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THE IMPACT OF THE RAINFED-UPLAND RICE PROJECT IN BULACAN AND NUEVA ECIJA*

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INTRODUCTION

The government of the Philippines and the International Rice Research Institute (IRRI) undertook a cooperative applied research on rainfed and upland rice in 1971. The Rainfed and Upland Rice Project (RURP) as it came to be known extended for a period of seven years. The project partially funded by two grants from the Rockefeller Foundation, the first in 1971 and the second in 1974.

This report is concerned only with that phase of the project covered by the initial grant in which the objective was to increase the productivity of farmers located in the rainfed and upland rice areas of Bulacan and Southern Nueva Ecija provinces. An IRRI report (RPTR) describes these initial steps as follows:

> "The original plan was to conduct field tests for 3 to 5 years to develop a package of cultural practices that could increase the rainfed and upland rice yields. However, the high yields obtained in 1971 with rainfed rice, inspite of the severe drought and tungro virus epidemic, convinced research workers and agriculturists of the province that the results could be safely recommended for adoption by farmers."
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> "In March 1972, the decision was made to launch a pilot extension program. The extension program would be conducted concurrently with the applied research program. The objectives of the pilot extension program were: (1) to further test the package of new technology on whole farm basis, and (2) to identify the important constraints that would need to be removed if the program were successful and a national program was to be organized.

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The program, called "Masagana 99" ("Masagana" means "bouatiful harvest," 99 represents the yield goal - 99 cavans/ha, or 4.3 t/ha), was designed to encourage rapid and widescale adoption of the package of practices. Plans were to use well trained, highly skilled, and action-oriented farm management technicians. The technicians were provided motorcycles to increase their mobility and improve their efficiency."

The activities described above were continued over a period of three years. The formal objectives of the project are set forth in Appendix A.

This study attempts to evaluate the Rainfed Upland Rice Project (RURP), in Bulacan and Nueva Ecija provinces covering a rainfed and upland rice areas of approximately 20,000 hectares. Though it is useful to evaluate pilot projects of this nature, such evaluation are inevitably very difficult. In the Rainfed Upland Rice Project for example, it is impossible to separate the impact of the pilot project from the National program and hence to identify benefits attributable to each. Thus, we refer in this study to RURP - Masagana 99 as the joint project whose impact we will attempt to assess in the rainfed project area. There were also a number of factors not related to the project as for example, year to year weather variability and the fertilizer shortage in 1973-74. It is difficult to identify and separate the changes due to these programs from changes due to these other exogenous factors.

Nevertheless, in order to obtain some estimate of the changes occurring (whether as a result of the pilot project or the national program), the Agricultural Economics Department of IRRI conducted an initial survey in 1971 as the project was starting and follow-up surveys in 1974 and 1977. These surveys provide a basis for determining what happened in terms of changes in production practices and inputs, and for identifying those factors accounting for the changes in rice production. The final survey was made over 3 years after the project activities were terminated in the Bulacan-Nueva Ecija site. This procedure was adopted because the impact of programs of this type in terms of farmer response and acceptance of new technology is not often realized immediately.

Rainfed Upland Rice Project (RURP)

Nearly 47% of the rice area in the Philippines is classified as rainfed lowland, and 27% as upland.1/ The yields are low, averaging about 1.2 tons and 1.0 ton per hectare, respectively. The principal factors contributing to these low yields are (Ross, 1974):

1/Rainfed rice grown on unbunded fields in which the soil is dry during at least part of the growing season.

(i) Low rainfall and uneven distribution of rainfall, and poor water management practices.

(ii) Inadequate control of weeds, insects and diseases.

(iii) Use of low yielding varieties.

(iv) Inadequate land preparation and improper time of planting and methods of stand establishment.

Through the initiation of the Philippines' Bureau of Agricultural Extension (BAEX), National Food and Agricultural Council (NFAC), and IRRI, an applied research project on rainfed and upland rice was established in the four municipalities of Bulacan, namely Sta. Maria, San Rafael, San Ildefonso, San Miguel and the Municipality of Gapan in Nueva Ecija. Approximately 54% of the rice area in Bulacan is rainfed. Of the seven rainfall patterns described for the Philippines, Bulacan and Nueva Ecija are in rainfall type B, with a dry period lasting only for four months (Dilag, et al., 1976). The study area includes six major soil types, namely Bantog clay loam, Buenavista silt loam, Buenavista sandy clay loam, Sibul clay, and Prensa clay loam (Fig. 1). The soils in the northern part of Bulacan and Southern Nueva Ecija tends to be sandier with less water holding capacity. Particularly for growing rainfed rice, soil water holding capacity is extremely critical.

In December 1970, project proposals (Appendix A), including project organization such as individual trial plans (selection of technicians, training programs, etc.) contribution of each participating agency and budget estimate were submitted to IRRI Administration. Following the approval of IRRI Administration, a memorandum of understanding was drawn in March 1971 (Ross, 1974). It included general outline of the project, personnel and budget, responsibilities of the cooperating agencies, modification of the agreement and termination. To undertake the research, twenty farm management technicians of the Bureau of Agricultural Extension were selected to work on the project and trained at IRRI on a special rice production course. Two officers of the same agency were also selected to work full time on the project. These appointments were effective for an initial period of 3 years starting March 1971. Two American Peace Corps volunteers with a training in rice production at IRRI were also detailed to the project for one year to assist in the organization and implementation of the trials. IRRI provided supplies and equipment and incentive pay for Bureau of Agricultural Extension personnel in the project. The program was to be administered by the head of the Office of the Rice Production Training and Research of IRRI and the Deputy Commissioner of Bureau of Agricultural Extension. However, after the initiation of the project, the head of the RPTR assumed an informal but effective position of project manager. Assistance in planning and carrying out of the project was provided by the IRRI staff, NFAC, Bureau of Soils, Bureau of Plant Industry, University of the Philippines at Los Baños College of Agriculture and the US Peace Corps. Figure 2 illustrates the organizational structure of the project (Ross, 1974).

Twelve different rainfed-upland trial plots were established in the project sites (see Appendix C Table 1 for location of project demonstration plots). These include nitrogen x stand establishment (rainfed), nitrogen x variety (rainfed, upland), varieties (rainfed, upland), herbicides (upland, rainfed), management (rainfed), insecticides (rainfed, upland), production (rainfed, upland). Beginning 1971 wet season, the project work started. Each trial plot was visited by the technicians at least 3 times per week. Field days were held, and group visits of the farmers were encouraged to see the best plots. The first year of the project resulted in 4-5 tons/ha yields on the average in the rainfed area, when varieties such as IR20 and IR22 were grown with higher level of management. This was accomplished inspite of severe drought and a severe outbreak of tungro virus disease condition. These trials continued in 1972 and 1973. On the basis of results of 150, 118, 246 trial plots conducted in 1971, 1972, 1973, respectively, it was evident that yields in the rainfed areas could be increased.2/ On the other hand, the rice yields obtained in the upland trials were low.3/ Due to the mixed success on upland, the focus of the project after the first year was almost entirely on the rainfed areas.

The high rice yield obtained in the rainfed areas in 1971 despite severe drought and tungro virus disease convinced the researchers that the results could be safely recommended to the farmers in the area.4/ In 1972, a pilot extension program was launched in Bulacan to determine the effects of the new technology when applied on a whole farm basis. This program, called "Masagana 99", was designed to encourage adoption of the package of cultural practices with regard to varieties, herbicide, insecticide, fertilizer practices, method of stand establishment and management levels by farmers in Bulacan (Ross, 1972). The strategies for successful implementation of this program and the recommended practices are shown in Appendix B.

During the first season of the M99 project in 1972 in Bulacan, 2,600 hectares of rice was grown with supervised credit and an additional 3,000 hectares using the recommended practices with other financing. Average yields of over 100 cavans/ha were reported (Ross, 1974). The pilot extension program was expanded further during wet season 1973. The average yield was said to remain high. As a result of the massive progress shown in the pilot extension program (Masagana 99), it was extended by the government of the Philippines to be a national program initially covering 17 additional provinces. Later, it was expanded further to 43 and then finally to 53 provinces with a target of a total of 500,000 hectares containing 100,000 hectares of rainfed area.

2/As in 1971, yields of 4-5 t/ha were consistently obtained with IR20, IR22 and IR577 in the rainfed trial plots.

3/In 1971, out of the 15 varieties tested, only IR5, IR8, IR937 showed yields above 2.0 t/ha. In 1972, all these varieties and in 1973 only IR5, IR8, IR577, IR1529 and IR1539 and C22-51.

4/For a detailed description, refer to the project review, Reports of 1971, 1972, 1973, RPTR, IRRI, Los Baños.

However, in the expansion from provincial to national level, the basic objectives and procedures of the Masagana 99 project changed. The focus was shifted in the national program to the irrigated areas, and the intensive applied research and extension procedures being tested in the RURP were abandoned. It should be emphasized that our study deals only with the Bulacan-Nueva Ecija provincial site of the RURP, which is a rainfed system of production not with the national program.

As a part of RURP, a pilot project was undertaken in San Miguel, Bulacan in 1973 on direct seeding of rice (Prabowo, 1977). The objective was to advance the seeding date to make it possible to grow two crops of rice in the same year on the rainfed area. While this procedure has been successfully introduced in some other parts of the Philippines, it did not prove successful in the RURP area due mainly to the rainfall pattern in Bulacan. Direct seeding has been adopted by only a few farmers and has not had a major impact on production. With the recent widespread adoption of early-maturing varieties, the possibility of multiple cropping in Bulacan may be re-examined.

Objectives and Hypotheses

The specific objectives of the study are:

(i) To determine the changes which took place in the RURP study area between 1971 and 1977 with respect to: (a) varieties, (b) fertilizer, herbicide, and insecticide application practices, (c) methods of stand establishment, and (d) yields.

(ii) To determine whether the changes observed in the input levels and cultural practices among villages is associated with the presence or absence of RURP applied research plots or with other specific factors such as proximity to town or the main highway, soil and topography.

(iii) To estimate the impact of the change in inputs on the level of production.

Our main concern was with the practices that have been recommended by RURP-Masagana 99 for increasing production of the rainfed rice crop. The hypothesis is that the project has stimulated changes in input use and production, and that the changes occurring are more pronounced in those villages where demonstration plots were located.

It is also hypothesized that villages near the main highway or town would change the practice more rapidly than those more distant. Other factors such as soil conditions are believed to affect the nature of the response to extension efforts.

SAMPLING PROCEDURE

A stratified two-stage sampling procedure was used to select villages for the study and farms within each study village. The stratification was based on three criteria, namely:

(i) location - by municipality

(ii) distance from the nearest town or the highway - either "far" (> 5 km) or "near" (< 5 km)

(iii) extension - "with" or "without" applied research projects of RURP

From the 23 villages with RURP plots (Appendix C, Table 1), one village was randomly selected from each of the five municipalities and one additional village from the entire sample (Fig. 3). Thus, there were six villages with RURP demonstration plots, one from each municipality except two from San Miguel (Table 1).

The distance of each of these villages to the poblacion (town) and main highway was measured in kilometers. Villages with a distance of less than 5 kilometers to the town or to the main highway were classified as "near villages," those 5 kilometers or more as "far villages."

Six other villages were then purposively chosen to pair with each of the original six. The criterion for the selection of these six villages was that they should not have a demonstration plot, but should be in the general vicinity of one of the six RURP villages, although not necessarily in the same municipality. Thus, in Sta. Maria for example, both villages are "near" the town, but only Sta. Clara was in RURP, and San Gabriel was not (Table 1). On the other hand, Kapalangan in Gapan and Tartaro in San Miguel are "far" from the highway.

In summary, a total of 12 villages were chosen which were well scattered throughout the project area (Fig. 3). Six villages are "near" and six "far" from the main highway or town. For each of these groups of 6, three had demonstration plots and three did not.

The next step was to select the rainfed rice farmers from each villages for the surveys. Farm lists were obtained from the village captains and 20% of the farms with a minimum of 20 for those with less than 100 farms were chosen by random sampling from each village list. The number of farmers selected by this procedure per village is shown in Table 2. A total of 282 farmers in the 12 rainfed villages were interviewed in the benchmark survey for 1971 by the Department of Agricultural Economics, IRRI, the nature of the data collected being summarized in Appendix D. The survey for 1974 covered a total of 230 farms and that for 1977, 199 farms. As shown in Table 2, a number of farms in the benchmark were not interviewed in the follow-up surveys.

Characteristics of the Sample Villages

A rough inverse relationship exists between average yield per hectare, farm size, and location among the rainfed villages (Fig. 4). For instance, there is an increase in yield per hectare as one moves from the northernmost village (Kapalangan in Nueva Ecija) to the southernmost village (San Gabriel and Sta. Clara in Bulacan), and also as average farm size increases and yield decreases (Fig. 4). These differences in yield may be due to the differences in physical charateristics such as soil types or rainfall, among the rainfed villages. In terms of the yield performances, one could rank Sta. Clara and San Gabriel, the two southernmost villages, as the highest and Kapalangan, the northernmost village, as the lowest.

IR5, IR20 and IR36 were the most popular varieties among the rainfed farmers in 1971, 1974 and 1977, respectively. In most cases, lack of inputs was considered to be a major constraint in achieving higher yields.

