THE ECONOMICS OF TIMELINESS IN THE CROP INTENSIFICATION OF RAINFED FARMS IN ILOILO, CENTRAL PHILIPPINES

by

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DECLARATION

Except where otherwise indicated, this dissertation is my own work.

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ABSTRACT

The main purpose of this study has been to investigate the role of timeliness in the crop intensification of rainfed farms in Iloilo, Central Philippines. Specifically, it undertakes an economic evaluation of reducing the delay in crop establishment by comparatively estimating the additional benefits between power tiller use and carabao in land preparation.

A simulation model of rice crop growth is used to predict yield estimates by incorporating established functional growth relationships, local environmental determinants (landscape positions of field), and management criteria given 31 years' annual rainfall data to account for variability. The simulated yields are then economically evaluated to determine the level of profitability (additional returns) by using time and partial budgeting techniques.

In general, yields were higher and stable in lower field positions using a shorter turn-around period (TAP) of crop establishment. The inverse relationship between grain yield and TAP, grain yield and landscape position (LP) was mainly due to

(i) Water availability in the field, and

(ii) Timeliness of crop establishment.

Specification of the cropping strategy, i.e. TAP's of 5,10,20 and 30 days, showed that the shorter the TAP, the higher the additional returns in using carabao. To compare the power tillers (7 TAP), Additional Returns were better than 10,20 and 30 but lower than 5 TAP of carabao. This suggests that the time saved in reducing the delay in TAP, compensated for the cost of using both 5 TAP and power tillers, in terms of higher

AR. Moreover, the ratio of AR and additional costs (AC) indicated that extra investments were substantially compensated for by the extra returns, particularly in the shorter TAP.

The profitability of 3 cropping patterns was evaluated by TAP and landscape position. Again, better returns were obtained in the lower landscape positions and shorter turn-around period. The Dry Seeded Rice - Transplanted Rice-Mung (DSR-TPR-Mung) pattern appeared to be more profitable using the measures of higher AR and higher AR/AC ratio. The (Wet Seeded Rice) WSR-TPR-Mung and WSR-WSR-Mung followed in that order, which implied that there were two important reasons for the differences. One is the length of time the pattern was standing on the field and secondly, the possibility of early establishment and harvesting of the crops in the sequence. The most profitable pattern can be established and harvested early and stayed in the field for considerably shorter period compared to the other two patterns.

Riskiness in crop intensification was initially investigated to partly explore the variability, both in terms of yield given 31 rainfall years and the probability of getting the specified level of AR assumed to help explains the farmers' adoption.

Finally, the overall conclusion of the study suggests that timeliness in crop intensification of rainfed farms in Iloilo is a critical and important element of the farmers' cropping strategy which can significantly affect both the crop performance and eventually the income of the farmers.

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CHAPTER 1

INTRODUCTION

1.1 Nature and Importance of the Problem

Rainfed lowland rice accounts for 48 per cent of the total growing area in the Philippines and about 40 per cent of the effective crop area is devoted to rice (Baecon, 1974). Like most South and Southeast Asian countries, the yield levels are generally low providing a livelihood for more than a million rainfed rice farmers. Research on rice has been intensive for the last two decades, particularly in areas which the International Rice Research Institute (IRRI) and Ministry of Agriculture of the Philippines consider to have a high potential for increasing productivity. Of particular interest in recent years has been the impact of seed-fertilizer technology on crop intensification in rainfed lowland areas, where common practice has been to plant a single rice crop after which the land is left fallow. On-farm testing of technology is one of the key links in determining technology-environment interactions. A large body of agronomic research has dealt with these questions. Researchers, however, because they are dealing with more or less unpredictable weather conditions in rainfed areas, appear to have paid more attention to recommending production methods conditioned by the environment for which they are recommended (Zandstra, 1978). In line with this, as environmental factors change from year to year, season to season or even within a given season, the management criterion has been considered one of the distinctly salient points in crop production. Zandstra further indicated that crop production and crop yield can be considered to be the result of two multi-dimensional vectors; the environment (E) and management (M) so that:[1]

$$\bar{Y} = f\ (\bar{M},\bar{E}\_ \qquad (1.1)$$

Specifically for cropping systems, the researcher has to rely on his understanding of the relation $\bar{Y} = f\ (\bar{E},\bar{M})$ to predict the best management vector $(\bar{M})$ from the information about the environment factor $(\bar{E})$. The interactions of these two vectors can imply that the most appropriate level of $\bar{M}$ will depend on the type of environment and/or specific environment (E_i):

$$\bar{Y} = f\ (\bar{M},\bar{E}_i) \qquad (1.2)$$

and the decision rules in management of any input is directly influenced by physical conditions, e.g., rainfed lowland rice farm, landscape position of plots.

One of the management factors in question in this study is 'timeliness' in terms of successfully sequencing crops in relation to the limiting environmental factors.[2] There have been numerous studies dealing with this in Cropping System Research (CSR), but the emphasis of this study is on the physical and economic relationship of timeliness.[3] Tuning-up of new production

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1 This equation was inspired by the treatment of system development (Y) used by Keller, Peterson and Peterson (1973).

2 Timeliness strictly in operational terms refers to the capability of the farmers to plant and harvest the crops on time to maximize the use of limiting factors, e.g. rainfall or alternatively to avoid drought conditions.

3 CSR is discussed in Chapter 2.

methods to fit the physical and socio-economic environment of the farmer might increase the probability of farmers adopting and further increase the benefits derived from additional investments. The intensification of crop production is here defined as maximizing the use of per unit area of land by planting two or more crops in a sequence per unit time. This has a direct bearing on the farmers' capability to sustain additional resource inputs and to readjust his management techniques. This can be problematic when changes both in resource inputs and management will not interact positively. The risk associated in investing the generally low level of additional input resources has to be taken into account since this may lead to rejection of the particular recommended production method.

The province of Iloilo is one of the research sites of IRRI, CSP on which this study is based empirically (Figure 1.1). The complexity of the cropping system in this area is shown in Figure 1.2. The common practice for many years has been to plant a single rice crop using a photosensitive variety, BE-3 (Burmese Experimental3). It is normally transplanted in June-July but harvested only during December. This crop is usually followed by a poorly managed upland crop of mungbean with an average yield of less than 200 kg^{-1} ha^{-1}. Following introduction and gradual adoption of the short-maturing rice varieties developed by IRRI, this provided the opportunity to harvest the first crop early and plant another crop or two depending on the onset of the dry season. Double cropping of rice in the area has been recorded to be substantial for the last three years, but this can be misleading information if one is looking at the other side of

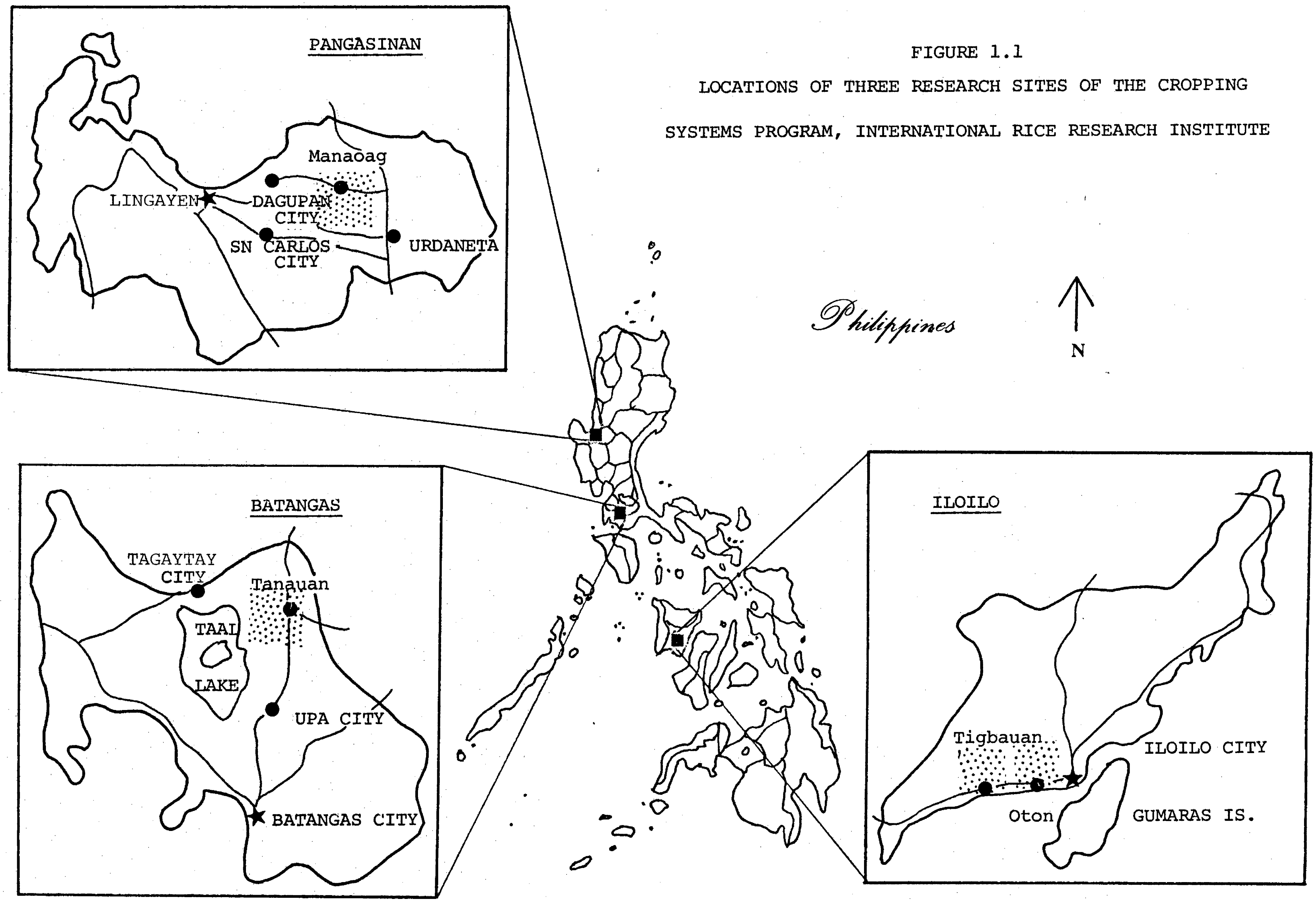
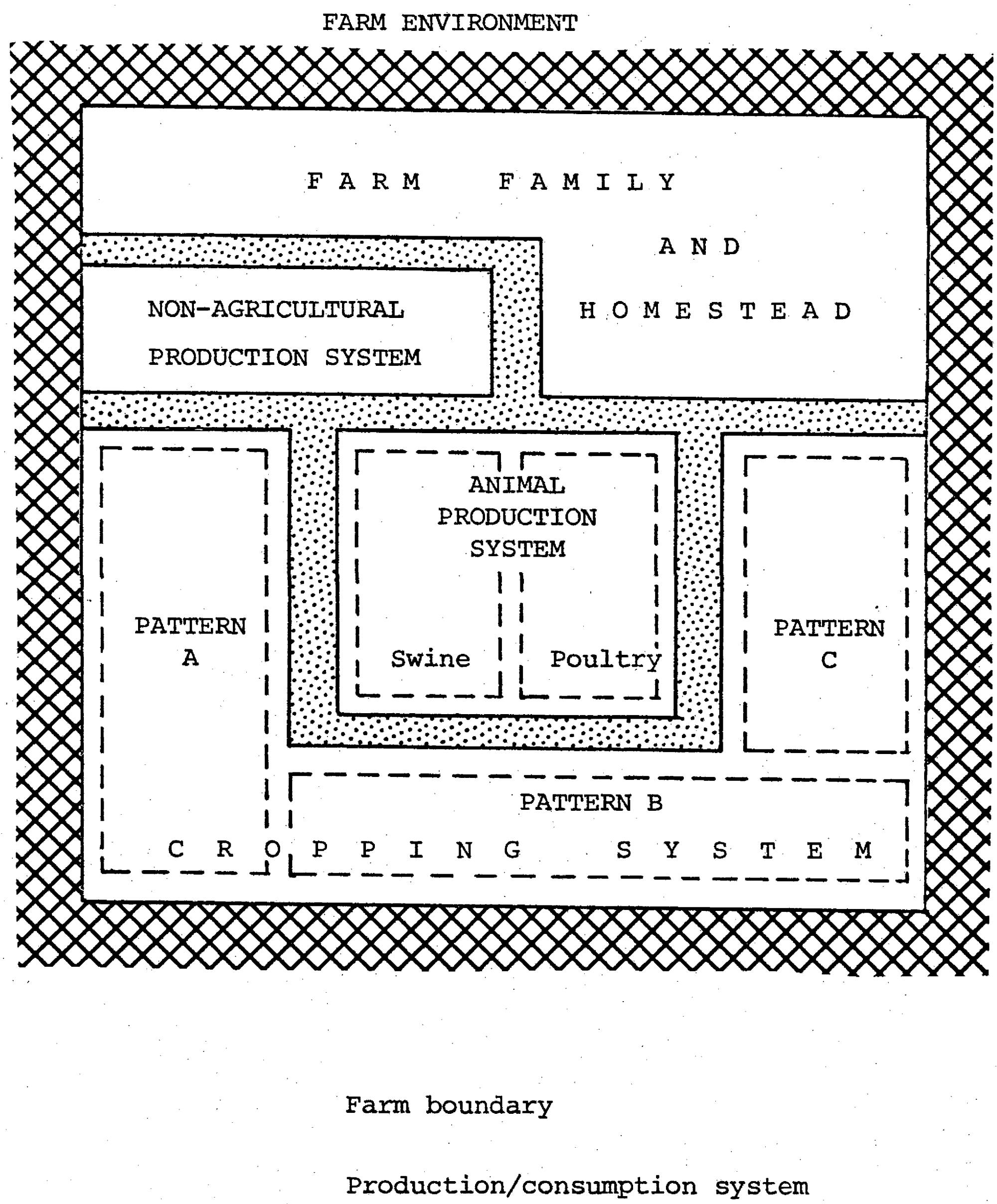


FIGURE 1.1

LOCATIONS OF THREE RESEARCH SITES OF THE CROPPING SYSTEMS PROGRAM, INTERNATIONAL RICE RESEARCH INSTITUTE

FIGURE 1.2

SCHEMATIC PRESENTATION OF SMALL FAMILY FARM



the picture, i.e., the failure of a proposed crop and switching to another due to weather conditions. Year to year variations in weather do produce such responses as shown by the experimental studies conducted in 1976-77 (Tables 1.1 and 1.2). Accordingly, research has been concentrated on the effect of local environment and management on the performance of proposed cropping patterns. In this study the following factors are considered to affect the cropping pattern performance:

(i) Rainfall pattern.

(ii) Landscape position.

(iii) Water-management scheme.

(iv) Type of cropping patterns.

(v) Method of crop establishment.

(vi) Turnaround periods.

(vii) Resource requirements.

The above items underline both the physical and management factors influencing firstly, the cropping pattern performance in terms of productivity and secondly, the profitability of the patterns. The variability of rainfall in a given season dictates the operational technique (farm operations), in establishing the crop early and successfully. More importantly, the element of timeliness of the first crop has a direct consequence on the succeeding crops. It is hypothesized that early planting will give a greater chance of planting the second crop successfully by avoiding the drought brought on by the early onset of the dry season. Bolton (1978) found that the delay of establishing a second crop cost approximately 70 kgs/ha of rice a day under experimental levels of

TABLE 1.1

TYPE OF CROPPING PATTERNS BY LAND DESCRIPTION

UNDER FARMERS' MANAGEMENT, OTON AND TIGBAUAN, 1976-77

Cropping Pattern	Description (Ha)				TOTAL	
	Rainfed Lowland	Upland	Irrigated	Partial[a] Irrigated	Ha	%
Rice-Fallow	13.1	--	0.6	4.1	17.8	20
Rice-Rice	18.3	--	13.0	2.6	33.9	37
Rice-Upland crops[b]	27.2	0.6	-	-	27.8	30
Rice-Rice-Upland	0.7	-	-	-	0.7	1
Corn-Others[c]	2.6	5.0	-	-	7.6	8
Upland-Upland crops	0.1	1.8	-	-	1.9	2
Others-Fallow	0.6	1.1	-	-	1.7	2
Total	62.6	8.5	13.6	6.7	91.4	100
Percentage	69	9	15	7		

Notes: a Partial irrigation refers to the use of water from the canal only during the first crop.

b Upland crops consist mainly of mung and cowpea.

c Others include corn, rice and upland crops.

The total crop land is 95.6 hectares, the difference from the total (91.4 ha) is 2.2 ha on cropping pattern trials and the remaining area was left vacant throughout the year.

TABLE 1.2

DISTRIBUTION OF PROPOSED, SHIFTED, UNPLANTED, AND ACTUAL CROP COMPONENTS OF RAINFED CROPPING PATTERNS DURING THE SECOND CROP, BY LANDSCAPE POSITION. ILOILO 1977-78 CROP YEAR

Landscape Position	Number of Fields							
	Proposed		Shifted		Unplanted		Actual	
	Rice	UC[a]	Rice	UC	Rice	UC	Rice	UC
Bottomland	8	-	-	-	-	-	8	-
Plain	16	9	2UC	4R	2	2	16	5
Plateau	15	14	11UC	2R	2	3	4	20
Sideslope	9	17	9UC	1R	-	4	1	21
Total	48	40	22	7	4	9	29	46

a Upland Crops

inputs but this would safely be adjusted to about 30 kgs a day at the farmers' level of resource use (Figure 3.1).[1]

On the other hand, the site's toposequence where researchers categorized the land units according to landscape position of the plot is important. Raymundo's (1977) classification categorized the area into five main district land units, namely (Figure 1.4):

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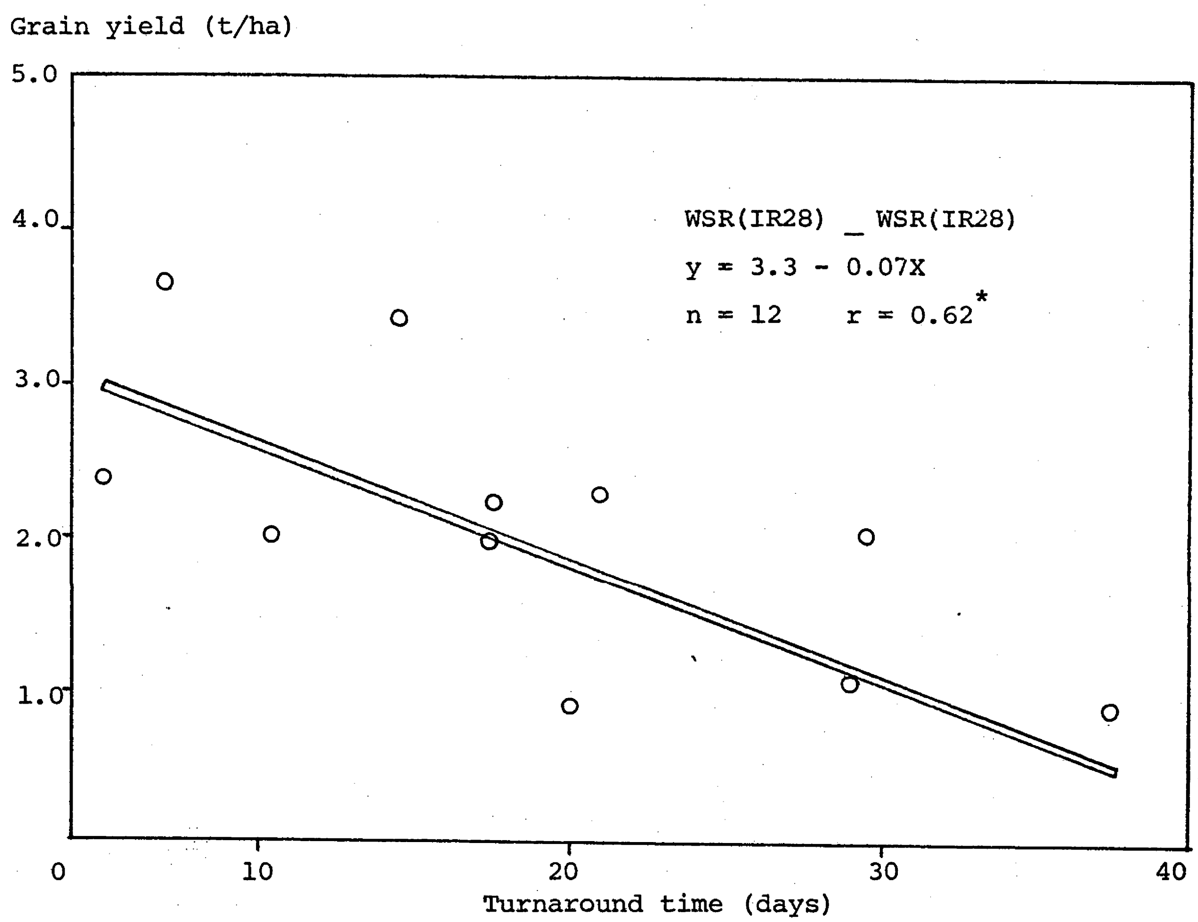
1 Adjustments were crudely based on the relationship between the experimental and farm's own level of inputs and output.

FIGURE 1.3

RELATIONSHIP BETWEEN YIELD OF SECOND RAINFED RICE CROP AND TURNAROUND TIME, ILOILO, 1976



(i)

(i) Knoll

(ii) Plateau

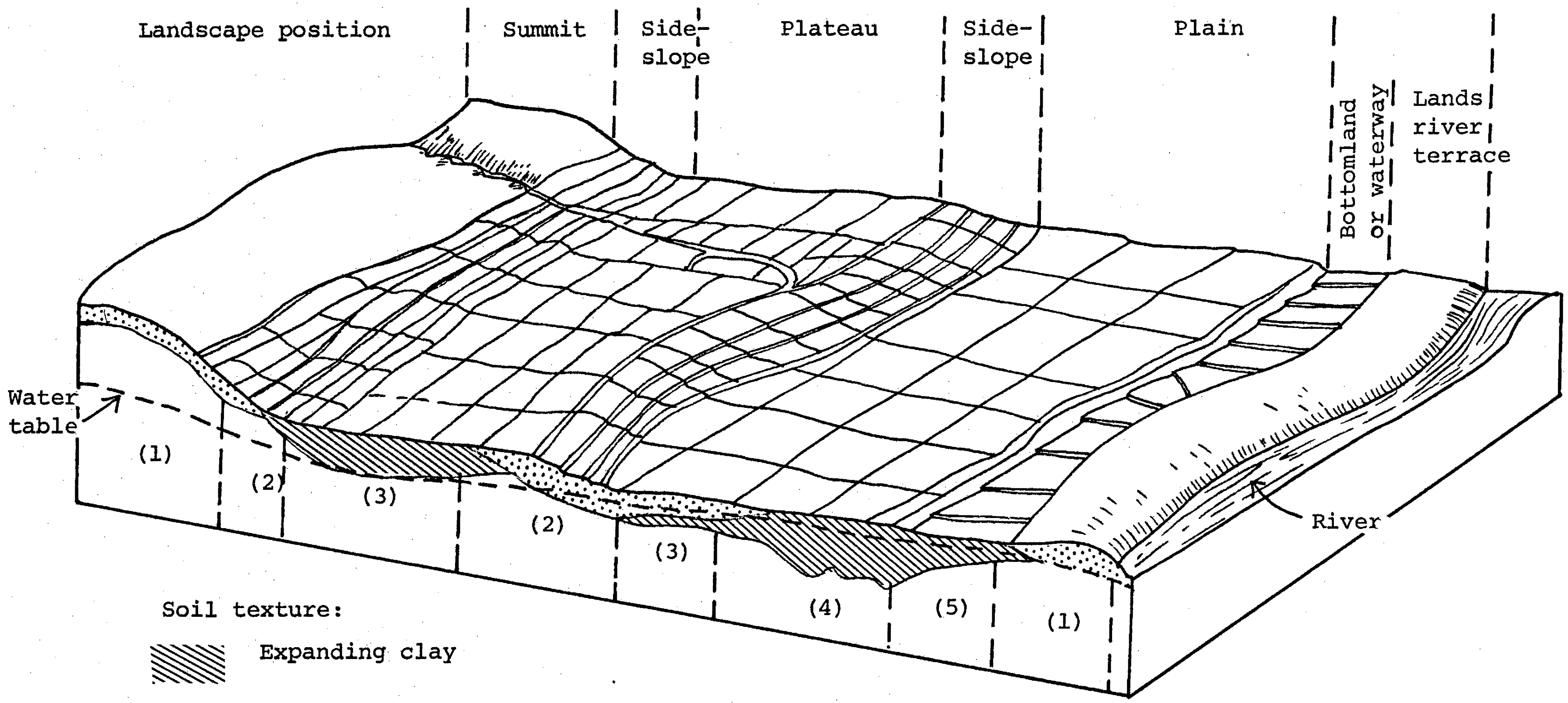
(iii) Sideslope

(iv) Plain

(v) Bottomland

FIGURE 1.4

SCHEMATIC PRESENTATION OF GEOMORPHIC AND PEDOLOGIC
CONDITIONS IN ILOILO OUTREACH SITE



Soil texture:

Expanding clay

Loamy texture or non-expanding clay

Hydrology:
(1) Pluvic, (2) Fluxic, (3) Fluxi-cumulic, (4) Cumulic, (5) Cumulo-delugic

Source: Raymundo, 1977

These positions affect crop performance to a great extent (Table 1.3). Discussion of the features of each land unit is given in Chapter 2. In this area, an average farm is likely to be fragmented, such that at least three landscape positions are represented. The farmer is faced with the job of scheduling farm operations, for example, land preparation when the rainy season starts. Timeliness again is not only a function of the physical nature of the farm but also the farmer's capability to sustain the required level of inputs, i.e., draft power, power tiller, particularly at the critical stage of crop production.

This is where this study is concerned with investigating the physical and economic relationship of establishing crops given the local environmental conditions and the farmer's level of resources. A simulation model is used to determine the productivity of the specified cropping patterns by quantifying the bio-physical factors that influence the yield and simultaneously subjecting these crops to specified management control, i.e., the length of turnaround period (TAP). This enables the researcher to further test the profitability of cropping patterns under the above conditions, by using partial budgeting.

The main point of interest is the effect of varied TAP's where it is hypothesized to be critical in rainfed areas with limited options because of the variability of the weather. The TAP is the period between harvesting the preceeding crop and planting the successive crop in a sequence. Lateness of the first crop, not to be ignored, can directly lead to failure of the second crop and third crop or the land can be left fallow. In Iloilo, the average

TABLE 1.3

PERFORMANCE OF THE RICE-BASED CROPPING PATTERNS
IN THE DIFFERENT LANDSCAPE POSITIONS ACROSS SOIL
TYPES, IRRIGATION CLASSES AND BUND POSITIONS
ILOILO 1976-77 CROP YEAR

(kg/ha)

Pattern Groups	Landscape Position		
	Plain	Plateau	Sideslope
Rice-Rice-Rice	14076 (2)	11808 (13)	-
Rice-Rice	6948 (2)	6566 (14)	6864 (6)
Rice-Rice-Upland			
Rice	10195 (6)	9126 (34)	6906 (10)
Legumes/Sorghum	188[a]	103[b]/2146 (1)	188[c]
Rice-Upland			
Rice	4495 (2)	4416 (2)	5302 (10)
Legumes/Sorghum	1742	722	599[d]/8326 (1)

Figures in brackets refer to the number of observations

- a Includes 2 failures
- b Includes 16 failures
- c Includes 3 failures
- d Includes 1 failure

TAP between two crops of rice is about three weeks and it is claimed that it can be substantially reduced for a higher crop performance (yield effect) and an increased number of crops in a pattern (intensification effect). Since the investigation is on the evaluation of the performance of cropping patterns given local environmental conditions and specified management control, profitability estimates can then be used as an appropriate index of farmer's adoption. Comparative costs and benefits (gross margins) between the use of hired draught power (carabao) and power tillers (hand tractors) allows the possibility of recommending each technique at specified TAP in certain landscape positions given the rainfall conditions for 30 years. The study is not involved in investigating the effect of the introduction and use of tractors on a community basis.

