FOOD & FERTILIZER TECHNOLOGY CENTER

PROGRAM ON INTEGRATING CROP PRODUCTION IN LOWLAND RICE AREAS OF THE PHILIPPINES

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FOREWORD

In 1990, the Center began a series of field trials and field demonstrations to provide information to lowland rice farmers in the Philippines on how to make more intensive use of their paddy fields by growing other crops during the off season. This Bulletin briefly describes the project, and presents papers by two scientists who attended a Workshop to discuss the project results. One is by an irrigation specialist, and presents valuable information on the efficient use of water resources, especially during the dry season when water is scarce. The second paper, by a social scientist, surveys the farmers who took part in the project, and presents some of their comments. It also discusses concepts such as increased productivity, and the different way in which these may be viewed by researchers and by farmers.

We feel this Bulletin will be of interest, not only to those who are working to improve crop production in the rice-growing lowlands of Asia, but also those who are interested in farmers' reactions to agricultural development projects - which hopefully means all those involved in such projects. The two papers were presented by their authors at an international Workshop on "*Integrating Crop Production in Lowland Rice Areas*", held in the Philippines in February 1994 and co-sponsored by the College of Agriculture, University of the Philippines at Los Baños; Central Luzon State University, Nueva Ecija; and the Provincial Agricultural Office, Dept. of Agriculture, Bulacan.

PROGRAM ON INTEGRATING CROP PRODUCTION IN LOWLAND RICE AREAS OF THE PHILIPPINES

I. INTRODUCTION

In 1990, the Food and Fertilizer Technology Center began a series of field trials and field demonstrations in the Philippines, aimed at providing information for farmers on profitable ways in which they can make more intensive use of their paddy fields. Increased diversification not only gives farmers higher incomes but more stable ones, since they do not depend on a single commodity. They can also respond more efficiently to market forces, selecting relatively high-value crops for which there is a good market demand. A further point is that intensive monoculture of rice does not seem to be sustainable in the long term. On research stations and in other areas where rice has been cultivated intensively for twenty or thirty years, a slow decline in fertilizer efficiency has been observed. This means that current yields cannot be maintained without higher levels of inputs. The best solution seems to be a more diversified cropping system, in which the production of rice is alternated with other crops.

The project opened in March 1990 with an international seminar at the University of the Philippines at Los Baños (UPLB), cosponsored by FFTC and the Institute of Plant Breeding of UPLB, on "*Integrated Technology for Field Corn Production in Paddy Fields*". Papers presented at the seminar by speakers from seven countries in Asia described recent research into the production of corn in paddy fields, the problems encountered, and how these had been solved. This provided the data for two years of field trials, mainly in Pangasinan, Central Luzon, the results of which were reviewed and discussed at an international workshop held in early 1992. Discussions with farmers and extension specialists at the field trials showed that the main constraints were not technical but economic. The farmers' main concern was whether an off-season crop of corn would give them a reasonable profit, in view of the fluctuations in corn prices. They were also worried about whether there would be enough water available for an off-season corn crop, and whether there would be a supply of good hybrid seed at a moderate price.

On the basis of these results, it was decided to extend the diversification project to cover a wider range of crops. Accordingly, the field trials set up in 1992 evaluated the potential of a number of crops: peanut, mungbean, cowpea, corn and sweet potato. Two of these were on-station trials, at the University of the Philippines at Los Baños (UPLB) and Central Luzon State University (CLSU). There were also on-farm trials on six farms at San Ildefonso, Bulacan, and in Muñoz, Nueva Ecija.

These field trials evaluated the potential of a number of crops, including mungbean, cowpea, and sweet potato, during the off season. The results showed that at UPLB, corn, mungbean, cowpea and sweet potato could be grown successfully after rice. In Bulacan, where generally only a single wet-season rice crop is grown, the most promising upland crops for integrating with a lowland rice crop were green corn and peanut. Sweet potato gave good yields, but farmers found that there were problems of pests (especially potato weevil) and marketing.