The "near" villages tended to have a smaller farm size (Table 3). However, the pattern is not consistent. If we ignore Sta. Clara and San Gabriel, and yields per hectare (Table 3) do not vary greatly between "near" and "far" villages. On the average, less than 6% of the rice area is planted during the dry season in majority of the villages (Table 3). The first crop in wet season is planted in July/August and harvested in November/December. The second crop is planted in December and harvested in February/March.

The average farm size per capita is relatively bigger among far villages, however, near villages showed a large proportion of landless workers (Table 4).

The major environmental factors influencing yields vary among the rainfed villages. The main damage to the rice crop was caused by tungro virus infection (1971-72), drought (1971-72, 1972-73), floods (1972-73), typhoons (1973-74, 1974-75).

CHANGES IN YIELD, INPUT USE AND CULTURAL PRACTICES

We begin this section by summarizing some of the major changes that have taken place in yields, technology, and input use over the survey period (Table 5). First impressions suggest that yields seem to have risen appreciably between 1974 and 1977, but as we shall see subsequently, part of the explanation is related to the weather. Nitrogen input per hectare rose steadily during the period. Expenditures for pesticides and herbicides rose very sharply from 1971 to 1974 during the period when the RURP-Masagana 99 program was most active. The proportion of area under modern varieties was already at a very high level (69%) in 1971, and rose even further after 1974 as early maturing varieties spread.

Yields

The yield of traditional varieties have remained static while that of the modern varieties has risen significantly particularly in 1977 (Table 6). The sampling procedure was designed to test certain hypotheses about changes occurring in yield and input use. Those villages with RURP demonstration plots are compared to those villages without RURP demonstration plots. However, no significant difference is shown in yield between villages with plots and without RURP plots. The yields seem to have been somewhat lower in those villages with plots, and between 1971 and 1974 yields appear to have risen in these villages while they remained static in the other villages. (Results by individual village are reported in Appendix E.)

Villages near the highway or main towns have significantly higher yields than far villages for all years except for the traditional varieties. However, changes in yield seem to have occurred at about the same rate in each set of villages.

Villages were classified by soil type (Table 7). Significantly higher yields were reported on the Prensa clay loam both by farmers and by RURP research workers conducting yield trials. The differences by soil type in yield response to nitrogen is illustrated in Fig. 5. Again the superior characteristics of the Prensa clay loam are evident. Yields increased significantly to about 2 t/ha or more in 1977 in all villages except those located in the Bantog clay loam and Buenavista silt loam. These villages - particularly Kapalangan in Southern Nueva Ecija - transplanted very late in 1977 due to the delay in the onset of the monsoon rains and later suffered from drought. Much of the area in Kapalangan could not be harvested. However, in the other villages, the introduction of early maturing varieties seems to have permitted farmers to escape the effects of delay in transplanting. This issue will be discussed in more detail subsequently.

Inputs and Credit

As in the case of yields, nitrogen input per hectare was found to be somewhat lower in the villages with RURP demonstration plots than in those without at the start of the project in 1971 (Table 8). By 1974, the amount of nitrogen being used by villages with plots had risen from 31 to 39 kg/ha while the amount being used by those without plots had fallen from 38 to 33 kg/ha. Nitrogen input rose significantly in three of the six villages with plots and in two without plots, but fell significantly in two without plots. One village where nitrogen input declined was Anyatam (Appendix E). This is a low lying village whose ricelands border the main highway. Because of poor drainage and frequent flooding, lands next to the highway embarkment continued to be planted to the taller traditional varieties. The rice crop was severely damaged by floods in 1972 in this village, which may have been one factor to discourage fertilizer use.

By 1977, nitrogen input had increased to its former level. For all villages, nitrogen input rose to over 40 kg/ha, but the amount of phosphorous applied remained almost constant at just over 20 kg P_2O_5/ha. The level of N and P being used by the farmers are approximately half of the 1971 RURP recommendation of 90 kg N/ha and 40 kg P_2O_5/ha, but represents a significant gain, given the risks and uncertainties involved in rainfed rice production.

Villages using the lowest amount of nitrogen and phosphorous in 1971 were located in the Prensa clay loams (Table 8). As shown in Figure 5 although these are not as responsive to nitrogen input as Sibul clay is, higher yield is still evident. By 1977, the two villages located on these soils - Sta. Clara and San Gabriel - were applying over 40 kg N/ha. However, it is important to note that farmers were using large amounts of organic matter (Table 9). The organic matter comes largely from small poultry and hog enterprises located on many of the farms in these villages. It is apparent that the application of organic matter has contributed significantly to the consistently higher yields reported on the Prensa soils. Use of organic matter elsewhere was modest mainly because of its limited availability.

The most important change in rice production practices from 1971 to 1974 was in the combination of plant protection practices and weed control methods. Adoption of insecticides increased in all villages with and without RURP plots from around 60 to 80% (Table 10). The use of granular insecticide increased, but because these are expensive, most farmers preferred to use granular in combination with liquid or just liquid insecticide.

The use of chemicals for weed control also increased substantially over the period of the study; those depending solely on hand weed control fell from over 70% in 1971 to less than 50% in 1974 and 1977 (Table 11). Mechanical weeding was only widely practiced in a few villages.

The sharp increase in expenditure on both weedicides and insecticides between 1971 and 1974 seems to reflect the success of the RURP-Masagana 99 program in convincing farmers to increase their use of these inputs (Table 12). But severe crop losses due to tungro virus in 1971 may have been an even more important stimulant to insecticide input. Again no significant differences can be found in villages <u>with</u> compared to those <u>without</u> RURP plots, or in villages <u>near</u> compared to those far from the main highway or town. However, the level of input use seems to have been highly variable among villages (Appendix E). The low response among some villages seemed to be due to other factors such as unfavorable experiences in growing modern varieties (e.g. Anyatam) or no serious infestation of tungro virus or brown planthopper (e. g. Sta. Clara).

Efforts to encourage the farmers to use a higher level of inputs were reinforced by a major credit program under the Masagana 99. Credit was provided to Masagana 99 members through the rural banks and the Philippine National Bank. Table 13 indicates the percent of membership and the amounts borrowed for specific purposes in the sample villages in 1974.

Effect of Demonstration Plots

One of our initial hypotheses was that villages with demonstration plots might respond more rapidly to the adoption of modern inputs and improved cultural practices than those without. However, in general, there was no significant difference in the rate of change between the two groups of villages. Farmers were asked whether they were aware of the RURP demonstration plots and whether they were planning to adopt any of the new practices being demonstrated (Table 14). Most of the farmers in the villages where the plots were located were aware of the plots, but those in neighboring villages were generally not aware of the plots. Most farmers who were aware of the plots said that they were not planning to try these practices being demonstrated. There seemed to be a sense of feeling among many farmers that the input practices being recommended were too expensive.

By 1974, however, the number of farmers who said they were trying some of the recommended practices was high in a few villages. However, from the answers given in Table 15 as to why the new technology was not tried, it is clear that there were problems in even defining what practices are being recommended and how the level of input and cultural practices differ from what the farmer is now doing.

Early maturing Varieties

Two-thirds of the area was already planted to modern varieties at the time the RURP began in 1971 (Table 16 and Fig. 6). The adoption of MVs and the use of modern inputs was lowest in Sta. Clara and San Gabriel villages located on the Prensa soils. In 1971, IR5 was the most widely planted variety, but following the severe attack of tungro virus in that year, IR5 virtually disappeared. By 1974, IR20 was the most widely planted variety. Use of MVs rose significantly in the Prensa clay loams where farmers were not greatly affected by the tungro virus attacks. But elsewhere the growth in the adoption of MVs seems to have stagnated or even declined in 1974 as compared to 1971.

Adoption of the original MVs (IR8 and IR5) reduced the length of the growing season (transplanting to harvest) from 150 days or more (with traditional photoperiod sensitive varieties) to 120 to 130 days. By 1974, some of the lines that mature in 100 days or less (e.g. IR1561 and IR747) were being tested by farmers (Fig. 6) although no early maturing lines had been officially released. Three years later, in 1977, over half of the area was planted to early-maturing varieties, the most popular was IR36 which was occupying about 34% of the area (Fig. 6).

Yields were higher for the farms sampled in 1974 as compared to 1971, but were sharply higher in 1977 (Table 5). In order to understand the reason for this increase, we have examined the data for 72 farmers planting only IR5 in 1971, for 32 farmers planting only IR20 in 1974 and for 28 farmers planting only IR36 in 1977.

As shown in Figure 7, the yields of IR5 dropped sharply due to the fact that the late planted crop was most severely affected by tungro virus (IRRI, 1972). IR20 yields were reduced by typhoons in 1974 (Fig. 7). It appeared initially that 1977 also would be a bad year. The rains were late (Fig. 8) and farmers were delayed in planting by about two weeks (Table 17 and Fig. 9). Despite this, IR36 plantings were harvested at least a week earlier than those of IR5 and IR20. By the first week in November, about 80% of the harvest on the IR36 farms was complete. Further, weather was favorable during the latter part of the growing season as rains were adequate during the flowering period in September. Farmers complained of the dry spell in October, but there were no serious storms throughout the entire growing season. Yields tapered off for those farms harvesting after the first week in November. However, compared to IR5 and IR20, the yield decline was delayed by several weeks (Fig. 7).

In 1977, early maturing modern varieties, including IR36, yielded 2.2 t/ha, medium modern varieties 2.2 t/ha, and medium late maturing varieties 3.2 t/ha. All three varietal types performed well. The principal medium late variety, C4-63, was grown primarily in the two southernmost of the 12 barrios surveyed where soil and moisture conditions were more favorable. From the limited information available, it would appear that under ideal conditions, medium late maturing varieties, such as C4-63 or IR5, gave higher yields than IR36. Plant breeders recognize that there is a decrease in yield as the maturity date is shortened, but there is no precise information as to the magnitude of decline.

Information on the relationship between the age of seedling, at transplanting duration of maturity and yield also is inadequate. For modern varieties, the "recommended" practice has been to transplant seedlings about 21 days of age. It was argued that yields decline as seedling age at transplanting extends beyond 30 days. Recent evidence sheds doubt on this issue (IRRI, 1977 Constraints to High Yields). Farmers in the survey area typically transplant seedlings at 28 to 35 days of age (Table 18). This may help to explain the short growth duration of approximately 80 to 85 days for IR36 (Fig. 9).

The evidence suggests that the sharp increase in yields in the survey area between 1974 and 1977 was due both to favorable growing conditions and the use of early maturing varieties. The use of early maturing varieties was particularly beneficial in 1977 because of the delay in transplanting due to the lack of rain. Even for this small area, early maturing varieties are not the total answer. In the future, farmers may discover that the proper choice of variety will depend on when the monsoons start. For example, if the rains are early, later maturing varieties planted before July 1st may give a higher yield than early maturing varieties such as IR36. Farmers will have to weigh the potential for added yield against the added risk of delaying the harvest date, or the potential for growing a second crop following rice.

This success with early maturing varieties reported in Central Luzon was repeated elsewhere in the Philippines. In Iloilo, for example, the introduction of early maturing varieties resulted in an expansion in the area double-cropped (Tinsley, Price and Zandstra, 1977). By 1977, 55% of the area was planted to early maturing varieties and the area being double cropped rose to 47% of the total (Table 19). Early maturing varieties are normally sown on lands prepared before the first of July. The wet-seeded method (broadcasting on puddled soils) is used which facilitates the growing of two crops. There seems to be little difference in yield for wet seeded vs. transplanted rice, although this is not well documented. On lands prepared after the first of July, late maturing varieties are planted and only a single crop is harvested.

IMPACT OF CHANGES IN INPUT USE AND CULTURAL PRACTICES ON YIELD

As mentioned previously, it is extremely difficult to separate the impact of changes in yield due to changes in the level of input and cultural practices from changes in yield due to weather. In 1971, severe crop damage occurred in the study area due to tungro virus. The typhoon damage in 1974 was severe. Weather in 1977 was more favorable, although planting was delayed due to the delay in the onset of the monsoon rains. In order to take account of those weather variability and to identify more precisely the imapct of the change in specific inputs and cultural practices to the change in yield, we fit response functions separately for each year. The response functions were of the following form:

$$Y_i = \beta_0 + \beta_1 N + \beta_2 N^2 + \beta_3 M + \beta_4 C + \beta_5 D_1 + \beta_6 D_2 + \beta_7 D_1 N + \beta_8 D_2 N + \beta_9 H + \beta_{10} OF$$

where:

Y	=	yield in year i (kg/ha)
N	=	amount of nitrogen used (kg/ha)
M	=	proportional area under modern varieties per hectare
C	=	costs of weeding and plant protection/ha (₱/ha)
OF	=	amount of organic fertilizer used (kg/ha)
D_1	=	intercept dummy variable for Sta. Clara

D_2 = intercept dummy variable for San Gabriel

D_1N = slope dummy variable for Sta. Clara nitrogen response

D_2N = slope dummy variable for San Gabriel nitrogen response

H = dummy variable for date of harvest where H=1 for date of harvest from second week of September to fourth week of October and H = 0 for the date of harvest from first week of November to fourth week of December.