1.2 Objectives of the Study

The present study undertakes an economic evaluation of timeliness in crop intensification with emphasis on shortening the TAP in a cropping sequence given three dominant landscape positions in a toposequence. Specifically, the objectives are as follows:

(i) To discuss the environmental and management factors that affect the timeliness of crop operations;

(ii) to evaluate different turnaround periods on the profitability of cropping patterns by comparing: (a) the use of draught power sources in land preparation, and (b) the use of power tillers;

(iii) to examine the riskiness of crops and cropping patterns over a range of local physical environments; and

(iv) to identify a profitable combination of crops

given the physical and management regime
and discuss the possibility of extrapolation
to other areas similar to Iloilo.

1.3 Outline of the Analysis

The following chapters discuss the economic evaluation of timeliness in crop intensification in Iloilo, Central Philippines. Specifically Chapter 2 describes and presents some findings on existing farm conditions from the IRRI CSP[1] conducted from 1975-79. The approach for the analysis is outlined and discussed in Chapter 3. Chapter 4 presents the economic consequences of reducing the delay of turnaround period. It incorporates the measurement of inputs, the use of shadow wage rates, changes on the use of inputs and profitability estimates for the cropping pattern. It also includes an attempt at examining the riskiness of growing crops on landscape positions given 30 year rainfall data. The last chapter is a summary and conclusion of the study.

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1 CSP = Cropping Systems Program

CHAPTER 2

FARMERS' PRESENT CROPPING STRATEGIES: AN EMPIRICAL EVALUATION BASED ON THE IRRI CROPPING SYSTEM PROGRAM

2.1 The Iloilo Outreach Site

The IRRI Cropping System Program (CSP) initiated research activities in collaboration with the Philippine Bureau of Plant Industry in three outreach sites that can be considered climatically and edaphically typical of large areas in Southeast Asia. One of the sites is in Iloilo province located south of Manila, covering seven villages of Oton and Tigbauan municipalities (refer back to Figure 1.1). The area represents typical rainfed growing conditions and is similar to other rainfed areas in some parts of the country. It is one of the highest producing rice provinces in terms of annual production and is a source of the staple crop for neighbouring provinces during lean months (Norada, 1978).

2.2 Physical-Environmental Conditions

2.2.1 Climate

Rainfall is one of the major climatic factors in crop production and determines the start, duration and end of the growing season. Farmers in particular consider rainfall as the major factor determining the performance of his chosen cropping pattern and to some extent his welfare (Table 2.1). Variability of the onset of the wet season and conversely the onset of the dry season has a direct implication on the scheduling of field operation. The

TABLE 2.1

FARMERS' CONSENSUS ON THE MAJOR DETERMINANTS IN ESTA
ESTABLISHING A SECOND RICE CROP IN RAINFED LOWLAND AREAS
ILOILO, 1977

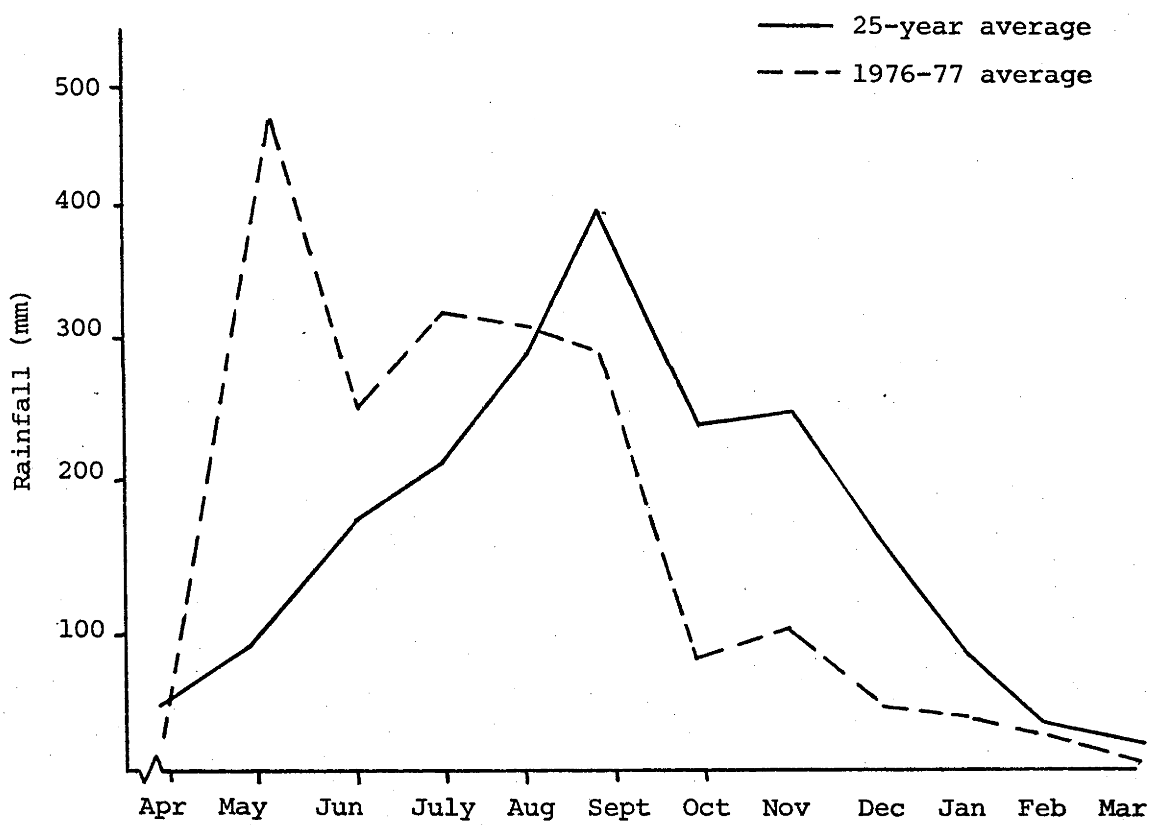
Factors Considered	Farmers Reported		Ranking
	No	Percent	
Rainfall	38	100	1
Landscape Position	35	92	2
Land Preparation	35	92	2
Labor Availability	32	84	3
Cost of Crop Establishment	32	84	3
Power Constraints	27	71	4
Type of Crop Establishment	26	68	5
Delay in Harvesting First Crop	21	55	6
Entrapment	19	50	7
Others	8	21	8

farmers' preference for the earliness of rainfall and lateness of the dry season increases the probability of successful patterns, however, the variation of the intensity of rainfall within the growing period more often than not affects the overall performance of the crop. For example, rainfall in the early part of May followed by a sudden dry spell may lead to crop failure or replanting of the first crop. Economically speaking, this results in a loss of resources in terms of timeliness, or a readjustment of field operations can give a slim chance of double cropping.

In Iloilo, the 'normal' rainfall patterns consist of five to six consecutive months of over 200 mm and between three to four months of 100 to 200 mm (Figure 2.1). The cumulative

FIGURE 2.1

DEVIATION OF THE 1976-77 MONTHLY RAINFALL FROM THE 25-YEAR AVERAGE



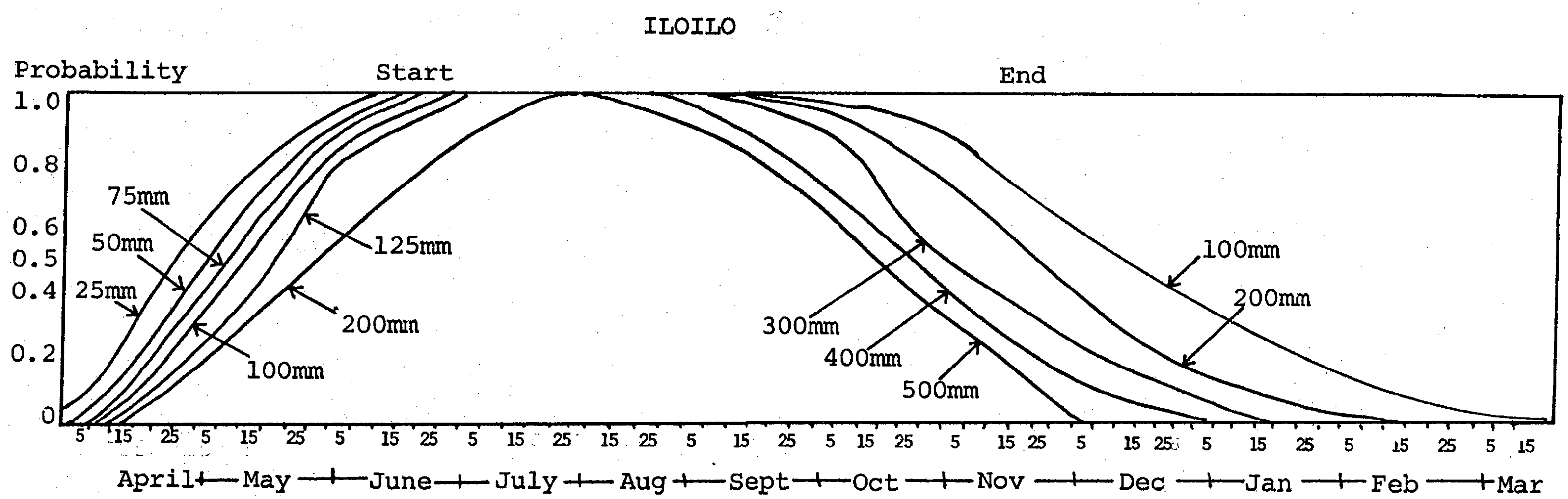
probabilities of rainfall by a certain date (start) and still receiving a certain amount of rain after a given date (end) for Iloilo are given in Figure 2.2. Early rainfall (April and May) is principally convectional and most erratic (Bolton, 1980). Mid season rainfall is mainly cyclonic and more dependable while late season rainfall is commonly discontinuous. There are three rainfall classes within Iloilo Province (Alicante et al, 1947; Magbauna and Morris, 1980). The first rainfall class has two seasons, dry from December to April and wet from June to October (Figure 2.3). The second class also has a wet season from June to October, with no pronounced peak period and only two dry months, while the third class is bimodal, with two rainfall peaks corresponding to the southwest and northeast monsoons.

The site's rainfall pattern is categorized in the first class, however, it has a shorter wet season than most of the other areas in the group. It has been shown from the five year rainfall data for the seven villages that there appears to be a village to village rainfall variation which was reflected by differences in planting dates, however, in this study for practical reasons, it is considered to be a minor limitation and it is assumed that it will not affect the evaluation.

The day length, temperature and solar radiation are other factors that can influence the performance of crops sufficiently to make production not economically rewarding (Zandstra, 1978). There are crops which are sensitive to day length such as soybean and mungbean to a lesser extent. Experimental studies in Iloilo showed that soybean yield stability is affected by day length, while

FIGURE 2.2

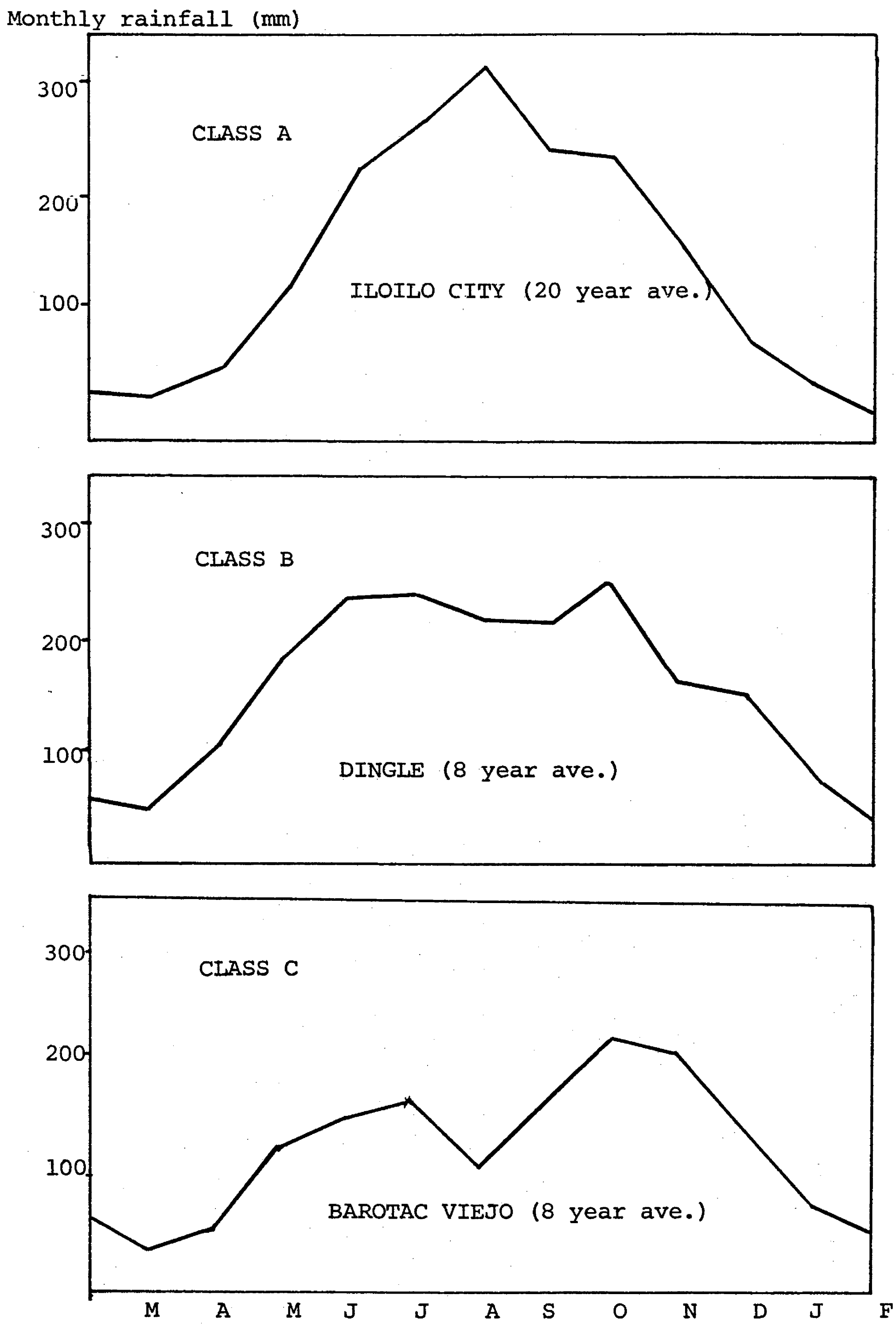
THE CUMULATIVE PROBABILITIES OF HAVING RECEIVED A GIVEN AMOUNT OF RAIN ON A CERTAIN DATE (START) AND OF STILL RECEIVING A CERTAIN AMOUNT OF RAIN AFTER A GIVEN DATE (END) FOR THE ILOILO RAINY SEASON (TIGBAUAN RAINFALL RECORDS)



Source: Morris and Zandstra, 1978

FIGURE 2.3

THE THREE MAIN RAINFALL CLASSES IN ILOILO PROVINCE



mungbean, critical planting dates in November with low solar radiation, high temperatures and shorter day length substantially reduce its yield (Morris et al, 1979).

2.2.2 Landscape Positions of the Plots[1]

The location of rice paddy systems is largely determined by landscape position. As a rule, because of the high dependence of hydrology with landscape position, wet land rice areas are mainly situated at the lower positions in the landscape (Raymundo, 1977). The above phenomenon is directly related to the water table, where lower landscape positions are closely associated with the shallow ground water table while higher landscape positions generally have a deeper ground water table.

For the last five years (1976-80) cropping pattern testing in the site was dictated partly by the landscape position of the field. Results showed that performance of crop varies according to the position (refer back to Table 1.3). It is somewhat related to the capability of the positions to retain water both in the root zone and surface level (Pers. comm Angus). The relationship holds that the higher the position of the field, the lower is the water holding capacity and the greater is the drainage condition. Obviously, soil type determines the movement of water laterally and vertically as seepage and percolation respectively. One will expect a higher percolation rate in light soils. Water management particularly in rainfed areas appears to be affected by landscape positions and this is very important for farmers'

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1 Plots and fields are used interchangeably and refer to the piece of land regardless of size used for crop production.

scheduling of operations which in turn affects the timeliness of the successful planting of two or more crops.

This study considered landscape position of the plots as one of the major determinants of increasing cropping intensity in rainfed areas. In this connection, it is relevant to define and discuss each position in relation to the farmers' scheduling of field operations. Referring back to Raymundo's finding, the following are heavily drawn from his paper shown in Figure 1.4 (Raymundo, 1977).

(i) Knolls and summits are small rounded hills at the highest part of the landscape. They are landscape positions represented by narrow elevated areas with crests which are less than 300 meters wide at the widest section. They are generally characterized by lateral slopes parallel to the axis of the crest and terminal slopes on either or both ends. In addition, these positions are unbunded with light soils and commonly planted with upland crops such as corn, upland rice and usually left vacant at the onset of the dry season. They are easily drained and cannot accumulate water because of their unbunded feature. From the survey administered by the economic researchers, they represent around 12 per cent of the total area (Price, 1980).

(ii) Plateaus are high level areas with water tables that recede rapidly with the onset of the dry season. Paddies are roughly square, enclosed with bunds, and have little vertical drop between them, hence they are difficult to drain. These areas are exposed to high winds during the dry season, so the best crops to plant during this period are of creeping habit, such as peanuts, sweet potato, watermelons and some vegetables. Raymundo characterized plateaus that are broad flat areas (less than 1.5 per cent slope), more than 200 meters at the narrowest section between drainage ways where water levels or dry stream beds. Price reported that this position is the most dominant in terms of area, representing approximately 56 per cent of the test site.

(iii) Sideslopes on the other hand are areas that usually connect knolls and plateaus, or plateaus and plains, and are terraced and bunded (Magbanua et al, 1977). Paddies in these areas are narrow with their longer sides at right angles to the slope, and with a greater vertical drop between than in either plateau or plain. Water can be accumulated and drained only during the rainy season. Raymundo categorized this position as those areas with slope gradients greater than 1.5 per cent. These are normally occupied by a terraced paddy system. Because of the sloping position of these areas, water availability will be less during the early dry season onward which may limit plantings of a second rice crop, while upland crops like mungbean and cowpea may suffer drought extensively, primarily because of less water at the root zone areas because of higher rate of percolation.

(iv) Plains are broad flat areas (1.5 per cent slope gradient) which are generally more than 500 meters at the narrowest section. These are areas located on the lower part of the landscape and tend to have heavier soils than the plateaus. The water table is nearer the surface and recedes less rapidly with the onset of the dry season. Rice plots are elongated rectangles with little vertical drop between them. They readily accumulate water, but are difficult to drain. This position represents around 17 per cent of the site.

(v) Finally, the lowest position across the typosequence is the bottomlands, where during the rainy season sufficient depth of flooding occurs to restrict the use of short statured varieties to early maturing intermediate statured varieties and three rice crops can be grown. Flooding potential is very high, which leads to planting a monoculture type of rice throughout the growing season in a year. These positions represent only about six per cent of the total area and can be considered negligible.

Having characterized the different positions in the typosequence, at this point establishing their importance to crop intensification is now in order. Half the farms in the area have at least two or three landscape positions and as rain water comes in, scheduling of field operations is critical on the part of the farmer (Table 2.2). The field operations which consist of about 30 major categories range from seed bed preparation to post-harvest activities connoting the complexity of the system, where the farmer's day to day decisions have a direct bearing on his investment and expected economic return. Consider a 'typical' farm with the following characteristics obtained from a farm-record keeping study conducted by the Agricultural Economics Department, 1976-77:

(i) 1.4 hectare of land.

(ii) The farm consists of at least three landscape positions and is fragmented.

(iii) One draught power source (carabao).

(iv) Access to hand power tiller at prevailing custom rate.

(v) Credit access with average rate of 30

TABLE 2.2

SUMMARY OF THE NUMBER OF LANDSCAPE UNITS PER FARM IN RAINFED LOWLAND AREAS IN ILOILO, 1976-77

Land Units	No of Farms Reported	Total Area (ha)	Average Area per Farm (ha)
One Land Unit per Farm			
Plateau	13	13.30	1.02
Plain	4	3.77	0.94
Sideslope	2	1.31	0.65
Waterway	-	-	-
Two Land Units per Farm			
Plateau-Sideslope	3	5.88	1.96
Plateau-Waterway	2	5.73	2.86
Sideslope-Waterway	1	0.88	0.88
Sideslope-Plain	1	3.34	3.34
Three Land Units per Farm			
Plateau-Sideslope-Waterway	4	16.36	4.09
Plateau-Sideslope-Plain	4	9.10	2.27
Sideslope-Plain-Waterway	2	4.23	2.11

per cent interest rate per season (six months).

(vi) Average yield of around two tons per hectare in the first crop with alternatives of a second rice crop and upland crops.

(vii) A full time farmer and available family numbers for some operations of 1.9.

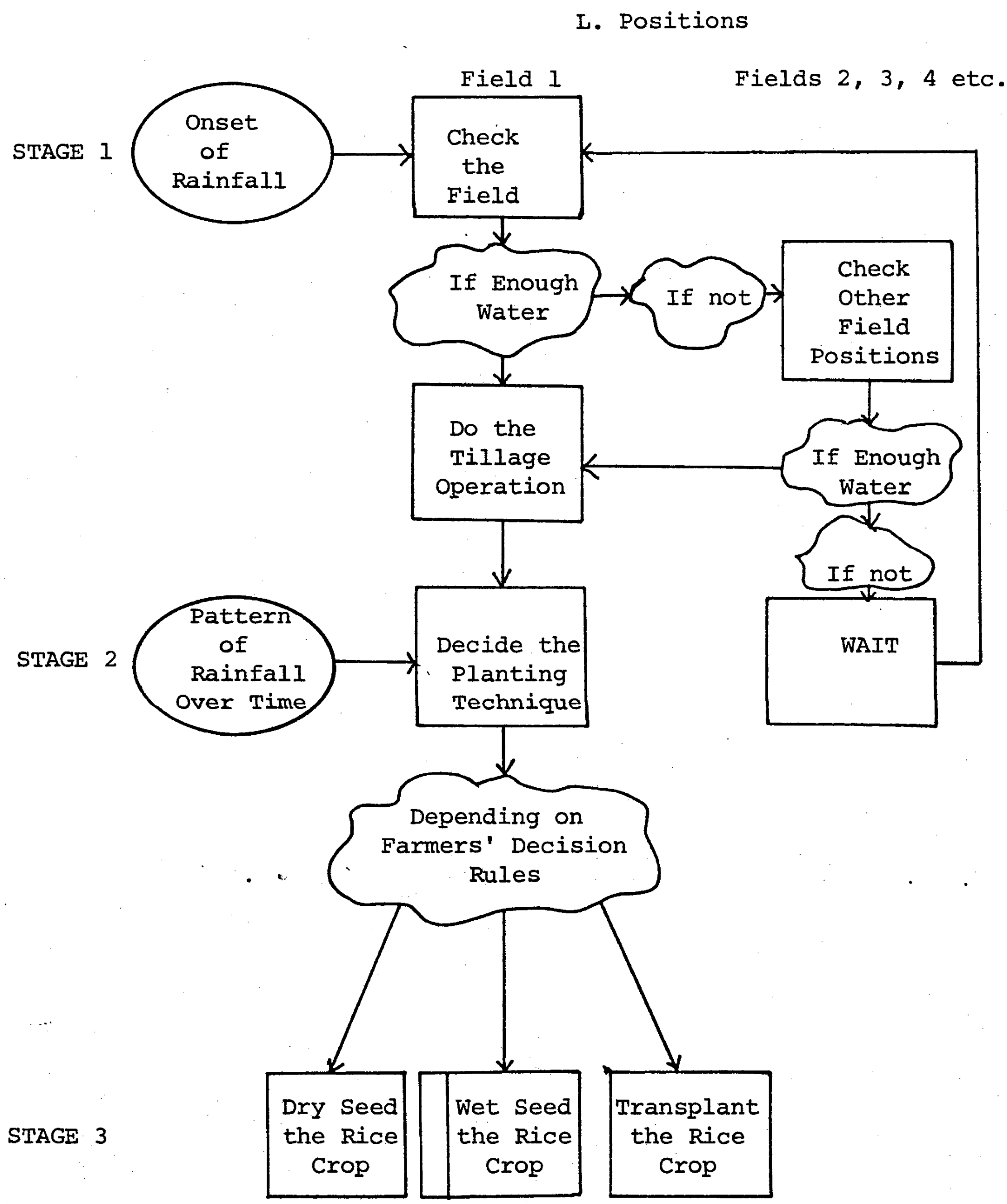
One of the first major decisions he will make is to plant the first crop of rice (staple crop) in his fragmented farm. The onset of rainfall will obviously dictate his field operations, whereas the choice of crop establishment appears to be at his discretion, whether it is dry, wet seeded, or transplanted. However, the amount of water in the paddy influences the choice of planting technique, thus the alternatives open to him at this stage are dictated by the water conditions in different landscape positions. Because of the variability of rainfall both in terms of its earliness or lateness and the accumulated amount of water, the farmer will be in a position to decide which he thinks the best given his available resources and field conditions. The farmer's decision making process is outlined in Figure 2.4.

Figure 2.4 indicates the situation faced by the farmers during the first crop establishment where given the onset, pattern of rainfall, accumulated water in the field, available resources and landscape position, one has to do a series of multi-related decisions to have a good chance of planting the first crop in anticipation of double cropping or to some greater degree triple cropping. There are tentative indications that the farmers' preference of land preparation is a function of landscape position as affected by the water condition in the field (Figure 2.5). They tend to prepare first the upper areas with high drainage conditions, in relation to the erratic rainfall pattern which may limit them to being able to plant the first crop in these positions (Roxas et al, 1977).

