a signifficant positive relationship between the percentage of family labor used and the number of adult family workers available per ha. Variations in the number of adult family workers per hectare explains 58% of the variations in the percentage of family labor use.

The wage rates for land preparation varies across sites, but little variation is observed in wage rates for other operations such as planting (Table 10). It is also very difficult to quantify opportunity costs for family labor because this requires rigorous examination of off-farm employment opportunities. The methods of payment and crop sharing for harvesting and threshing show some diversity (Table 10). In Ilocos Norte, harvesters and threshers are either paid in cash or in kind. In Rayuray, harvester-threshers are paid in cash. Here, even though rice yields are high (about 3.2 tons per ha) the average farm size is only .80 hectare. Hence to obtain their subsistence supply of rice farmers would rather pay cash for harvesting than share their crop. In San Lorenzo, crop sharing (1/6 of the total gross production) is practiced probably because

farm sizes are larger (1.17 hectares) and rice yields are moderately high (2.67 tons per ha). In the two villages in Ilocos Norte which have a high availability of family labor (3.7 and 5.2, respectively), very little hired labor is used in harvesting and threshing. This is because the small farm sizes enable the farm family to perform all the work. In this site, threshing machines are not used because farmers preserve the straw for mulching non-rice crops.

In Cagayan where rice yields are lower (about 2.14 tons per ha on the average) and farms are larger (about 2.61 ha on the average), harvesters-threshers obtain 1/5 or 1/6 of the total gross production. In this site, harvesting and threshing is considered as a social activity in which relatives, friends and neighbors in the same village participate. Threshing machines are not used because farmers say they would rather share their produce with the harvesters and threshers in their village.

In Zambales, harvesters are paid in cash while threshing machine operators are paid 8% of the gross production of palay. The workers who do the harvesting are different from the workers who operate the threshing machines. In Tacloban, two villages practice the "gama" arrangement while in two villages the arrangement is to share 1/5 or 1/6 of the total gross production with the harvester-threshers. Tacloban is the only site where the "gama" system of labor arrangement was encountered.

Exchange labor. Exchange labor is important only in Zambales. In a traditional society, exchange labor is one of the more common forms of labor use. It tends to disappear with increasing monetization and commercialization brought about by the advent of better communications, development of markets, infrastructure and new technology. Exchange labor is still one of the main sources of labor in one quite remote village in Sitio Bunga, Zambales. Here 39.7% of the total labor used for rice production comes from exchange labor (Table 8). The arrangement requires repayment of a precise equivalent of labor by the members of the team which exchange labor within the village. The arrangement is still practiced mainly because of the village' remoteness. Although it is only 4 kms away from the town, it is not served by any public transportation. The village economy remains at a low level of monetization as shown by the lower levels of income as shown by Table 6.

Another factor which may partly explain exchange labor use are the uniformly small farm sizes (about .65 hectares on the average). Balancing of labor obligations is easier to achieve when farms are of equal size. There are few non-farm job opportunities in this area. The availability of carabaos (1.4 carabaos per farm), similar cropping practices and the absence of severe time restrictions in rice production also contribute to the use of exchange labor. It involves the obligation to reciprocate the task to be undertaken at a specific time, thus activities which involve high labor expenditure over short periods or where timing is critical cannot be undertaken. Sixty percent of the farmers in this area grow long-maturing traditional rice varieties for consumption

Production relationship

Despite the diversity in specific cropping systems employed by farmers across sites, reflecting largely different qualities of physical resources, economic resources, labor and cash inputs, which can be assumed to be of homogenous quality across regions, explain much of the value of the output of cropping systems. A simple production function relating value of output per hectare to labor costs and materials costs per hectare was estimated. The equation below shows that labor and materials fairly reliably determine the value of production per hectare.

$$Y = 1955 + 3.95X_1 + 2.63X_2 \quad , r^2 = .77$$

where X_1 = material costs and X_2 = labor costs. The coefficients are significant at 5% level.

The results of the study indicate that:

1. The farms are all basically semi-subsistence, small sized farms. However, the degree of subsistence orientation varies considerably across sites. Given this variability different criteria for evaluation of new technologies for these farms may be needed.

2. Even if sites are within similar rainfall regions, the farming and cropping systems show a high degree of diversity.

3. Despite diversity in specific crops and cropping patterns, farmers' income per hectare appeared to be strongly related to their employment of variable inputs, labor and materials.

4. Rice double-cropping is practiced only when supplementary irrigation is possible. The irrigation observed comprised farmer controlled systems dependent upon natural on-farm supplies. Whether second crops are rice or some other crops depends on a host of factors. Among these are the nature and cost of available supplementary irrigation, management techniques, and markets.

5. Intensity of resource use in rice production depends on other crop and livestock components of the farming systems.

6. Rice production is mainly governed by the need to obtain subsistence requirements. Whether resources are diverted to obtain larger surplus depends on the nature of the other components of the farming system and would be related to opportunity costs of resources, off- and non-farm earnings, etc.

At this stage of analysis, we have attempted to develop qualitative models of the farming systems in the different sites. We identified the major linkages and resource flows within each system and tried to relate this broadly to some of the environmental factors. From this, we proceed to quantify the major relationships in the models and to more rigorously determine the influence of the exogenous determinants of the systems. This will hopefully provide a basis, through the cross-site comparisons, for gaining insights into principles for design of new cropping systems, which will be appropriate to different farming systems.

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Table 1. General physical characteristics of the study areas, in the different sites.

Site	No. of wet[a] months	No. of dry[b] months	Dominant soil surface texture	Dominant soil PH range	Dominant soil organic matter range (%)	Topography
Ilocos Norte						
Rayuray	3-4	5-6	clay	7.6	1.54	flat
San Lorenzo	3-4	5-6	silty clay loam	7.6-7.7	1.23-1.40	flat
Nangayudan	3-4	5-6	clay loam	6.2-7.0	1.26-1.84	gently sloping
Pasil	3-4	5-6	Clay	7.6-7.8	.78-1.44	gently sloping
Zambales						
Amungan	5-6	5-6	loam	6.4	1.64	flat
Inhobol	5-6	5-6	sandy loam	7.2	.69	gently sloping
Sta. Rita	5-6	5-6	clay loam	6.8	1.54	flat
Sitio Bunga	5-6	5-6	clay loam	6.2	1.52	gently sloping
Cagayan						
Camalaniugan	5-6	2-4	silt loam	6.6-7.0	1.44-2.17	flat
Gattaran	5-6	2-4	clay	6.1-6.3	1.33-2.30	flat
Tacloban						
Dacay	3-4	< 2	loam	7.0	1.71	flat
La Paz	3-4	< 2	clay loam	6.2-6.3	3.01-3.07	flat
Capacungan	3-4	< 2	loam	6.0-6.1	1.96	flat
Mayorga	3-4	< 2	clay loam	6.0-6.1	2.58-2.82	flat

[a] Months with more than 200 mm. [b] Months with less than 100 mm.