The results of the yield response estimates are shown in Table 20. Significant coefficients were obtained for nitrogen and organic matter. The intercept dummies were highly significant for both Sta. Clara and San Gabriel showing that yields were a ton higher than the average of the other 10 villages in the former village and 2.5 t/ha greater in the latter village. Both of these villages are located on the Prensa soils. Perhaps because of the high level of organic fertilizer input in San Gabriel, addition of nitrogen does not seem to increase yield (D_2N - e.g. for 1977 the slope coefficient for San Gabriel is -48.36 + 28.62 = -19.94). The coefficient for date of harvest is highly significant in all three years and late harvest after the first of November results in a yield decline of about half a ton.

In order to remove the effect of such things as weather and insect damage on the yield response, we can take the mean input coefficients for all variables for each year in turn and substitute them in the 1971, 1974 and 1977 yield response functions. The average yields for the three years using 1971, 1974 and 1977 mean inputs can be calculated. The results are shown in Table 21 and compared with the actual yields reported by farmers.

The results suggest that relative to 1971 and 1974, 1977 was in general a more favorable growing year. Yields were about 0.3 t/ha higher in 1977 than estimated on the basis of the average of 3 years condition, 0.2 t/ha lower in 1974, and 0.10 t/ha lower in 1971. Removing the effect of weather factors, the significant gain in yield is still seen to occur between 1974 and 1977.

The contribution of nitrogen, insecticides and herbicides, earlier harvesting date and organic fertilizer to gain in yields is shown in Table 22. The procedure used to obtain these estimates is the same as used in obtaining yield estimates in Table 21 with the exception that results are presented in terms of changes from 1971 to 1974 and from 1974 to 1977. The major factor contributing to the gain in yield in the first period was increased use of organic fertilizer and increased use of insecticide and herbicide while the major factors contributing to the gain in yields in the latter period was the increased use of nitrogen and organic fertilizer and the earlier harvest date due to the introduction of the early maturing varieties.

These results agree in general with out initial findings using tabular analysis, although in the yield response analysis, the impact of the early maturing variety seems to be somewhat muted.

RAINFED FARMS VERSUS IRRIGATED FARMS

Generally, rainfed farms show substantial lower yield and input use compared to irrigated farms. The gap between yield is explained by the adoption of the technology which goes with the introduction of new varieties. Comparing Nueva Ecija irrigated farms with Bulacan rainfed farms, Table 23 shows the obvious difference in the level of inputs applied between these two types of farm. Rainfed farmers tend to be more conservative in terms of adoption, is it because these farms are more "risk averse" than irrigated farmers? It is clear that the higher input use in irrigated farms resulted in higher yields. Some studies indicated that it is not clear whether this was due to a more favorable yield response on irrigated farms or due to the greater risk aversion of the rainfed farms (Barker and Herdt, 1978).

Presumable factors having to do with water are the main things responsible.

CONCLUSIONS

The objective of the study reported in this paper has been to evaluate the impact of the RURP on the increase in rice yields in the Bulacan-Nueva Ecija study area. It is, of course, difficult to separate the impact of RURP from other related programs such as Masagana 99.

Through the analysis of surveys taken in 1971, 1974 and 1977, it was possible to analyze the changes occurring in input use and yield during the 3-year period when RURP was in operation (1971 to 1974) and for the 3-year period following the termination of the RURP project.

What is perhaps most evident in the first 3-year period is the major increase in the use of organic fertilizer. Although the coefficient of this variable (OF) was significant only for two years, 1971 and 1977, it appears that the use of organic fertilizer did have some impact on yield. In fact, this change was perhaps the only major change occurring in the initial three years. Other cultural practices and input levels remained close to 1971 levels. Inorganic fertilizer (N) might have increased along with organic fertilizer, but in 1974, due to the national and world shortage, fertilizer particularly urea was in fairly short supply in some locations. Massive importation of fertilizer in 1974 and 1975 corrected this situation and in fact led to a surplus of stocks.

It is evident that in general there is no basic difference in the response of villages with or without demonstration plots and near or far from the highway or main towns. There is, however, a considerable difference in some villages due to location.

It was observed that the Prensa soils are generally more productive but less responsive to fertilizer inputs than other soil type. In yield response functions, the slope dummies for the two villages in the Prensa soils tended to be negative, indicating that there was no gain to be had from further addition of nitrogen. This may be the result of the fact that these villages are applying significant amount of organic fertilizer.

In general, as one moves from the Prensa soils (Sta. Clara and San Gabriel) to the north toward Nueva Ecija, the soils tend to become sandier and more subject to drought. The sandy texture and poor water holding capacity of these soils delays the transplanting. Farmers in Anyatam and in Kapalangan seem to have the most unfavorable situation. Anyatam is a low lying village part of whose lands lie adjacent to the main highway embarkment. This area is poorly drained and in general not suited to the modern semi-dwarf varieties. Kapalangan is the northernmost village in the study area located in Southern Nueva Ecija with generally sandy soils.

Between 1974 and 1977, among the significant changes that occurred was the introduction of the early maturing varieties. These varieties were being tested in the RURP program and a pilot project was initiated to attempt to combine early maturing varieties with direct seeding of rice to obtain 2 rice crop in the rainfed area. Despite the failure of this pilot project in Bulacan, the early maturing varieties spread rapidly in the project area covering one half of the total area by 1977. Although late onset of the monsoons delayed planting of rice in this year, the number of farmers harvesting their rice before the first of November rose to 33% as compared with 15% in 1974. This seems to have added at least 100 kg/ha to rice yields.

Tremendous publicity given to Masagana 99 undoubtedly has influenced farmers in project areas as well as outside these areas to conform to Masagana 99 technology.

In summary, in this study we have been able to pinpoint the change in inputs and cultural practices in the RURP study area between 1971 and 1977 and the related impact on yields. However, it is difficult or impossible to determine how much of the credit should be given to the RURP per se, to the Masagana 99 which followed close on the heels of the RURP, or to other unrelated factors.

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Table 1. Paired villages according to location, distance from town or highway and presence or absence of demonstration plots.

Village	Municipality	Distance from		Distance designation	Demonstration plots
		Town	Highway		
Sta Clara	Sta. Maria	2.0	5.0	Near	Yes
San Gabriel	Sta. Maria	1.0	3.0	Near	No
Pasong Intsik	San Rafael	22.0	6.0	Far	Yes
Alagao	San Ildefonso	13.0	12.0	Far	No
Calasag	San Ildefonso	4.5	1.5	Near	No
Pinaod	San Ildefonso	3.0	2.0	Near	Yes
Sta. Catalina	San Ildefonso	9.0	6.0	Far	No
Tartaro	San Miguel	12.0	10.0	Far	Yes
Anyatam	San Miguel	2.5	0	Near	No
Camias	San Miguel	2.0	0	Near	Yes
Partida	San Miguel	13.0	10.0	Far	No
Kapalangan	Gapan	9.0	10.0	Far	Yes

Table 2. Number of farms surveyed in the benchmark (1972) and follow-up (1974) surveys

Municipality	Village	No. of sampled farms		
		1971	1974[a]	1977
Sta. Maria	Sta. Clara	20	18	17
	San Gabriel	23	18	17
San Rafael	Pasong Intsik	20	16	16
San Ildefonso	Alagao	20	18	14
	Calasag	20	14	11
	Pinaod	20	17	14
	Sta. Catalina	20	15	15
San Miguel	Anyatam	20	18	16
	Tartaro	20	18	11
	Camias	38	30	27
	Partida	32	28	26
Gapan	Kapalangan	29	20	15

[a] Reasons for the reduction in numbers resurveyed in 1974 and 1977 compared to the size of the 1971 sample include the fact that a few farmers had moved, some had obtained irrigation, a vew were no longer farming, and a few had died.

Table 3. Mean yields/hectare cultivated acreage (percent), percent area double cropped, average farm size by village. Sample of 460 farms in twelve villages of Bulacan and Nueva Ecija.

Study villages	Distance designation	Yields per hectare a/ (tons/ha)	Total cultivated acreage (percent)	Percent area double cropped b/	Average farm size (ha)
Sta. Clara	Near	2.0	80	2	1.5
San Gabriel	Near	3.2	80	3	1.8
Pasong Intsik	Far	1.1	80	2	3.4
Alagao	Far	1.4	75	0	2.9
Calasag	Near	1.2	80	6	2.0
Pinaod	Near	1.3	70	0	2.4
Sta. Catalina	Far	1.6	70	2	2.8
Tartaro	Far	1.6	80	5	2.1
Anyatam	Near	1.1	85	4	2.5
Camias	Near	1.3	80	1	3.5
Partida	Far	1.3	90	5	4.6
Kapalangan	Far	0.7	70	3	3.5

a/ Average of 1971 and 1974 crops.

b/ Wet season average = 100.

Table 4. Total population, households, average family size, percent in farming, business or services and landless laborers by village. Sample of 460 farms in twelve villages in Bulacan and Nueva Ecija.

Study villages	Distance designation	Households (no.)	Average family size (no.)	Average farm size per capita (ha)	Occupation of Households		
					Farmer (%)	Business services (%)	Landless laborers (%)
Sta. Clara	Near	250	8	0.2	78	2	20
San Gabriel	Near	360	7	0.3	85	10	5
Pasong Intsik	Far	80	6	0.6	77	3	20
Alagao	Far	200	7-8	0.4	90	1-2	8-9
Calasag	Near	189	5-6	0.4	55	3	42
Pinaod	Near	500	8	0.3	70	2	28
Sta. Catalina	Far	170	6	0.5	97	2	1
Tartaro	Far	900	10	0.5	90	1-2	8-9
Anyatam	Near	350	4-5	0.2	70	1-2	8-9
Camias	Near	400	6	0.5	40	5	55
Partida	Far	274	8	0.6	75	2	23
Kapalangan	Far	320	7	0.4	91	4	5

Table 5. Average yield and chemical input/ha and area in new varieties for 12 rainfed villages in Bulacan and Nueva Ecija, Central Luzon, Philippines, 1971, 1974 and 1977.

Year	Yield[a/] (t/ha)	Nitrogen[a/] (kg/ha)	Expenditure in herbicide & insecticide (₱/ha)	% area in modern varieties	% area in early maturing varieties
1971	1.4 a	30 a	7	69	0
1974	1.5 a	36 a	137	69	5
1977	2.2 b	43 b	134	88	53

[a/] Any means in the same column followed by the same letter are not significantly different at 5% level.

Table 6. Yield in (tons/ha), 12 villages in Bulacan and Nueva Ecija, 1971-1977.

Village category	Modern varieties			Traditional varieties			All varieties		
	1971	1974 A	1977 B	1971	1974 A	1977 B	1971	1974 A	1977 B
Villages with and without RURP									
With plots	1.1	1.6 *	2.2 ***	1.0	1.5	1.9	1.1	1.5*	2.2 ***
Without plots	1.5	1.5	2.4 ***	1.9	1.5 *	1.1 ***	1.7	1.5	2.2 ***
Villages near and far									
Near	1.7	1.7	2.6 ***	1.7	1.8	1.6	1.7	1.8	2.5 ***
Far	1.1	1.5 *	2.0 ***	1.4	1.2	0.9	1.2	1.4	1.9 ***
All villages									
	1.3	1.5	2.3 ***	1.5	1.5	1.4	1.4	1.5	2.2 ***

*, **, *** significant at 0.10, 0.05, 0.01 levels, respectively.

A = test of significant difference between mean yield of 1971 and 1974.

B = test of significant difference between mean yield of 1971 and 1977.

Table 7. Yields (tons/ha) by soil type in Bulacan and Nueva Ecija 1971-1977.

Soil type	Yield (tons/ha)				
	Survey			RURP trials	
				IR5	IR20
	1971	1974A	1977B	1971	1972
Bantog clay loam[a]	0.4	1.0*	0.7*	3.6	3.2
Buenavista sandy clay loam[b]	1.4	1.3	2.0***	2.7	2.4
Sibul clay[c]	1.2	1.4	2.6***	3.1	3.3
Buenavista silt loam[d]	0.6	1.6**	1.5***	3.4	4.3
Prensa clay loam[e]	2.6	2.4	3.5***	5.1	5.2

[a]Kapalangan

[b]Camias, Anyatam, Pinaod, Alagao, Sta. Catalina.

[c]Partida, Tartaro

[d]Calasag, Pasong Intsik

[e]Sta. Clara, San Gabriel

*,**, *** - significant at 0.10, 0.05 and 0.01 levels, respectively.

A, B - Test of significant difference between mean yield of 1971 and 1974 and 1971 and 1977 respectively.

Table 8. Amount of N, P_2O_5 (kg/ha) by soil types and by plots in Bulacan and Nueva Ecija, 1971-1977.