The situation of the second crop is another matter in

FIGURE 2.4

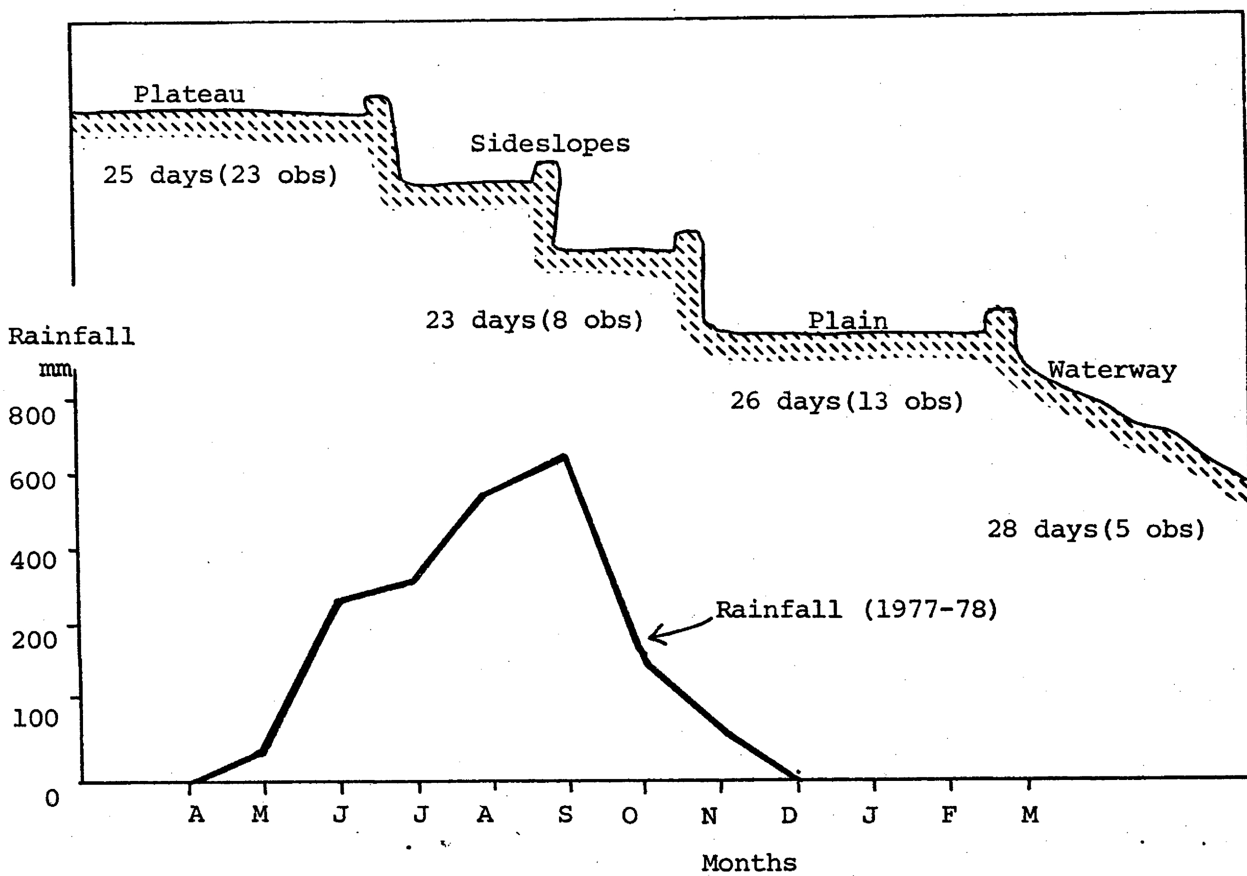
SCHEMATIC DIAGRAM TO DETERMINE FIRST CROP ESTABLISHMENT



question. Although planting the second crop is highly dependent on the earliness of the first crop, some other factors may influence the delay in establishing it, to name a few, harvesting operations

FIGURE 2.5

TURNAROUND PERIOD BETWEEN TWO RICE CROPS
BY LANDSCAPE POSITION IN RAINFED LOWLAND AREAS IN ILOILO, 1977-78



are a clear constraint while the lack of draught power can put the farmer in a difficult situation. To illustrate from experimental studies in the area, it is shown in Figure 2.6 how the agronomic researchers tackled the planting of Rice-Upland Crops (AC), Rice-Ratoon-UC, Rice-Rice or Rice-Rice-UC (Morris et al, 1979).

Figure 2.6 is based on the assumption that there is sufficient power and labour to cope with land preparation and

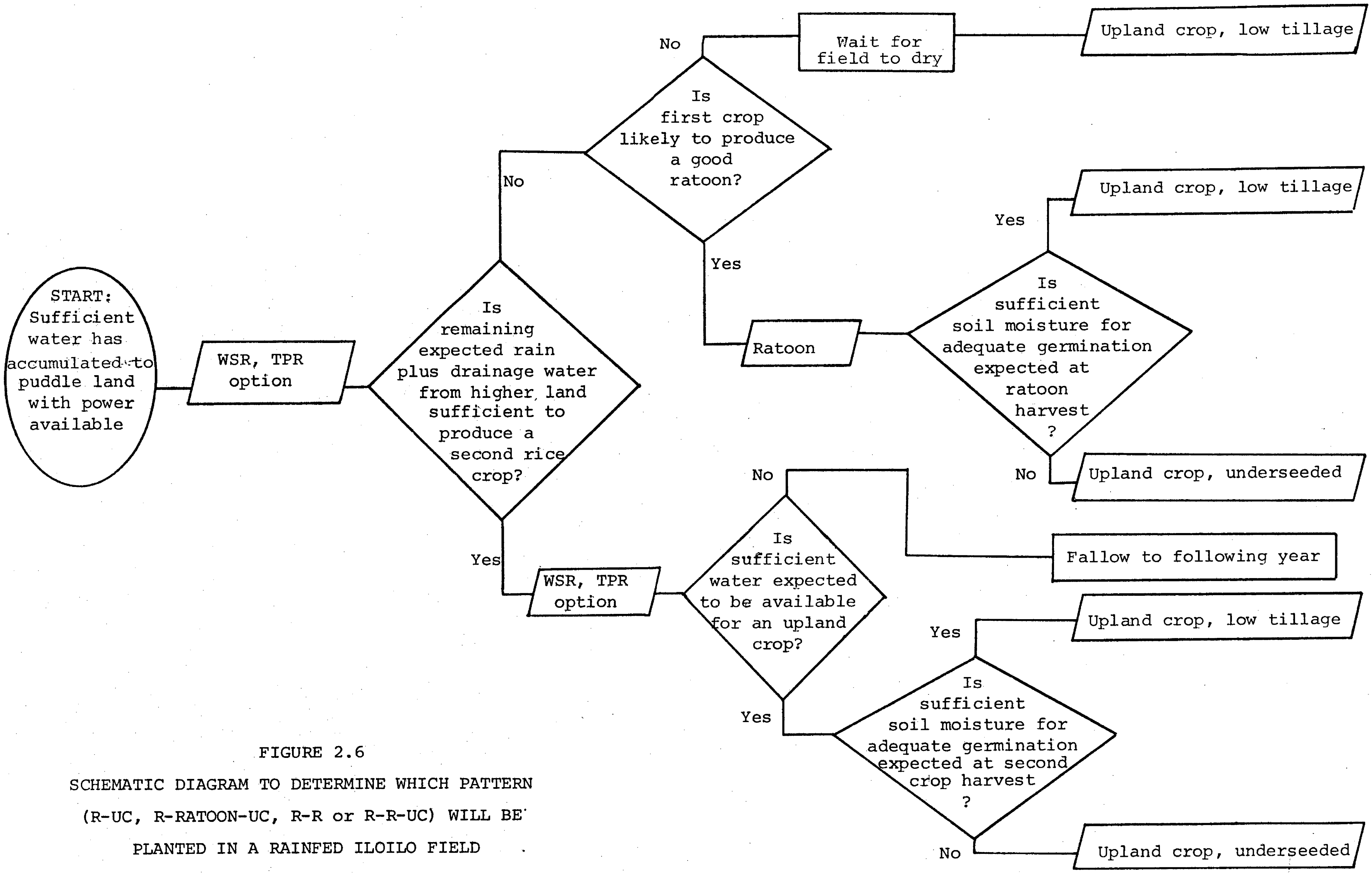


FIGURE 2.6

SCHEMATIC DIAGRAM TO DETERMINE WHICH PATTERN (R-UC, R-RATOON-UC, R-R or R-R-UC) WILL BE PLANTED IN A RAINFED ILOILO FIELD transplanting requirements, therefore it is strictly agronomic in nature. The constraints on reducing the turnaround period (TAP) have been ignored which in this study played a significant role.

The use of dominant crops like upland rice, corn, mungbean and creeping vegetables like watermelon and yam are restricted mainly to upland areas. Traditional rice varieties in rainfed lowland areas are tall statured, long-maturing, susceptible to lodging and low yielding types. This rice crop is normally transplanted and after it has been harvested, the land is left fallow or alternatively planted to a low input upland crop of mungbean.

The short, early maturing rice varieties developed by IRRI in the early sixties were not adopted in the area until the early seventies when the so called Masagana 99 was launched by the government.[1] The success of the program was evidenced by the awareness of the farmers of new technological input packages. When the IRRI-BPI CSP was launched in 1975, 80 per cent of the activated farm land was single cropped and only small portions of the area were either double cropped or planted by mung after the first crop (refer back to Table 1.1). While the testing of new cropping patterns proposed by IRRI was in progress, adoption and diffusion was observed not only by participating farmers but also by non-farmer cooperators. There were dramatic changes in farmers'

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1 Masagana 99 is aptly named as it has a yield of 99 kavans per hectare (equivalent to 5 tons/hectare; it is a packaged set of new technology promoted by government technicians for the farmers, with easy access to credit from the banks.

existing cropping patterns particularly in the use of the high yielding varieties (HYV) observed during 1976-77 (Table 2.3). Shifting from rice-fallow to rice-rice was particularly evident.

TABLE 2.3

RICE-RICE BY VARIETY IN FARMERS' PRESENT SYSTEM, OTON AND TIGBAUAN, ILOILO 1976-77

Cropping Pattern	Variety								All Varieties	
	HYV-HYV		HYV-LOCAL		LOCAL-LOCAL		LOCAL-HYV			
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
WSR-WSR	17.8	91	0.2	1	0.1	1	1.5	7	19.6	58
WSR-TPR	2.6	38	3.2	47	-	-	1.0	15	6.8	20
TPR-TPR	3.7	88	0.1	2	0.2	5	0.2	5	4.2	12
TPR-WSR	2.7	82	0.3	9	-	-	0.3	9	3.3	10
Rice-Rice	26.8	79	3.8	11	0.3	1	3.0	9	33.9	100

2.3 Farmers' Present Cropping Strategies

This section briefly outlines the farmers' present strategies in the test area in relation to the ways their management skills interact with the existing environment. Although the discussion is based on an intensive record keeping study conducted by IRRI over the last five years, and particular emphasis in evaluation is based on the 1976-77 cropping season, it is considered that it gives an indication of the major determinants that play an important role in crop intensification. Furthermore, the present study is solely based on this specific environment, and therefore any attempt for extrapolation purposes, must be resigned to look closely at the various underlying assumptions made from this site.

2.3.1 Historical Cropping Patterns

Cropping systems in different parts of the world were developed mainly by trial and error. The pressure brought about by existing conditions, say for example during and after wars, lead farmers to raise more food. They tended to make use of available cultivars suited to the locally existing physical environment for the intensification of cropping either to satisfy their immediate basic needs or for profit motives. Socio-economic demands have partly pressured the farmers to intensify and/or give incentives for them to increase productivity (Raymundo, 1977).

In the Iloilo test site, planting of different cultivars has been the farmers' primary source of improving their standard of living. The availability of new technological inputs like short and early rice varieties led to a considerable increase in productivity per unit area which partly satisfies the demands for basic needs. Farmers responses to the survey revealed that planting these cultivars has been passed from one generation to another and there are some indications that certain cultivars have come from either neighbouring or distant places (Pers. comm, Iloilo farmers).

2.3.2 Rice Planting Techniques

Historically, the use of transplanting techniques for establishing a rice crop has been the observed practice for many years (Pers. comm, farmer-cooperator). Although, some farmers claimed that the alternative techniques of dry seeding and wet seeding provide a good chance of early planting 'double cropping', they tend to favour the use of the transplanting technique even though it is more laborious for the basic reason that there is less riskiness in production. The yield of a transplanted rice crop was believed to be more dependable primarily because it is planted when the water is adequate in the paddy throughout the growing period.

At this point, it is helpful to describe each technique as follows:

(i) Dry seeding (DSR) - This technique is more popular in upland unbunded areas, where the soils are light textured and easily drained. It is considered that the earliest planting of the first crop can be achieved even in rainfed wet land areas with this technique since the field is prepared at the time of the early germinating rain, normally the first and second weeks of May and then the seeds are broadcast on the dry surface of the soil before the end of May. There is some risk involved since after broadcasting the seeds, if no more rain falls for the next few weeks, germination and the stand of the crop is affected and the possibility of losing the crop is very high. However, if the crop is successful, the potential of two or more crops in a sequence is high.

(ii) Wet seeding (WSR) - This technique was recently re-introduced in the area by the IRRI-BPI program. The method involves preparing the land under wet conditions (accumulated water) and broadcasting the seeds into the wet soil surface. The technique proved to be highly successful, where a large portion of the area in the region was planted using WSR after a year of re-introduction. The main reason for adoption is more economic in nature, because the labour requirements for planting are substantially reduced compared to the transplanting technique 25 man hours to 200 man hours/hectare respectively. Some farmers reported low yields of WSR compared to TPR, but there was no conclusive evidence even under experimental conditions, where in fact the yield did not vary significantly.

(iii) Transplanting (TPR) - This method involves a thorough land preparation normally at the end of June, where the field must be in the submerged water condition. There is a prior seed bed preparation for seeding requirements from which at the average age of 20 days, seedlings are transplanted from the seed bed to the field. The seedlings are planted in rows in anticipation of the use of mechanical rotary weeders and other cultural practices. The farmers usually employ a hired transplanter who is paid at the current market wage rate for this operation.

The choice of planting technique by farmers has been partly discussed, but to reiterate the main criteria of selection it is listed below:

(i) Onset of rainfall.

(ii) Accumulation of water in different landscape positions.

(iii) Labour and power availability.

(iv) Choice of rice varieties and subsequent rice or upland crops, i.e., choice of cropping pattern.

2.3.3 <u>Planting Strategies</u>

Surveys showed that from 1975-77, there was a dramatic adoption of wet seeding compared to the two other techniques (refer back to Table 2.3). In addition using HYV's was synonymous with wet seeding, thus suggesting that farmers planting WSR were planning to plant another rice crop, while TPR will be followed by an upland crop of mung.

It appears that farmers have decision rules in relation to the onset of rainfall, dry season and double cropping of rice. In general, dry seeding is practiced from the latter part of April to the latter part of May; wet seeding on the other hand is from the middle part of May to the end of June, while TPR normally occurs from the middle of June to the early part of August. The above description was based both on historical activity analyses and interpersonal communication with the farmers, while the author worked in the area. The farmers' preference for wet seeding is somewhat dramatic for the first crop, while for the second rice crop TPR after the first crop of WSR or DSR appears to be the dominant technique. In terms of planting strategies in relation to time as a function of rainfall, it can be summarized as shown in Table 2.4.

TABLE 2.4

RICE PLANTING TECHNIQUES VS TIME IN SEQUENCE IN RAINFED AREAS IN ILOILO

First Crop	Time	Second Crop	Time
DSR	Early	DSR	not planted
WSR	Medium	WSR	early October
TPR	Late	TPR	late October

Planting strategies by landscape position is more complicated to assess. The farmers' decision rules specifically choosing a technique is inconsistent particularly in the first crop because of the many factors requiring consideration, not only the rainfall pattern and intensity but also for strong socio-economic reasons (Figure 2.7). Experimental studies in the site showed the varied productivity levels of different planting techniques by landscape positions (Magbanua et al, 1977). It appears that there is a one to one substitutability of WSR and TPR but not with DSR since as previously mentioned, DSR is preferred on high lying areas and is restricted to first crops while WSR and TPR are planted both in high and low areas in the first crop; however, TPR is more popular in low areas (plain) during the second crop.

2.4 The Critical Turnaround Period (TAP)

2.4.1 Merits of Reducing the TAP

The extent to which a specific cropping pattern maximizes the utilization of land and available rainfall largely depends on the turnaround period. Patterns with short turnaround periods may increase the chance of putting in more crops in the pattern and thus allow more efficient use of the available resources. The alternative merits of reducing the TAP is by allowing later crops to avail themselves of more precipitation which could result in higher and more stable yields.

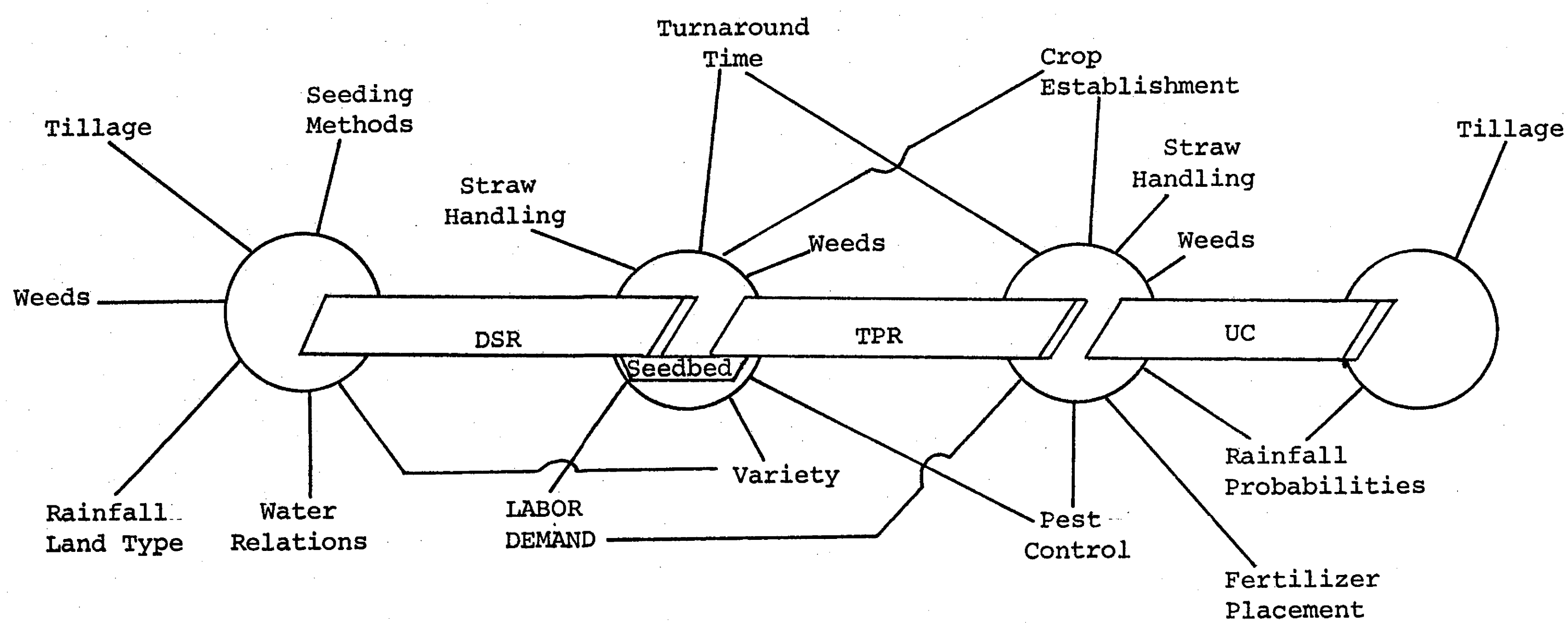
2.4.2 Constraints of Reducing the TAP

There are a lot of built-in limitations either physical or socio-economic in nature that can substantially hinder the effort of shortening the delay in establishing the subsequent crop. To briefly illustrate this, the physical limiting factors are listed below:

FIGURE 2.7

TO ASSIGN COMPONENT TECHNOLOGY TO A PATTERN REQUIRES
A CAREFUL SELECTION FROM MANY ALTERNATIVES

DSR = Dry Seeded Rice; TPR = Transplanted Rice; UC = Upland Crops



(i) Continuous rain during the TAP because farmers do not work under these conditions.

(ii) Entrapment of fields where the farmer cannot bring in his carabao or implements because there is no available access from neighbouring fields where the crop is still standing.

(iii) Most farmers preferred the rice straw of the first crop to rot prior to land preparation and this causes considerable delay.

(iv) Allowing a week of standing water to facilitate (iii) is practiced when the first crop is TPR.

The socio-economic constraints can be discussed as follows:

(i) The delay contributed by harvesting and post-harvest operations. The most common system of harvesting is called 'pasapar' where harvesting, threshing and cleaning are carried out by a group of 10 to 50 persons or more, working for a 1/6 share of crop production (Juarez and Duff, 1980). This is the group of people contracted by the farmer to harvest his crop at a specific set date, and non-availability of this labour will in some cases certainly delay the operation and thus land preparation is affected.

(ii) Availability of one draught power source limits the farmer to finishing the land preparation quickly enough to establish the second crop early. On the average, it takes around 25 days to finish a hectare of land without considering other disruptions on the process. Furthermore the number of operations in land preparation, for example the number of plowings and harrowings, dictates the pace of the operation in relation to the type of planting technique to be used.

(iii) To plant TPR the farmers have to hire transplanters in the area and this has been a great problem, because these people preferred harvesting the first crop rather than transplanting, which are simultaneous operations at that time (Table 2.5). The labour demand and supply situation is not at equilibrium point for the two operations since the market wage rate (equivalently) of harvesting is higher than land preparation and thus delay in establishing the crop is evident.

(iv) Prominent farmers who have access to credit and cash availability engaged the use of both a thresher and power tiller to speed

TABLE 2.5

MONTHLY TOTAL LABOUR UTILIZATION FOR MAJOR OPERATIONS ON THE FARMS OF 45 ECONOMIC COOPERATORS OTON AND TIGBAUAN, ILOILO, 1976-77

Month	Labour Use By Operation (Man Days)								Total
	Land Preparation		Planting		Crop Maintenance[a]		Harvest & Past Harvest		
	Days	%	Days	%	Days	%	Days	%	
April	64	30	13	6	25	12	112	52	214
May	516	80	71	11	34	5	23	4	644
June	569	65	200	23	100	12	2	-	871
July	518	27	1067	57	263	14	39	2	1887
August	189	20	437	45	99	10	242	25	967
September	413	24	179	10	60	3	1097	63	1749
October	260	22	245	20	124	10	574	48	1203
November	174	24	249	35	156	22	133	19	712
December	75	6	74	6	50	4	1034	84	1233
January	85	7	31	2	20	2	1158	89	1294

a/ Crop maintenance includes fertilizer application, spraying pesticides, and weeding operations.

up the operation. The average farmers who have not yet sold the first crop even if it is already harvested can not hire the services of power tillers because of its cash for cash basis of payment.

Another major consideration is the economy of scale; farmers having small farm sizes who have decided to double crop a small portion of their farms, would not find it economic at all to invest in the hire of a power tiller.

2.4.3 Survey Findings on the Length of TAP

The length of TAP for various cropping patterns is given in Table 2.6 from the results of a survey conducted by Iloilo in 1976. These figures are based on the farmers own levels of resources used in the operations. The differences between cropping patterns and between types of crop establishment showed that this critical period can substantially explain the complexity of the cropping system.

TABLE 2.6

AVERAGE TURNAROUND PERIOD OF THE DIFFERENT GROUPS OF CROPPING PATTERNS DURING THE FIRST TO SECOND CROP, ILOILO, 1976

Pattern Groups	No of Fields	Turnaround Periods (days)
1. Rice - rice	83	21.0
2. Rice - upland crop	13	40.8
3. Corn - upland crop	6	56.2
4. C + R - upland crop	4	40.5
5. Corn - rice	2	30.5
Total	108	

Studies on farmers' consensus on the relative importance of physical factors is given in Table 2.7 while on socio-economic factors is given in Table 2.8. The surveys revealed indications that can help the researchers in turning up management decision rules to solve the problems in the delay of TAP.

TABLE 2.7

AVERAGE TURNAROUND PERIODS OF THE RICE-RICE CROPPING PATTERN DISTRIBUTED TO DIFFERENT METHOD OF ESTABLISHMENT WITHIN THE SEQUENCE, ILOILO 1976

Pattern Groups	No of Fields	Turnaround Periods (days)
1. WSR - WSR	56	19.5
2. WSR - TPR	20	24.8
3. TPR - WSR	4	12.5
4. TPR - TPR	3	27.3
Total	83	

TABLE 2.8

FARMERS' CONSENSUS ON THE RELATIVE IMPORTANCE OF PHYSICAL FACTORS AFFECTING LAND PREPARATION FOR THE SECOND RICE CROP, ILOILO, 1977

Physical Factors	Farmers Reported a/		Ranking
	Number	Per Cent	
Rainfall	38	100	1
Landscape Position	35	93	2
Entrapment	20	53	3
Area	15	40	4
Distance to House	10	27	5

a/ Total number of respondents = 38.

More interestingly, farmers listed the major determinants in establishing the second rice crop, as shown in Table 2.9, which support the researchers' position of looking closely at three factors associated with crop intensification.

TABLE 2.9

FARMERS' CONSENSUS ON THE RELATIVE IMPORTANCE OF SOCIO-ECONOMIC FACTORS AFFECTING LAND PREPARATION FOR THE SECOND RICE CROP, ILOILO, 1977

Factors Considered	Farmers Reported[a]		
	No.	%	Rank
Power Constraint[b]	33	87	1
Labor availability[c]	18	47	2
Cash Available	18	47	3
Non-farm Jobs[d]	5	13	4
Off-farm Work[e]	4	10	5
Others	4	10	6

a Total number of responsents = 38

b This is related to both the farmer's practice of preparing the land by himself with one carabao, and also the unavailability of threshers and power tillers in the area.

c They are not hiring laboreres to prepare the land.

d Farmers involved in non-farm activities like tricycle driving, buying and selling, etc.

e Farmers working in other people's fields.

CHAPTER 3

EVALUATION OF TIMELINESS IN CROP INTENSIFICATION: METHODOLOGICAL FRAMEWORK

3.1 Introduction

This chapter discusses the methodology used in the study in two sections:

(i) Simulation model[1] and

(ii) economic evaluation component.

The objective of using a simulation model is to predict the productivity estimates of a rainfed rice crop based solely on rainfall records for 31 years together with the management decision rules of the farmers, for economic analysis. The model attempts to capture the determinants, both the physical and management factors, that account for the differences of yield in these areas. The bio-physical component that deals with the growth and development of the crop is reviewed briefly, while the management criteria and decision rules are discussed in more detail.

The section on economic evaluation includes the technique of partial budgeting, the use of shadow wage rates for labour, the measurement of inputs, charges on the use of cash inputs, factor and output prices and the criterion of profitability.

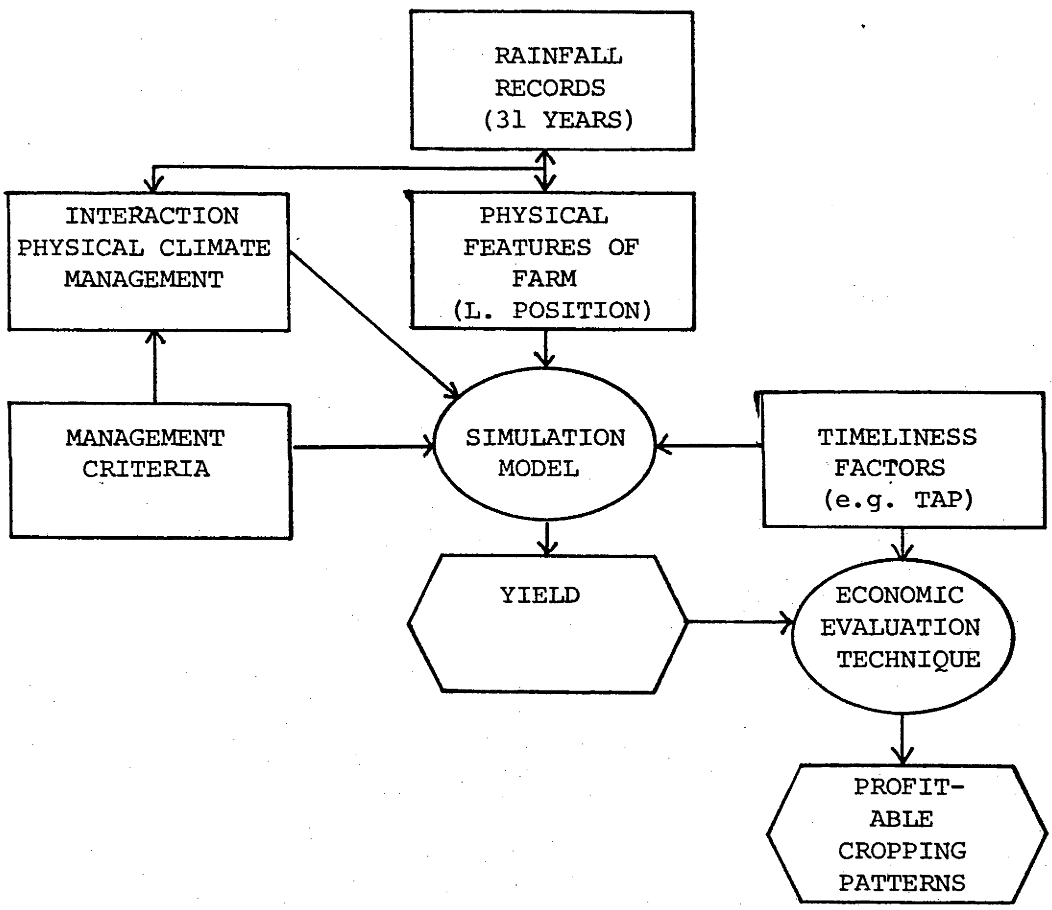
Crop modelling and partial budgeting used in the study are collectively an approach to investigate specific rice production problems that require both the assessment of the interaction of

1 For detailed discussion, see Angus and Zandstra (1980).

environment-management factors in relation to the farmers' present use and availability of resources. Conceptually, the approach is illustrated below (Figure 3.1).