A number of varieties of each crop were tested, but in general there were no consistent and significant differences in yield between them. In Bulacan, the acidic soils typical of the area had a pH of 4 to 5, and responded well to applications of lime. Unless lime was applied, mungbean did not grow well, and did not respond to fertilizer. In general, fertilizer applications on these acidic soils, particularly of inorganic fertilizer, had to be carefully judged to avoid damage to crops.

The project areas are mainly rainfed. Water deficiency during the dry season is a major constraint to successful crop production. The on-farm trials were integrated with a second project supported by the Provincial

Department of Agriculture, Nueva Ecija, which is promoting the construction of small farm reservoirs. These reservoirs can be used for fish production as well as to irrigate crops during the dry season. A typical small farm reservoir has a capacity of 1000-1500 m^3 of water. This provides enough water for 3000 m^2 of upland crops irrigated three or four times. In general, the reservoir occupies around 10% of the area it will irrigate.

The benefits include, not only increased crop production, but better control over the timing of crops. Often the initial storage is used for seedbed preparation, so that farmers are able to plant, and therefore harvest, early and get a better price.

The two papers published in this Bulletin were presented at a Workshop which discussed the technology of integrating crop production in lowland rice area. Participants at the Workshop assessed the results of the field trials and the feasibility of extending this integrated technology to farmers elsewhere. The first paper discusses availability of water, and how to best utilize available water resources during the dry season in areas where these are scarce. The second paper gives an account of the reaction of farmer cooperators to the project, and their comments on the perceived costs and benefits.

II. EVALUATION OF THE RESULTS OF THE FIELD TRIALS: A FOCUS ON IRRIGATION

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(Chinese Abstract) 摘 要

影響作物產量最重要的因子之一便是土壤水分有效性，特別是作物生長在旱季地區，水源缺少或水費昂貴地區。水分有效性和灌溉措施如同其他因子肥料、栽培密度，作物保護一樣必須要列入考慮，當做一個重要的農藝因子。當綜合農業生產技術推廣至農民之前，許多生產瓶頸必須要調查，特別是在雨季水田地區。

(Japanese Abstract) 摘 要

土壌の有効水分は農作物の収量を決める最も重要な要因の一つである。特にもともと水が少なく高価なところで、作物を乾期に作る場合はそうである。水と灌漑設備の利用可能性は、総合的農作物生産においては、肥料、栽培密度、作物保護とともに重要な栽培条件の一つである。総合技術体系を農家に普及するにあたっては、特に天水田地帯では、各種の障害要因を事前に良く調べておく必要がある。

(Korean Abstract) 초 록

토양수분함유도는 작물수확량에 영향을 주는 중요인자중의 하나임에 틀림없다. 건조기에는 특히 농업용수가 부족하기 일 쑤이고 관개에 비용이 드는 등, 식물가용수분이 작물생장에 크게 영향을 준다. 이러한 측면에서 관개수로및 농업용수문제는 비료 못지 않게 중요한 작물생장요인으로써 작물의 밀식도, 병충해방제등과 함께 작부체계를 종합관리하는 데 고려되어야 할 것이다. 저지대 비농사지역에서는 특히 이러한 물문제를 비롯한 여러 인자를 종합적으로 고려한 농민지도와 이에 상응하는 연구가 있어야 할 것이다.

II. EVALUATION OF THE RESULTS OF THE FIELD TRIALS: A FOCUS ON IRRIGATION

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ABSTRACT

One of the most important factors that influences the yield of field crops is soil moisture availability. This is especially the case when crops are grown in the dry season in areas where water is scarce or costly. The availability of water and irrigation practices both need to be taken into account as important agronomic factors, like fertilizers, plant density and crop protection, in integrating crop production. Numerous constraints also need to be investigated before integrated technology is extended to farmers, particularly in rainfed lowland rice areas.

PROJECT FOR INTEGRATED CROP PRODUCTION IN LOWLAND RICE AREAS

A recent project studied the feasibility of integrated crop production in lowland rice areas in the Philippines. These included both on-farm and on-station trials. This paper discusses the research approach in general terms, and its applicability to other parts of rainfed lowland Southeast Asia.