	Nitrogen (kg/ha)			Phosphorous (kg/ha)		
	1971	1974 A	1977 B	1971	1974	1977
Av. by presence or absence of RURP demonstration plots						
With plots	31	39	44 ***	24	25	24
Without plots	38	33	42	18	20	21
Av. by location to town or main highway						
Near	28	35	41 ***	16	16	18
Far	38	41	45	26	29	26
Av. by total	33	36	43 ***	21	22	22
Av. by soil type						
Bantog clay loam[a]	19	35 **	28	24	31	25
Buenavista sandy clay loam[b]	39	31	39	19	19	17
Sibul clay[c]	35	46 *	52 ***	29	31	32
Buenavista silt loam[d]	44	49	46	24	25	25
Prensa clay loam[e]	13	24 *	41 ***	14	14	14

[a] Kapalangan

[b] Camias, Anyatam, Pinaod, Alagao, Sta. Catalina

[c] Partida, Tartaro

[d] Calasag, Pasong Intsik

[e] Sta. Clara, San Gabriel

*, **, *** significant at 0.10, 0.05 0.01 levels, respectively.

A, B = test of significant difference between mean N kg/ha of 1971 and 1974 and of 1971 and 1977, respectively.

Table 9. Amount of organic fertilizers (tons/ha) used by plots and by soil type in 12 villages in Bulacan and Nueva Ecija, 1971-1977.

	Organic fertilizer (t/ha)		
	1971	1974	1977
Av. by presence or absence of RURP demonstration plots			
With plots	0.16	0.85	4.11
Without plots	0.05	0.49	2.90
Av. by location by town or main highway			
Near	0.13	1.08	4.38
Far	0.08	0.26	0.89
Av. by trial	0.10	0.67	3.43
Av. by soil type			
Bantog clay loam	0	0	0
Buenavista sandy clay loam	0.1	0.5	1.9
Sibul clay	0.2	0.2	1.1
Buenavista silt loam	0	0.3	1.9
Prensa clay loam	0.2	2.2	6.4

Table 10. Plant protection practices, 12 villages in Bulacan and Nueva Ecija, 1971-1977.

	Percent adoption			Type of chemicals											
				Granular			Liquid			Wettable			Combination		
	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977
Av. by research project															
With	58	84	86	6	13	1	63	40	47	5	2	2	27	45	50
Without	58	77	78	7	18	4	78	40	45	4	1	5	11	41	46
Av. by research location															
Near	61	67	70	0	14	3	87	55	53	1	1	6	12	30	38
Far	66	94	94	13	16	2	54	25	40	8	3	2	26	56	56
Av. by total villages	58	80	81	6	15	2	70	40	46	5	4	4	19	43	48

Table 11. Method of weeding (percent), 12 villages in Bulacan and Nueva Ecija, 1971-1977.

	Only hand weeding			Only chemical weeding			Only mechanical weeding			Combination		
	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977
Av. by research project												
With	71	47	49	7	16	17	2	18	0	12	35	34
Without	71	36	45	4	18	20	1	8	0	15	45	35
Av. by research location												
Near	74	53	52	6	13	15	1	6	0	8	32	32
Far	68	30	42	5	21	22	2	20	0	20	40	36
Av. by all villages	71	42	47	5	17	19	2	13	0	14	40	34

Table 12. Cost of weeding and plant protection practices (₱/ha) deflated by chemical price index (1971) in 12 villages in Bulacan and Nueva Ecija, 1971-1977.

	Weedicide			Insecticide			Total		
	1971	1974	1977	1971	1974	1977	1971	1974	1977
Villages with and without RURP plots									
With	6	28	21	9	52	52	15	79	73
Without	2	25	21	6	51	44	9	75	65
Villages far and near									
Near	4	25	19	6	34	44	10	59	63
Far	5	27	23	9	69	52	13	96	75
All villages									
	4	26	21	8	52	48	12	79	73

Table 13. Amount of Masagana 99 credit and percent of credit used in inputs, 12 villages in Bulacan and Nueva Ecija, 1974.

Villages	Masagana 99 credit (₱/ha)	Percent of credit used in		
		Fertilizer	Herbicide	Plant protection
Sta. Clara	453	51	4	15
Pasong Intsik	646	48	1	16
Pinaod	532	47	6	11
Camias	489	37	7	16
Tartaro	482	42	7	19
Kapalangan	430	50	2	13
Anyatam	0	0	0	0
Calasag	652	41	5	16
Alagao	301	40	8	19
San Gabriel	462	40	6	5
Sta. Catalina	413	36	6	16
Partida	484	50	6	12

Table 14. Awareness of the RURP demonstration plot, 1971.

	Aware of the demo plot		Planning to try		Technologies to be tried	If not trying, why?
	Yes	No	Yes	No		
Barrios with RURP						
Camias	60	40	20	23	Straight planting, basal appln. of fert., use diff. varieties	Expensive, area too big, irregular shape; not convinced
Pinaod	94	6	0	88	--	Expensive; laborius; time consuming, area too big, lack of water, not interested
Sta. Clara	94	6	28	71	Straight planting, use HYV	Laborius, not interested, expensive, area too big, no available inputs
P. Intsik	100	0	6	94	Straight planting	No available rotary weeder area too big, expensive, not interested, laborious
Kapalangan	90	10	25	65	Straight planting. use HYV, basal appln. of fert.	Expensive, area too big, laborious, lack of water, no available inputs
Tartaro	78	22	22	61	Straight planting, use HYV	Expensive, not interested convincing, laborious
Barrios without RURP						
Anyatam	11	89	0	11	-	Expensive, not interested.
Calasag	29	71	7	21	Straight planting	Expensive, laborious
San Gabriel	22	78	6	18	Proper distance of planting	Expensive and laborious, not interested
Sta. Catalina	13	87	0	13	-	Expensive and laborious
Partida	32	68	4	29	Straight planting	Expensive, laborious
Alagao	17	83	0	17	-	Expensive, area too big and irregular

Table 15. Information about the RURP demonstration plot, 1974.

	Tried practices seen in demo plot		Technologies tried	If no, why not?
	Yes	No		
Barrios with RURP				
Camias	40	60	Straight planting, used new HYVs, granular insecticide, basal fert. application	Have not seen, not so clear and complicated, expensive
Pinaod	24	76	Direct seeding, granular insecticide, used new HYV	Have not seen any, expensive and laborious, not so convincing.
Sta. Clara	6	94	Straight row planting	Did not observe it well not so clear, not so convincing
P. Intsik	62	38	Basal fert. appln. and granular insecticide, proper timing of spraying of chemicals, direct seeding	Not so clear and complicated, not so convincing, expensive
Kapalangan	35	65	Direct seeding, straight row planting, proper timing of spraying of chemicals	Have not seen any, not convincing, expensive
Tartaro	11	89	Straight row planting, basal fert. application	Not so convincing, have not seen, did not observe it well.
Barrios without RURP				
Anyatam	6	94	Straight row planting	Have not seen any. Not so convincing, not so clear and complicated.
Calasag	50	50	Direct seeding, granular insecticide and herbicide	Have not seen any, not so convincing, not so clear
San Gabriel	0	100	-	Have not seen any, not so clear, not practiced in the area.
Sta. Catalina	13	87	Use of granular insecticide	Expensive, have not seen any, not so clear and complicated

more

Table 15 cont'd. . . . .

Partida	0	100	-	Have not seen any, drought problem, did not observe well.
Alagao	17	83	Use of granular insecticide, proper spacing	Expensive and laborious have not seen any, did not observe it well.

Table 16. Area under varieties by plots, location and soil type in 12 villages in Bulacan and Nueva Ecija, 1971-1977.

Village category/ soil type	Area (percent) under					
	Modern			Traditional		
	1971	1974	1977	1971	1974	1977
Av. by presence or absences of RURP demonstration plots						
With plots	71	68	96	29	32	5
Without plots	68	69	82	32	31	18
Av. by location to town or main highway						
Near	59	63	84	42	38	16
Far	80	75	93	20	25	7
Av. by total	69	69	88	31	31	12
Av. by soil type						
Bantog clay loam	54	48	95	46	52	5
Buenavista sandy clay loam	79	64	80	21	36	20
Sibul clay	85	74	97	15	26	3
Buenavista silt loam	67	75	86	33	25	14
Prensa clay loam	43	71	94	57	29	6

Table 17. Percent area transplanted by second week of July in 12 villages in Bulacan and Nueva Ecija, 1971-1977.

Village category	Percent area planted by the end of second week of July		
	1971	1974	1977
Av. by presence or absence of RURP demonstration plots			
With plot	72	71	14
Without plot	73	73	13
Av. by location to town or main highway			
Near	71	76	19
Far	74	69	8
Av. by trial	72	72	13

Table 18. Average age of transplants (days) by varieties, 12 villages in Bulacan and Nueva Ecija.

Village category	Av. age of transplanted seedlings (days) of Modern varieties			Traditional varieties		
	1971	1974	1977	1971	1974	1977
Av. by presence or absences of RURP demonstration plots						
With plot	33	32	30	37	33	40
Without plot	35	34	31	38	36	44
Av. by location to town or main highway						
Near	33	31	29	36	34	46
Far	35	35	32	39	35	36
Av. by total	34	33	30	38	34	43

Table 19. Use of early-maturing rice varieties and double-cropping in Oton and Tigbauan Municipalities, Iloilo, crop years 1974-75 to 1977-78.

Crop year	% of cultivated area on which first rice crop was an early-maturing variety	% cultivated area double cropped in rice
1974-75	2	5
1975-76	19	20
1976-77	40	37
1977-78	55	47

Table 20. Estimated regression coefficients for yield response function, dependent variable-yield (kg/ha)

	1971	1974	1977
No. of observation	230	230	199
R^2	0.46	0.33	0.43
F	18.32	10.96	14.49
Independent variables			
N	7.44 *** (3.99)	-13.949 * (1.81)	28.622 *** (5.81)
N^2	-0.005 (1.51)	0.234 *** (3.23)	-0.099 *** (4.89)
OF	0.40 *** (4.15)	0.022 (0.51)	0.046 * (1.89)
M	-111.111 (0.71)	55.093 (0.28)	234.306 (0.73)
C	-0.411 (0.06)	1.461 ** (2.21)	0.747 (1.06)
D_1	594.879 * (1.86)	1041.979 *** (2.81)	1267.345 *** (2.82)
D_2	2514.468 *** (8.82)	1977.070 ** (2.21)	3133.347 *** (8.45)
D1.N	15.244 (0.10)	-11.156 (1.08)	3.414 (0.35)
D2.N	-25.378 ** (2.45)	-4.341 (0.34)	-48.362 *** (3.24)
H	518.972 *** (3.99)	229.352 (1.56)	660.018 *** (3.88)
Constant	823.327	1029.304	472.964

Table 21. Impact of changes in input use on yield (t/ha)

	Input levels for		
	1971	1974	1977
Predicted yield of 1971 function using mean input levels of independent variables for 1971, 1974 and 1977	1 35	1.68	1.88
Predicted yield of 1974 function using mean input levels of independent variables for 1971, 1974 and 1977	1.35	1.30	1.61
Predicted yield of 1977 function using mean input levels of independent variables for 1971, 1974 and 1977	1.86	1.99	2.20
Average predicted yield	1.52	1.69	1.89
Actual yields	1.40	1.50	2.20

Table 22. Contribution of related factors to the gain in yield.

Factors	1971-1974	1974-1977
Yield gain (t/ha)	0.17	0.20
Due to:		
Nitrogen (t/ha)	0.01	0.08
Insecticide/herbicide (t/ha)	0.03	0.01
Organic fertilizer	0.13	0.04
Early harvest	0.0	0.04
Proportional area under modern varieties	0.0	0.02

Table 23. Comparison of input use and yields of irrigated rice farms in Nueva Ecija and rainfed farms in Bulacan.

	Irrigated[a]	Rainfed[b]
Farm size (ha)	2.6	2.8
Chemical fertilizer (kg N/ha)	76	36
Other chemicals (₱/ha)	147	93
Labor mandays[c] (mandays/ha)	113	96
Yield (tons/ha)	2.6	1.7

[a] Average for 1975, 1976 and 1977 wet season in Nueva Ecija. Source: R. Barker and R. W. Herdt, Rainfed Lowland Rice as a Research Priority, An Economist's View. A paper presented at the International Rice Research Conference, April 17-21, 1978.

[b] Average of 1971, 1974 and 1977 in this study, Bulacan.

[c] Iloilo data, 1976/1977.