FIGURE 3.1

CONCEPTUAL DIAGRAM OF THE APPROACH IN THE STUDY



3.2 The Simulation Model

This section is partly drawn from research papers written by J.F. Angus who developed the model used in the present study.

The model has been the result of studies at IRRI and the Iloilo outreach site in collaboration with the fellow researchers concerned with evaluating the performance of cropping patterns in rainfed areas.

Technically, the simulation is trying to duplicate the conditions that exist in the real world (Paris and Price, 1976). Simulating crop productivity, (where a crop is conceived as that which undergoes bio-physical growth and development in several stages conditioned by management decision rules made by farmers), is the main interest of this modelling technique. If these interrelationships of environment and management factors and their influence on yield can be modelled and expressed in quantitative terms, the effects of alternative courses of actions on the part of the farmer can then be evaluated in economic terms.

As a general strategy, a crop model should focus on the factors responsible for most of the yield variations (Angus and Zandstra, 1980). The above strategy will reduce the deficiency of the limitation that not all factors considered endogenously and exogenously determined can be incorporated. Pruning down to the most relevant factors can be aided by experimental findings on the problem in question, but again because of the dynamics of changing environmental conditions, one has to realize its implication to the validity of the model. The virtues of simulation models in research have been argued previously (e.g. Nix, 1976, de Wit, 1978).

The earliest example of a simulation model for rainfed rice is described in an unpublished report by Slatyer (1954) using rainfall records for Darwin, Northern. Based on these records and scores of assumptions about seeding dates, soil moisture recharge and release patterns together with evapotranspiration rates, the growing season was estimated to be adequate in that area for a rice crop in four out of five years.

This work provided a basis for Chapman and Kinimonth (1972) to produce a model that estimated the probability of crop failure for rainfed rice grown in the same region. Wickham (1971) developed a rice crop simulation with an original multiple linear regression model with emphasis on stress days. Yield was predicted from stress days using a multiple linear regression equation which used separate totals for stress days in the vegetative and early reproductive growth stages (panicle initiation to heading) together with an interaction term between the effects of vegetative stress and the rate of fertilizer nitrogen.

Other rice problems have been approached using crop modelling. For example, (Wickham, 1973; Ahuja, 1974; Iwaki, 1975; Paris and Price, 1976 and van Kuelen, 1976, 1978).

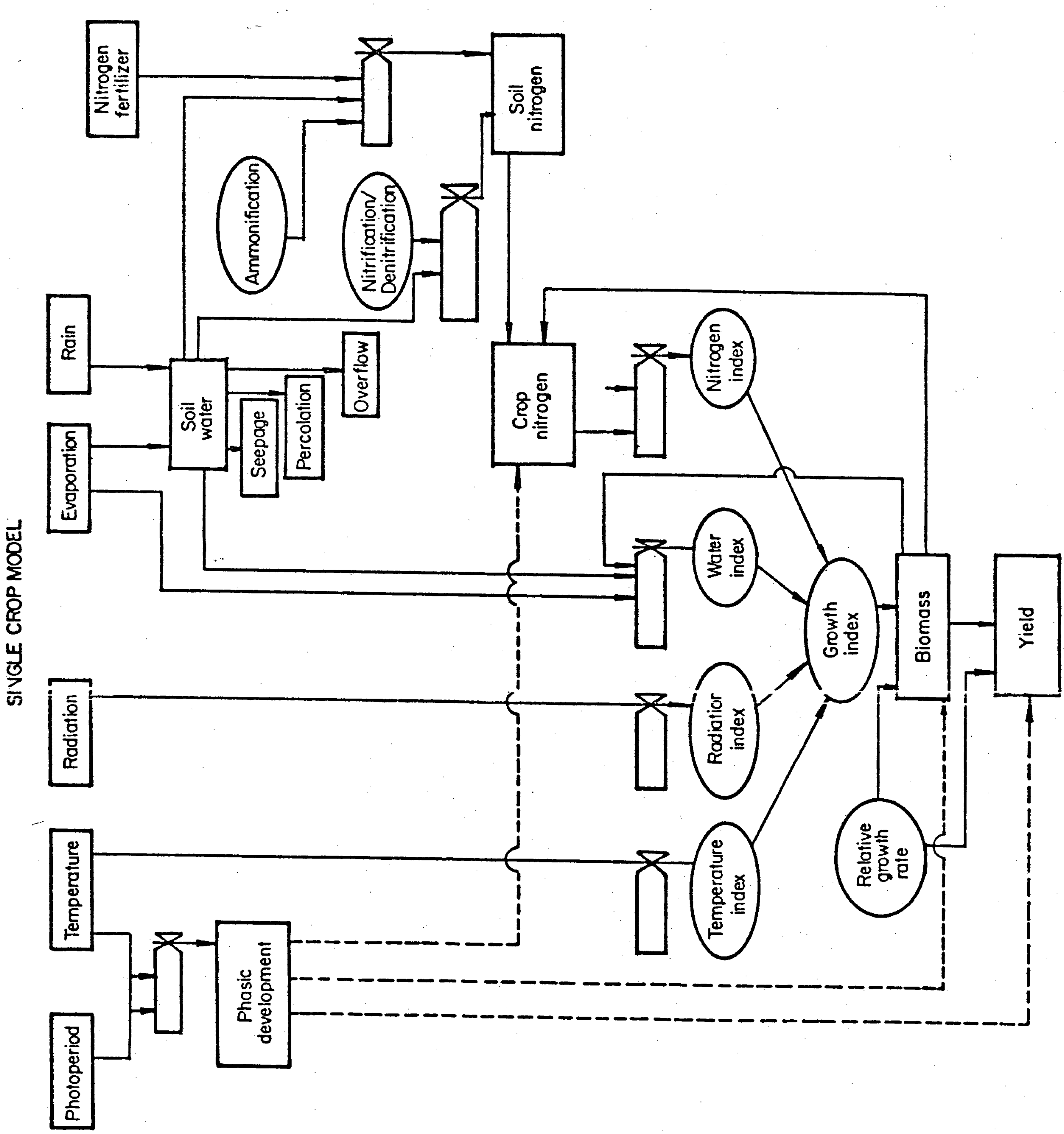
3.2.1 Bio-physical Components

The bio-physical aspect deals primarily with the growth and development of the crop as it is affected by temperature, solar radiation, nitrogen status and the moisture condition of the soil (Figure 3.2).

Firstly, temperature and photo period determine the phasic development of the crop. This is mainly because they both affect the duration of rice's life cycle, where temperature affects the duration of all phases of cultivars; and photo period affects the duration of only the pre-antheses of some cultivars (Vergara and

FIGURE 3.2

FLOW CHART OF A SIMULATION MODEL OF FLOODED PUDDLED SOIL



Chang, 1976). In the Philippines, temperate climate crops develop rapidly because high temperatures speed up the biological clock and reduces the flowering and grain filling periods (Zandstra, 1979; Monteith, 1978). The affect of temperature in the humid tropics is considered to be a non-linear equation that gives a better fit than a straight line, which suggests that the day degree or heat unit system which is based on the assumption of a linear response of development is inappropriate (Angus and Zandstra, 1980). Temperature affects growth as well as phasic development but the narrow range of temperature in the humid tropics which is favourable to rice growth means that temperature is not an important factor for rice growth in this study.

Crop physiologists stressed the effects of solar radiation on crop production. Yoshida (1978) reported that solar radiation is related to paddy potential evapotranspiration and a guide for effective nitrogen application. The most commonly used model for estimating solar radiation is in the form (Tamisin and Zandstra, 1980):

$$Q_t = Q_o \ (a + b \ n/N)$$

where Q_t = solar radiation in langley/day;

Q_o = extra-terristrial radiation in langley/day;

n/N = % possible sunshine; and

$a + b$ = are derived constants.

Some studies suggest that variability of solar radiation was not dependent on sunshine duration alone but on some other factors such as month of the year and the distribution of rainfall (Tamisin and Zandstra, 1980). In Angus' model, solar radiation is expressed as

cal/cm^2 per day which is shown in Figure 3.3. From the existing meteorological data available for solar radiation in Iloilo, it is a limiting factor in the wet season.

Thirdly, the water condition of the soil over time greatly influences the performance of the crop. Although rainfall dictates water availability, the landscape position of the field can modify the water regime substantially (IRRI Annual Report for 1979). This is directly related to the duration of standing water and losing it at various stages of the rainy season. In this respect, the water balance model is affected both by rainfall and actual evaporation separation (Figure 3.4).

The water balance model is given below:

$$PW_i = PW_{i-1} + R_i - E\ crop_i - E\ soil_i - SP_i - OF_i$$

where PW_i is perched soil water content in mm;

SP_i is seepage and percolation in mm/day;

OF_i is overflow from the field in mm/day;

E crop is transpiration from the crop; and

E soil is soil evapotranspiration.

In this version of the model the water balance is of a single levelled and bunded field in rainfed lowland conditions. Because of the critical availability of water in rainfed areas, the success of double cropping rice is a function of the immediate availability of water in the root zone especially in the vegetative stage of the crop. Availability of water is in turn affected by the following:

(i) Soil evaporation.

FIGURE 3.3

COMPONENTS OF THE GROWTH INDEX IN RELATION TO RADIATION, TEMPERATURE AND THE RATIO OF ACTUAL TO POTENTIAL EVAPORATION (E_A/E_T)

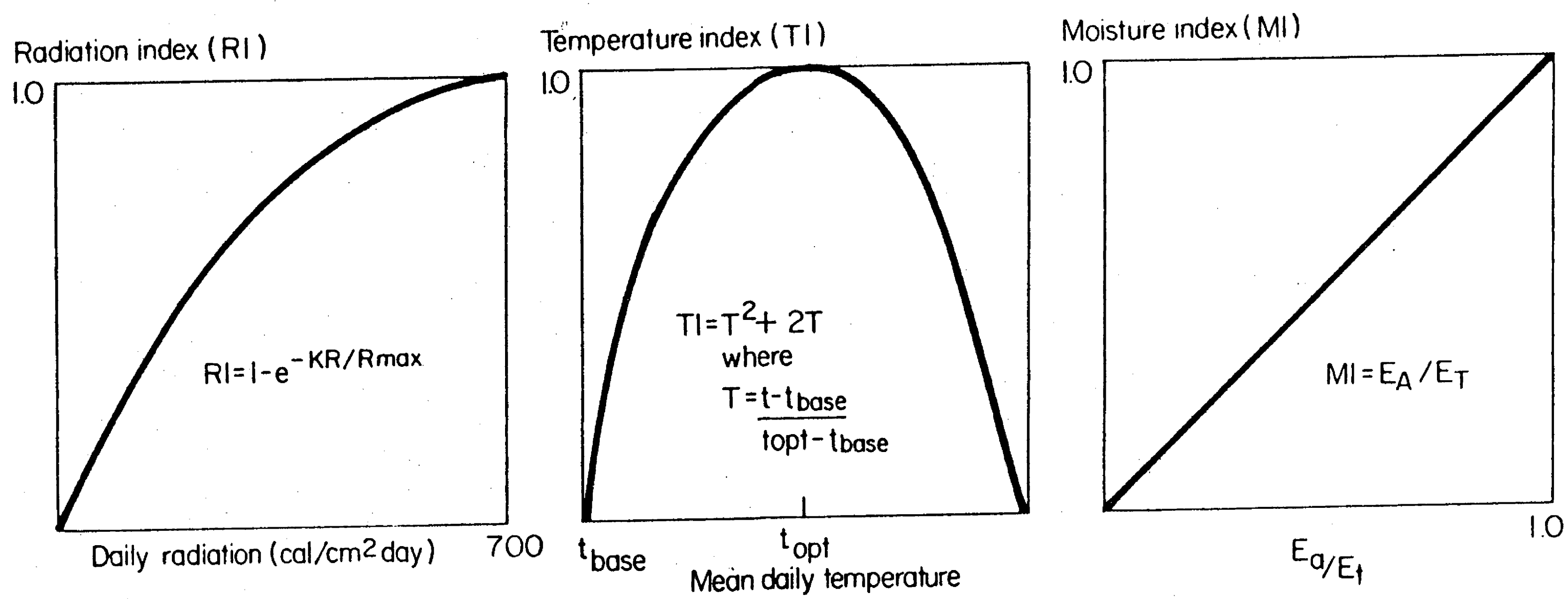
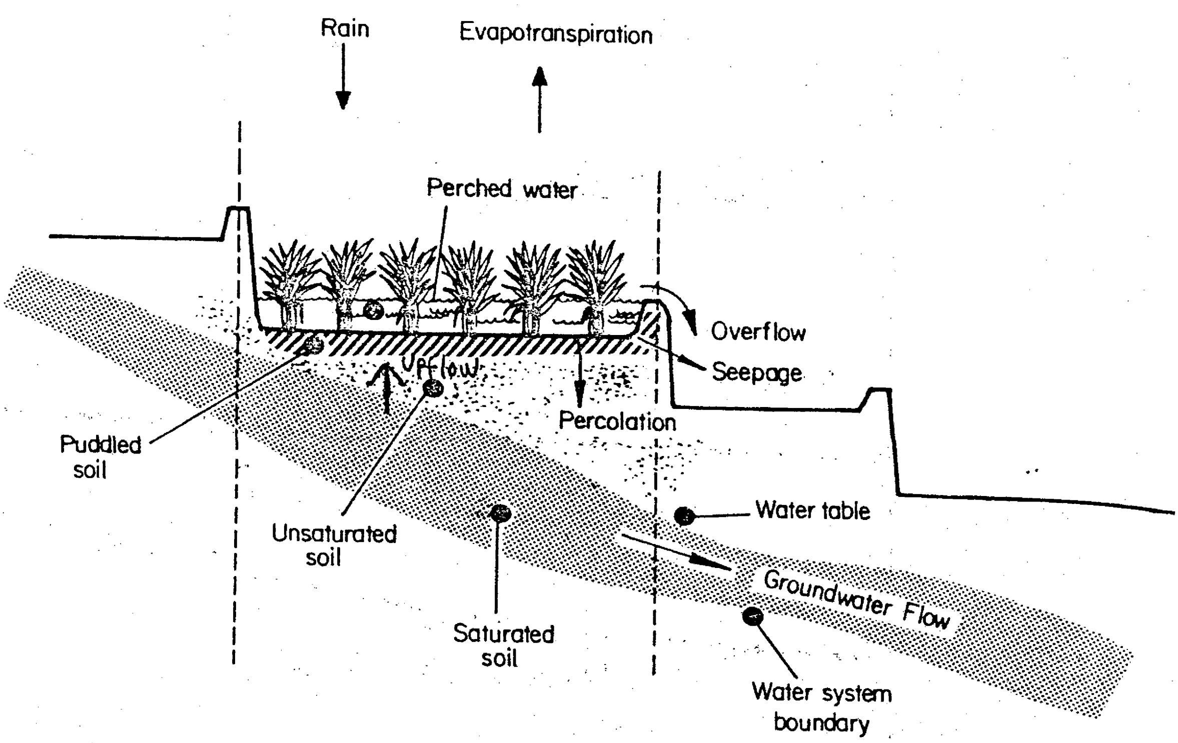


FIGURE 3.4

COMPONENTS OF WATER BALANCE IN A TOPOSEQUENCE



(ii) Transpiration.

(iii) Seepage.

(iv) Percolation.

(v) Lateral flow.

Soil evaporation refers to the loss of water to the atmosphere from the field. The rate of water loss will depend on whether the soil surface is wet or dry, where for a drier soil surface the rate is affected by the water movement to the soil surface from the subsoil. Transpiration on the other hand, refers to the loss of water through the crop itself. The conventional technique for measuring transpiration is to assume that it equals the pan evaporation when water is adequate. In wet land rice fields, Bolton (1980) indicated that the pattern is that the ratio of actual to potential transpiration falls as the soil water contest declines.

Seepage and percolation are defined as the lateral flow of water from one field to another, and the vertical downward movement of water in the paddy respectively. Although they are both measured together, empirical findings at the site show that because of the effect of landscape position separate measurements should be made. A side slope position, for example, will effectively have a faster rate of seepage than percolation, where in the simulation of yield of a second rice crop, it is expected that yield in this position is relatively lower compared to either plateau or plain. Lateral or ground water flow which at this stage is considered difficult to measure is assumed to affect water availability across landscape positions in the toposequence. There are indications that the nature of the puddled condition of the soil is more relevant. Unpuddled, steep and high fields lead to a faster groundwater flow.

Lastly, the nitrogen status of the soil influences the uptake of nitrogen in the form of NO_3^- and NH_4^+. The level of these forms of N in the soil depend on the rates of fertilizer input and also on the rates of loss or transformation by the process of nitrification/denitrification, volatilization and uptake. The model incorporated these processes to capture the effect of the level of nitrogen available for crop requirements.

At this point, discussion on the growth index GI which relates growth to the various environmental factors discussed above. Fitzpatrick and Nix (1970) quantified the relationship of radiation stress, temperature and moisture stress or a function of the ratio of actual to potential evapotranspiration. The growth index they developed explained the relationship between the crop growth and environmental parameters. This can be expressed as:

$$GI = RI \times TI \times MI$$

where RI = the radiation index;

TI = temperature index; and

MI = the moisture index.

There is no <u>a priori</u> reason for favoring a multiplicative equation for the growth index. However, this form of index has been used in a number of biological applications such as forest growth, milk yields and bird migrations, and has given a good fit of observations (H.A.Nix, pers. comm., 1981). The basic limitation of the equation is when one factor is limiting where it is scaled 0, the GI is zero which means that there is no growth at all; however, in reality one can expect that even when there is no solar radiation, growth exists even at a limited level. Therefore the weight of each factor is mathematically equal and thus the interaction of each of them is simulated by its product. Each of the three environmental indices is scaled between 0 and 1 and when each is non-limiting GI is 1. When more than one factor is limiting, the effect on GI is dominated by the lowest of the three indices.

The effect of the crop nitrogen status is introduced into the GI by postulating a maximum crop nitrogen status (MCNS) at which growth is not limited to nitrogen. This was done by estimating the maximum nitrogen status which varies throughout the development of the crop in the analyses of crops grown with luxury applications of nitrogen fertilizer. The cumulative uptake and the computed biomass then measures the actual proportion of nitrogen, where the degree of nitrogen stress is estimated from the ratio of actual nitrogen proportion in the crop tissue to MCNS proportion for a given state of development. Having introduced the nitrogen stress, then the GI is redefined as:

$$GI = RI \times TI \times MI \times NI$$

Under experimental conditions, the growth index as contributed by each environmental parameter discussed can give a potential yield of biomass of about 15 tons per hectare. In this study, the yield potential of the biomass is assumed to be lower than that of the experimental biomass level because the simulation model is based on farm conditions as local management constraints were introduced. After a lengthy tuning up of the parameters, we come up with a yield potential of biomass of 11 tons per hectare. This yield potential is initially controlled by the relative growth rate at the beginning of the crop cycle as shown in the growth of crop biomass in the Gompertz equation (Thornley, 1976):

$$\frac{dw}{dt} = \alpha \, W_c^{-\beta t}$$

where W is biomass;

t is time; and

α and β are constants with α equivalent to the relative growth rate at the beginning of crop cycle and β defining the decrease in α with time.

3.2.2 Management Components of the Model

The virtue of any simulation model trying to duplicate what is happening in the real world would depend not only on an established functional relationship of crop growth but also to a great extent on the management component of how these environmental factors are tackled by farmers. Consider a rainfed crop that relies on rainfall for water requirements over the growing period; to maximize its use farmers would resort to practices that favour the achievement of that objective. Knowledge of this set of information certainly would help the interaction of these factors positively and minimize the basic problem of any simulation approach, that is, irrelevant input to meaningless output.

An intensive farm-household record keeping (FRK) study conducted by IRRI and the author's experience working with the farmers in that area are the main thrust of verifying relevant variables needed for management decision rules. One of the limitations of this aspect of activities is obviously the tendency to ignore greater variability between one farm to another by using the results of an average farm.

The objective is to simulate the yield of rice by incorporating the management criteria believed to exist strategically from the farmers' view-point.

Firstly, the choice of cropping patterns from many alternative ones requires a careful selection and we used the following:

(i) Cropping patterns which represent the dominant patterns presently planted by farmers in the area, WSR-WSR-Mung.

(ii) Inclusion of potential patterns from experimental trials, DSR-TPR-Mung.

(iii) Patterns reflecting socio-economic constraints like availability of transplanters for second crop of TPR, WSR-TPR-Mung.

Secondly, establishment of each type of rice planting has specific rules to follow. For example, DSR is planted in unflooded soil conditions with definite cut-off dates. It is planted earlier than WSR and TPR, generally starting from the 1st week of May to the end of May depending on the onset of the rain. Both WSR and TPR are planted in flooded conditions although the former is established a little earlier than the latter, because TPR needs more surface water for its characteristic planting scheme.

Thirdly, landscape position affects the movement of water, either vertically (percolation) and laterally (seepage). It is assumed that in percolation and seepage, the rate is faster for side slope down to plateau and less likely in plain positions. This has a great impact on the establishment of a second crop, where it is expected that crops are more likely to be successful on the plain than on the plateau and least successful on the side slopes. The relationship has been evident in experimental cropping pattern testing. The simulated rates of water movement have been adjusted to represent the relationship. The yield of the crops planted in these positions are hypothesized to follow the same trend particularly in the second crop, while in the first crop, it is not expected to vary significantly because of more or less adequate water availability as shown by the rainfall pattern.

Fourthly, the provision of replanting crops which failed to establish is introduced in the model so as to capture the effect of variability of rainfall. There are years where rainfall patterns are considered to be erratic, i.e., early onset then followed by a dry spell after a couple of weeks. In this case, DSR is subjected to drought conditions around late of May, and the model is directed to replant first WSR if time permits, then TPR if there is adequate water after the dry spell. The obvious consequence of replanting is on the planting of a second crop because it may be too late to do so.

Fifthly, the cut off dates after which a second rice crop is assumed to be too risky has been incorporated as a decision rule.

From survey studies, farmers have indicated their latest feasible planting dates for a second rice crop by landscape position (Table 3.1). This is an important element for avoiding many failures and low second crop yields, by allowing the model to plant second rice crops after the estimated cut-off dates.

TABLE 3.1

FARMERS' CONSENSUS ON THE APPROPRIATE TURNAROUND PERIOD BETWEEN TWO RICE CROPS BY LANDSCAPE POSITION IN RAINFED LOWLAND RICE IN ILOILO 1977

Landscape Position	Number of Days	Turnaroud Period (Weeks)
Plateau	16	2.3
Sideslope	14	2.0
Plain	21	3.0
Waterway	26	3.7

Finally, the assumption of "intermediate level of technology" needs to be discussed. This refers to the amount of input used, for example, the level of nitrogen applied to the crop. The quantity of inputs will affect productivity and thus economic evaluation of the patterns tested is directly related to its use. The intermediate level in this respect is the 'average' amount of material inputs presently used by the farmers. The model can use experimental levels of N (100 Kg N/ha) compared to the farmers existing use of about 40 Kg N/ha. The use of the farmers' level of input is more for empirical reason, as it is more applicable to the real life situation.

3.3 Budgeting Techniques

Partial budgeting is used to evaluate a proposed change in the overall system. In this study, it is used to assess the profitability of the cropping patterns simulated by specifying the length of turnaround periods.

There are two kinds of budgets calculated namely:

(a) Time budgets.

(b) Profit budgets.

3.3.1 Time Budgets for Carabao-Drawn Implement in Land Preparation (TBC)

A time budget is a necessary first step in calculating the resource requirements, i.e., additional hours of draught power required in TAP, and possible time saving, i.e., shortened TAP as a result of reducing the delay of land preparation. The use of historical activity analysis of record-keeping farmer-cooperators for the period of five years was appropriately considered to estimate resource requirements in terms of man-day equivalents of physically finishing certain farm activities.

The physical requirements needed in the estimation procedure are as follows:

(i) Average man-day to prepare a hectare of land. The figure was obtained from the activity analysis of FRK 1975-78. Appendix Tables A.1, A.2, A.3, A.4 and A.5 are the estimates of draft power and other farm operations like planting, care and control requirements per unit area of land. It should be noted that there is a tendency for downward bias of the figures because reports of the farmers include only the physical requirement of each actual operation and do not include the time of preparation and other disruptions (rest for example) during the activity. However, it is not considered a major limitation for this study because it is not significantly large enough to alter the appropriateness of the resource requirement. Furthermore, averaging a farm activity over a wide range of physical conditions entails a great deal of gross error in calculation, however, adjustments and careful assessment of the activity are well taken into account, i.e., checking on the consistency of operations in terms of operation of the activity (the same number of plowings, harrowings for example).

(ii) Number of carabao/farm - Almost every farm-household in the area owns a carabao as the major source of draft power. In budgeting the required time to prepare a hectare of land using the 25 days average requirements, a 10 day TAP implied that the family supplied 10 days and the remaining 15 days were contributed by hiring additional carabao.

(iii) Average farm size - Over a period of five years of study, farm size on average is 1.4 hectares. Ownership and tenure status of the farm is not considered an important variable in this study, and it is assumed that the tenants have the right to decide the farm activities independently of the land owner.

(iv) Number of available family workers per farm - It was surveyed that the number of family workers is 2.9. This should not be misinterpreted as the potential labour source that in the absolute sense, the available family workers who are living and working on the farm. There are of course indications that some operations are preferably performed by the farmer himself like land preparation, while on the other hand, family members were doing planting, weeding and other less taxing activities.

(v) Harvest operations - Since the physical requirements of harvesting the rice crop is more of a function of yield rather than per unit area, it is calculated by using a sharing system for harvesters. To get the cost of harvesting a hectare of rice in this area, 1/6th of the gross rough palay was paid to the harvester. Therefore, no time budgets were prepared for this operation because of the above phenomenon.

The components of the time budgets used are as follows:

Labour inputs of:

- Land preparation
- Planting
- Weeding
- Herbicide application

These inputs differed significantly as TAP changes in three cropping patterns selected. Land preparation was found to vary between the type of crop establishment. Farmers claimed to prepare the land thoroughly for TPR compared to WSR and DSR respectively. This was shown also by the labour requirements obtained from historical activity analysis. Furthermore, the timing of land preparation over the rainfall period indicated that DSR was planted early, WSR and

TPR when there is standing water in the field. DSR were seeded after germinating rain while WSR is more or less at saturation level and TPR when the field is fully saturated.

Planting operations differ between DSR, WSR compared to TPR. While DSR and WSR required about four man-days per hectare, TPR required 25 man-days. The basic reason is due to the need for transplanting the seedlings in rows for TPR while DSR and WSR can be easily broadcast. In weeding operations, as a result of less thoroughness in land preparation, weeding problems were more serious in DSR and WSR than TPR. Care and control requirements were higher in DSR and WSR because of greater competition between the crop and the weeds for soil nutrients. On the other hand, since TPR was in rows, controlling the weeds is easier. Because of this relationship, herbicide applications were higher than in TPR.