Irrigation Practices in the Program

The project paid much attention to the interaction between crop species, crop varieties, and different rates and kinds of fertilizer application. For the on-station trials, irrigation water was provided. Small farm reservoirs served as the main source of supplemental irrigation water in the on-farm trials. Land preparation consisted of plowing, either once or twice, followed by one to three harrowings. The mungbean and cowpea areas of the on-station trials at UPLB were mulched with rice straw in order to conserve soil moisture. In both the on-farm and on-station trials, the off-season crops after rice included corn, mungbean, soybean and sweet potato.

The irrigation practices were as follows:

On-Station Trial at UPLB

Green corn: Irrigated immediately after planting, using an overhead type of irrigation, followed by three irrigations at two-week intervals. Furrow irrigation was used for the fourth irrigation.

Baby corn: Irrigated immediately after planting, using an overhead type of irrigation, followed by three irrigations at one-week intervals.

Mungbean: First irrigation two weeks after emergence using a "Perfo-Rain" type. The second and third irrigations were carried out at two week intervals.

EFFECT OF IRRIGATION ON CROP PRODUCTION

When the water supply does not meet crop water requirements, water stress develops in the plant. This will adversely affect crop growth, and ultimately crop yield. The effect of water stress on growth and yield depends

Key words: Irrigation scheduling, water deficit, irrigation methods, small farm reservoir, crop diversification, supplemental irrigation

on the crop species and variety on the one hand, and the magnitude and the timing of occurrence of the water deficit on the other. The effect of the magnitude and the timing of the water deficit on crop growth and yield are of major importance in scheduling irrigation with an available but limited water supply during the growing period of the crop, and in determining which crops should have priority for irrigation water.

When a water deficit occurs during a particular part of the total growing period of a crop, the yield response to water deficit can vary greatly depending on how sensitive the crop is at that particular growth period. In general, crops are more sensitive to water deficit during emergence, flowering and early yield formation than they are during the early stages (vegetative stage, after establishment) or the late growth period (ripening). However, the yield response to water deficit can vary in different varieties of the same crop. In general, high-producing varieties are also the most sensitive in their response to water, fertilizer and other agronomic inputs. For this reason, low producing varieties which show less response to water may be more suitable for rainfed crop production in areas which are prone to drought. To attain high yields under irrigation, it is necessary to use high yielding varieties which are the most responsive to water, so that high water utilization efficiency per harvested yield is obtained. What varieties to use can be based on field evaluation and selection trials.

Crops may be grown with supplemental irrigation, or with full irrigation. Doorenbos *et al.* (1979) recommended the following schedule of irrigation for selected crop species.

Bean

When a bean crop is grown with supplemental irrigation, the water supply should be directed towards meeting water requirements during the establishment period and the early part of the flowering period. When the crop is grown under full irrigation, soil water depletion during the flowering and yield formation periods should not exceed 40 - 50% of the total available soil water. When the crop is grown for dry seed, the depletion level during the ripening period should not exceed 60 - 70%. Water stress in the plant can be detected by eye, because the leaves turn a dark bluish-green color.

Corn

To obtain a good stand and rapid root development, the root zone should be wetted at or soon after sowing, if this is possible. If we take into account the level of evapotranspiration to meet full water requirements, the water depletion level is about 40% in the establishment period, 55 - 65% during the vegetative period, and also flowering and yield formation, and up to 80% during the ripening period.

Where rainfall is low and the supply of irrigation water is restricted, irrigation scheduling should be based on the need to avoid water deficits during the flowering period, and also during the yield formation period. If severe water deficit during the flowering period is unavoidable, water may be saved by reducing the supply during the vegetative period as well as during the yield formation period, without incurring any additional yield losses.

Groundnut

Depending on the level of crop evapotranspiration and the water-holding capacity of the soil, irrigation intervals should vary from 6 - 14 days for sandy soils, and up to 21 days for loamy soils, with shorter intervals during flowering when depletion of the available soil water should not exceed 40%. In the case of supplemental irrigation, best results are obtained when water is applied during the flowering period.

Pea

For optimum yield levels, the soil water depletion in most climates should not exceed 40% of the total available soil water. Irrigation frequencies of 7 - 10 days are common. When water is in short supply, irrigation should be adequate during the flowering and yield formation periods, with possible savings during the vegetative and ripening periods. If frequent irrigation is not possible, the water supply should be scheduled at pre-irrigation, at flowering and at the yield formation period. If there is only one irrigation, this should be at least 40-60 days after pre-irrigation.