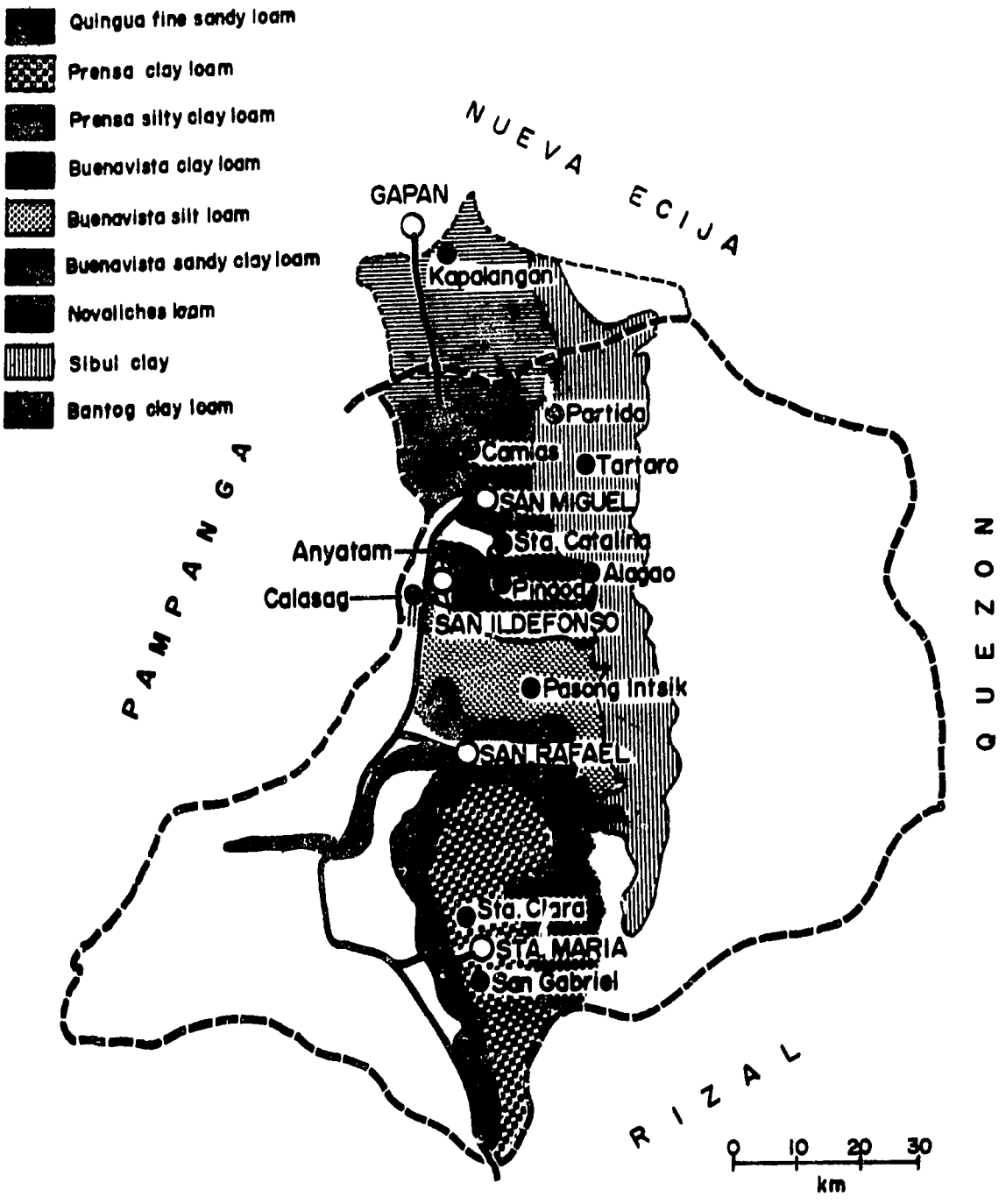

Fig. 1. Soil map of Bulacan province.

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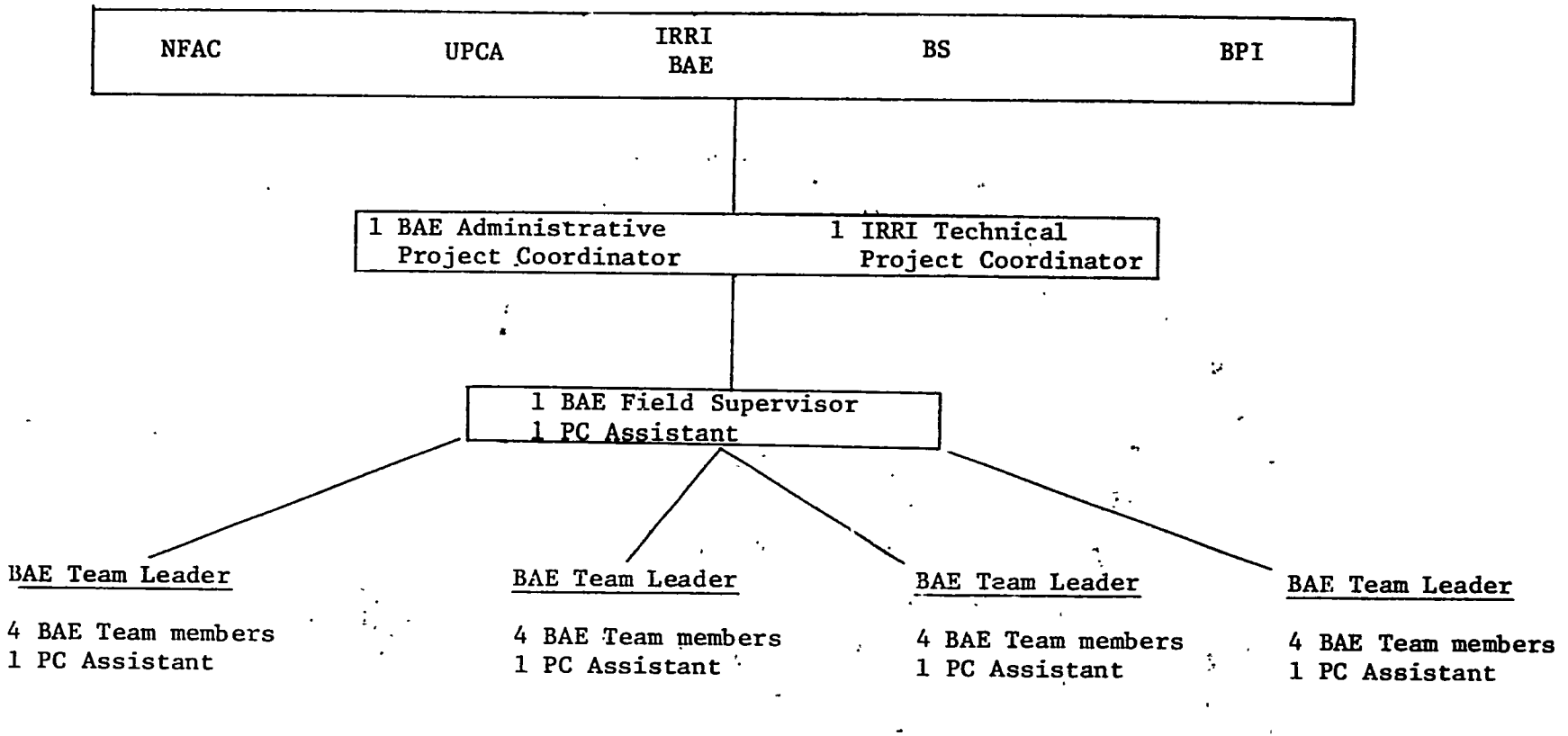

NFAC - National Food and Agriculture Council
UPCA - University of the Philippines College of Agriculture
IRRI - International Rice Research Institute
BAE - Bureau of Agricultural Extension
BS - Bureau of Soils
BPI - Bureau of Plant Industry

Figure 2. Organizational Chart

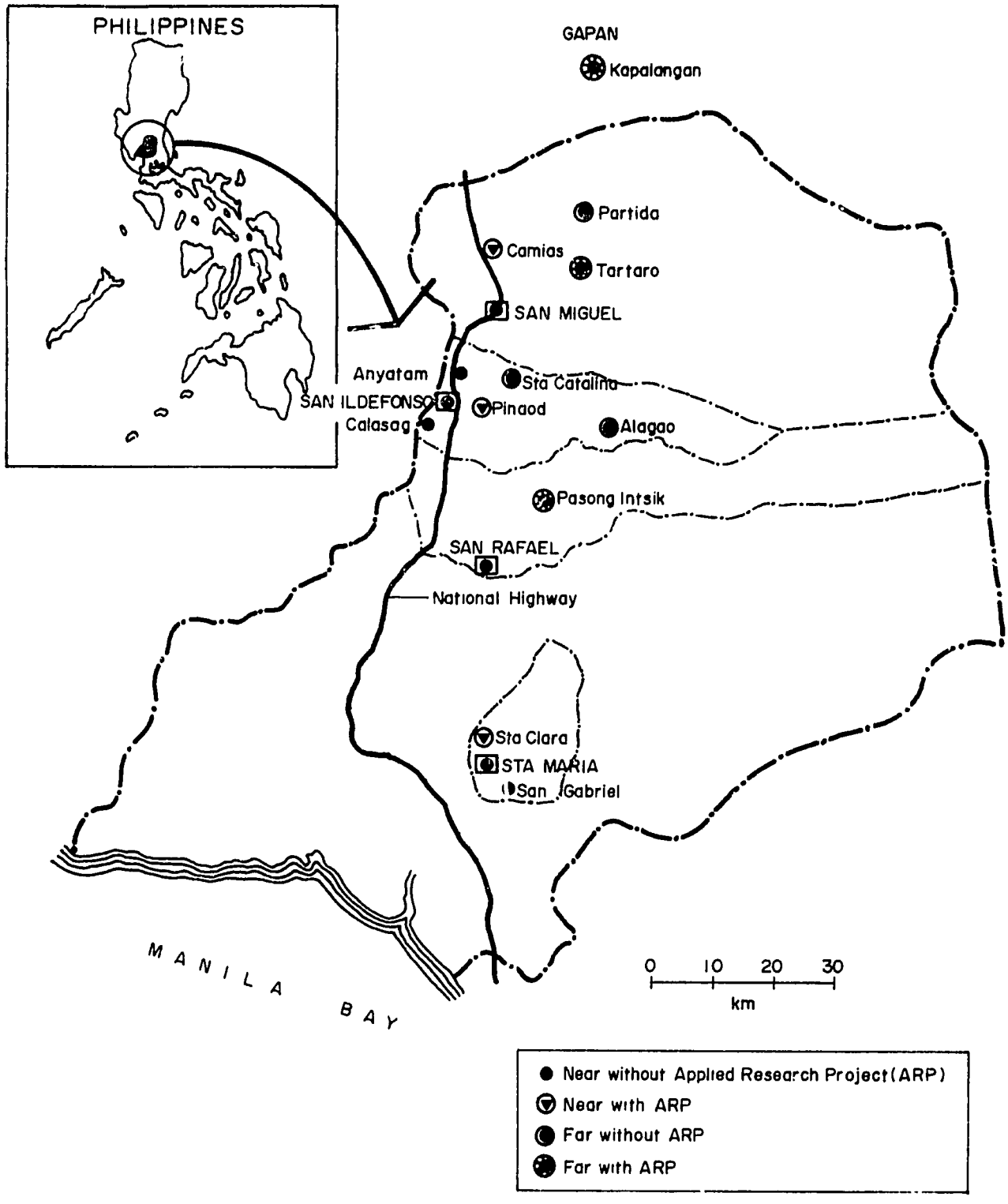

Fig. 3. Map of the study area in Bulacan.

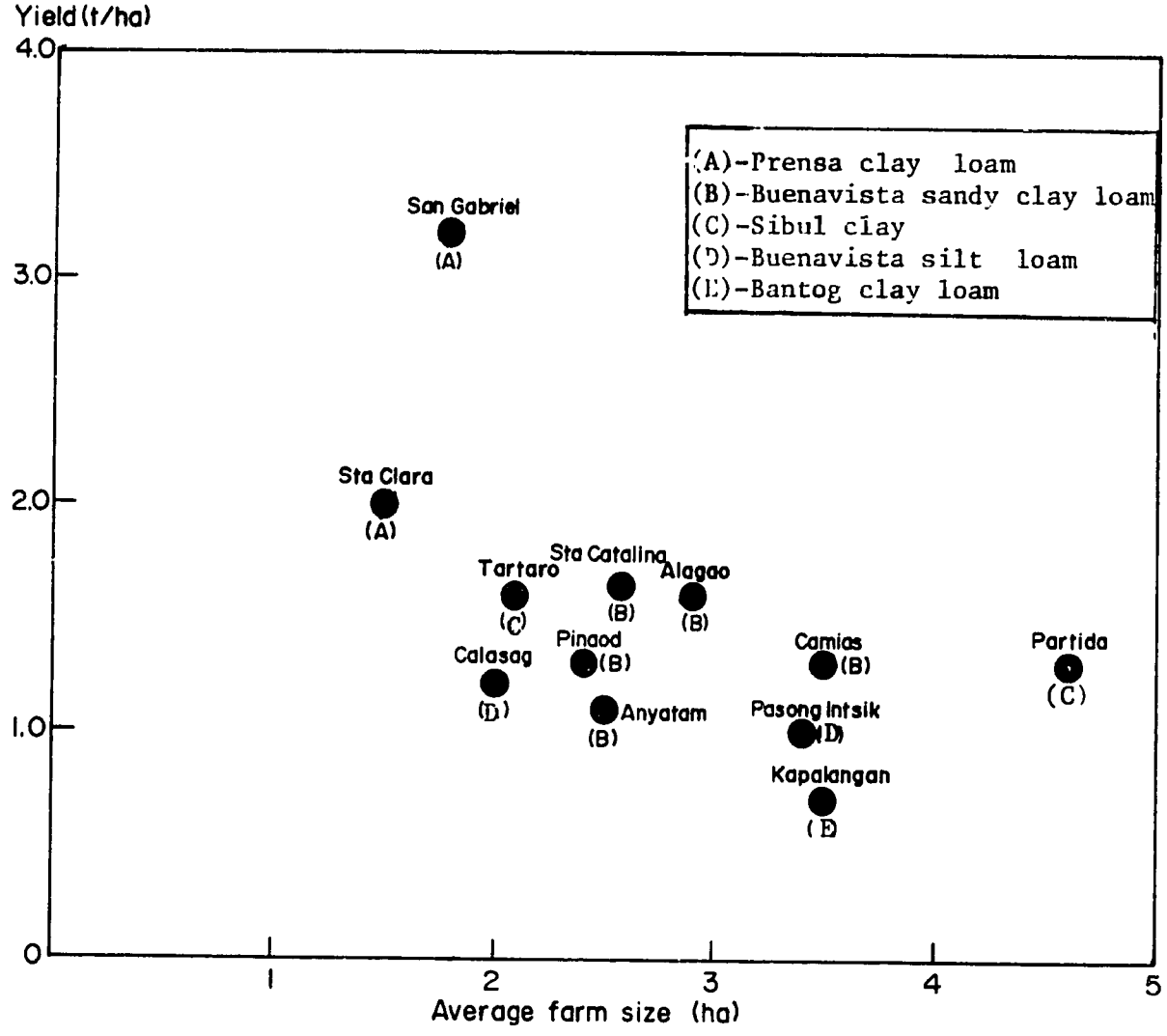

Fig. 4. Relationship between average yield and farm size, location, soil type by villages.