Table 2. Farm size and value of cash crops sold and produced across sites.

Sites	Ave. farm size (ha)	Value of total crops sold per farm (₱)	Value of total crops produced per farm (₱)	%
Ilocos Norte	.77	2415.0	6245.0	38.70
Zambales	1.42	985.0	3495.0	28.20
Tacloban	1.48	3268.0	6115.0	53.40
Cagayan	2.61	885.0	6045.0	14.70

Table 3. Percentage of crop land in rainfed rice-based patterns in two sites (Zambales and Cagayan).

Cropping patterns	Zambales				Cagayan	
	Sitio Bunga	Sta. Rita	Inhobol	Amungan		Gattaran
Rice-fallow	98.1*	86.0*	76.0*	60.4*	91.9*	68.7*
Rice-mungbeans	1.9	10.9	16.4	37.0	8.1	20.6
Rice-vegetables		3.1	1.9	2.6		
Rice-watermelons			5.7			
Rice-rice						10.7
Rice-corn						
Rice-camote						
Rice-garlic						
Rice-garlic-mung						
Rice-tobacco						
Rice-garlic-corn						
Others						
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

*Dominant cropping pattern.

Table 4. Percentage of crop land in rainfed rice-based patterns in two sites (Tacloban and Ilocos Norte).

Cropping patterns	Tacloban				Ilocos Norte			
	Dacay	La Paz	Caba-cungan	Mayorga	Rayuray	San Lorenzo	Nangu-yudan	Pasil
Rice-fallow	41.2	41.2*	73.9*	35.9	6.0	1.0	7.0	28.0
Rice-mungbeans				8.5	1.0	1.0	6.0	
Rice-vegetables							14.0	
Rice-watermelons								
Rice-rice	50.2*	38.5	13.8	38.6*				
Rice-corn	5.6	16.9	7.9	10.6			19.0	
Rice-camote		3.4						
Rice-garlic					53.0**	59.0*	32.0*	67.0*
Rice-garlic-mung					18.0	5.0	6.0	1.0
Rice-tobacco					22.0	27.0	13.0	
Rice-garlic-corn						6.0	3.0	4.0
Others	3.2		4.4	6.4	6.0	1.0		
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Dominant cropping pattern.

Table 5. Farm size and multiple cropping index, across sites.

Sites	Average farm size (ha)	MCI[a/]
Ilocos Norte	.77	190.0
Zambales	1.42	120.5
Tacloban	1.48	136.8
Cagayan	2.61	107.0

[a/] $MCI = \frac{\text{Effective crop area}}{\text{Absolute crop area}}$

Table 6. Sources of cash per farm, across sites.

Site	Ave. farm size (ha)	Crop sales (₱) Rice	Crop sales (₱) Non-rice crops	Total cash income from crops (₱)	Off-farm income per year (₱)	Cash income from livestock (₱)	Total cash from income (₱)	%
Ilocos Norte								
Rayuray	.80	0	3,720	3,720	44	295	4,059	100.0
San Lorenzo	1.17	0	4,600	4,600	490	485	5,575	100.0
Nanguyudan	.65	0	275	275	720	480	1,475	100.0
Pasil	.47	0	1,060	1,060	215	608	1,883	100.0
Zambales								
Amungan	1.87	1,965	515	2,480	4,050	655	7,185	100.0
Iniobol	1.73	470	705	1,175	3,360	1200	5,735	100.0
Sta. Rita	1.45	270	0	270	1,885	61	2,216	100.0
Sitio Bunga	.65	24	24	24	705	47	776	100.0
Cagayan								
Camalaniugan	3.28	930	30	9601	1,495	146	2,601	100.0
Gattaran	1.94	545	30	575	745	618	1,938	100.0
Tacloban								
Dacay	1.80	815	3885	4700	310	225	5,235	100.0
La Paz	.95	400	3000	3400	720	0	4,120	100.0
Cabacungan	1.34	0	4,400	4,400	590	0	4,990	100.0
Mayorga	1.82	760	590	1,350	1,455	0	2,805	100.0

Table 7. Fertilizer use and rice yields, across sites.

Site	Average farm size (ha)	Value of fertilizer/ha 1 crop rice	Amount of Nitrogen/ha 1 crop rice	Rice yield (t/ha)
Ilocos Norte				
Rayuray	.80	502.0	86.0	3.22
San Lorenzo	1.17	475.0	107.0	2.67
Nanguyudan	.65	240.0	85.0	1.57
Pasil	.47	528.0	95.0	2.99
Zambales				
Amungan	1.87	115.0	31.0	2.06
Inhobol	1.73	274.0	26.0	2.22
Sta. Rita	1.45	192.0	23.0	2.05
Sitio Bunga	.65	104.0	19.0	1.92
Cagayan				
Camalaniugan	3.28	0	0	2.06
Gattaran	1.94	0	0	2.22
Tacloban				
Dacay	1.83	26.0	18.7	2.36
La Paz	.95	13.0	29.5	2.73
Cabacungan	1.35	40.0	21.0	1.61
Mayorga	1.82	23.0	10.9	1.63

Table 8. Percentage of labor utilization by labour source and mandays per hectare, across sites.

Site	Family	Exchange	Hired		Total hired labor	Total labor	Mandays per hectare 1 crop rice
			Pre-harvest	HV-TH & post-harvest			
Ilocos Norte							
Rayuray	33.9		40.3	25.8	66.1	100.0	113.8
San Lorenzo	46.4		20.2	33.4	53.6	100.0	88.4
Nanguyudan	83.9	5.7	3.4	7.0	10.4	100.0	94.4
Pasil	84.7		10.9	4.4	15.3	100.0	130.6
Zambales							
Amungan	18.8	11.8	38.8	30.6	69.4	100.0	92.1
Inhobol	41.4	11.4	28.9	18.3	47.2	100.0	104.6
Sta. Rita	33.5	10.5	39.4	16.6	56.0	100.0	119.1
Sitio Bunga	35.6	39.7	12.5	12.2	24.7	100.0	98.8
Cagayan							
Camalaniugan	11.7	0	45.0	43.3	88.3	100.0	66.3
Gattaran	42.6	0	31.4	26.0	57.4	100.0	91.4
Tacloban							
Dacay	42.3	0	34.6	23.1	57.7	100.0	146.7
La Paz	23.5	1.5	40.4	34.6	75.0	100.0	100.0
Cabacungan	12.1	.6	39.1	48.2	87.3	100.0	118.4
Mayorga	9.2	0	28.3	62.5	90.8	100.0	191.7

Table 9. Percentage of family labor used and number of total adult workers per hectare, across sites.