Potato

Where rainfall is low and the supply of irrigation water is restricted, irrigation scheduling should try to avoid water deficit during the period of stolonization and tuber initiation and growth. The supply of water can be restricted during the early vegetative and ripening periods. Savings can also be attained by allowing the soil to dry out during the ripening period, so that all available stored water in the root zone is used by the crop. This practice may also hasten maturity. Correct timing of irrigation may save one to three irrigation applications, including the last irrigation prior to harvest.

Soybean

Soybean is usually not grown under full irrigation. Under some climatic conditions, however, one or more supplemental irrigations during critical growth periods will substantially increase yields. If only one application can be given, the best time for it is in the late flowering period when small pods are beginning to appear. If two applications can be given, it is usually wise to give the first application at pre-emergence to assure rapid establishment of the plant. If a third application is possible, it will give the best results if given at the beginning of pod filling.

Irrigation Methods

Selection of the best irrigation method must take into account the topography, soil conditions and farm size in the lowlands where rice is being grown during the wet season. The furrow basin and basin methods are most likely to be suitable. Systems which provide water under pressure, such as sprinkler and drip systems, might be convenient when measuring the quantity of water supplied in field trials, especially when a experiment seeks to analyze crop growth and yield response under different amounts of water. However, they are usually too expensive for on-farm use.

Adaptive Research on Crop Response to Water

Adaptive research on crop response to water should determine firstly, the maximum yield under conditions of full water requirements, in which other growth factors do not limit yields. Secondly, it should look at the effect of limited water on yield over the total crop period, or during important stages of it. This information will allow us to assess the relationship between yield and water use.

The experimental program should be oriented towards solving problems. Therefore, first of all, an analysis must be made of the present yields in relation to the agronomic and irrigation practices in farmers' fields in existing projects. This would include an analysis of crops and their varieties; the present yield levels, the planting dates and growing periods; crop husbandry practices such as plant populations, cultivation methods, weed control, pest and disease control, and harvesting techniques; as well as the frequency and amount of irrigation. With special reference to irrigation methods and practices, information on water quality and soil fertility is needed to determine possible limiting factors to high production, and the adverse effects when improved water schedules based on experimentally determined relationships between yield and water use are applied in the field. Furthermore, the analysis of present field practices will indicate the variables, in addition to water supply, which may need to be included in the experimental design.

The experimental site should be selected as fully representative of the climatic, soil and water conditions of the area where the results will be applied. Areas with steep slopes, or low-lying areas subject to flooding, should be excluded. The soil should preferably be deep, without hard pans or dense layers, and with no physical or chemical limitations. Areas with a high water table should be avoided, except where such limitations form part of the experimental treatment. The drainage system may include whatever is necessary. The site should also be within an agricultural area surrounded by irrigated crops. A fully controlled and guaranteed water supply should be available.

Table 1. Constraints to diversified cropping, and measures to overcome them

Constraint	Potential remedial measures
Unreliability of water distribution	Better system of water management, study of suitable control structures, intensive training
Soil suitability problem	Research on soil suitability, advice to farmers
Inadequate water storage	Study of additional water storage, increased water use efficiency, advice on crops that require a limited amount of water
Inadequate existing infrastructure	Improvement of infrastructure to meet changed objectives, improve flexibility
Drainage problems	Improvement of drainage system, advice on crops that are tolerant to water logging
Lack of good quality seeds	Research for better varieties
Cultural practices favoring rice cultivation	Increasing farmers' confidence in irrigated crop diversification
Salinity problems	Good drainage and water control
Interference between different farm activitives	Water operation planning, study of variors farm activities
On-farm development	Farmers' participation in cost sharing and maintence programs

Experiments should be conducted with high-producing varieties well adapted to the prevailing climatic conditions, with an adequate plant population, soil fertility and crop production. To obtain results that are statistically meaningful, each treatment should have sufficient replications. Typical irrigation treatments might include:

- One "wet treatment", or treatment with no water deficit over the total growing period.
- One "dry treatment", which involves considerable water deficit throughout the total growing period.
- One or more "mixed treatments", with water available during selected growth stages only.