It should be noted that the use of fertilizer for all crops was the same, at the rate of farmers' use of around 40 Kg N per hectare. This is more or less termed as "intermediate technology" where the rate of usage is below the experimental (100 Kg N) but higher than a low input crop (10-20 Kg N). The use of average figures can be inappropriate because of wide variations of usage, but practically it is more significant to avail of it to represent 'typical' farmers in the community.

To illustrate how the time budgets were used is given below:

Years	: 1949-79
Cropping Pattern	: WSR-WSR-Mung
Landscape Position	: Plateau
Turnaround Period	: 10 days
Simulated Yields	: Crop 1, Crop 2, Crop 3

Crop 1 - WSR

Labour Inputs	Requirement (md/ha)	Source Family	Source Hired	Total
Land Prep.	25	10	15	25
Planting	4	4		4
Weeding	15	15		15
Herb App'n.	2.5	2.5		2.5
Harvesting	1/6th of simulated yield x Py			

Note: Carabao days is 6 hours/day while the rest are 8 hours/day.

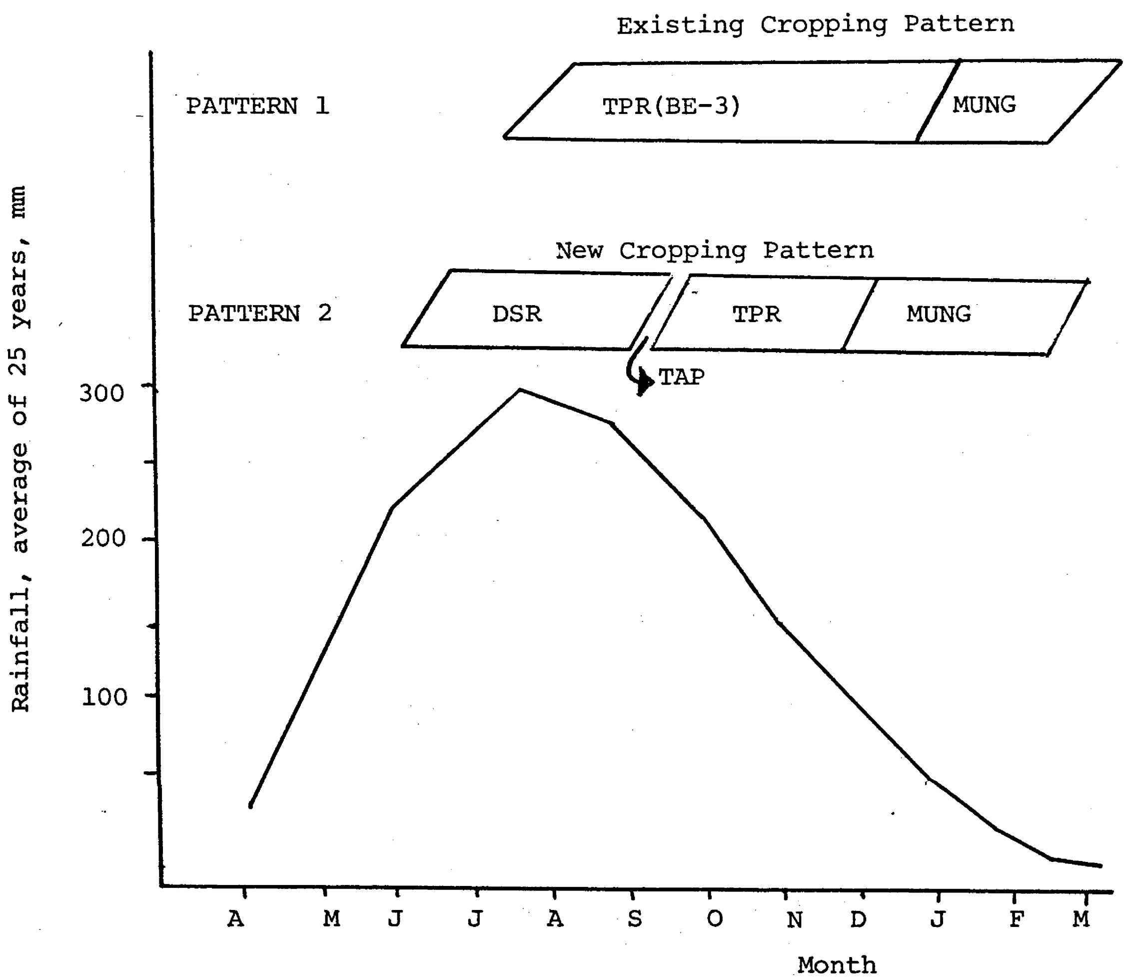
The requirements from historical activity analyses were used to determine whether the farm needs to hire carabao if the turnaround period was reduced from the average TAP of 23 days to 10 days. Since the farm has only one carabao he has to hire an equivalent of 15 may-days of draught power to finish the land preparation in 10 days. The other operations except for harvesting were performed by the farmer himself and his family members.

Crop 2 and Crop 3 have different sets of labour requirements for all farm operations. Totally, the three crops in a pattern with a specified TAP is evaluated in terms of timeliness of establishing the crops early enough to make use of available moisture and/or avoiding drought conditions particularly for second and third crops. This can be shown graphically in Figure 3.5.

Pattern 1 has been the most common cropping pattern planted by the farmers for the last five decades, while pattern 2 is the new pattern introduced by IRRI CSP in the area. The great possibility of planting three crops will depend on the availability of rain water and the timeliness of establishing the crop early. One of the main problems is the length of turnaround period before the first crop and before the second crop. Again, landscape position

FIGURE 3.5

AN EXAMPLE OF EXISTING AND NEW CROPPING PATTERNS IN ILOILO



contributes greatly to the limitation because the availability of water in the field is more a function of not only rainfall but the position of the field in the toposequence. For a TAP of 20 and 30 days, land preparation was performed with 20 carabao-days supplied by the farmer, while 5 days were from hired laborers. The basic difference from 10 TAP was that more hired carabao-days were used compared to 20 and 30 TAPs because the farmer can work to fill up the requirements; however, it is hypothesised that the performance of crops is affected since establishing the crops was considerably late.

3.3.2 Time Budgets for Tractor-Drawn Implements for Land Preparation

The use of power tillers can substantially shorten the time spent on land preparation, thus implying a considerable reduction in the length of turnaround period compared to carabao-drawn implements. The question of availability of power tillers at the time when they are needed is not the major concern of this study since Juares and Duff (1980) reported that proliferation of these has been dramatic in relation to the introduction of high yielding varieties and double cropping of rice. Moreover, investigation of a farmer owning a power tiller and the social impact to the community has been ignored in this study to limit the problem of evaluating the use of power tillers to terms of timeliness and profitability. It is assumed that the farmer can hire a tiller at the existing custom rate either from farmer neighbours or from private land owners living in the town proper.

Budgeting the time needed to finish a hectare of land required assumptions as follows:

(i) An IRRI-type power tiller (7 HP) operating 2.3 times faster than the carabao-drawn implements (Orcino and Duff, 1977).

(ii) Conversion of (i) from the average length of land preparation using the carabao is:

$$PTR = \frac{\left(\frac{Q}{2.3}\right)}{C}$$

where PTR = power tiller requirement;
Q = average time required to prepare land by carabao;
2.3 = factor; and
C = carabao hours/day used by Orcino and Duff.

Substituting values:

$$PTR = \frac{\frac{125 \text{ hours/ha}}{2.3}}{7 \text{ hours/day}}$$

$$= 7 \text{ days per hectare}$$

The average length of turnaround period was 23 days and therefore power tiller use can reduce the delay and to evaluate the trade off of using it over carabao is then in order. Simulating the yield of crops by specifying a seven day turnaround period over different landscape positions is the next step in estimating profitability.

3.3.3 Profit Budgets

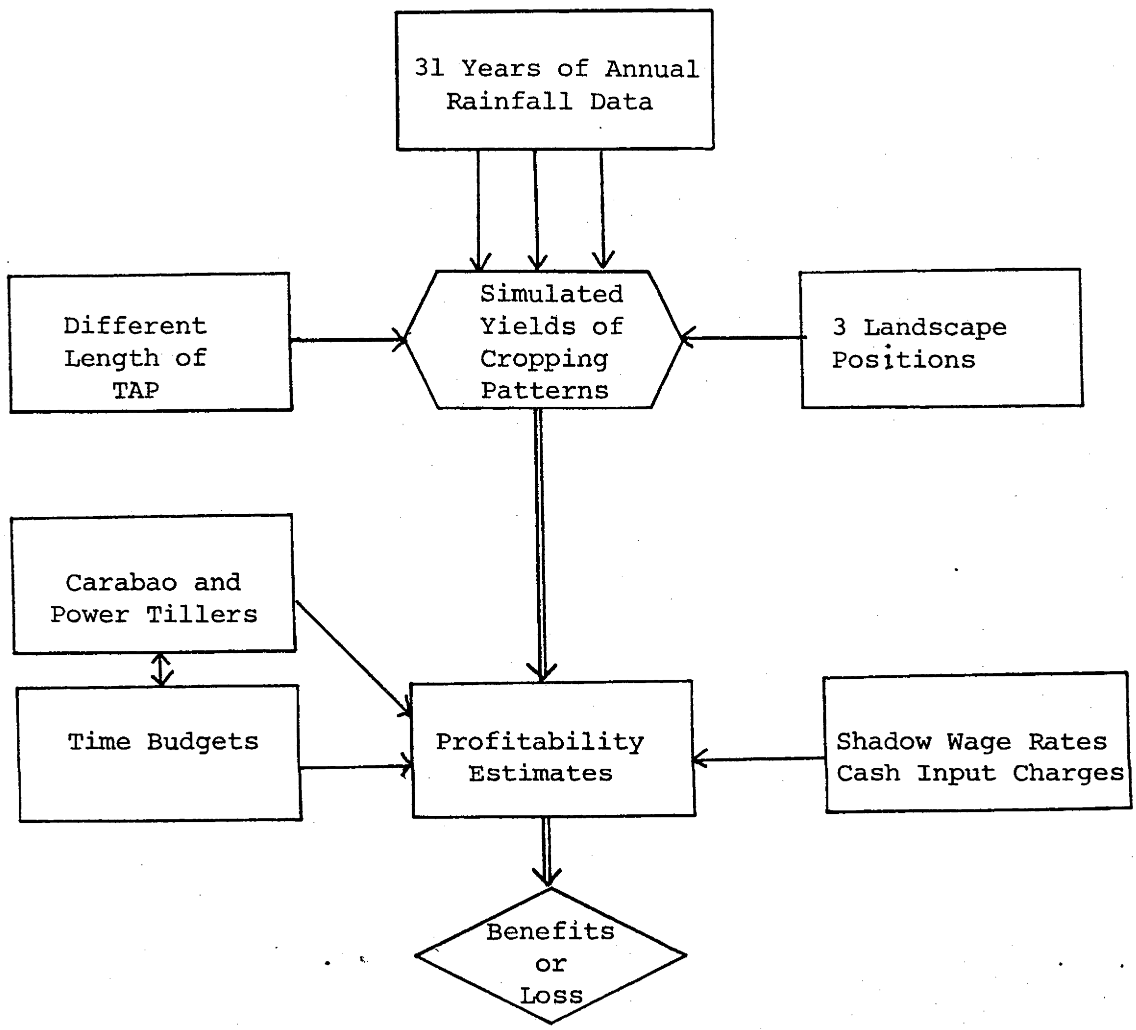
This section is one of the major components of analysis in the present study. The evaluation of the profitability levels of cropping patterns is aimed at determining the benefits derived in reducing the length of turnaround period by comparing the use of carabao and power tillers. The reduction in terms of the time saved by planting the crops early can be the key link to a successful crop intensification. It is hypothesized that the shorter the TAP, the greater is the profitability of cropping patterns. With the availability of 31 years of annual rainfall data of Iloilo, profitability estimates of cropping patterns for different lengths of TAP in three landscape positions are calculated. This is presented conceptually in Figure 3.6.

The steps taken in profit budgets are as follows:

Step (i) - Simulate the productivity of cropping patterns by landscape position using

FIGURE 3.6

SCHEMATIC DIAGRAM OF PROFIT BUDGETS



Thirty one years of rainfall data and specifying TAP.

For example:

Cropping Pattern	=	WSR - WSR - Mung
TAP	=	10 days
Landscape Position	=	Plateau
Simulated Yield	=	Crop 1, Crop 2, Crop 3
Explicit Dates of Operation	=	Planting and Harvesting

Step (ii) - Calculate the time required (time budgets) separately for carabao and power tillers for land preparation and other relevant operations. For each (i), there are corresponding physical requirements of labour inputs, i.e.:

$$TB_c = FL_j + HL_j$$

where TB_c = time budgets for carabao drawn implements;

FL = family labour;

HL = hired labour; and

j = operation

Step (iii) - Calculate the additional cost components of each crop in the pattern using (ii) and shadow wage rate (SWR), charge on the use of cash inputs (C) and material input prices (MIP). The cost component is divided into three:

(a) Pre-harvest labour costs (PHL).

(b) Material input costs (MIC).

(c) Post-harvest labour costs (PHC).

Pre-harvest labour costs include land preparation, planting, care and control, MIC are composed of seeds and herbicides while HC are the value of the yield shared by harvesters.

Mathematically:

$$PHC = \Sigma\ L_{ij}\ SWR_{ij}$$

where Li = labour inputs;

SWR = shadow wage rates;

j = activity or operation; and

i = input of activity

while,

$$MIC = \Sigma\ M_{ij}\ MIP_{i}$$

where Mi = material inputs; and

MIP = material input price

and,

$$HC = 1/6\ Y_s \times P_y$$

where Y_s = simulated yield; and

P_y = farm gate commodity price

Thus the additional variable cost (AVC) of a cropping pattern is equal to:

$$AVC = \sum_{l=1}^{3} (PHC_i + MIC_i)\ CC + HC_i$$

where PHC is the preharvest costs;

MIC is the material input costs;

CC is the charge on the use of input; and

HC is the harvesting cost

Step (iv) - Calculate the gross revenue of the cropping pattern, i.e.:

$$GR = Y_{s1} \times P_{y1} + Y_{s2} \times P_{y2} + Y_{s3} \times P_{y3}$$

where Y_s = simulated yields; and

P_y = price of the crop

Step (v) - Determine the additional return (AR) of the cropping pattern, i.e.:

$$AR = \sum_{i=1}^{n} GR_i - \sum_{i=1}^{n} AC_i$$

Step (vi) - Determine the ratio of additional return and for additional costs each cropping pattern by TAP and landscape position:

$$B/C = \frac{AR_{ij}}{AVC_{ij}}$$

where AR = additional gross return;

AVC = additional variable cost;

i = landscape position; and

j = TAP

Profit budgets for power tiller-drawn implements is given below:

PTC = 7 TRACTOR DAYS PER HECTARE = MRHT x CC

where PTC = power tiller cost;

MRHT = market rate of hiring the tractor; and

CC = charge on cash use

Then, to compute for additional return:

AR = GR - PTC + other additional costs

where GR = gross revenue; and

PTC = power tiller cost

3.3.4 Shadow Wage Rate of Labour Determination (SWR)

Determining the relevant wage rate for labour in this analysis is not a straight forward task. Two alternative points of view can be taken in this regard. One would be to identify the prevailing wage rate while the other would be to derive the true market wage rate which reflects the nature of labour use and availability. The latter approach is taken in this study which considers importantly the variation of labour use and availability in terms of its peakedness and slackness as shown in Table 2.5. This information is needed to compute the shadow wage rate of labour as follows:

(i) Family labour used (FL) measured by man-days per farm. From FRK, family labour used is obtained for one year recorded on a monthly basis (Table 3.2). These figures are the amount of work spent by members of the family including the farmer in order to know their contribution to total labor use.

(ii) Hired workers used (HW) measured by man-days per farm given in Table 3.2. This set of information is the amount of work spent by a hired labourer employed in the farm. Like FL, there is the average use obtained from 45 farm-households in Iloilo. Both FL and HW are regardless of operation and sex and were obtained by keeping a record of farm-households.

TABLE 3.2

MONTHLY LABOR UTILIZATION OF HIRED AND UNPAID FAMILY LABOUR ON THE FARMS OF 45 ECONOMIC COOPERATORS

	Labor Use (Mandays)				
	Family[a]		Hired		Total Days
	Days	%	Days	%	
April	4.2	82	0.9	18	5.1
May	11.9	83	2.5	17	14.1
June	12.9	66	6.5	34	19.4
July	18.3	44	23.6	56	41.9
August	9.3	43	12.3	57	21,6
September	12.3	32	26.5	68	38.8
October	10.0	37	16.7	63	26.7
November	7.9	50	7.9	50	15.8
December	6.7	25	20.4	75	27.1
January	6.8	24	21.9	76	28.7
Total	100.3	42	139.2	58	239.5

a Family labor includes operator, wife, children, and also exchange labor, which is all unpaid.

(iii) Imputed wage rate (IWR) in terms of ₱/day. As shown in Table 3.3, IWR are obtained by asking farmers how much they pay for a day's work by operation and were recorded in their farm-household expenditure items. The rates

TABLE 3.3

STANDARD RATES USED FOR IMPUTING FAMILY LABOR COSTS, OTON AND TIGBAUAN, ILOILO

	₱/day	Rate/hour
Rice Works:		
With Animal		
Plowing	10.00	1.25
Harrowing	10.00	1.25
Furrowing[a]	10.00	1.25
Levelling	15.04	1.88
Without Animal		
Fixing - clearing the Bund	4.96	0.62
Pulling and Bunding	4.96	0.62
Transplanting and Replanting	4.96	0.62
Fertilizer Application	4.96	0.62
Spraying Pesticides	4.96	0.62
Weeding	4.96	0.62
Harvesting and Post-harvest[b]	4.96	0.62
Non-rice Crop Works:		
Hilling-up	10.00	1.25
Off-barring	10.00	1.25
Making of Plots	10.00	1.25

a For direct seeded rice planted in furrows, for upland crops like corn and peanut the cost is the same.

b 1/6 of the total produce is the computed cost.

c This is particularly for yambean.

according to farmers are not changing within a year, implying the rates they pay during the first crop remain constant for the next crops in a year. Since in the area the provision of giving meals is not a common practice, which implies that the transaction is strictly financial in nature.

(iv) There is seasonality of labour use in terms of peakedness and troughness, where the former reflects a relatively higher demand for labour and to the contrary during slack periods. To capture this, the principle of probability is used and reflected in the SWR. A low SWR implies slackness and a high SWR indicates peakedness of labour use. Twenty-five man-days per month per farm is used as the probability for paying the full wage rate as available workers are few at this time and expect a low rate during slack periods since excess labour is available. This can be expressed as:

$$SWR = \frac{FL + HW}{25 \text{ man-days}} \times IWR$$

where FL = family labour used;

HW = hired workers used; and

IWR = imputed wage rate

From FRK, during peak periods, the amount of labour use didn't exceed 25 man-days. Furthermore, separation of the SWR by operation involving animals and without animals is done to reflect different rates of payment by operation as given in Tables 3.4 and 3.5.

In this study, labour use is reflected by a one year rainfall pattern. Since 31 rainfall years data were used to simulate the yield of cropping patterns, the static phenomenon is conceived to represent the field operations based on that one year (1976-77) for all 31 years. To illustrate this, all field operations were fixed for each crop basing from the planting dates of the farmers as a function of rainfall and subsequent operation, for that year. For example, if DSR is planted during May, SWR for planting remains the same for all the 31 years.

3.3.5 Charge on the Use of an Input

The value of capital in the form of cash for example will vary as a function of time and its opportunity over the growing period of the crops. It is assumed in this analysis, that all the use of inputs should be charged an interest rate on the principle that whether the farmers saved or borrowed it, the money can earn an interest for using it. The opportunity cost concept is applied in relation to the prevailing market rate of interest calculated at 30 per cent per season on the average. The use of 30 per cent is highly debatable, but farmers in the area indicated that repayment of loans is usually made after harvesting of the crop for a period

TABLE 3.4

SHADOW WAGE RATE OF LABOUR IN OPERATION INVOLVING CARABAO

Month	Family Workers (md/farm)	Hired Workers (md/farm)	Imputed[a/] Wage Rate ₱/day	Full Payment[b/] of IWR (LU)	SWR[c/] ₱/day
	(1)	(2)	(3)	(4)	(5)
April	4.2	0.9	10	25	2.04
May	11.9	2.5	10	25	5.76
June	12.9	6.5	10	25	7.76
July	18.3	23.6	10	25	10.00
August	9.3	12.3	10	25	8.64
September	12.3	26.5	10	25	10.00
October	10.0	16.7	10	25	10.00
November	7.9	7.9	10	25	6.32
December	6.7	20.4	10	25	10.00
January	6.8	21.9	10	25	10.00
February	5.3	9.2	10	25	5.80
March	3.2	2.1	10	25	2.12

Notes: a/ Imputed wage rate refers to the wage paid by farmers to hired labourers claimed to be constant all year round.

b/ In terms of probability, at 25 man/days/farm, it is a 100 per cent chance of getting a job where full payment of IWR is then realized.

c/ $$SWR = \frac{FW + HW}{\text{Full payment at 25 mds}} \times IWR$$

TABLE 3.5

SHADOW WAGE RATE OF LABOUR IN OPERATION WITHOUT CARABAO

Month	FW md/farm	HW md/farm	IWR ₱/day	FP at 20 md	SWR ₱/day
April	4.2	0.9	5	20	1.28
May	11.9	2.5	5	20	3.60
June	12.9	6.5	5	20	4.87
July	18.3	23.6	5	20	5.00
August	9.3	12.3	5	20	5.00
September	12.3	26.5	5	20	5.00
October	10.0	16.7	5	20	5.00
November	7.9	7.9	5	20	3.95
December	6.7	20.4	5	20	5.00
January	6.8	21.9	5	20	5.00
February	5.3	9.2	5	20	3.63
March	3.2	2.1	5	20	1.33

of six months and a great proportion of these borrowings were paid at that rate. The charge on the use of inputs is given as:

Cost components:

(i) Land Preparation Labour Cost (X_1)

(ii) Planting Labour Cost (X_2)

(iii) Weeding Labour Cost (X_3)

(iv) Herbicide Application (X_4)

(v) Seed Cost (X_5)

(vi) Herbicides (X_6)

Thus charge:

$$= \sum_{i=1}^{6} x_i \cdot IR$$

where IR is the interest rate of 30 per cent per season.

It should be pointed out that the harvesting cost is not included in the charges primarily because the farmers are not obtaining any cash to get harvesters since they are paying them on a share basis.[1]

3.3.6 Other Input Prices and Output Prices

The additional input costs of herbicides and seeds for each crop were estimated using the average amount used of each factor by the farmers. The prices of these material inputs were obtained as the farm commodity price paid by the farmers at the time of its use as shown in Appendix Table A.6.

The output prices received by the farmers for rice and mung were similarly obtained as farm gate prices, as shown in Appendix Table A.7. The use of this set of prices is synchronized with the time budgets for each operation as a function of time. As indicated

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1 Harvest cost is subtracted from revenue because it is a factor of yield; it is included as a cost component of AVC (see p.72) but the assumption that the farmers are not obtaining any cash to pay for the harvesters led the author with his supervisors to exclude any charges for the use of their services. Although there is an opportunity cost for the farmer, because it is a nonfinacial transaction, it is excluded in the charge on the use of inputs

earlier the timing of operations is based on a one-year (1976-77) rainfall pattern and prices of inputs and outputs have to be in line with the farm operations mentioned above.

3.4 Riskiness of Cropping Patterns

This section attempts to investigate the riskiness involved in planting two or more crops in a sequence by reducing or prolonging the TAP in specific landscape positions. The approach is rather crude and will be quantitatively improved in future work, however, the emphasis is to analyze the rate of success of growing the crops under the above conditions.

The objective is to determine the probability of the success of patterns planted over 31 years. It is hypothesized that the shorter the TAP, the establishment of cropping patterns is greater in terms of the frequency distribution compared to a longer TAP. Furthermore, more cropping patterns can be established in low landscape positions than in higher positions because of adequate water availability particularly during the second and third crops. The probability rate of success is given by:

$$PRS = \frac{FS}{TN} \times 100$$

where PRS = probability rate of success;

FS = frequency of success;

TN = total number of years (31).

Another approach to investigate riskiness in relation to farmers' adoption is to obtain a probability of getting a specified additional return (i.e., AR of ₱ 2,000/ha) given the cropping patterns planted in 31 rainfall years. The logic behind this is that, assuming an AR level that farmers will be likely to accept, the chances of obtaining it over time can be used as a measure of adoption.

From cumulative frequency distribution of AR by TAP and landscape position,

$$\text{Probability of getting ₱ 2,000/ha} = 1 - \frac{\text{CF at ₱ 2,000/ha}}{\text{N}}$$

where CF is the cumulative frequency at ₱ 2,000/ha;

N is the total number of years (31).

This set of probabilities can be presented and can infer the likeliness of adoption.

CHAPTER 4

ECONOMIC BENEFITS OF SHORTENING THE DELAY IN TURNAROUND PERIOD

4.1 Introduction

This chapter presents the economic benefits gained from reducing the turnaround period of planting three cropping patterns using two techniques of power use in land preparation.

Firstly, simulated productivity estimates are presented and discussed in relation to the cropping strategies and physical environment considered to affect crop performance. Secondly, profitability in terms of the additional returns obtained by reducing the TAP given two alternative techniques of land preparation are evaluated for farmers' adoption. The third section discusses the riskiness of different cropping patterns given the local environmental conditions incorporated in the model.

4.2 Simulated Yield Levels

The simulated yields of the two crops of rice presented in Tables 4.1 to 4.3 are based on the assumption that the crops are grown under the farmers' level of management. This is because the data base and the inclusion of management decision rules were derived from Iloilo research findings and the level of nutrition (40 Kg N/ha) is presently at the farmers' rate of fertilizer application. The predictions given by the model do not include the effects of calamities, such as the outbreak of pests and diseases, flooding damage or lodging. The predicted yields for WSR, DSR and

TABLE 4.1

SIMULATED MEAN GRAIN YIELD (t/ha) AND CO-EFFICIENT OF VARIATION (%) OF DSR-TPR-MUNG BY TAP AND LANDSCAPE POSITION, ILOILO (1949-1979)

TAP (days)	Landscape Position		
	Plain	Plateau	Sideslope
5	3.27 (12)	2.95 (10)	2.64 (21)
10	2.93 (14)	2.74 (16)	2.31 (38)
20	2.84 (27)	2.67 (29)	2.24 (52)
30	2.61 (49)	2.24 (62)	1.91 (74)

Note: ( ) Co-efficient of variation.

TABLE 4.2

SIMULATED MEAN GRAIN YIELD (t/ha) AND CO-EFFICIENT OF VARIATION (%) OF WSR-TPR BY TURNAROUND PERIOD AND LANDSCAPE POSITION, ILOILO (1949-1979)

TAP (days)	Landscape Position		
	Plain	Plateau	Sideslope
5	3.14 (7)	3.09 (21)	2.93 (42)
10	3.05 (16)	2.87 (42)	2.77 (62)
20	2.74 (28)	2.46 (53)	2.31 (68)
30	2.63 (55)	2.25 (64)	2.15 (86)

Note: ( ) Co-efficient of variation.

TABLE 4.3

SIMULATED MEAN GRAIN YIELD (t/ha) OF WSR-WSR CO-EFFICIENT OF VARIATION (%) BY TURNAROUND PERIOD AND LANDSCAPE POSITION, ILOILO (1949-1979)

TAP (days)	Landscape Position		
	Plain	Plateau	Sideslope
5	2.97 (12)	2.86 (18)	2.63 (22)
10	2.83 (27)	2.67 (32)	2.48 (39)
20	2.62 (42)	2.54 (47)	2.17 (57)
30	2.21 (56)	2.12 (62)	1.92 (78)

Note: ( ) Co-efficient of variation.