Sites	% family labor used	No. of total adult workers per hectare
Ilocos Norte		
Rayuray	33.9	2.6
San Lorenzo	46.4	2.6
Nanguyudan	83.9	3.7
Pasil	84.7	5.2
Zambales		
Amungan	18.8	1.2
Inhobol	41.4	1.3
Sta. Rita	33.5	2.2
Sitio Bunga	35.6	2.9
Cagayan		
Camalaniugan	11.7	1.0
Gattaran	42.6	1.2
Tacloban		
Dacay	42.2	0.4
La Paz	23.5	2.3
Cabacongan	12.1	0.6
Mayorga	9.2	1.3

Table 10. Wage rates (pesos/day) and methods of payments for hired labor in farm.sites.

Site	Land preparation with carabao	Planting	Harvesting	Threshing	Harvest-threshing
Ilocos Norte					
Rayuray	15	13	-	-	13
San Lorenzo	30	13	-	-	1/6 of gross production
Nanguyudan	15	13	-	-	-
Pasil	25	13	-	-	-
Zambales					
Amungan	20	10	5	8% of gross	-
Inhobol	17	10	5	8% of gross	-
Sta. Rita	15	10	5	8% of gross	-
Sitio Bunga	15	10	3	8% of gross	-
Cagayan					
Camalaniugan	20	10	-	-	1/5 of gross production
Gattaran	15	10	-	-	1/6 of gross production
Tacloban					
Dacay	23	13	-	-	1/4 of gama
La Paz	23	13	-	-	1/5 of gross production
Cabacungan	25	16	-	-	1/6 of gross production
Mayorga	18	11	-	-	1/5 gama

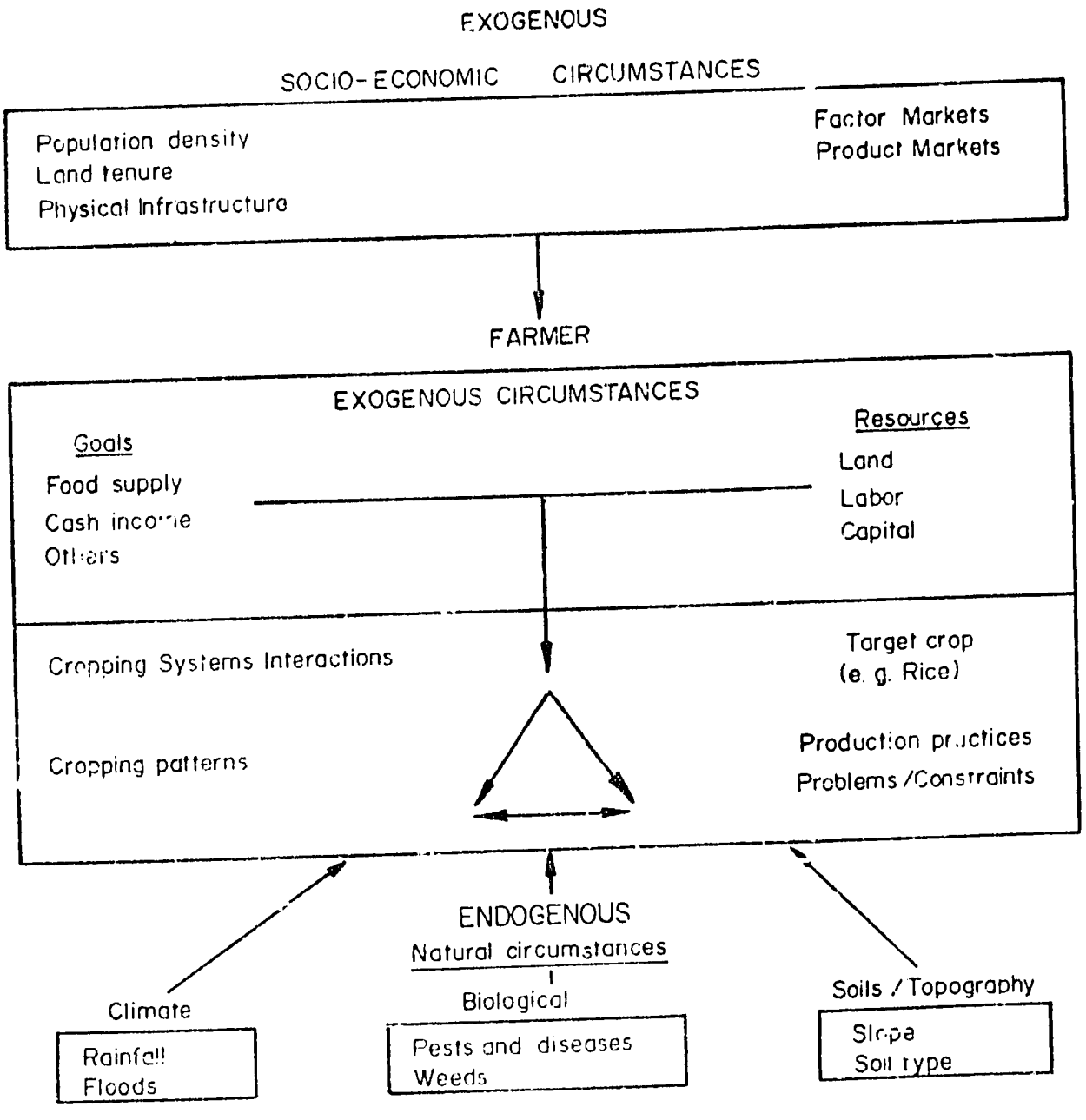

Fig. 1. Representation of various farm circumstances affecting crop production.