Small Farm Reservoirs

Guerr *et al.* (1988) suggested that the dissemination of small farm reservoir technology to new areas can help rainfed farmers increase their farm incomes, and provide them with greater security in their farming activities.

The benefits of small farm reservoir technology over other irrigation systems are as follows:

- For the dry season irrigation of riceland, the small farm reservoir is at least five times cheaper than deep wells, run of the river (gravity) systems, or surface pumps as regards the investment cost per hectare in the service area.

- The productivity of stored water is high, since it may be used for fish production as well as for irrigation.
- Small farm reservoirs are financed and used on an individual basis. This avoids the organizational problems inherent in publicly funded irrigation schemes with many beneficiaries.
- As long as there is water in the reservoir, there are no restrictions regarding the timing, volume, or frequency of water use.
- Since no permanent structures are involved in the design of small farm reservoirs, the cost of construction is low, and it is easy to enlarge the reservoir at a later date when more funds are available.
- The skills and materials involved in reservoir construction are locally available.
- Reservoirs store runoff and act as a sediment trap. If sufficiently large numbers are used, they help to reduce flooding and siltation, and increase ground water recharge.

Numerous studies have been conducted on the potential utilization of small farm reservoirs, especially in the Philippines. One interesting study concerned with integrated crop production in lowland rice areas is that by T.B. Sayco *et al.* (1989). This study was conducted in Tarlac, Central Luzon, during the 1988-1989 dry season, in order to develop optimal cropping decisions for rainfed rice farms with small on-farm reservoirs. A strategy to achieve the optimal utilization of land, water, capital, and family labor in the cultivation of rice in combination with non-rice during the dry season was pursued in the study.

Constraints to the Development of Crop Diversification

Many factors influence the development of crop diversification in an irrigation system. These factors may be structural or nonstructural. Suitable areas for diversified cropping are those with a good soil suitable for upland crops, which are free from flooding and have a dependable water supply. A list of common constraints, and the measures which can help overcome these, are listed in Table 1 (Tongthawee *et al.*). There are other factors which are not directly related to irrigation but are major constraints to crop diversification. These include marketing, infrastructure, and farmers' willingness to adopt a more diversified type of production.

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III. INTEGRATING CROP PRODUCTION IN LOWLAND RICE AREAS OF THE PHILIPPINES: A SOCIAL SCIENTIST'S VIEW

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(Chinese Abstract) 摘 要

當評估一個農業技術時，發現一個事實是農民對農業技術的觀念往往與研究人員有所不同，這種觀念上的差異在最後分析上必須要仔細的考慮。本文主要偏重於農民對水稻後種植其他旱作的利弊分析。

(Japanese Abstract) 摘 要

農業技術の革新といわれるものも研究者と農家の立場では異なる場合が多い。最終ユーザーは農家であることに留意して評価をする必要がある。米跡作作物の栽培にたいする農家の見解を紹介する。

(Korean Abstract) 초 록

농가들이 받아들이는 농사 신기술이나 이노베이션은 과학자들이 보는 견해와 사뭇 다른 때가 많아 농사신기술 평가에도 기술적인 요인 이외의 많은 것들이 고려되어야 한다. 농사 기술개발의 최종 목표는 농가이기 때문에 농사 신기술의 효과분석 역시 농가수용도를 효과분석의 최종척도로 삼아야 할 것이다. 이 글은 이러한 관점에서 필리핀 벼농사지역 간작을 중심으로 종합작부체계를 살펴보았다.

III. INTEGRATING CROP PRODUCTION IN LOWLAND RICE AREAS OF THE PHILIPPINES: A SOCIAL SCIENTIST'S VIEW

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ABSTRACT

It is now a fact that the farmers' views of an agricultural technology or innovation, which in most cases are different from those of the researchers, are a very significant consideration when evaluating said technology innovation, for in the final analysis, the farmers are the end of all agricultural development efforts. The present paper leaned very heavily on the farmers' assessment of integrating lowland crops after rice.