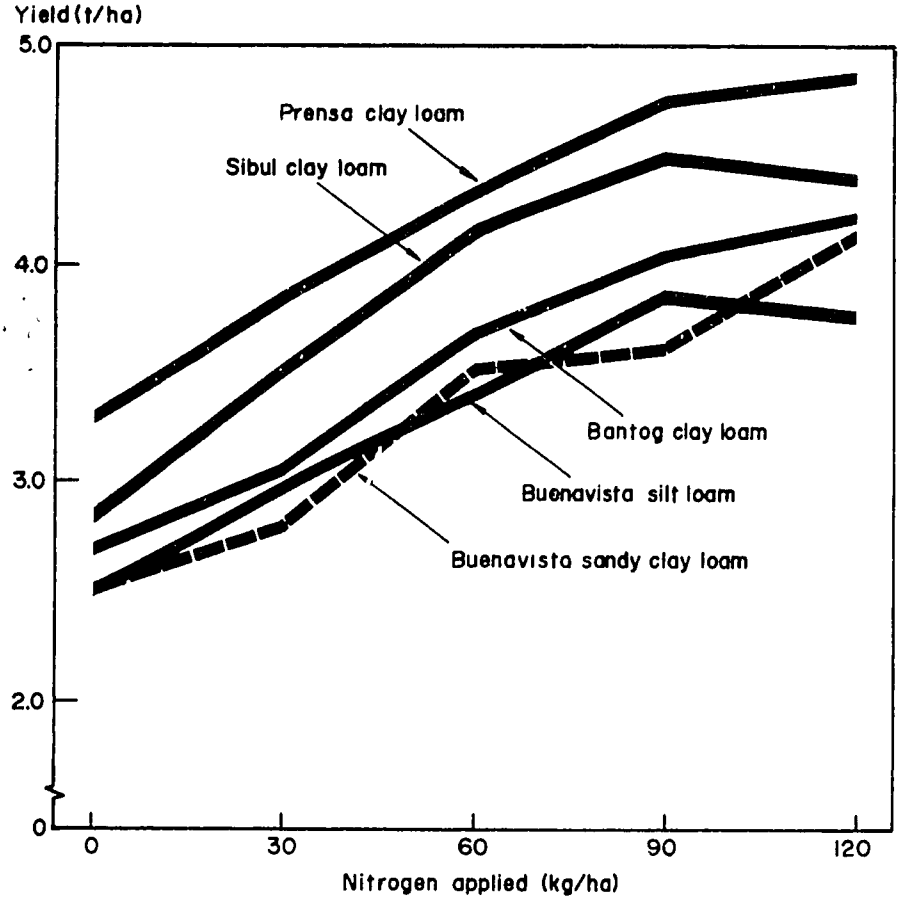

Fig. 5. Grain yields in rainfed paddies on five types of soil as affected by various levels of nitrogen, Bulacan, 1971 wet season. (From IRRI Annual Report 1971.)

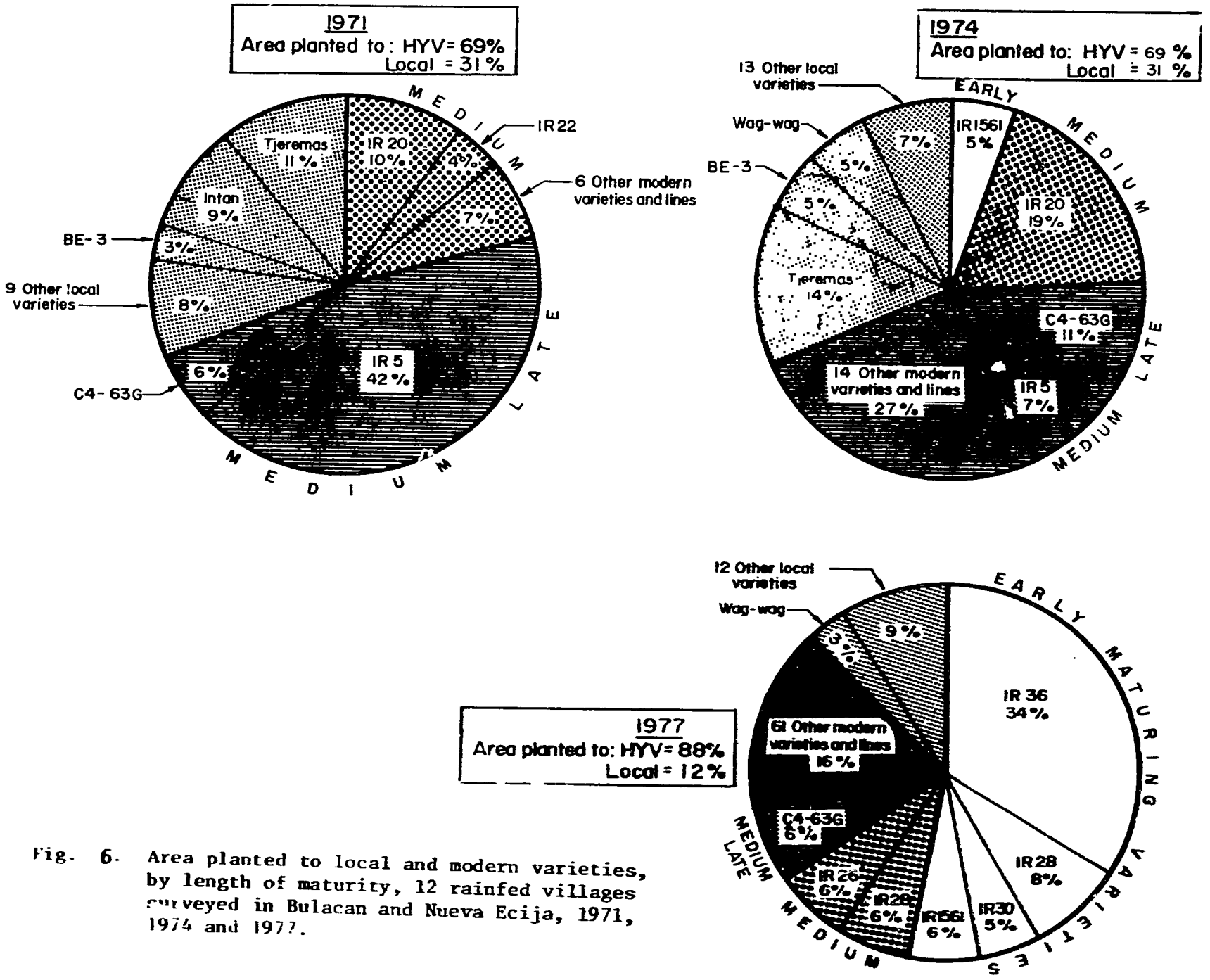

Fig. 6. Area planted to local and modern varieties, by length of maturity, 12 rainfed villages surveyed in Bulacan and Nueva Ecija, 1971, 1974 and 1977.

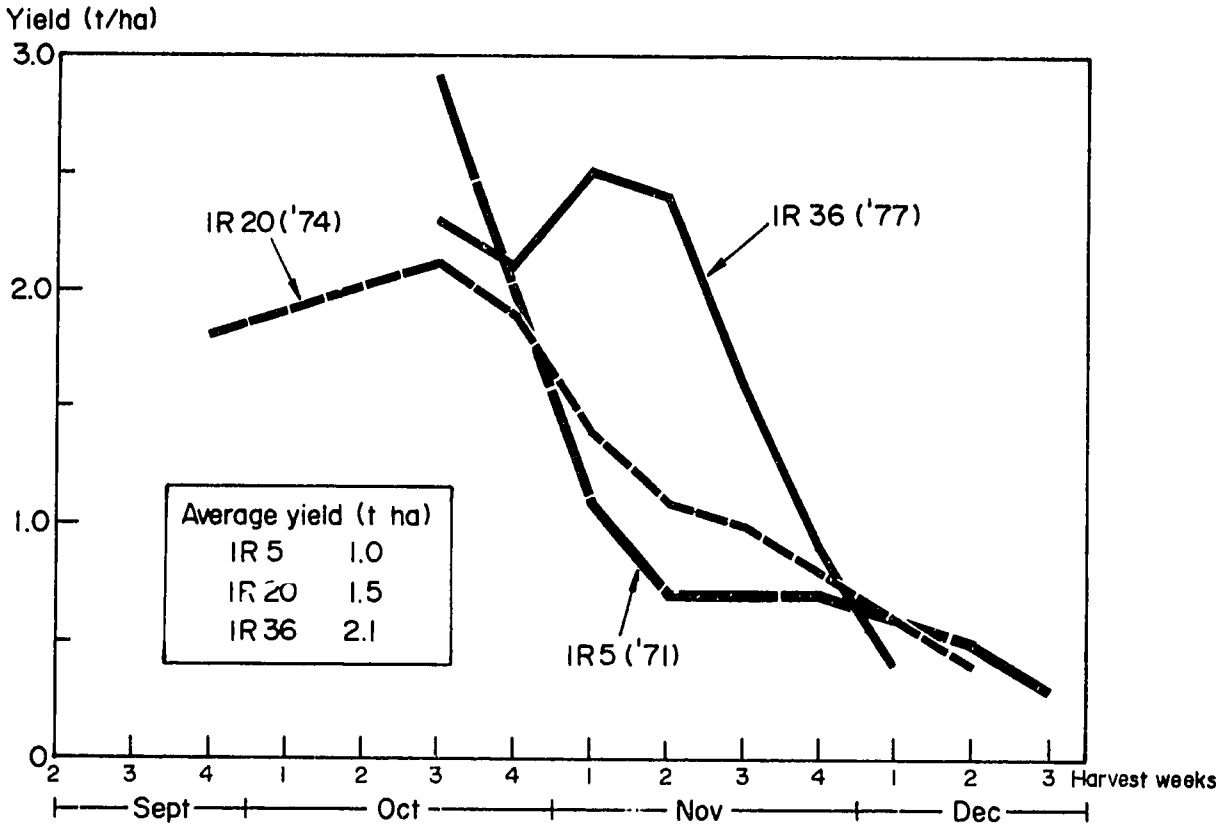

Fig. 7. Three-week moving average of yield of three varieties in three years in Bulacan and Nueva Ecija.