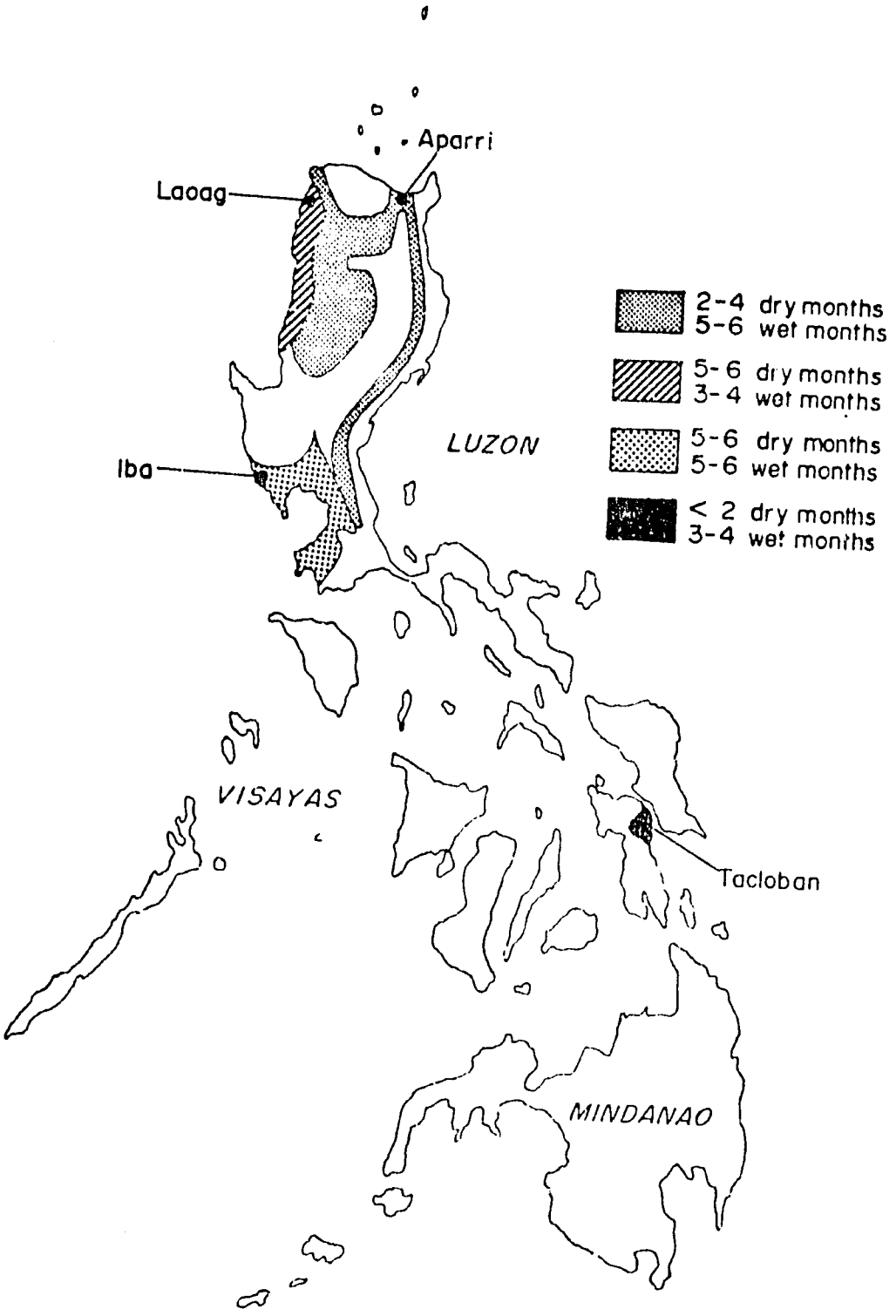

Fig. 2. Locations of research sites in the Philippines showing the number of wet and dry months.

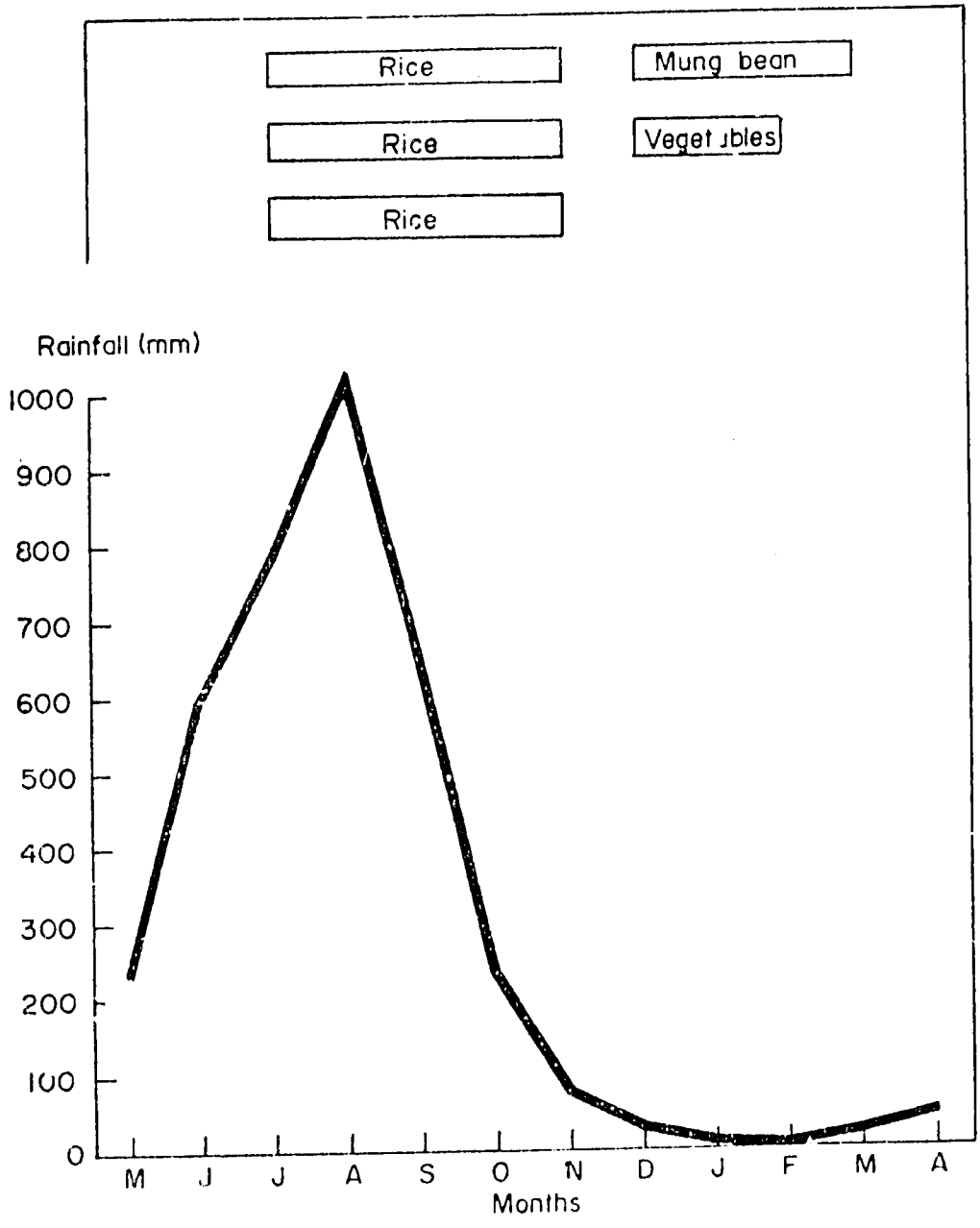

Fig. 3. Rainfall pattern in Iba, Zambales.