In 1987, the World Commission on Environment and Development (WCED) sounded this call:

> "The agricultural systems that have built up over the past few decades have contributed greatly to the alleviation of hunger and the raising of living standards. They have served the purposes of a smaller, more fragmented world. New realities require agricultural systems that focus as much attention on people as they do on technology, as much on resources as on production, as much on the long term as on the short term. Only such systems can meet the challenge of the future." (WCED 1987, cited in Reijntjes, Haverkort, and Waters-Bayer, 1993).

These three major concerns should lead us to the question "How can we researchers respond to the needs of smallholders for appropriate technology and innovations which will lead to sufficient and reliable yields but will not deplete the resource base upon which they depend?"

Integrating crop production in lowland rice areas in the Philippines is both a technology and an innovation. It is a technology according to Reijntjes, Haverkort, and Waters-Bayer's (1993) definition of technology as "specific knowledge, productive resources, inputs and services which are applied systematically to produce desired outputs." It is an innovation, according to Van den Ban and Hawkin's (1988) definition of an "idea, method, or object which is regarded as new by an individual, but which is not always the result of recent research." Integrating new crops after rice could open new doors for farm households. Transferring knowledge about this technical option and combining the forces of farmers, extension workers, and researchers in studying the opportunities and limitations of this option would definitely play a significant role in sustainable agricultural development.

High Productivity: The Farmers' Viewpoint

The overall objective of the Project, as stated in the research team's report, is "to identify appropriate cultivars and management practices that can make these crops perform better after rice and look at the economic aspect of the cropping pattern using some parameters" (Labios *et al.* 1993). Clearly it is increased production and farmers' income that are being targetted.

Both the on-station and on-farm trials showed that corn, mungbean, cowpea, sweet potato, and soybean can be grown after rice.

Keywords: Farmers' response, field trials, integrated crop production, on-farm trials.

Specific varieties were identified to give better yields under certain fertilizer levels. The variety and fertilizer trials also identified the varieties and the fertilizer rates (organic or inorganic) that gave the highest net benefits in pesos (Labios *et al.* 1993). Integrating these crops after lowland rice appears therefore to be a promising technical option. But whose point of view is considered when one talks of high yield or high productivity? As Van den Ban (draft of a forthcoming book on Extension) asks: "Who decides on the basis of which criteria what is better, good, useful, an improvement, a desirable direction, cultural and social development?"

Productivity is one objective of farm households (Reijntjes, Haverkort, and Waters-Bayer 1993), as are solidarity, continuity, and commitment (de Haan 1993). But while researchers generally measure productivity in terms of total biomass yield, yield of certain components, economic yield or profitability, farmers and farm families have their own ways of assessing productivity. They do not measure it solely in terms of market values, but according to a wide range of indicators. As one farmer involved in the project commented, sweet potato is not a high yielder because it cannot be stored for long, being vulnerable to weevil attack. He added that when the tubers are attacked by weevils, not even animals will eat them. Another farmer said that his choice of what crop to plant depends on what could earn him more income. He defined 'more income' not in terms of high yield, but in terms of the number of farmers growing the crop. He cited the case of sweet potato, as being unlikely to give him more income because many other farmers are also growing the crop at the same time. His idea of high income is to avoid growing the same crop which is being grown by the majority of farmers.

On the other hand, the productivity of corn is seen by farmers as having several dimensions, which bring more benefits. It is a food for both man and animals. It is easy to plant, the planting procedure being described simply as "araro lang, tudling, at tanim" (plow, mark the holes for planting, then plant the seeds). The ears of corn can be sold at any stage, i.e., young or mature, and in any manner. Harvested corn is easy to convert into cash, and can be stored for a long time. Similarly, peanuts can be stored for a fairly long time so that the farmer can wait for a better price. Peanuts also have many different uses.

These situations show the variety of indicators farmers use in viewing productivity. Outsiders trying to help farmers, — researchers, extension workers, or any development worker for that matter — should become aware of and accept these, as the objective reality of farming as far as the farmers are concerned.

Crop Integration: A Low-External Input Agriculture?