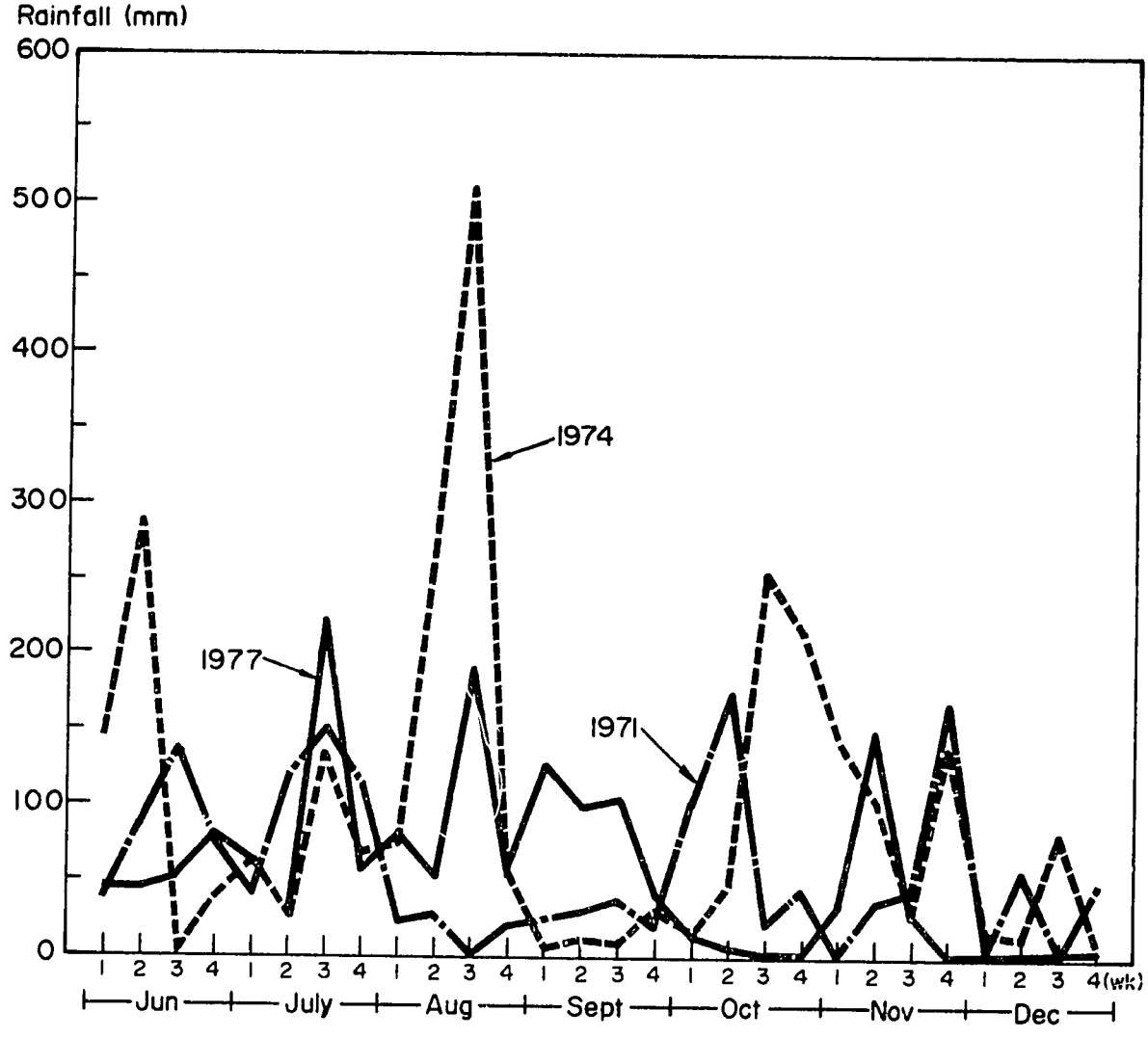

Fig. 8. Weekly rainfall at three locations (Sta. Maria, Angat and San Miguel) in Bulacan, 1971, 1974 and 1977.

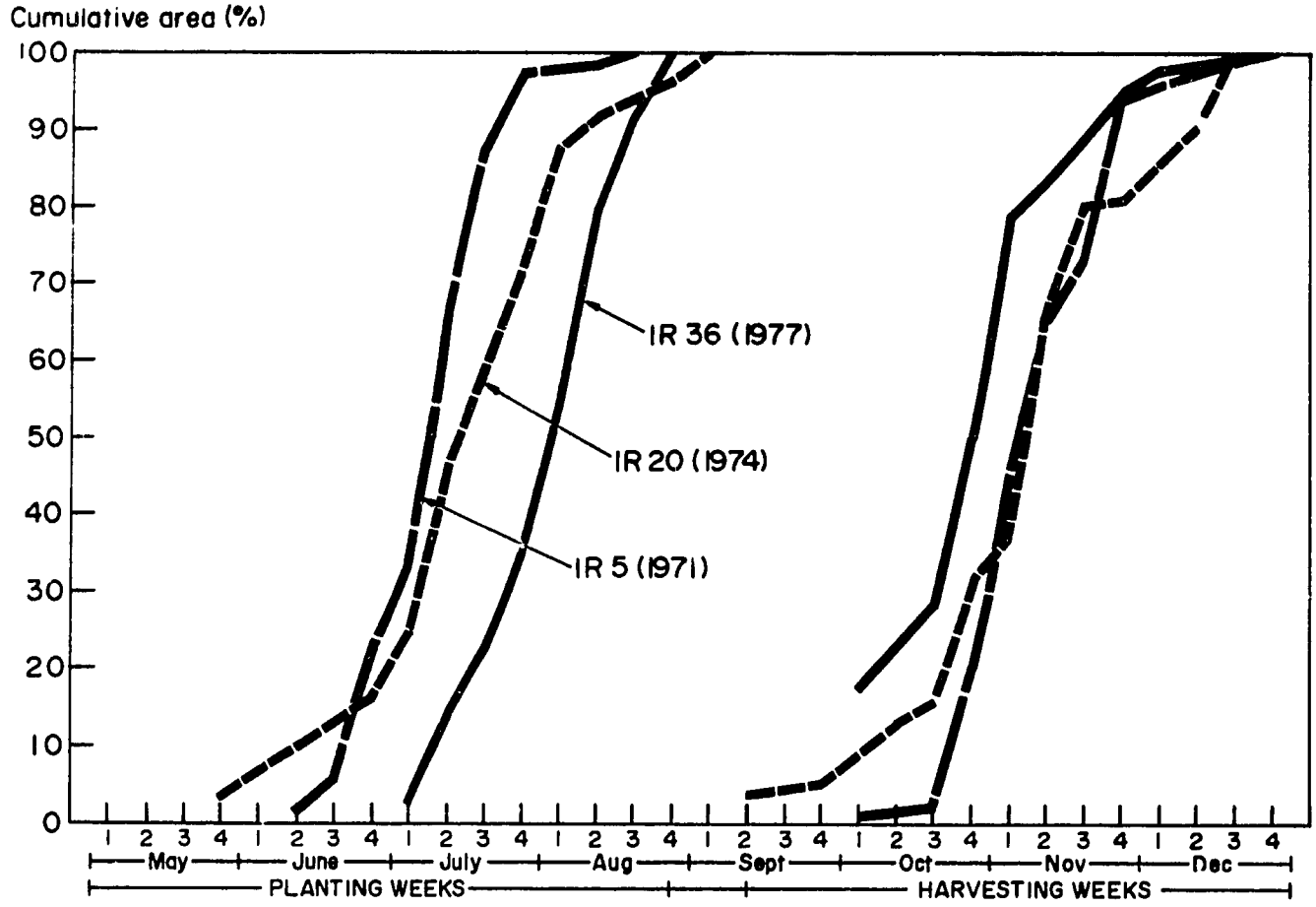

Fig. 9a. Cumulative frequency of area planted and harvested weekly in three years, three varieties, Bulacan and Nueva Ecija.

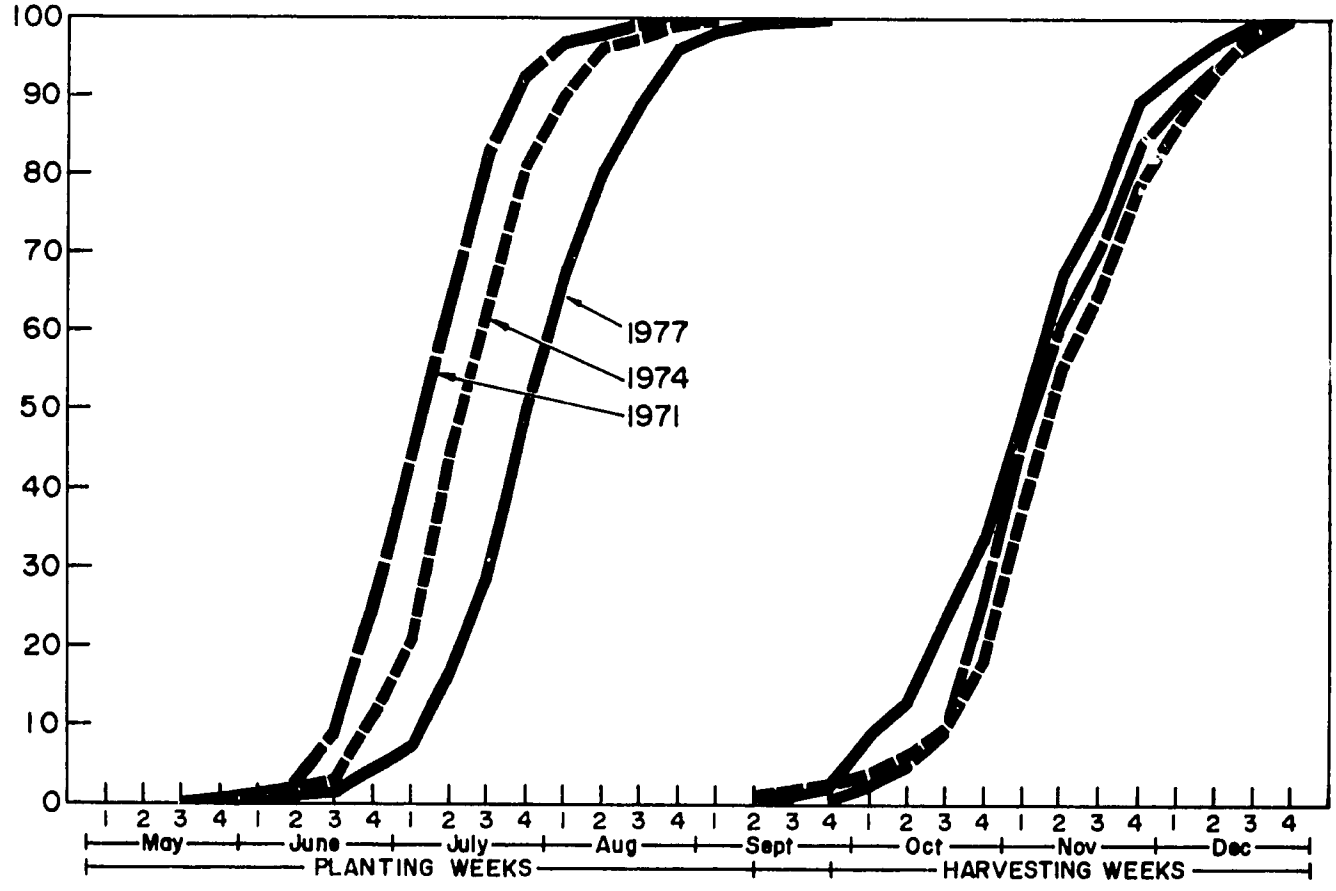

Fig. 9b. Cumulative frequency of area planted and harvested weekly in three years in Bulacan and Nueva Ecija.

APPENDIX A - Objectives of RURP[1/]

1. Field test available rice varieties, selection, herbicices, insecticides, rates and timing of fertilizer application, methods of stand establishment and different management levels which offered promise for increasing yields of rice under rainfed and upland conditions.

2. To determine the economic feasibility of growing crops other than rice in the rainfed and upland.

3. To train extension workers in establishing and management of applied research trials.

4. Develop applied research projects for rapid testing of preliminary research findings. Specifically, the project aims:[2/]

   a. To identify quickly rice varieties or selections which yield well under rainfed and upland conditions and develop a package of cultural practices which could be recommended to farmers.

   b. To identify cash crops which could be grown in the rainfed and upland areas to increase the income of the farmers and to provide sources of food for family consumption to improve nutrition.

   c. To establish working arrangement among researchers, administration, extension workers, farmers, and people from the mass media and agribusiness sector. Project demonstrations were located in 5 villages of 5 Sta. Maria, 5 of San Rafael, 4 of San Ildefonso, and 4 of San Miguel; all of Bulacan. In Gapan, 5 villages were included as project sites Appendix A, Table 1).[3/]

1/ Cuyno, R. V. "Organizing for Change: The Philippine Rainfed-Upland Rice Project. A Temporary Cooperative System for Developing and Diffusing Agricultural Knowledge," Unpublished Ph.D. thesis, Michigan State University, 1974. 197 pp.

2/ Ibid.

3/ See project review, Office of the Rice Production Training and Research, February 23, 1972 for complete description of the selection of research sites.

APPENDIX B - Strategies and Recommended Practices of Masagana 99 in 1972[1/]

Strategies

1. Formation of Food and Agricultural Councils in the provincial, municipal, and village levels to coordinate programs.

2. Development of a detailed program of work as

   a) sample work plan for each municipality (e.g. selection of pilot villages, village seminars, organizing field demonstrations, field days, etc.)

   b) Development of package of recommendations for growing rice based on the results of 1971 applied research trials.

   c) Sample farm plan and budget for one hectare rice farms.

   d) Outline responsibilities for agencies and personnel at all levels.

3. Selection of farm management technicians and training them at IRRI for 3 weeks to upgrade their advisory capacity.

4. Creation of farmer awareness of the new technology by proper use of communication media, e.g. techniques used included posters, banners, leaflets, newsletters, radio programs, signboards on model farms, village seminars.

5. Organize village seminars to train farmers in the skills of applying new technology.

6. Training of young farmer leaders to assist other farmers in applying correctly the new technology.

7. Assigning each technician five or six villages selected from each municipality covered by the program. The plan was to make these first village models of the entire municipality. Villages which offered the greatest potential for the development and where farmer and village officials interest were highest was selected.

8. Provide incentives and transportation for each technicians.

9. Production loans were made available through agriculture loan funds of the Rural Banks on the basis of the cost of the recommended package. Most of the loans were in the form of kind.

10. Coordination with pesticide and insecticide, fertilizer companies to insure that sufficient stocks of all recommended inputs are made available.

APPENDIX C - Location of Plot Demonstrations

Appendix C.Table 1. Location of project demonstration plots by village 23 villages in Bulacan and Nueva Ecija provinces.