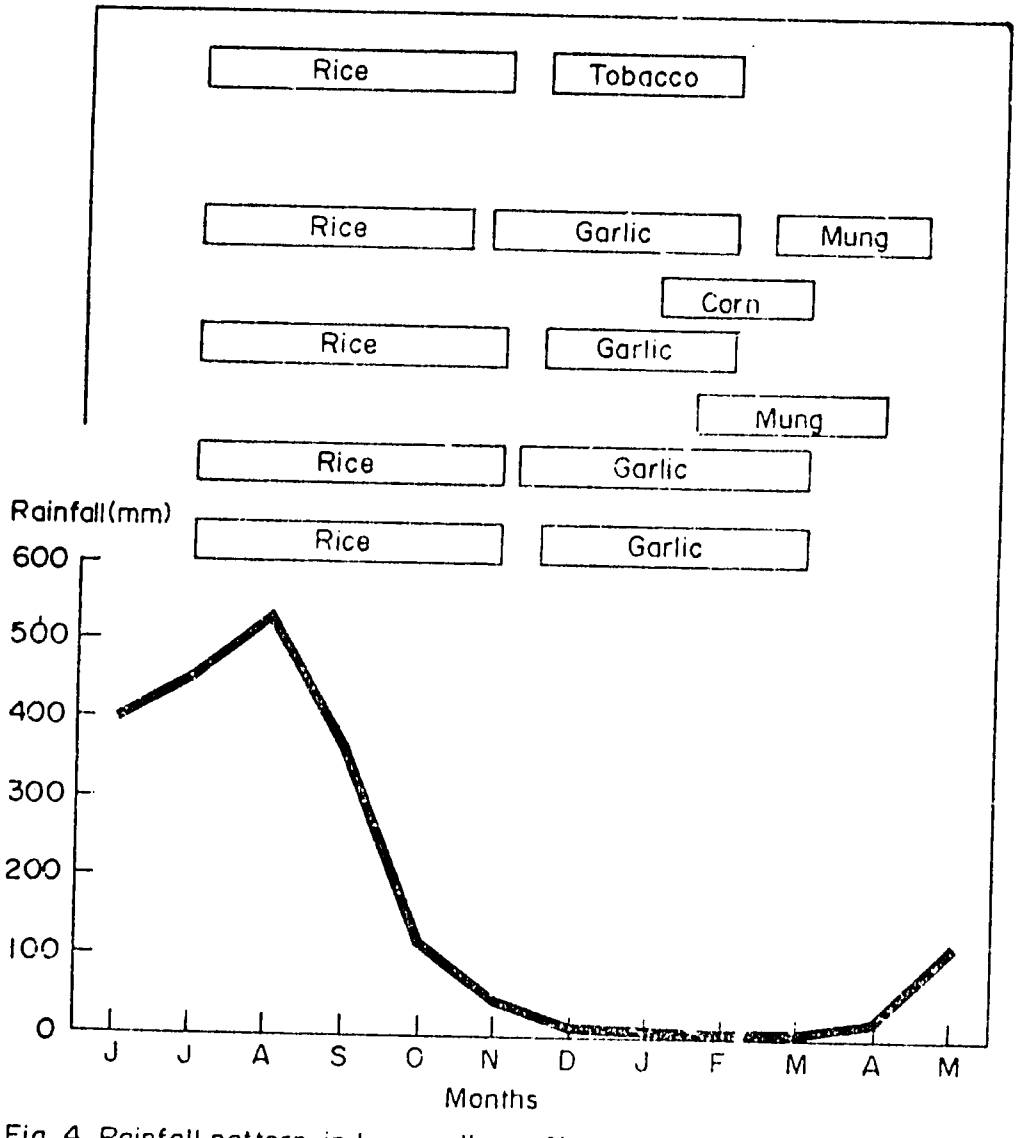

Fig. 4. Rainfall pattern in Laoag, Ilocos Norte.