Higher productivity is usually given primary attention in agricultural development. This is because billions of people will be added to the human family in the remaining years of this century. Hence, an annual increase in global food production of 3 - 4% is thought to be necessary (WCED 1987, cited in Reijntjes *et al.* 1993). But there is a danger in pushing productivity too far, as the ecosystem may become degraded and eventually collapse. Hence, even this very noble intention of increasing food production should be analyzed from the viewpoint of the farmers.

Why increase productivity? Perhaps if I pose this question to development workers, the response I will get is "To increase farmers' incomes, by producing more for exchange or for the market." But this may not necessarily be the way farmers themselves are thinking. As one farmer involved in the project said, "If I plant other crops after rice, it will only be for my family's consumption. There is not much water available even if I had a small farm reservoir, so this would be enough for me." Another farmer remarked that if he was to plant other crops after rice, yes, he would do it, for farming is his work, his life. Growing extra crops would keep him busy, give him exercise, and prevent him from going around and "makipagsitete" (local term for engaging in idle talk).

This view of farmers as growing crops for purposes other than increasing farm production for the market should not be taken as contra-developmental, or as showing resistance to change, for in the long run this view is likely to be beneficial. In petty commodity production (PCP), units of labor and capital (i.e. the means of production is within the production unit of the farm household) is characteristic of most farmers taking part in the program. In this case, it is the use value, which is the orientation of the PCP, rather than the exchange value, which determines how farmers are likely to react to the technology (Tolentino, forthcoming Ph.D. dissertation in Rural Sociology, Flinders University, Australia). Generally, when farmers grow crops for home consumption, their cultural management practices do not give impressive results, since they do not use much fertilizer, chemical pesticides, or improved varieties. This low external-input agriculture, or LEIA as Reijntjes *et al* (1993) call it, does not threaten to degrade the ecosystems, and hence enables farmers to survive much longer with the resources that they have.

There could be a tendency for crop integration to lean more towards high-external-input agriculture (HEIA) than towards LEIA. Reijntjes *et al* (1993) describe HEIA as depending heavily on chemicals and other outside inputs such as fertilizers, pesticides, improved seeds, machinery which uses fossil fuels, and often also irrigation. There is now already substantial evidence of the limitations of artificial fertilizers (e.g. the global risks arising from the release of nitrous oxide into the atmosphere, the "greenhouse effect,"), pesticides, and even improved seeds. The question to ask is, could crop integration after rice be studied as a possible low-input agricultural system?

Prospects for Adoption

Integration of crops after rice seems to have greater prospects of adoption in households with a labor surplus. One farmer openly expressed his desire to increase family income through sources other than rice farming, when he said "We are five in the family, and what we are producing now is not enough. We need about five hectares of land, or else need to have some "sideline" (the way in which local people refer to other sources of income), that's why this project is good". It may be argued therefore that the larger the farm household, the stronger the propensity to take on additional farming activities. Hence, the greater the likelihood that integration of crops would be an appropriate technical option.

There seems to be evidence also that more intensive agricultural production, in this case integration of crops after rice, increases where there is more than one adult generation present on the farm. This is the case of two farmers whose married children were living with them. The technology is proving to be an important part of the survival strategy for these rural households. However, it is possible for them to adopt it because they have a small farm reservoir, and water is a vital requirement of these off-season crops. Thus, integration of crops is only possible when water is available. The claims of farmers in the program that they sometimes did not get good results, especially with mungbean, because they were late in planting and therefore there was no more water, shows that water is an important constraint to integration. Farmers mentioned correct timing or early planting, and perhaps a study of cropping patterns in these areas with a view to maximizing the use of water impounded in the small farm reservoirs might be useful. Good performance on farms with small farm reservoirs would be the best proof for other farmers in the area that these reservoirs are economically viable.

While small farm reservoirs may not be a component of the present program, nevertheless, they bring an added dimension when we consider adoption of the technology by farmers. An interesting observation by Rolings (1988) is relevant to adoption of innovations by farmers. He pointed out that researchers and progressive farmers attract each other like magnets. The same can also be said of extension workers. This means that farmers who are usually noted as the first to adopt the innovations tested by researchers and offered by extension workers tend to be the favorites of rural development workers. The same may also be true of this project, in that the cooperators targetted for the project were those who have access to small farm reservoirs.