TPR crops assumed a duration of around 110 days for the IR 36 variety, where the seedlings are assumed to be 20 to 25 days old at transplanting.

From Tables 4.1 to 4.3, there was a consistent relationship between grain yield by landscape position and TAP. Generally, regardless of planting technique, rice crops on the plain performed better than plateau and sideslope respectively. A possible explanation agronomically, is the adequacy of water available to the plant particularly towards the start of the dry season. The plain with a low rate of percolation and seepage tends to have more or less stable yields as partly indicated by the low co-efficient of variation.

On the average, DSR-TPR followed by WSR-TPR and WSR-WSR have the same pattern of yields in descending order respectively. The earliness of DSR and good yield of TPR partly explained the differences, where from the point of view of crop intensification there is a good chance of double cropping rice and possibly an additional upland crop.

The results showed that the shorter the TAP, the higher were the yields obtained consistently in the three cropping patterns. The findings illustrate that the level of productivity can be improved by taking advantage of the available moisture needed by the crop particularly in the vegetative stage of crop growth. By cropping pattern, higher yields were observed in DSR-TPR given the length of TAP.

The implications of the results are that, depending on the water availability in different landscape positions which vary greatly, the farmers' logical strategy is to establish the crop first in higher field positions (plateau and sideslope) to be followed by the lower position (plain). This is because yields are comparatively stable in the plain compared to the other two positions and shortening the delay in TAP in these field positions can substantially increase the yields.

At this point, discussing specifically the performance of second crops in the cropping pattern is now in order. Figures 4.1 to 4.3 show the relationship between the grain yield and planting dates of the second crop. Yields of TPR were higher consistently in the plain position followed by plateau and sideslope. Bolton (1980) found also that TPR has relatively higher yields during the second crop compared to WSR. The explanation suggested is that TPR needs a wetter soil surface for a good stand and crop growth, and according to the rainfall pattern, a heavy accumulation

FIGURE 4.1

SIMULATED MEAN GRAIN YIELD OF SECOND CROP OF TPR IN
DSR-TPR-MUNG PATTERN BY PLANTING DATES AND LANDSCAPE POSITION,
ILOILO (1949-1979)

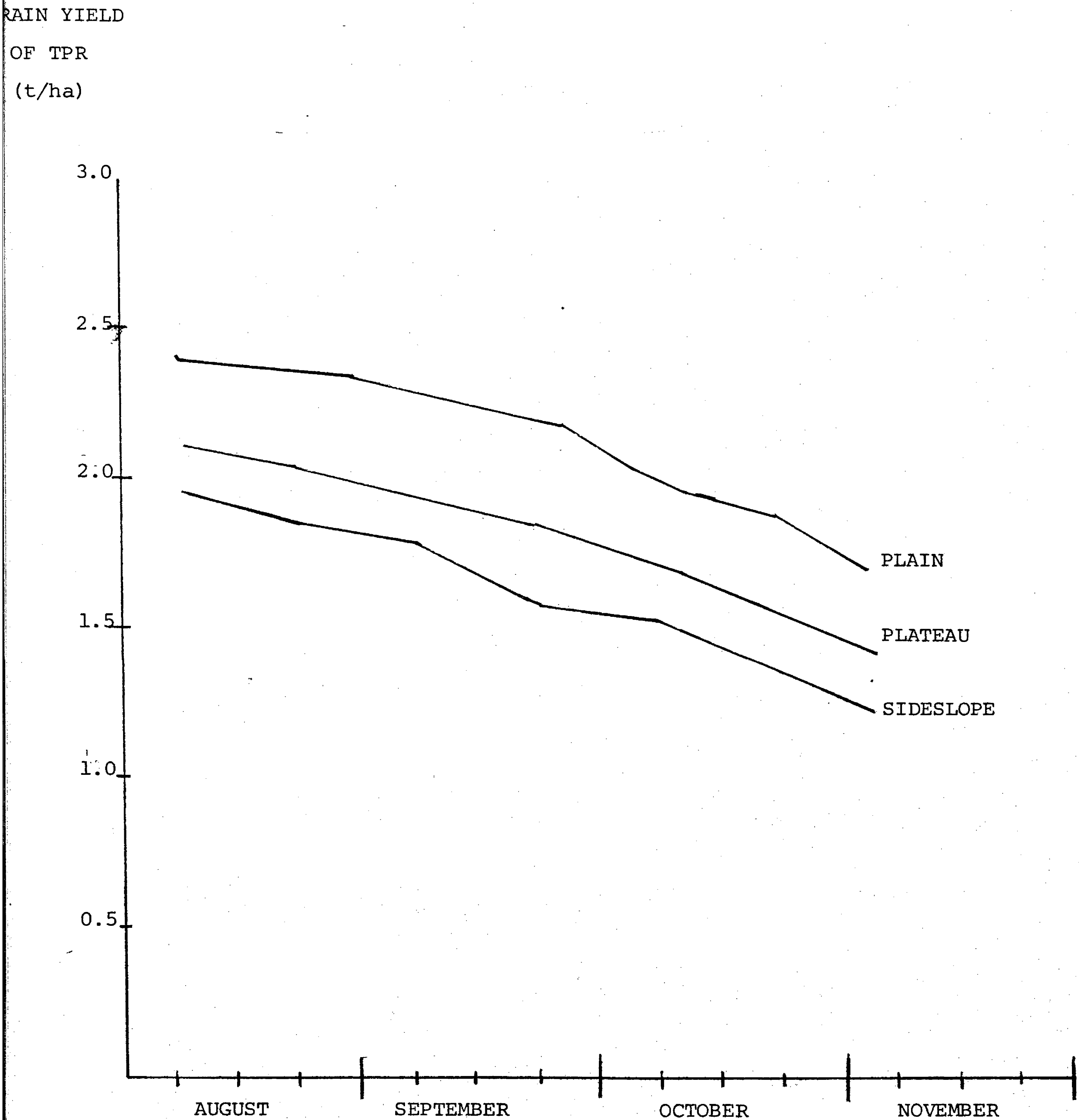


FIGURE 4.2

SIMULATED MEAN GRAIN YIELD OF TPR IN WSR-TPR-MUNG PATTERN BY PLANTING DATES AND LANDSCAPE POSITION, ILOILO (1949-1979)

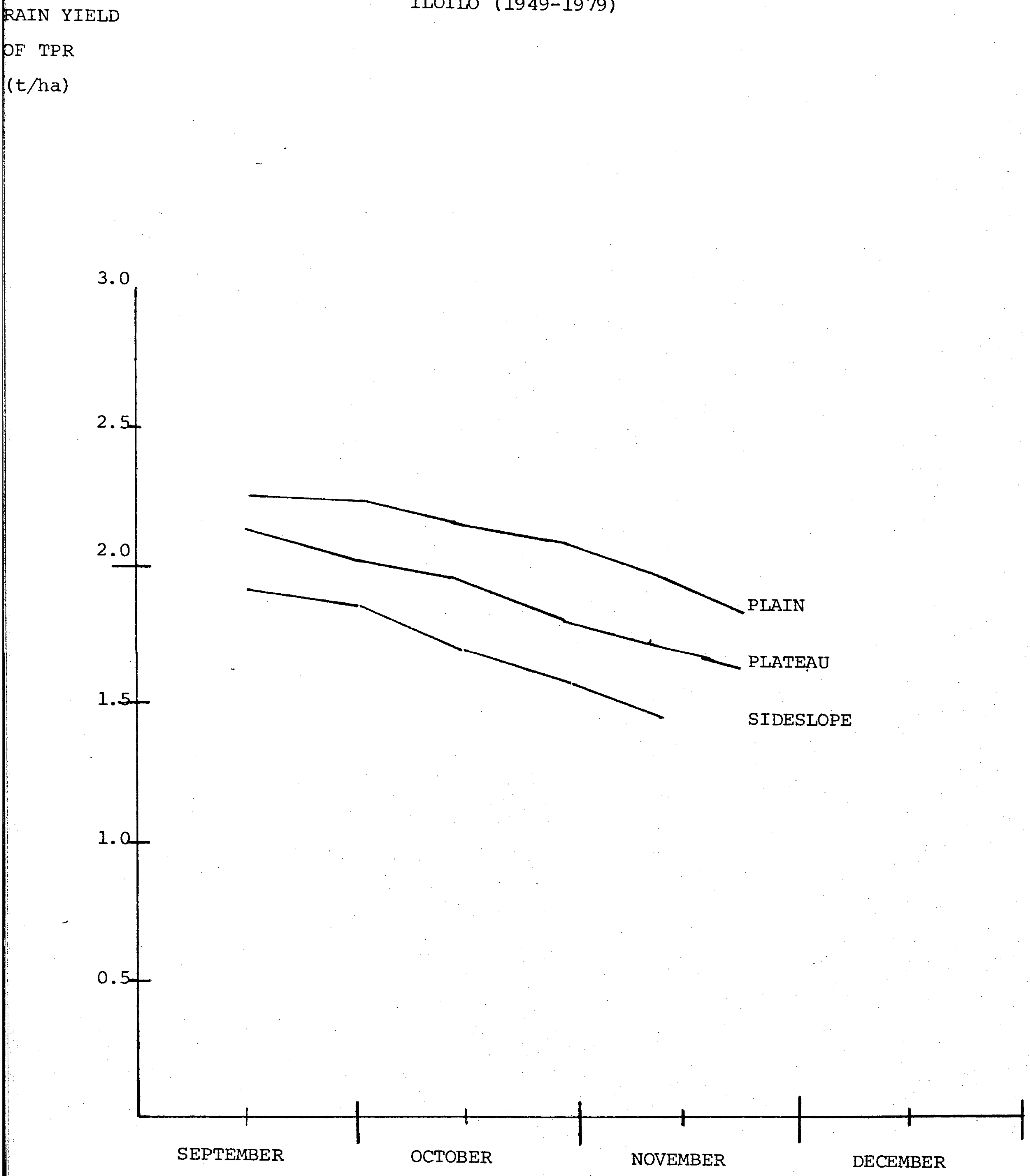
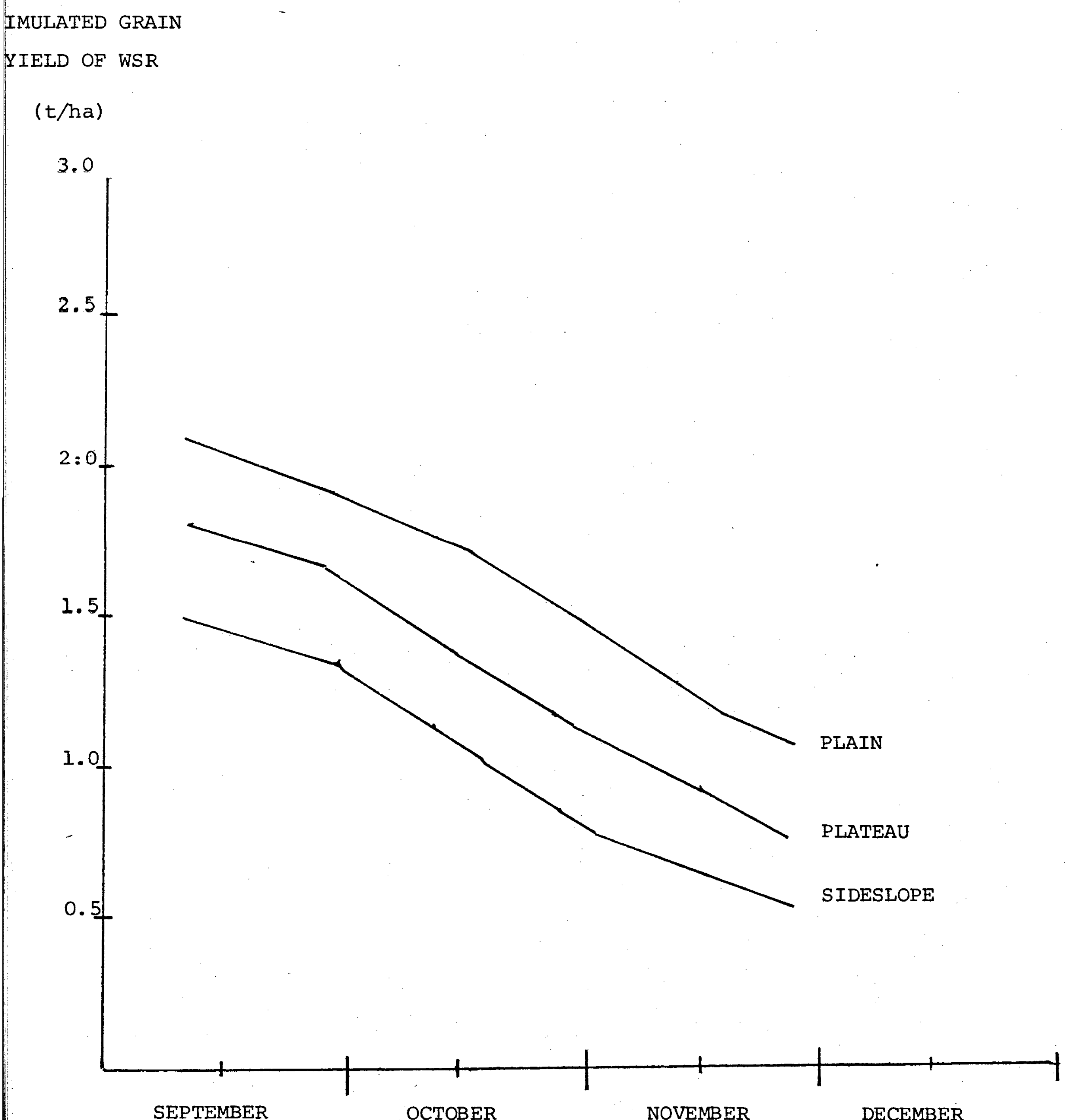


FIGURE 4.3

SIMULATED MEAN GRAIN YIELD OF SECOND CROP OF WSR IN
WSR-WSR-MUNG PATTERN BY PLANTING DATES AND LANDSCAPE POSITION,
ILOILO (1949-1979)



of water coincides with the TPR growing period. Moreover, another interesting point that can be drawn, is that TPR in the DSR-TPR pattern can be established almost a month earlier (August) compared to TPR in the WSR-TPR pattern (September). This again showed the importance of timeliness and the early establishment of the first crop and second crop respectively. Table 4.6 shows that WSR can be too risky if one is to delay its establishment. Planting differences between September and November could mean an average loss of around 1 ton/ha even in the plain. This shows how drought conditions affect performance considerably.

Summarizing from the simulated yields of rice in relation to TAP and landscape position, agronomically speaking, planting a double crop of rice in rainfed areas appears to require considerable management discipline for establishing the crop early in the higher positions in order to have a good chance of double cropping and maintaining stable yields.

It should be pointed out that the yield of mung is assumed to be constant because the model cannot simulate fairly reliable mung yields. In this connection, average mung yields were obtained from the historical yield levels of mung from farmers' existing crop records in Iloilo. Using four years of data, 170 Kg/ha was obtained for budgeting purposes. However, in terms of frequency (successful) of mung plantings, the model can predict reliably the planting dates of mung over 31 rainfall years. The cost budgeting of the mung crop is shown in Appendix A.8. The crop is considered to be a low managed crop with no substantial input except for planting and harvesting, but the crop can realize a very good price (₱ 5.00/Kilo) and therefore the returns were computed to be around ₱ 400/ha.

The next section deals with the profitability aspect of timeliness using partial budgeting techniques.

4.3 Economic Benefits Gained in Shortening the Delay in TAP

One of the objectives of this study is to evaluate economically the cropping 'strategies' by specifying alternative TAPs and comparing the use of carabao and power tillers in terms of additional returns obtained for each cropping pattern. The use of partial budgeting is considered to be of great use for application purposes, when one is confronted with the problems of farmers' adoption. A careful selection is made of the inputs which are supposed to vary when introducing a change (TAP) in the system. The use of the SWR is thought to be relevant because of the labour supply and demand situation during the establishment of the crops. Income foregone is reluctantly ignored because of the complexity of the system (multiple number of crops and pattern) and this limitation was partly corrected by specifying decision rules regarding the choice of cropping patterns to be tested. Additional returns were estimated using the farm gate prices received by the farmers at the time of disposal, while prices of inputs were obtained in the same fashion as output.

The comparison of the use of carabao and power tillers for land preparation is conceived of as an alternative technique available to farmers under the assumption that there are no constraints in terms of their availability and access to credit at the prevailing average interest rate (30%).

4.3.1 Benefits in Using Carabao-Drawn Implements

Carabao, as the major source of draught power in rainfed areas is considered by farmers as their partner in everyday farm activities. They pay special attention to caring for and providing necessities as if their survival wholly depend on this animal. Almost every farm household in the area has one carabao for land preparation and other operations. The earliness of planting the first crop and second crop depends partly on preparing the fields, therefore hiring of additional carabaos can be evaluated to determine if there is a positive incremental return or not. The average TAP is about three weeks and this study assumed that this can be shortened by using more carabao at the time of its use. There were four TAP's, 5, 10, 20 and 30 respectively, each of which is evaluated using partial budgets as discussed in Chapter 3.

Figures 4.4 to 4.12 present the cumulative frequency distribution of additional returns (AR) of three cropping patterns by landscape position (LP) and TAP. The idea of presenting this is to show for over 31 years rainfall data (daily) the variability of benefits (AR) that can be obtained by each cropping strategy (TAP) under the local physical environment (LP). Because of the nature of climatic conditions, farmers have limited alternatives but to choose logical strategies that can maximize benefits over-time and alternatively minimize the losses brought by the unpredictable environmental factors. As shown in Figures 4.4, 4.5 and 4.6, the additional returns for DSR-TPR-Mung gave a consistent pattern. The rule is that the strategy located at the most right hand side implied better returns. Then, the shorter the TAP (5), the better strategy

FIGURE 4.4

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURNS (AR) OF DSR-TPR-MUNG USING CARABAO BY TURN-AROUND PERIOD, ILOILO (1949-1979)

PLAIN

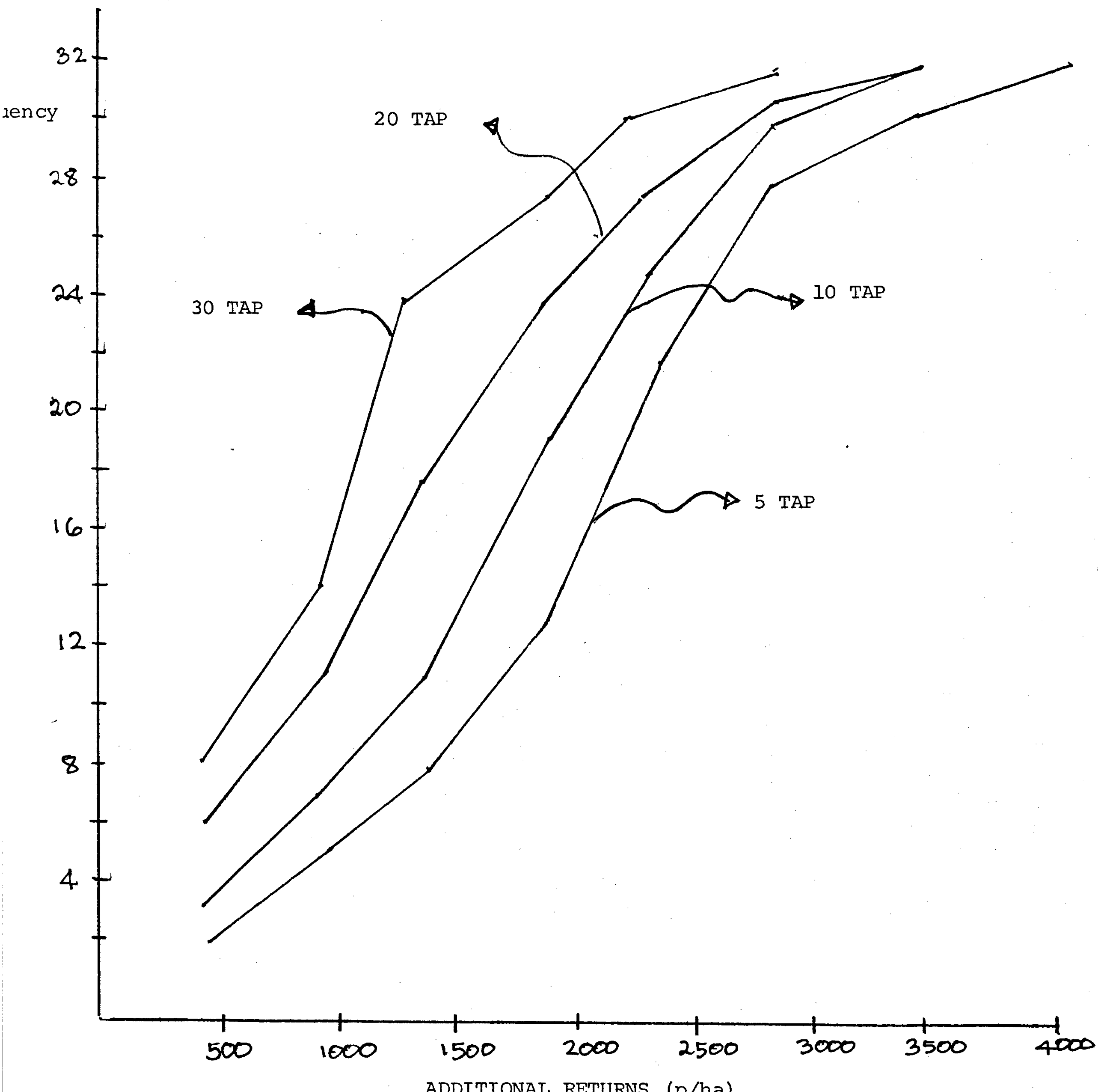


FIGURE 4.5

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR)
OF DSR-TPR-MUNG USING CARABAO BY TAP,
ILOILO (1949-1979)

PLATEAU

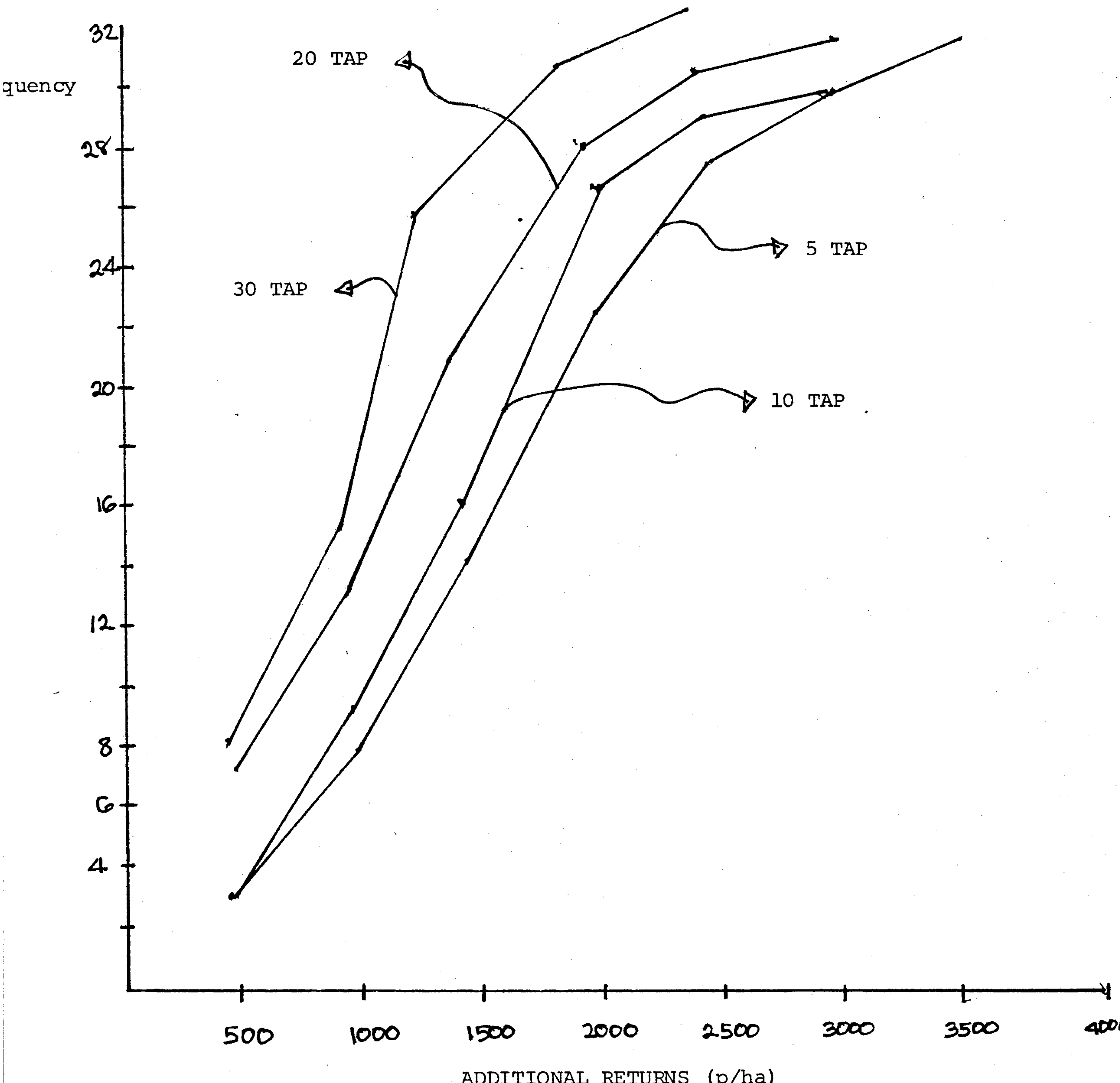


FIGURE 4.6

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR)
OF DSR-TPR-MUNG USING CARABAO BY TAP,
ILOILO (1949-1979)

SIDESLOPE

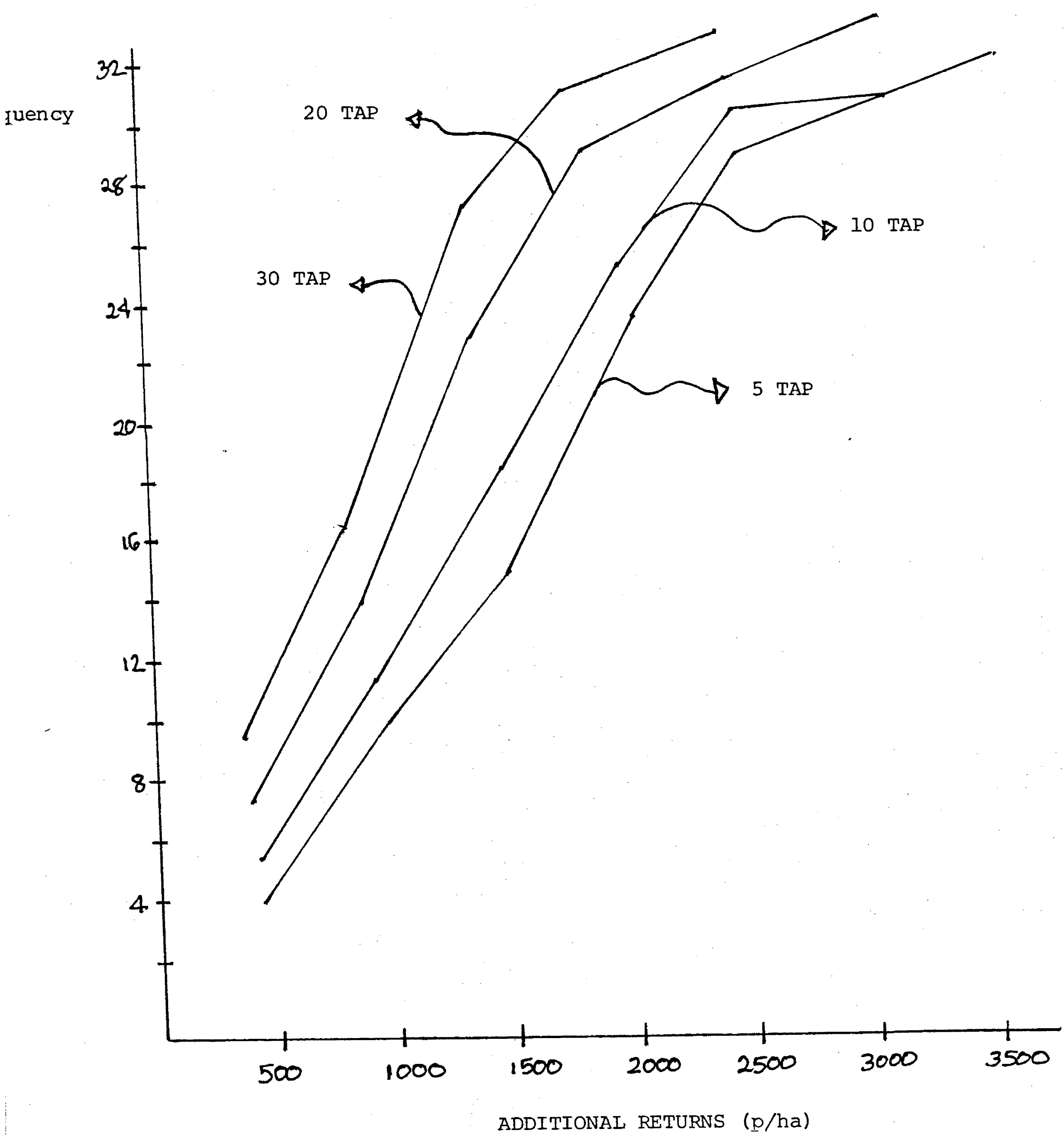


FIGURE 4.7

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR)
OF WSR-TPR-MUNG USING CARABAO BY TAP
ILOILO (1949-1979)