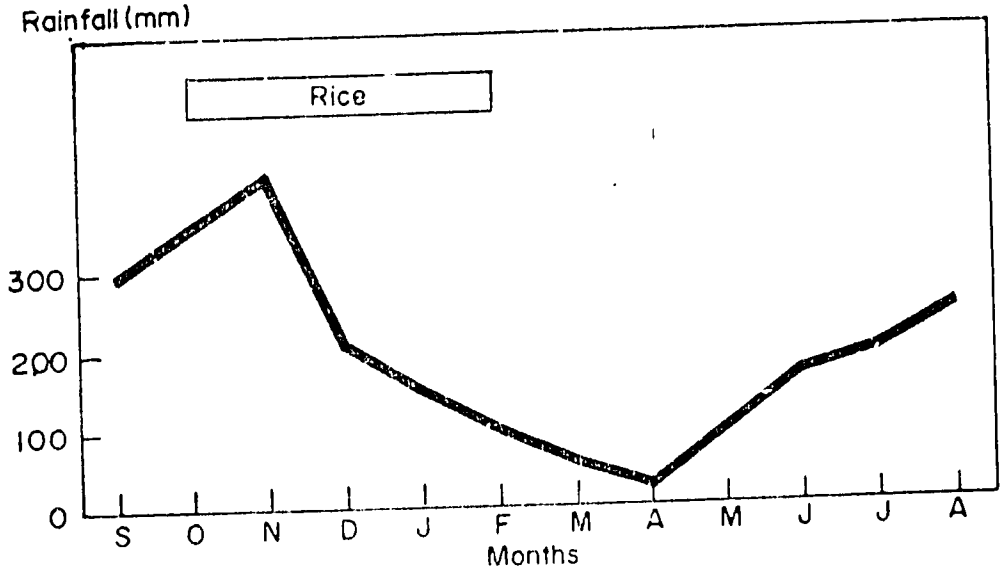

Fig. 5. Rainfall pattern in Aparri, Cagayan

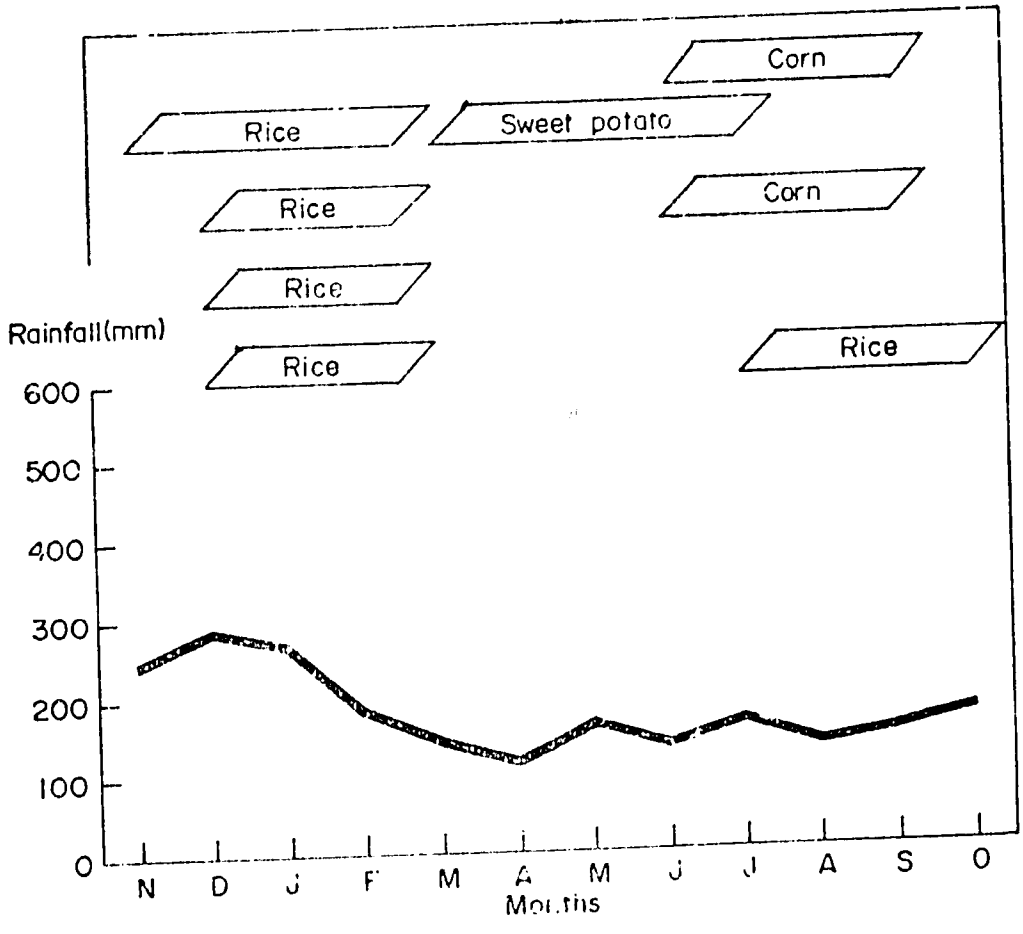

Fig. 6. Rainfall pattern in Tacloban, Leyte.

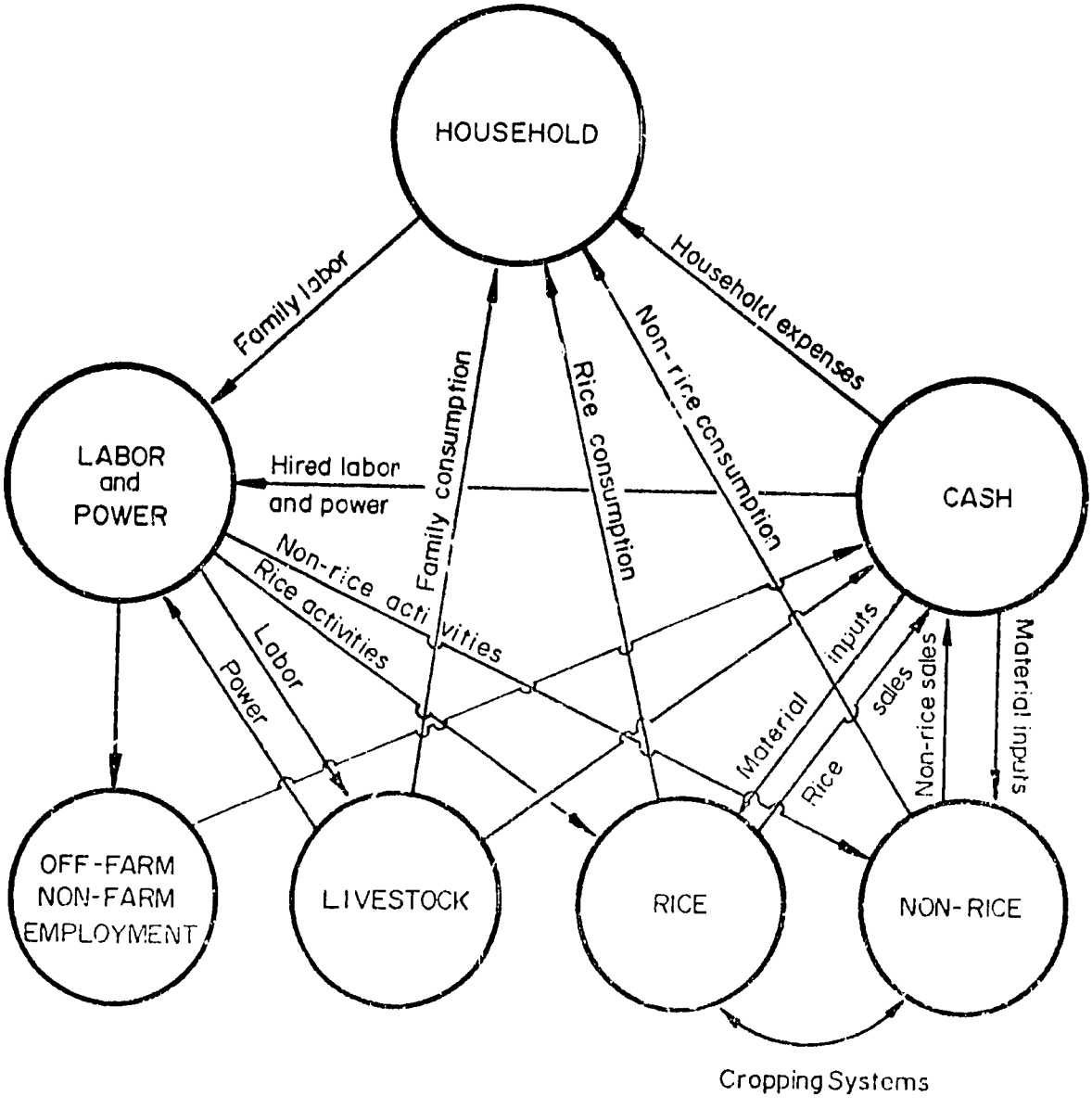

Fig. 7. Resource flows in the farming systems.