Cooperating farmers recalled that their small farm reservoirs cost about US$720 - 1000, (P18,000 to P25,000), payable over a period of five years. If a farmer is one of the first farmers in the area to own a small farm reservoir, this is a clear indication that he is in a different category than the other farmers in the study area. The integration of crops in these rice farming areas would not therefore have the same impact on all categories of farmer. It is likely to create a greater difference between the more progressive farmers and the less progressive ones. Within the existing farming system, this new technical option may be taken up more rapidly by more prosperous farmers who can afford some of the production inputs such as reservoirs, seeds, fertilizers, and some chemicals. However, past experience in the Philippines with high yielding varieties and the use of fertilizers has shown that smaller farmers follow the example of the more progressive farmers fairly soon (Rogers 1983). Hence, the possible adoption of the technology of integrated crop production will depend on who is able and willing to make use of this new opportunity, considering also market prospects if farmers decide to plant crops for sale. It is not for development workers to tell farmers what to do. The final decision-maker must be the farmer, whose virtues include entrepreneurial skills, choice, risk, and individual achievement (de Haan 1993).

Indigenous Agricultural Knowledge

A basic aim of rural people in their struggle for survival is to produce enough food for the family and to maintain the productive capacity of the land. In this struggle, they have developed their own technology through their own experimentation, and by integrating new information with the existing local agricultural knowledge. This forms what is now popularly labelled 'indigenous agricultural knowledge' (Roling 1988).

Part of the indigenous agricultural knowledge of the study areas is the growing of watermelon after rice. One farmer reported that it is more difficult to produce watermelon than to produce corn. However, he felt more inclined to plant watermelon because 3,000 sq. m of land planted in watermelon gave an income of US$640 (P16,000.00), while the same area planted in corn would earn around US$400. He also felt that watermelon is an appropriate crop for the area, although after two to three years, the watermelon plants were attacked by pests so he stopped planting the crop for a year, to give the land some time to rest. This farmer expressed a wish that the effect of resting the land should be studied by researchers, since he felt that farmers in his area did not know much about this or other technical aspects of growing watermelon.

Two things are of interest in the comments of this farmer. First, it is an example of what is called 'farmer demand-driven research' (personal communication, Dr. van den Ban 1994). This is a reversal of conventional ideas about research. In the model whereby farmers generate research, research is conducted, not because scientist want to know what is best for farmers, but because farmers demand answers to their questions and solutions to their problems.

The second and related idea is that researchers take an interest in locally-developed farming systems and indigenous agricultural knowledge. These should be seen as a source of sound ideas, using cultivars and practices adopted to local conditions which might lead to the sustainable use of local resources. As Reijntjes *et al.* (1993) suggest, indigenous agricultural knowledge contains many insights, observations and intuitions related to the environment, often including lunar or solar cycles, astrology, and meteorological and geological conditions.

Gender Bias

Women play a significant role in agriculture, particularly in decision-making, in labor allocation, and even in productive and income generating activities. Farmer cooperators identified specific activities in crop production that are appropriately women's work — planting, weeding, harvesting, and marketing. Marketing was given particular emphasis by one farmer, when he said "Ang magbenta ay trabahong pambabae ngunit walang marunong sa kanila" ("Marketing is a woman's job but none of them [referring to the women in his household] knows how do do it"). This is one area to which the extension system might pay attention in the diffusion of the technology. One other possible avenue for integrating women is in post-harvest processing. Perhaps researchers and extension workers could get some clues from the question raised by one farmer, "How can sweet potatoes be stored for a longer time?"

A Final Comment

The on-station and on-farm studies on crop integration have given us adequate answers to the agronomic questions raised by the researchers. We can now therefore conclude that yes, these crops can be integrated into lowland rice areas. Nevertheless the studies appear to fall withi. the development of conventional technology, being organized in terms of disciplines, especially agronomy, soils, and entomology, rather than in terms of the totality of the farm. Hence, if the results are to be passed on to extension staff for them to transmit to farmers, there may be significant constraints to its adoption, in view of other socioeconomic aspects of the farm households. How may these be addressed?

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