Province	Municipalities	Village
Bulacan	Sta. Maria	San Vicente Parada Sta. Clara * Cay Pambo
	San Rafael	San Roque Diliman Salapongan Pasong Intsik * Coral na Bato
	San Ildefonso	Pinaod * Gabihan Sitio Colomia Palapala
	San Miguel	Camias * Buliran Sta. Ines Tartaro *
Nueva Ecija	Gapan	Mubarak Mahipon Maruhat Kapalangan * Bungo

* Villages with demonstration plots chosen for the economic survey.

APPENDIX D - Type of Data Collected

The key elements in the RURP-M99 package of recommended practices were with regards to the varieties used, herbicides, insecticides, rates and timing of fertilizer application and methods of stand establishment.

A pre-tested survey questionnaire was used to collect the following data in the farm level in the benchmark in August 1972 for the wet season 1970-71.

i. Farm area owned, cultivated to rice, and tenure status of the farmers.

ii. Exten of average per farm under MV's, e.g., C4-63, IR5, IR8, IR12, IR20, and their yields/ha.

iii. Extent of average per farm under local varieties, e.g. Intan, Malagkit, Thailand (Binato), Wagwag, etc., and their yields/ha

iv. Method of land preparation -- plowing, harrowing, sources of power, etc.

v. Method of stand establishment - - straight row, ordinary transplanting, broadcasting, dates of planting.

vi. Fertilizer application practices -- kind of fertilizers used (organic, inorganic), amounts used: e.g. amount of N fertilizers for seedbed, field plants (kg/ha), method of fertilizer application (basal, top dress, etc.,), timing of applications.

vii. Insecticide application practices: kind of insecticides used, (e.g. granular, liquid, wettable, combination), amount used for seedbed, field plants and timing of insecticidal applications.

viii. Weeding applications: type of weeding (hand, chemical, mechanical), type of chemical weedicide used (granular, wettable, liquid, combination), and frequency of treatments.

The follow up survey was done in September 1975 for the wet season, 1974-75 and in December 1977 for the wet season, 1977-78. In addition to the above data, additional information was sought with regard to Masagana credit, cropping pattern and pump irrigation.

i. Masagana credit facilities - participation of Masagana credit program, type of credit taken, other types of credit obtained.

ii. Pump irrigation-extent of farms irrigated, so.rces of pumps.

iii. Cropping pattern - extent of first and second crop of rice. Other crops by variety, dates of planting, harvest area, yields/ha.

Appendix E.
Table 1. Yield in (tons/ha), 12 villages in Bulacan and Nueva Ecija.

Village category	Yield (tons/ha)								
	Modern			Traditional			Total		
	1971	1974	1977	1971	1974	1977	1971	1974	1977
With demonstration plots									
Sta. Clara[n]	2.0	2.1	3.2	1.9	1.8	0.4	1.9	1.9	3.1
Pasong Intsik	0.4	1.6	1.8	0.5	1.5	1.1	0.4	1.6	1.7
Pinaod[n]	1.6	1.3	2.1	0.4	1.8	0.5	1.0	1.5	2.0
Tartaro	1.2	2.1	3.3	1.3	1.5	2.3	1.3	1.8	3.2
Camias[n]	1.4	1.1	2.3	1.2	1.4	3.2	1.3	1.3	2.3
Kapalangan	0.3	1.2	0.7	1.9	0.8	1.1	0.4	1.0	0.7
Without demonstration plots									
San Gabriel[n]	3.4	3.3	3.9	3.4	2.3	2.3	3.2	2.8	3.8
Calasag[n]	0.5	1.3	1.4	1.0	1.9	0.4	0.8	1.6	1.3
Alagao	1.5	1.5	2.5	1.4	0.9	0.4	1.5	1.2	1.8
Anyatan[n]	0.9	1.0	2.5	1.5	1.4	1.5	1.2	1.2	1.9
Sta. Catalina	1.6	1.5	1.9	2.0	1.0	0.9	1.9	1.3	1.9
Partida	1.0	0.7	2.2	2.1	1.2	0.6	1.5	1.0	2.4

[n]Near villages

Appendix E.

Table 2. Amount of N, P_2O_5 (kg/ha) by location in Bulacan and Nueva Ecija, 1971-1977.

Village category	Nitrogen (kg/ha)			P_2O_5 (kg/ha)		
	1971	1974	1977	1971	1974	1977
With						
Sta. Clara[n]	9	24	46	19	15	13
Pasong Intsik	47	55	48	28	30	27
Pinaod[n]	39	39	46	23	24	22
Tartaro	37	50	56	28	31	32
Camias[n]	32	29	43	20	18	23
Kapalangan	19	35	28	24	31	25
Without						
San Gabriel[n]	17	23	31	9	13	17
Calasag[n]	40	42	41	19	19	22
Alagao	30	44	44	30	32	29
Anyatam[n]	33	9	28	8	5	2
Sta. Catalina	62	35	34	13	18	10
Partida	33	43	53	30	31	31

[n]Near villages

Appendix E.

Table 3. Amount of organic fertilizer used in 12 villages in Bulacan and Nueva Ecija (t/ha).

Village category	Organic Fertilizer		
	1971	1974	1977
With			
Sta. Clara[n]	0.30	3.10	8.30
Pasong Intsik	0	0.56	1.00
Pinaod[n]	0	1.06	0.96
Tartaro	0.45	0.10	1.27
Camias[n]	0.20	0.30	2.82
Kapalangan	0	0	0
Without			
San Gabriel[n]	0.18	1.50	4.60
Calasag[n]	0	0	2.80
Alagao	0	0.50	0.46
Anyatam[n]	0.10	0.55	3.44
Sta. Catalina	0	0	1.60
Partida	0.02	0.38	0.90

[n]Near villages

Appendix E.
Table 4. Plant protection practices, 12 villages in Bulacan and Nueva Ecija.

Village category	Percent adoption			Type of Chemicals											
				Granular			Liquid			Wettable			Combination		
	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977
With															
Sta. Clara[n]	17	44	29	0	12	0	100	76	80	0	0	0	0	12	20
Pasong Intsik	56	100	100	22	12	6	11	12	6	0	0	6	67	76	82
Pinaod[n]	59	70	93	0	33	0	90	33	54	0	0	8	10	33	38
Tartaro	83	94	100	7	12	0	53	29	27	0	0	0	40	59	73
Camias[n]	63	93	100	0	7	0	79	46	63	0	4	0	21	43	37
Kapalangan	70	100	93	7	0	0	43	45	57	29	10	0	21	45	43
Without															
San Gabriel[n]	22	50	35	0	22	33	100	78	50	0	0	0	0	0	17
Calasag[n]	93	93	91	0	0	0	84	31	30	8	0	20	8	69	50
Alagao	61	89	93	0	25	0	91	25	62	9	0	0	0	50	38
Anyatam[n]	50	50	62	0	11	0	67	67	40	0	0	10	33	22	50
Sta. Catalina	80	94	87	8	36	0	84	14	69	8	7	8	0	43	23
Partida	43	86	92	33	12	4	42	25	29	0	0	0	25	63	67

[n]Near villages

Appendix E.
Table 5. Method of weeding (percent), 12 villages in Bulacan and Nueva Ecija.

Village category	Only hand weeding			Only chemical weeding			Only mechanical weeding			Combination		
	1971	1974	1977	1971	1974	1977	1971	1974	1977	1971	1974	1977
With												
Sta. Clara	89	78	71	0	11	6	6	11	0	0	11	23
Pasong Intsik	56	12	6	6	38	44	0	25	0	25	50	50
Pinaod	65	38	67	0	19	8	0	19	0	0	43	25
Tartaro	61	11	0	6	17	27	0	33	0	33	67	73
Camias	72	53	48	28	11	18	0	4	0	0	29	33
Kapalangan	80	75	93	0	0	0	5	15	0	15	10	7
Without												
San Gabriel	44	29	29	6	24	18	0	0	0	33	47	53
Calasag	93	43	43	0	7	14	0	0	0	7	50	43
Alagao	61	17	71	0	33	21	0	39	0	39	50	7
Anyatam	83	79	62	0	7	23	0	0	0	6	14	15
Sta. Catalina	86	21	54	7	29	23	0	0	0	0	50	23
Partida	61	27	28	11	8	19	4	7	0	7	61	52

Appendix E.

Table 6. Area under varieties by soil type, by plots and by location in 12 villages in Bulacan and Nueva Ecija.

Village category	Area (percent) under					
	Modern			Traditional		
	1971	1974	1977	1971	1974	1977
With						
Sta. Clara	13	52	98	87	48	2
Pasong Intsik	87	81	90	13	19	10
Pinaod	91	69	90	9	31	10
Tartaro	91	90	94	9	10	6
Camias	89	67	98	11	33	2
Kapalangan	54	48	95	46	52	5
Without						
San Gabriel	73	90	91	27	10	9
Calasag	47	68	79	53	32	21
Alagao	91	91	85	9	9	15
Anyatam	38	29	36	62	71	64
Sta. Catalina	75	68	93	25	32	7
Partida	83	69	98	17	31	2

Appendix E.

Table 7. Percent area transplanted by second week of July, 12 villages in Bulacan and Nueva Ecija.

Village category	Percent area planted by the end of the second week of July		
	1971	1974	1977
With			
Sta. Clara	67	69	18
Pasong Intsik	86	74	6
Pinaod	70	64	21
Tartaro	89	62	22
Camias	54	91	18
Kapalangan	63	67	0
Without			
San Gabriel	80	93	15
Calasag	82	76	16
Alagao	71	64	16
Anyatam	70	61	24
Sta. Catalina	68	76	7
Partida	64	68	6

Appendix E.

Table 8. Average age of transplants (days), by varieties, 12 villages in Bulacan and Nueva Ecija.

Village category	Average age of transplanted seedlings of (days)					
	Modern varieties			Traditional varieties		
	1971	1974	1977	1971	1974	1977
With						
Sta. Clara	30	28	32	39	40	-
Pasong Intsik	31	34	32	35	32	40
Pinaod	32	32	28	36	32	-
Tartaro	33	34	28	35	32	-
Camias	33	30	28	35	30	-
Kapalangan	36	33	32	42	33	-
Without						
San Gabriel	30	30	29	34	34	31
Calasag	37	31	27	31	29	-
Alagao	37	38	35	39	38	32
Anyatam	34	32	32	40	40	50
Sta. Catalina	35	32	32	39	32	-
Partida	39	40	31	45	40	-

Recommended practices of the RURP Project (1971)

A) Varieties - HYV's IR20, IR20-1, C4-63, C4-137, C4-63G, CD and BPI 76 (NS), IR5

B) Method of stand establish - Transplanting not later than 2nd week of July.

C) Cultural Practices.

1. a. Seed and seedling treatment

   Carbofuran solution at the rate of 1.5 kg per cavan of seed for 24 hrs. or Broadcast any insecticidal granules (except BMC) 25 days before transplanting.

   b. Soak the seed for 24 hrs.

2. Sow the germinated seeds in a well prepared seedbed (area of 400 sq. meters per cavan of seeds 22 days before transplanting.)

3. First plowing of the land -- 22 days before transplanting.

4. Harrow the field and puddle the soil - 14 days before transplanting.

5. Second harrowing - seven days before transplanting.

6. Broadcast basal fertilizer - final harrowing - 2 days before transplanting

   Clayey soils - 3 bags of 16-20-0

   Loamy soils - 4 bags of 14-14-14

7. Soak the pulled seedlings in carbofuran soil for 24 hrs at the rate of 3 kg per cavan.

8. Transplanting - rainfed 20 x 20 cm at 2-3 seedlings per hill at a depth of 2-3 cm.

9. Irrigate the field to a depth of 3.5 cm 3 days after transplanting

   Broadcast 2-4D, IPE - granular or Agroxone G, Ciga-Geigy 2, N-DG, Eptem M, Hedonal G, Machete 5G, Planters 2, 4-D IPE Saturn G, Shell 2-4 D granules. Tavron G, Treflan R, Tok, U-46-D6, Weedone G. Wegrd Wk.

10. Weed control - 15 days after transplanting. Hand weed or use of rotary weeder. If chemicals are used spray 2, 4-D, or MPCA at the rate of 1-2 likes per ha in 100 gals of water.

11. Split application of fertilizers - 30 days after transplanting. Broadcast 2 bags ammosul and 1 bag of urea per ha.

12. First insecticidal application

Broadcast granular insecticide at 1 kg a.i. per ha or any insecticidal spray except carbofuran and M. I. P. C.

13. Second split application of fertilizer - 45 days after transplanting. 2 bags of ammosul or 1 bag of urea per ha.

14. Second insecticidal applications - 50 days after transplanting. Varieties C4-63, C4-63G, C4-137, C12, BPI-76. Broadcast granular insecticides 1 kg a.i.

IR20, and IR-20-1. Broadcast insecticide granules, 1 kg a.i. per ha if there are 10 seed treatments per sq. meter area.

15. Third insecticidal application - 75 days after transplanting. 1-1/2 kgs. a.i. per hectare of the above insecticides after checking for stemborer. Brown planthopper and rice bug damage.

16. Drain water from the field - 85 days after transplanting.

17. Harvest 100 days after transplanting.