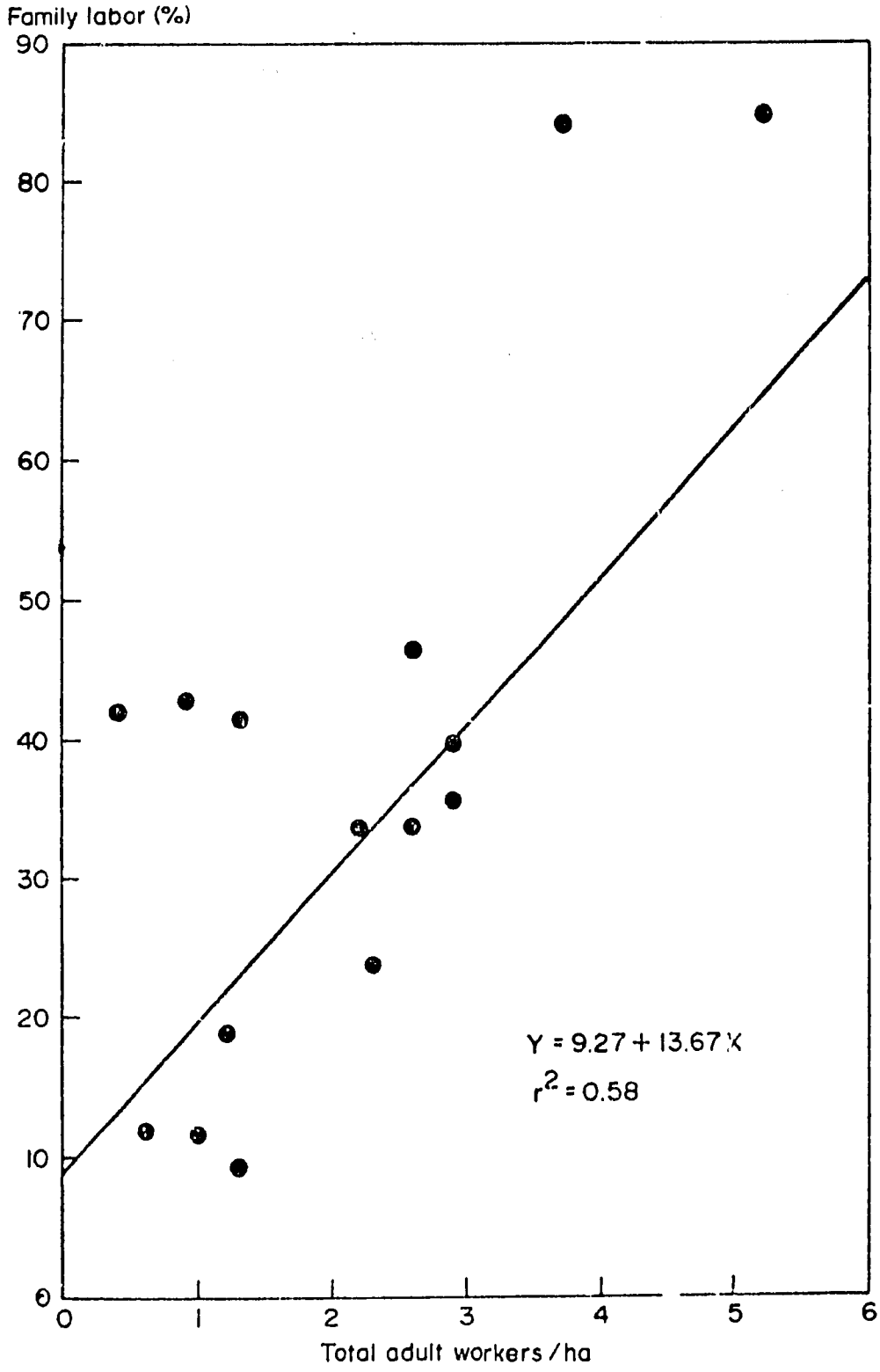

Fig. 8. Percentage of family labor and total adult workers per hectare, four sites.

Appendix Table 1. Sites for which information has been received for the purpose of cross-site analysis of determinants of cropping systems.

Village	Municipality	Province	Country
5 villages	Manaoag	Pangasinan	Philippines
San Lorenzo	San Nicolas	Ilocos Norte	Philippines
Nanguyudan	Paoay	Ilocos Norte	Philippines
Rayaray	Batac	Ilocos Norte	Philippines
Santa Rita	Masinloc	Zambales	Philippines
Sitio Bunga	Masinloc	Zambales	Philippines
Sitio Mabuhay	Inhobol	Zambales	Philippines
	Pimai		Thailand
		Ubon	Thailand
Alilino	Camalaniugan	Cagayan de Oro	Philippines
Lapogan	Gattaran	Cagayan de Oro	Philippines
5 villages	Tigbauan	Iloilo	Philippines
Amungan	Iba	Zambales	Philippines
Cale	Tanauan	Batangas	Philippines
		Bukidnon	Philippines
		Capiz	Philippines
		Agusan del Sur	Philippines

APPENDIX

Table 2. Physical determinants

Village/or Municipality	No. dry mo.	No. wet mo.	Soil text.	Topo-graphy	% Low-land irrig.	% Low-land rainfed	% dry-land	Depth watertable (m) Wet months	Depth watertable (m) Dry months
Manaoag	6	4*	heavy	flat	61	21	18		
San Lorenzo	6	4*			0	85	15		
Nanguyudan	6	4*	medium	rolling	2	82	16		
Rayaray	6	4*			0	97	3		
Santa Rita	6	4*	heavy	flat	11	89	0		
Sitio Bunga	6	4*	heavy	rolling	9	86	5		
Inhobol	6	4*	medium	rolling	4	96	0		
Pimai	7	5	light	flat	0	100	0	.2	1.4
Ubon	7	5	light	flat	0	100	0	.3	1.5
Alilino	3	6	light	flat	0	100	0		
Lapogan	3	6			4	89	0		
Tigbauan	3	6*	heavy	flat	34	56	10		
Amungan	6	6*	medium	flat	0	92	8		
Cale	6	6	medium	flat	0	0	100		
Bukidnon	1	6	medium	rolling	--- 3 ----		97		
Capiz	3	8*	medium	rolling	--- 66 ---		34		
Agusan	1	10*	m-h	r-f	--- 50 ---		50		

* Dry mo. = 100 mm rainfall, wet mo. = 200 mm rainfall

APPENDIX

Table 3. Macroeconomic determinants

Site	Man/ land ratio	Labor wage $/d	Draft power cost $/d			Price of N ($/kg)	Price of rice ($/kg)	Land rent/ ha/crop	Irrig. cost/ ha/crop	Interest rate %/yr	Market distance
			Animal	Hand tractor	4-wheel tractor						
Manaoag	3.0	.8				.49					
San Lorenzo	4.4	2.6	1.8			.46					
Nanguyudan	9.1					.67					
Rayaray	5.8	1.8	1.0			.49	.14				
Sitio Bunga	3.7	1.2	1.0			.51	.12				
Inhobol	1.0	1.6	1.2			.47	.14				
Pimai		1.0				.06				12	
Ubon		1.0				.06				12	
Alilino	1.5	1.9	1.6								
Lapogan	2.7	2.0	1.0			.53					
Tigbauan		.7*									
Amungan	2.8	2.0	1.3			.48	.14				
Cale	7.3	2.3					.22				
Bukidnon	.8	.9*					.15				
Capiz	2.1	.5*					.09				
Agusan	1.1	.6*					.12				

* Cash market wages. May not reflect food and produce compensation.