PLAIN

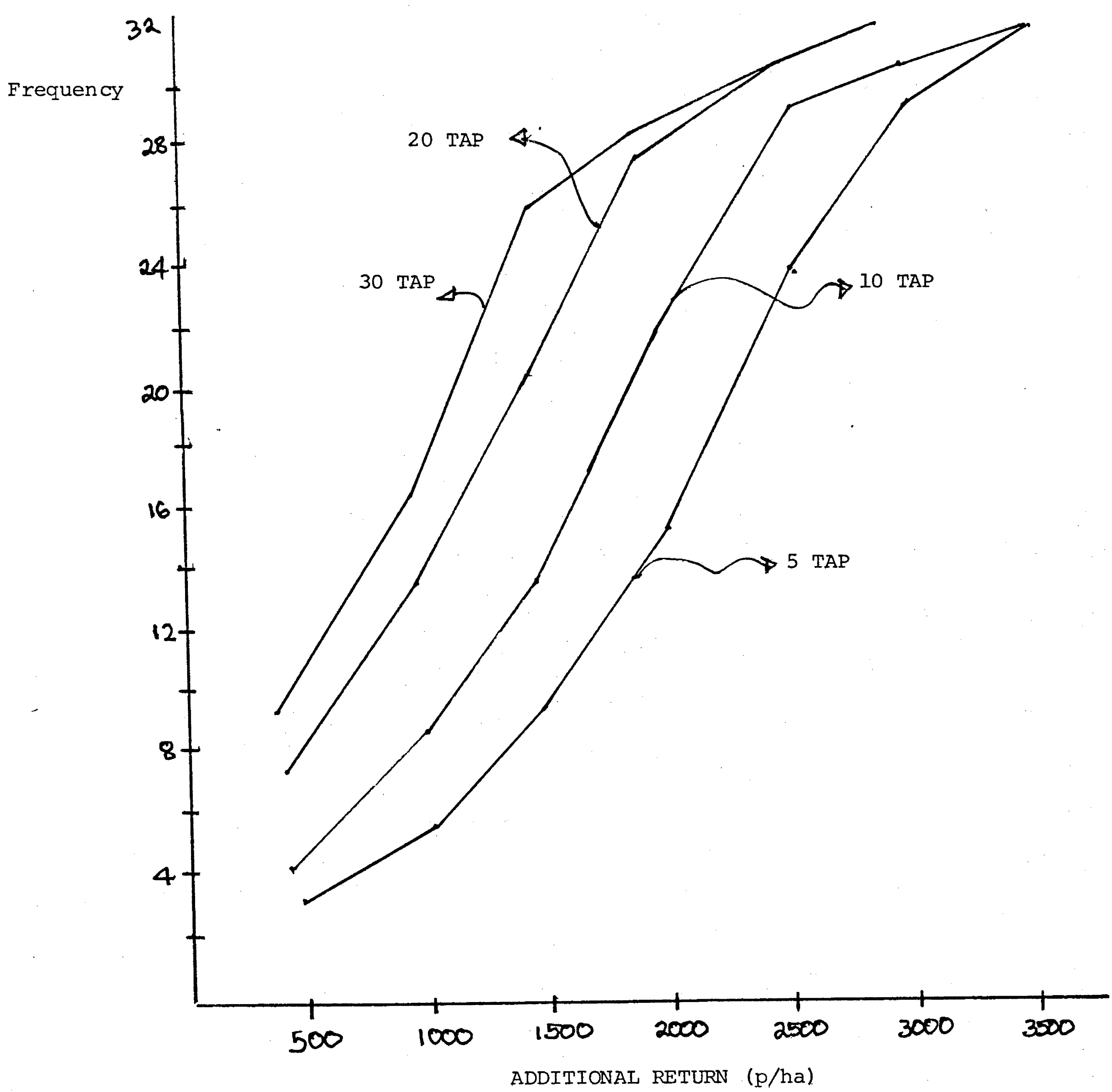


FIGURE 4.8

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR) OF WSR-TPR-MUNG USING CARABAO BY TAP, ILOILO (1949-1979)

PLATEAU

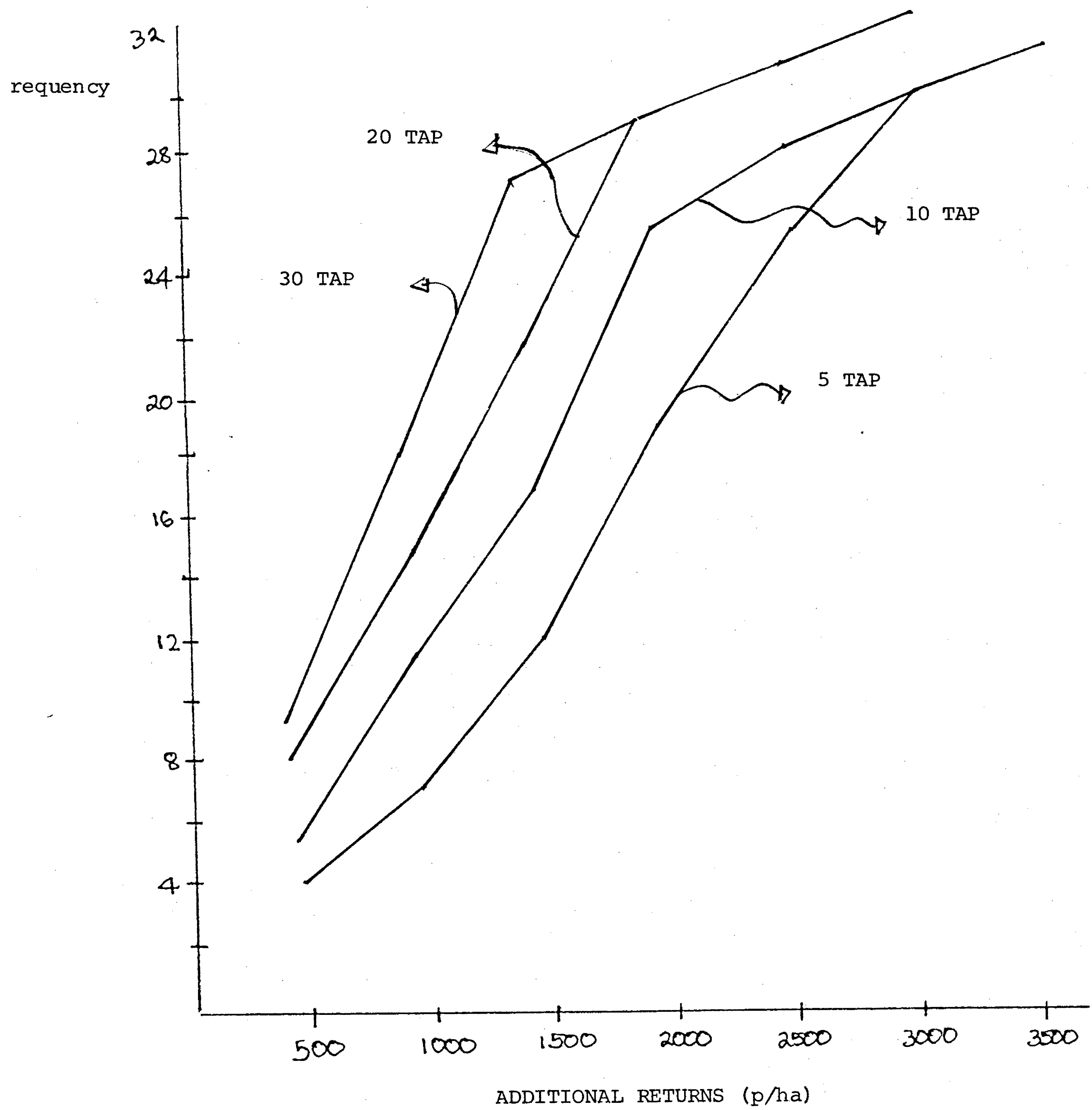


FIGURE 4.9

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR) OF WSR-TPR-MUNG USING CARABAO BY TAP, ILOILO (1949-1979)

SIDESLOPE

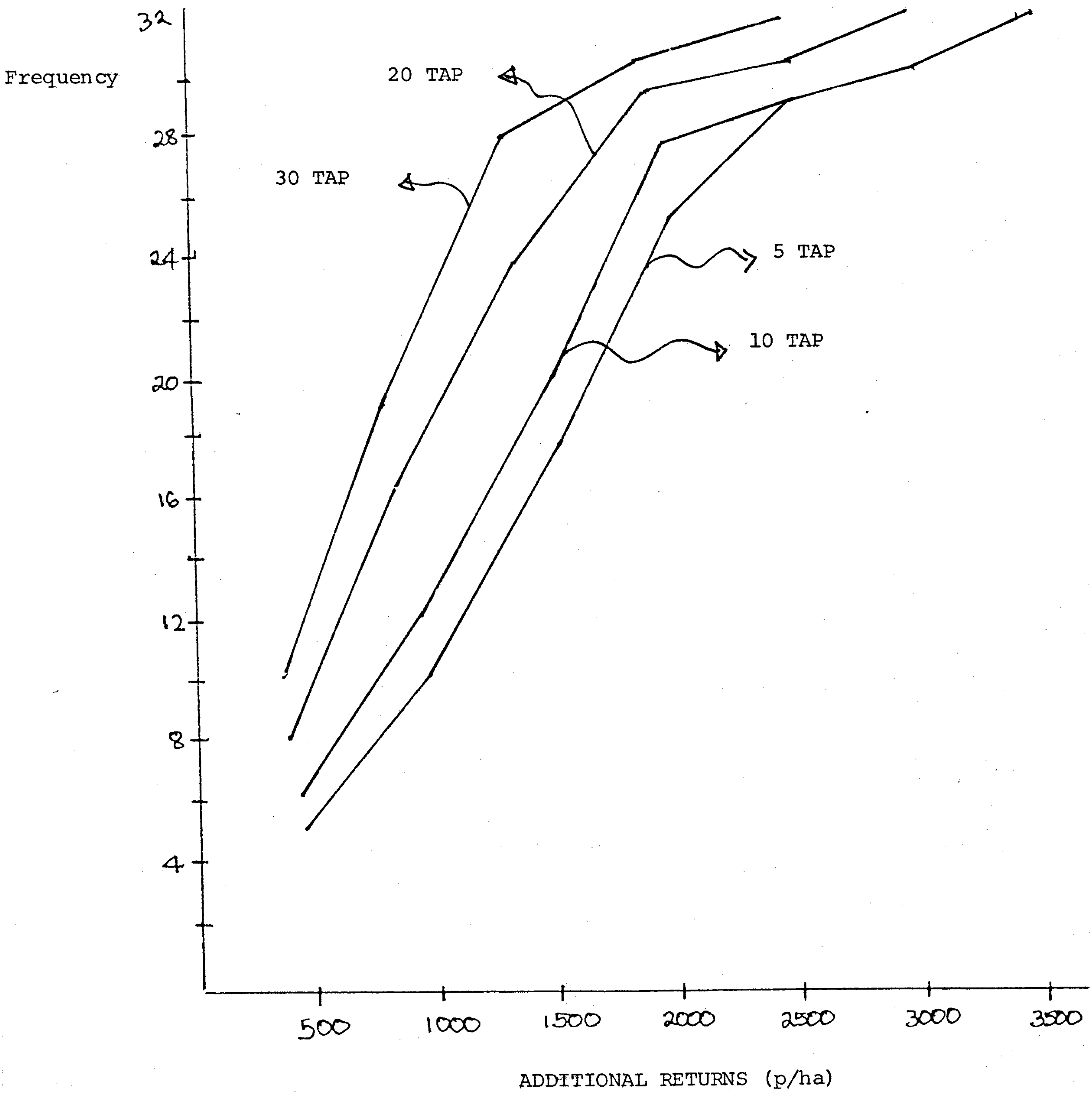


FIGURE 4.10

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR) OF WSR-WSR-MUNG USING CARABAO BY TAP, ILOILO (1949-1979)

PLAIN

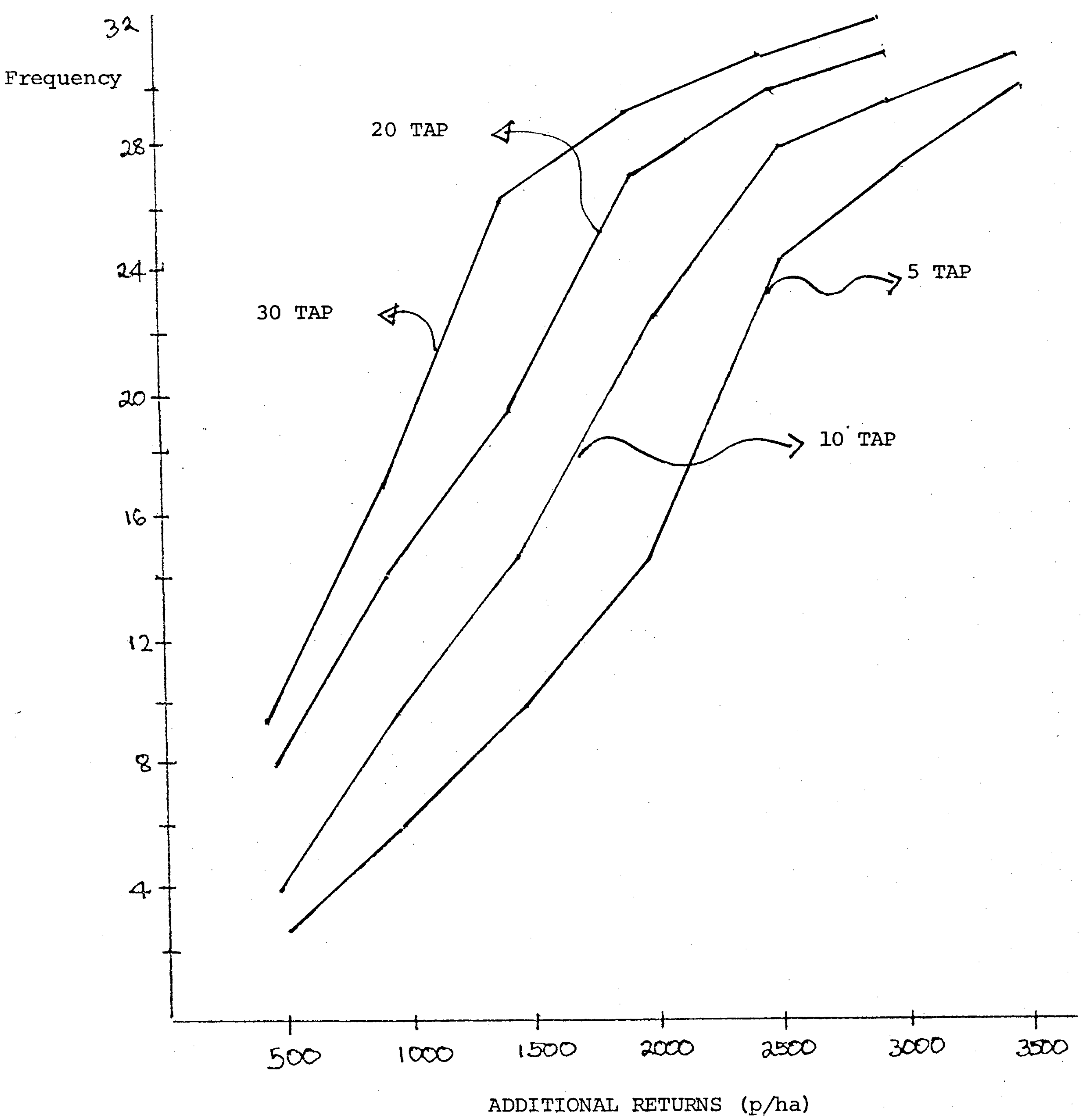


FIGURE 4.11

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR)
OF WSR-WSR-MUNG USING CARABAO BY TAP,
ILOILO (1949-1979)

PLATEAU

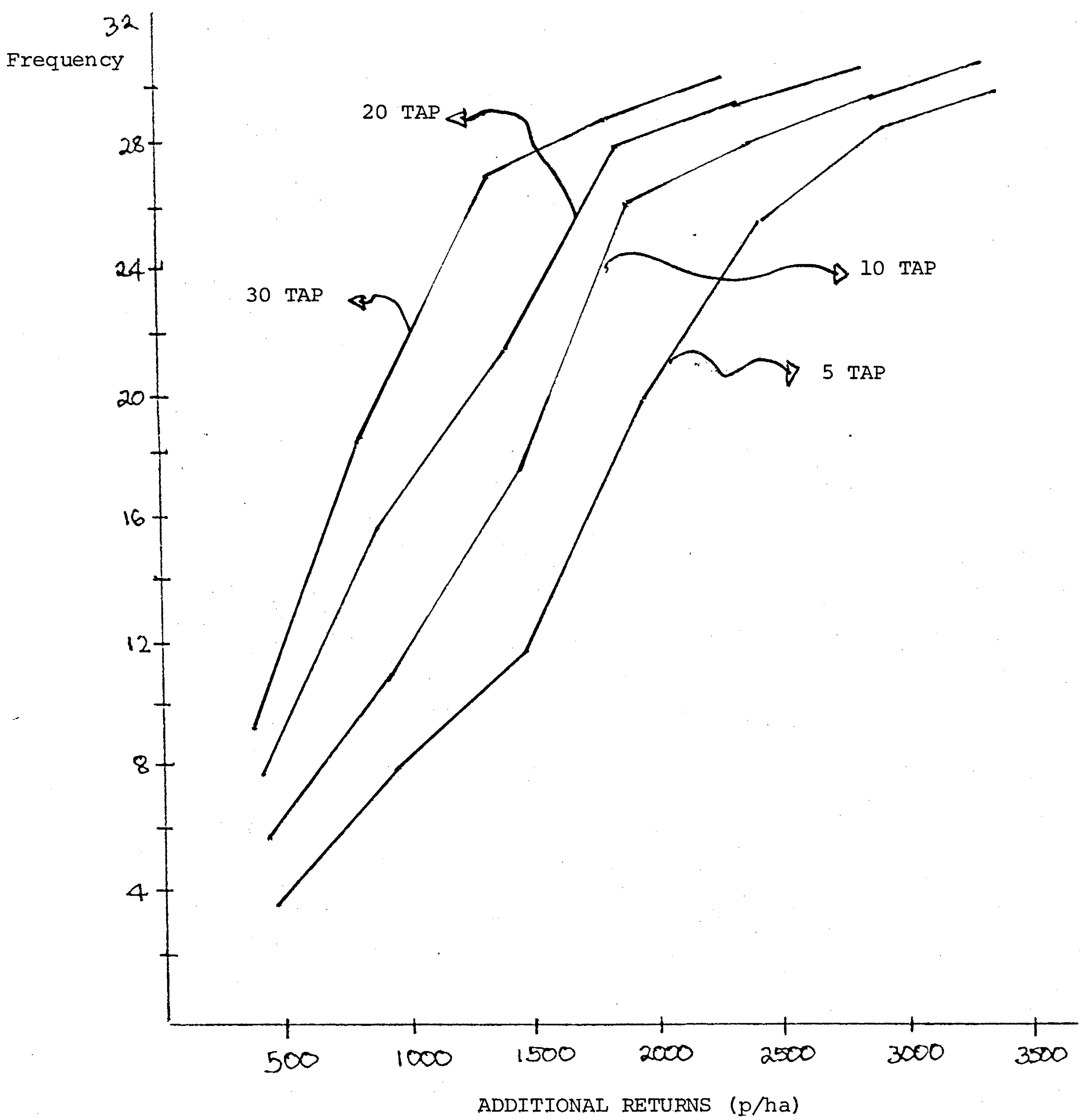
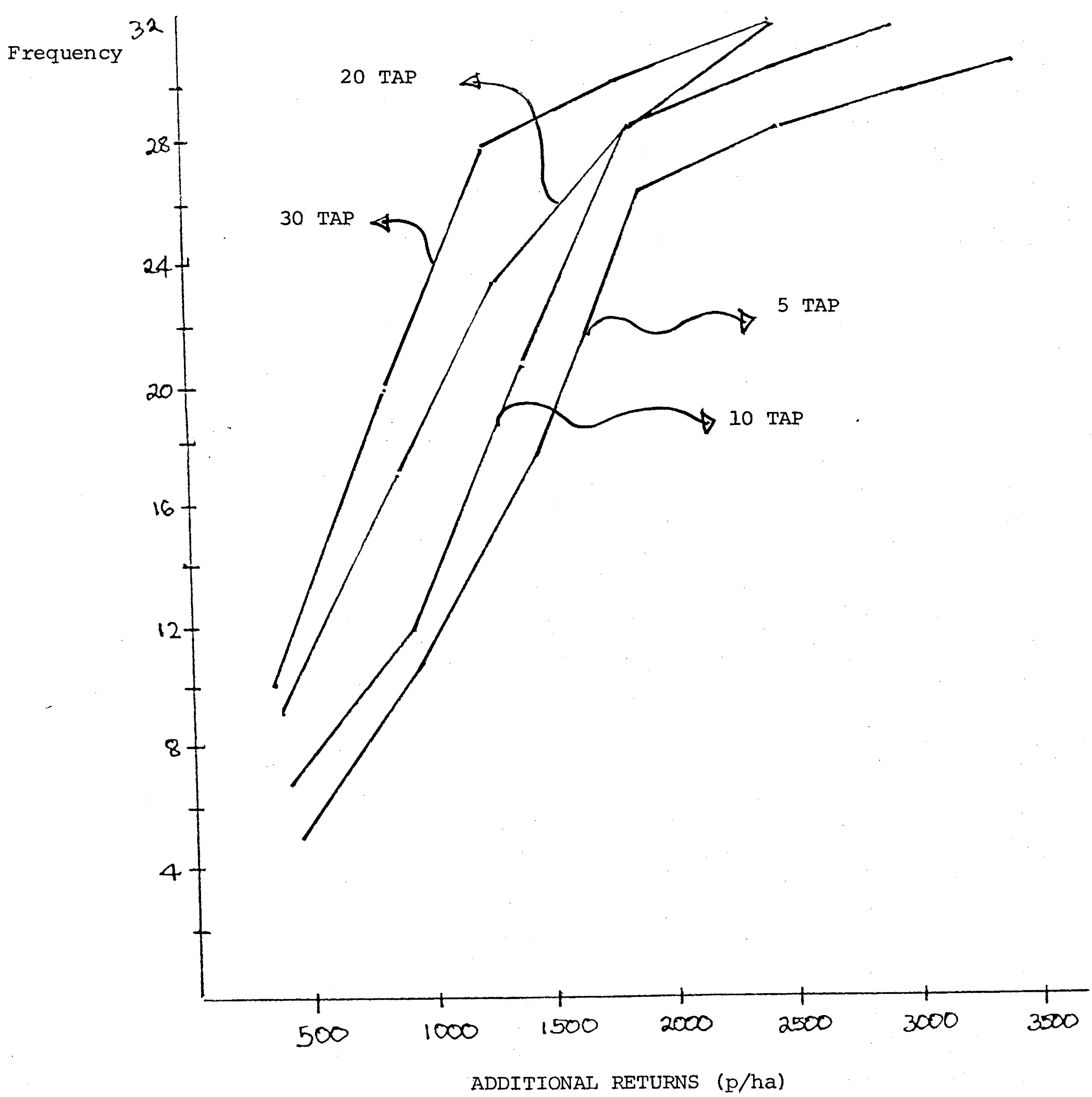


FIGURE 4.12

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (AR)
OF WSR-WSR-MUNG USING CARABAO BY TAP,
ILOILO (1949-1979)

SIDESLOPE



it is and vice versa. This holds true for all landscape positions, however, better returns can be obtained for plain followed by plateau and sideslope. Comparing 5 TAPs for plain and 5 TAPs for plateaus and sideslopes it was indicated that the former was more to the right side and quantitatively speaking realized higher additional returns for plains than the other two positions. Similarly, plateau was better than sideslope.

In WSR-TPR-Mung (Figures 4.7 to 4.9) the same pattern of relationship was observed, although the basic difference was that return levels in DSR-TPR-Mung were generally higher. This suggests that because DSR was planted early compared to the first crop of WSR (WSR-TPR-Mung), timeliness favoured the second and third crops. By strategy, 5 TAPs had a considerable advantage compared to 10, 20 and 30 respectively. The reason primarily is that the first crop was planted relatively late (compared to DSR), therefore establishing quickly after harvesting reaped better results.

Amongst the three cropping patterns, WSR-WSR-Mung (Figures 4.10 to 4.12) appeared less profitable. This is due to the lengthy duration of crops in the field (two crops of WSR are lengthy compared to WSR-TPR and DSR-TPR) where crop performance was affected by the onset of the dry season. The relationship, (the shorter the TAP, the better returns obtained), gave an indication that crops which require longer growth duration should be established early enough to take advantage of rainfall and avoid the drought conditions during the dry season.

The above discussion answered positively the earlier hypothesis of the study, that the earlier the planting of crops the better returns can be expected. The strategies presented to the farmers are primarily taken from the point of view of benefits, where results showed that the shorter the TAP, the better profits they can realise.

Now, let us look at the additional costs for each TAP using carabao. The farmers' rejection of any cropping strategy for that matter was in some cases due to high associated costs. Stabilizing strategies will depend on the capability of the farmers to sustain the required investment in the long run. Since IRRI cropping system research is geared to testing technology at the farmer's level of resources, if there is no institutional support from the government, like credit, the on-farm testing of technology must initially explore the possibility of the potential of adoption by the farmers through comparing existing cropping patterns with that of new improved patterns in terms of profitability estimates through partial budgeting techniques.