APPENDIX

TABLE 4. MICROECONOMIC DETERMINANTS

Site	Farm size (ha)	Tenure % land owned	Family size	Adult male workers	Adult female workers	No. Draft animals	Value of farm capital	Non-crop farm income	Non-farm income	Loans received
							- - - - - - - - - - US $ - - - - - - - - - -			
Manaoag	1.84	25	5.5					- - - - 306 - - - -		122
San Lorenzo	1.17		5.1	2.9	1.5	1.8				146
Nanguyudan	.65		5.9	1.6	.7	2.5			139	2
Rayaray	.80		4.6	1.4	1.2	2.2				146
Santa Rita	1.48		5.7	2.0	1.8	1.1			251	166
Sitio Bunga	1.53		5.7	1.4	.7	1.2			96	31
Inhobol	4.80		4.9	2.8	.5	2.3			461	25
Pimai		100	6.6	- - - 3.7 - - -		-			1132	198
Ubon		100	6.9	- - - 3.7 - - -		-			258	103
Alilino	3.28		5	1.5	.5	1.3				46
Lapogan	2.07		5.5	1.8	1.4	1.7				152
Tigabauan	2.05	20						132	307	79
Amungan	2.08		5.9	.5	.7	1.1			555	663
Cale	.93		6.8	1.4	1.1	.8			169	
Bukidnon	6.4	85	5	.8		.5			71	115
Capiz	2.8	63	6.0	1.5		1.4			43	59
Agusan	5.5	95	6	1.7		.5			89	8

APPENDIX

TABLE 5.

LAND UTILIZATION

Site	% land cultivated	MCI on cultivated land	% cultivated land-weeks used	% area planted in				Cultivated area (ha)
				rice	other fc	veg., perish.	perennials	
Manaoag	100	174		50	40	3	7	1.89
San Lorenzo	100	216		44	13	43	0	1.17
Nanguyudan	98	247		53	36	11	0	.64
Rayaray	100	211		43	15	42	0	.80
Santa Rita	98	105		98	2	0	0	1.45
Sitio Bunga	58	102		99	1	0	0	.89
Inhobol	35	127		82	12	6	0	1.68
Pimai		100		100				
Ubon		100		100				
Alilino	100	106		98	2	0	0	3.28
Lapogan	100	112		92	8	0	0	2.07
Tigbauan	100	207		70	30	0	0	2.05
Amungan	98	130		75	23	2	0	2.04
Cale	100	186	.57	40	42	17	2	.93
Capiz	65	150		83	15	0	2	1.82
Agusan	68	180		38	32	0	30	3.74
Bukidnon	70	170		16	80	0	4	4.48

fc = field crops

APPENDIX

TABLE 6. LABOR UTILIZATION

Site	Total labor/ farm (md)	% labor/farm by source				MD labor/used/ha/crop			
		Operator	Family	Exch	Hired	Rice	Other fc.	Veg. per.	Perennials
Manaoag	216	- - - 48 - - -		2	50	66	69		
San Lorenzo	284	35	23	0	42	87		155	
Nanguyudan	106	40	45	5	10	106			
Rayaray	237	26	13	1	60	109		188	
Santa Rita	163	17	18	10	55	112			
Sitio Bunga	119	29	19	19	18	133			
Inhobol	244	23	16	15	46	110			
Pimai	405	- - - 60 - - -		1	39	-			
Ubon	610	- - - 97 - - -		1	2	-			
Alilino	220	10	1	0	89	67			
Lapogan	99	30	10	1	59	46			
Tigbauan	225	27	14	5	54				
Amungan	175	18	5	6	70	86			
Cale	185	- - - 79 - - -			21	41			
Bukidnon	161	- - - 54 - - -			46	- - - - 21 - - - -			
Agusan	176	- - - 80 - - -			20	- - - - 47 - - - -			
Capiz	205	- - - 67 - - -			43	- - - - 60 - - - -			

APPENDIX

TABLE 7.

TRACTION POWER USE

Site	Animal draft power/farm			Mechanial traction power/farm*			Traction power, md/ha/crop*				
	Total md/ farm	% owned	% hired	Total md/ farm	owned	hired	Rice	Other fc	Veg., perish.	Peren- nials	All crops
Manaoag											
San Lorenzo							19.7				
Nanguyudan							12.9				
Rayaray							21.1				
Sta. Rita							17.4				
Sitio Bunga							16.7				
Inhobol	39.6	0	100				14.8				
Pimai											
Ubon											
Alilino	48.4	98	2								
Lapogan							6.9				
Tigbauan							15.5				
Amungan							20.9				
Cale							12.6				
Bukidnon							20.8				
Capiz											20.9
Agusan							7.6				
							21.3				

*Animal equivalents. 1 hand tractor md = 4 animal md, 1 four-wheel tractor md = 8 animal md.

APPENDIX

Table 8 FERTILIZER USE

Site	Value fert. /farm	Value of fertilizer/ha/crop					Amt. of fertilizer/farm				kg N/ha 1 crop rice
		rice	Other fc	Veg. perish.	Perennials	All crops	N	P	K	Manure	
Manaoag											
San Lorenzo	152.0	66.8		63.1							
Nanguyudan		33.3									
Rayaray	99.6	68.3		56.2							
Santa Rita	36.8	25.4									
Sitio Bunga	12.9	14.4									
Inhobol	65.5	37.5									
Pimai											
Ubon											
Alilino	0	0									
Lapogan	3.6	1.7									
Tigbauan											
Amungan	32.1	15.8									
Cale	82.1										
Bukidnon						46.9					
Agusan											
Capiz											

APPENDIX

Table 9

PESTICIDE USE

Site	Value of insecticides /farm	Value of herbicides /farm	Value of seed/ farm	Value of materials /farm	Value of all materials/ha/crop				
					rice	Other fc	Veg. perish.	Perennials	All crops
Manaoag									
San Lorenzo	3.6								
Nanguyudan	2.1								
Rayaray	5.4								
Sta. Rita	6.1								
Sitio Bunga	4.3								
Inhobol	2.0								
Pimai									
Ubon									
Alilino	6.2								
Lapogan	0								
Tigbauan									
Amungan	4.0								
Cale	2.7								
Bukidnon		0		91					12.0
Capiz				19					5.8
Agusan				24					4.3

APPENDIX

Table 10

PRODUCTION AND INCOME

Site	Prod. /farm	Rice	Other fc	Veg. perish.	Perennials	All Crops	Yield/ ha/crop rice (t)	Net crop income /farm	Non-crop income farm	Non-farm income farm	Total Income /farm	Total Income /family member
Manaoag	644	424	54				2.2					
San Lorenzo	1962	460		1260			1.3					
Nanguyudan	145					227	1.1					
Rayuray	1106	461		922			1.5					
Sta. Rita	354	263					1.1					
Sitio Bunga	228	272					1.1					
Inhobol	529	296					1.1					
Pimai												
Ubon												
Alilino	733	223					.7					
Lapogan	481	232					.9					
Tigbauan	1456	404					3.0					
Amungan	575	286					1.1					
Cale	598	286					1.3					
Bukidnon	551	150					1.0					
Capiz	428	135					1.5					
Agusan	367	132					1.1					