Taking the most profitable cropping pattern (DSR-TPR-Mung) in the plain position, the average additional costs (AC) and additional returns are presented in Tables 4.4 to 4.6. The

TABLE 4.4

AVERAGE ADDITIONAL COSTS AND ADDITIONAL RETURNS OF DSR-TPR-MUNG IN PLAIN BY TAP, ILOILO (1949-1979)

TAP	(1) Additional Cost (₱/ha)	(2) Additional Returns (₱/ha)	Ratio (2)/(1)
5	1612	2261	1.40
10	1564	1976	1.26
20	1523	1632	1.07
30	1332	1312	0.98

TABLE 4.5

AVERAGE ADDITIONAL COSTS AND RETURNS OF WSR-TPR-MUNG IN PLAIN POSITION BY TAP, ILOILO (1949-1979)

TAP	(1) Additional Costs (₱/ha)	(2) Additional Returns (₱/ha)	Ratio (2)/(1)
5	1587	2161	1.36
10	1525	1806	1.18
20	1482	1435	0.97
30	1296	1241	0.96

TABLE 4.6

AVERAGE ADDITIONAL COSTS AND RETURNS OF WSR-WSR-MUNG IN PLAIN POSITION BY TAP, ILOILO (1949-1979)

TAP	(1) Additional Costs (₱/ha)	(2) Additional Returns (₱/ha)	Ratio (2)/(1)
5	1577	2064	1.31
10	1512	1725	1.14
20	1463	1387	0.95
30	1277	1193	0.93

additional costs were higher for the shorter TAP since the farmers have to hire additional carabao. The AR was ₱ 2,261/ha to ₱ 1,612 (AC) in 5 TAP while it was ₱ 1,312 and ₱ 1,332 for 30 TAP respectively. The ratio of $\frac{AR}{AC}$ was higher for the shorter TAP which suggests that in terms of per peso (₱) investment, higher returns were obtained and only 30 TAP got a ratio of less than 1. In the WSR-TPR-Mung pattern, the average AR ranges from ₱ 1,241 to 1,587 and AC ₱ 1,296 to ₱ 1,587 for 5 and 30 TAP respectively. Additional costs were higher in DSR-TPR-Mung than in WSR-TPR-Mung because of the additional hand weeding operations and herbicides for the first crop of DSR. Nevertheless, the shorter TAP has a higher ratio and the same thing is true in the WSR-WSR-Mung pattern. However, again the ratios were smaller than the above two patterns.

The above results show that the additional costs do not differ significantly but the additional returns vary considerably. The effect of timeliness was shown to be a vital factor in increasing benefits particularly in the shorter TAP strategy.

4.3.2 Benefits of Using Power Tillers

The use of power tillers along with the mechanical threshers were not a common practice until two vectors of technological change had been made available in the area namely:

(i) high yielding short statured rice varieties (HYV) which led to double cropping of rice, and

(ii) irrigation facilities constructed in neighbouring areas which hasten the proliferation of power tillers and threshers to become available also even in rainfed areas.

Many farmers considered that the duration of land preparation can be reduced by using power tillers and Juarez and Duff

(1980) found a positive relationship between double cropping of rice and the use of power tillers.

Figures 4.13 to 4.15 showed the cumulative frequency of three cropping patterns by landscape position. The additional returns of three patterns were lower using power tiller (7 TAP) compared to 5 TAP but higher than 10 TAP using carabao. In practice it is unlikely that sufficient carabao could be assembled to complete the TAP in 5 days and this notional value was included to indicate whether returns to additional investment continued at values of TAP of less than 10 days. The use of the power tiller 7 days after harvest is probably the earliest realistic data on which cultivation could commence and it is likely that innovative farmers would tend to choose power tillers because of the overall benefits derived from it, i.e.,

(i) early establishment which leads to (ii),

(ii) higher AR.

Although 5 TAP had a higher AR, in reality hiring more carabao at the time of second crop establishment would be difficult considering the demand for harvesters affecting available workers for land preparation.

A comparison of power tillers and 10 TAP in terms of AR for WSR-TPR-Mung is shown in Figure 4.16. The cumulative frequency line of power tillers was further to the right than 10 TAP which suggests better returns over time. The additional cost component is shown comparatively in Tables 4.7 and 4.8. Although the additional costs of power tillers were relatively higher than carabao in 10 TAP, the additional returns did not vary very much,

FIGURE 4.13

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURNS (p/ha)
OF DSR-TPR-MUNG USING POWER TILLER BY L. POSITION,
ILOILO (1949-1979)

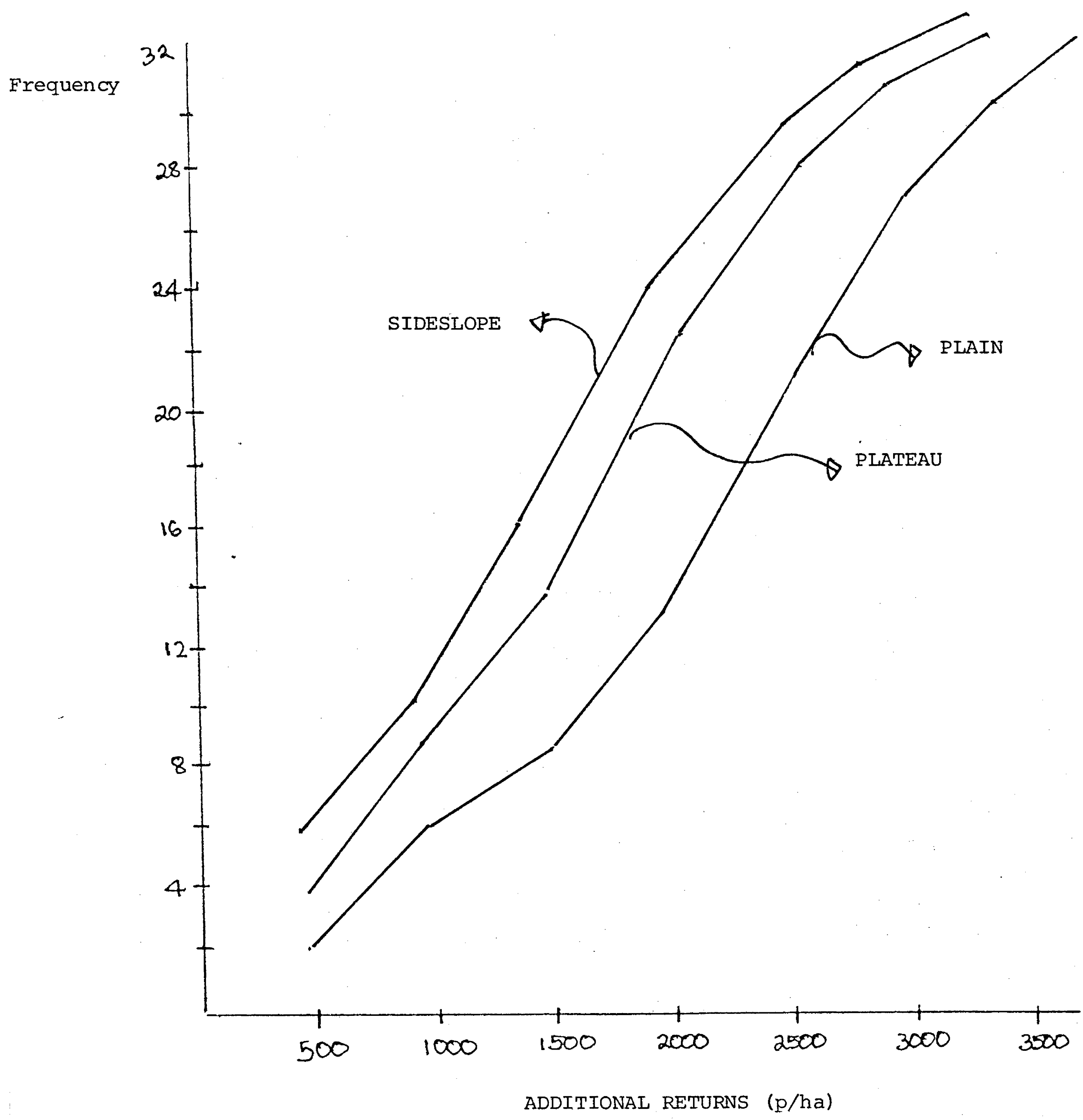


FIGURE 4.14

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURN (p/ha) OF WSR-TPR-MUNG USING POWER TILLER BY L. POSITION, ILOILO (1949-1979)

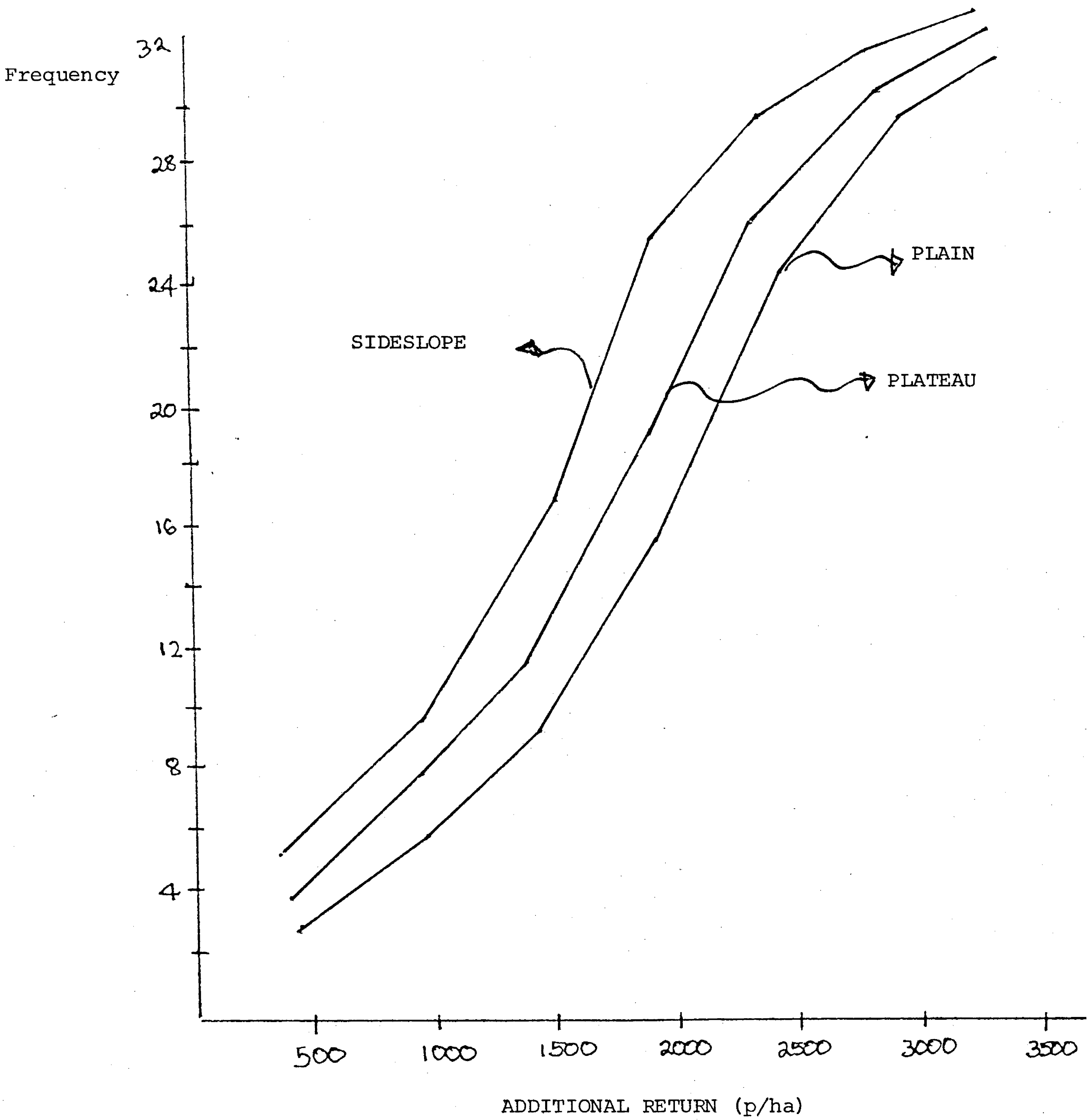


FIGURE 4.15

CUMULATIVE FREQUENCY DISTRIBUTION OF ADDITIONAL RETURNS (p/ha) OF WSR-WSR-MUNG USING POWER TILLER BY L. POSITION ILOILO (1949-1979)

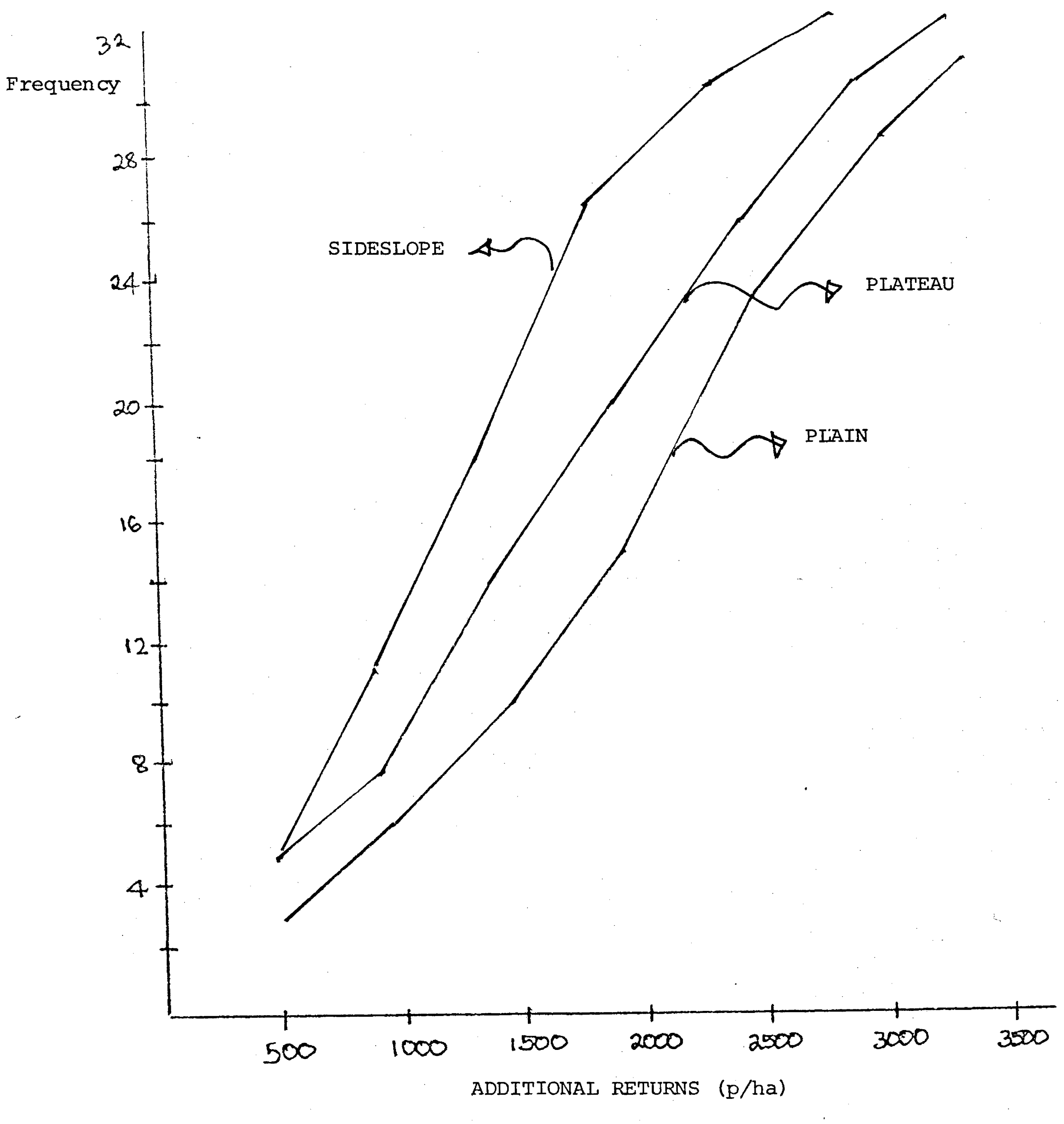


FIGURE 4.16

COMPARISON OF USING CARABAO (10 TAP) VS. POWER TILLERS (7 TAP) IN TERMS OF ADDITIONAL RETURN (AR) IN WSR-TPR-MUNG IN PLATEAU POSITION, ILOILO (1949-1979)

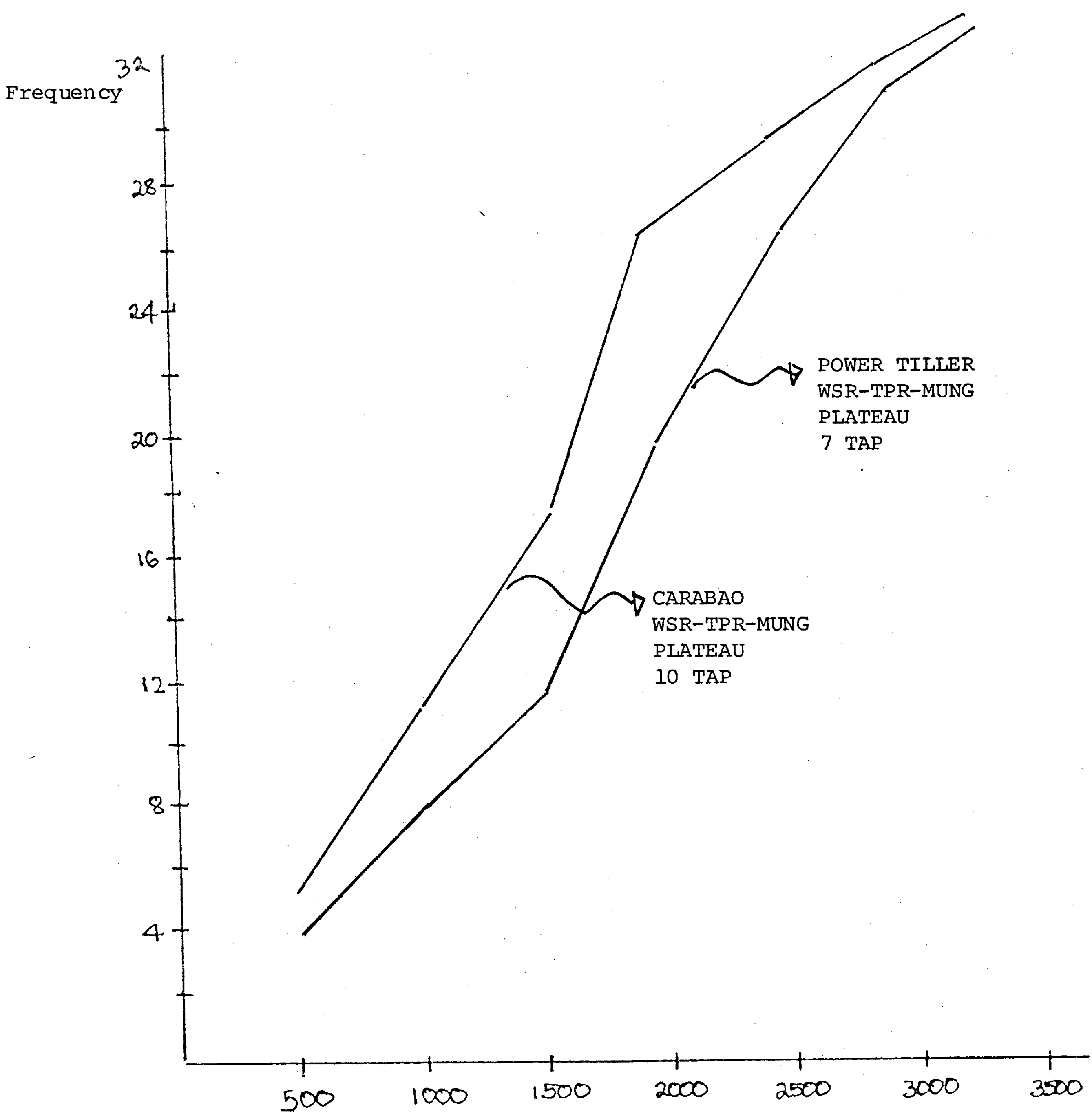


TABLE 4.7

THE COMPARATIVE AVERAGE ADDITIONAL COSTS (AC)
AND ADDITIONAL RETURNS (AR) OF POWER TILLER AND
CARABAO IN DSR-TPR-MUNG, ILOILO (1949-1979)

Cropping Pattern	Carabao (5 TAP)			Power Tiller (7 TAP)		
	AC ₱/ha	AR ₱/ha	Ratio AR/AC	AC ₱/ha	AR ₱/ha	Ratio (2)/(1)
DSR-TPR-Mung	1612	2261	1.40	1851	2232	1.26
WSR-TPR-Mung	1587	2161	1.36	1762	2134	1.21
WSR-WSR-Mung	1577	2064	1.31	1768	2037	1.15

TABLE 4.8

THE COMPARATIVE AVERAGE ADDITIONAL COSTS (AR)
AND ADDITIONAL COSTS (AC) OF POWER TILLER AND CARABAO IN
DSR-TPR-MUNG, ILOILO (1949-1979)

Cropping Pattern	Carabao (10 TAP)			Power Tiller (7 TAP)		
	AC ₱/ha	AR ₱/ha	Ratio AR/AC	AC ₱/ha	AR ₱/ha	Ratio AR
DSR-TPR-Mung	1564	1976	1.26	1851	2232	1.26
WSR-TPR-Mung	1525	1806	1.18	1762	2134	1.21
WSR-WSR-Mung	1512	1725	1.14	1768	2038	1.15

in fact they were slightly higher for power tillers. The ratios of AR/AC are almost the same, which implies that AR invested in a power tiller covers the extra cost with better returns (higher yield levels).

In summary the two sections discussed above, productivity and profitability estimations evaluated the effect of shortening the delay in establishing the cropping patterns by using strategies in terms of four TAPs. The next section deals with the riskiness of using the cropping patterns in a specified local environment over 31 rainfall years.

4.4 Risks in Crop Intensification

This section is an attempt to initially investigate the riskiness of growing cropping patterns in rainfed areas. The objective is to present to the farmers the variability of outcome[1] and possibly infer how he will choose from a limited number of alternatives.[2] To do this, reviewing the specific situation assumed in the study is necessary, as follows:

- (i) Three cropping patterns are selected, and
- (ii) planted in three landscape positions (PLN, SS, PLT), to evaluate the
- (iii) timeliness of establishing the crops by
- (iv) specifying the strategies in terms of length of TAP (5, 10, 20, 30 for carabao and 7 TAP for power tillers, and
- (v) grown in 31 rainfall years of the area to account for variability.

It should be pointed out that the variability of outcome does not depend only on the length of TAP, but it is assumed that the

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1 Outcome in this study refers to the frequency of successful patterns (regardless of yield levels) in a pre-determined length of time (31 years).

2 Alternatives refer to strategies in reducing the delay of establishing the crop (TAP).

differences are largely accounted for in terms of successful patterns. This is because lateness of establishment may lead to crop failure of succeeding crops in a sequence. Successful patterns are defined as those patterns planted and harvested regardless of yield levels.

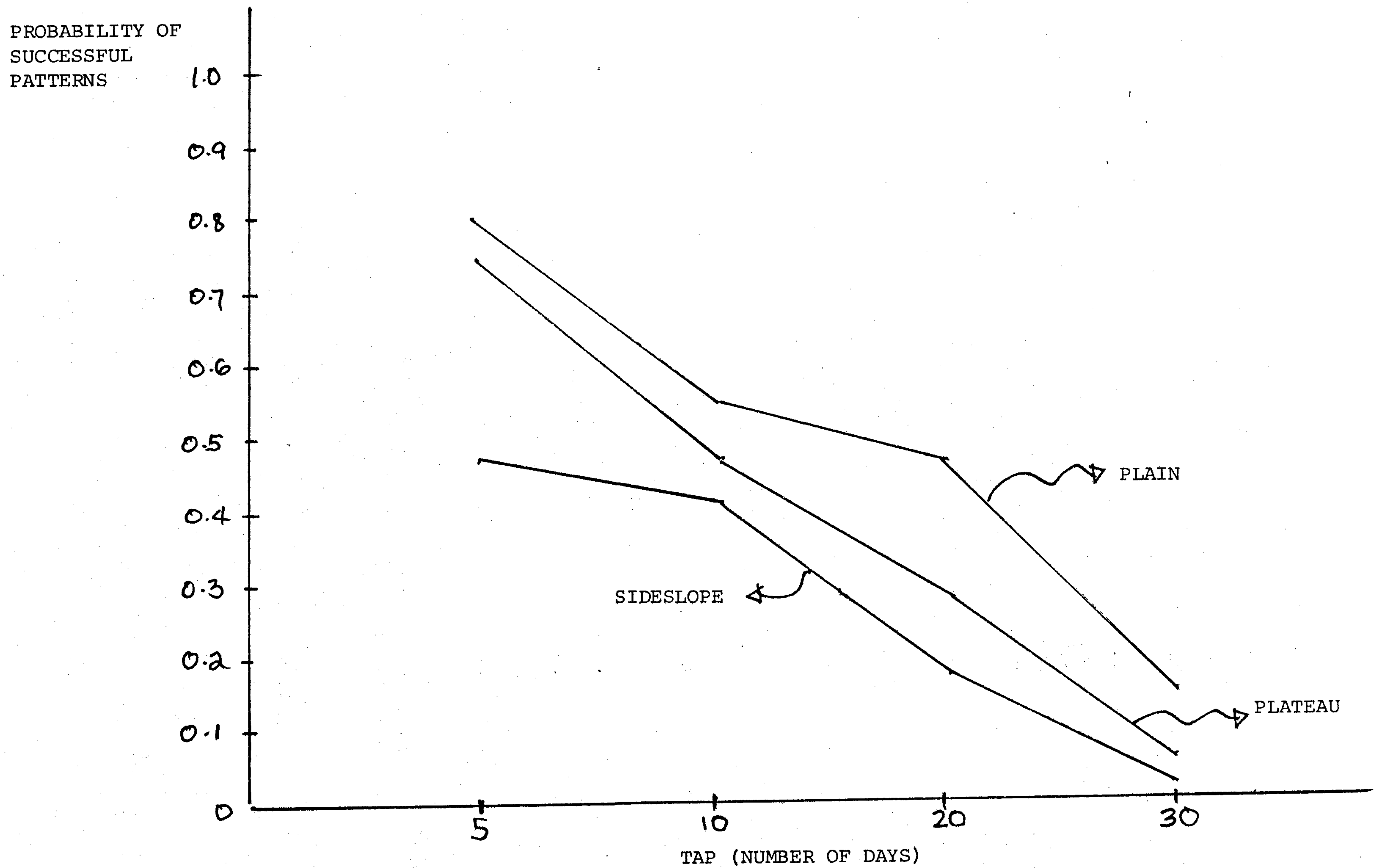
Now, let us take the most profitable cropping pattern (DSR-TPR-Mung) to illustrate the probability of a successful pattern as shown in Figure 4.17. The overall relationship that can be drawn about riskiness is that the shorter the TAP, the greater the chance of getting a successful pattern and vice versa. It implies an inverse relationship between TAP and successful pattern.

In this study, it is assumed that farmers can easily obtain additional hired labour for extra land preparation (e.g. 5 TAP as compared to his present average 23 TAP), in reality however, it is difficult to get these for the following reasons:

(i) During the establishment of crops particularly the second crop, which coincides with the harvesting operation on a community basis, the farmers (as hired labourers) prefer to do harvesting because the real wage rate is effectively higher than the LP land preparation.

(ii) Farmers themselves are engaged in preparing their own crop land if they are not involved in harvest operations. In this area, most hired labourers are farmers also and

PROBABILITY OF SUCCESSFUL PATTERNS (DSR-TPR-MUNG) BY TAP AND LANDSCAPE POSITION,
ILOILO (1949-1979)



practically no landless labour is available nor transient labour.

In this context, the feasible strategy has two main decision rules: Firstly, if the farmer does not face a labour constraint for land preparation, the shortest TAP appears the most feasible one in terms of getting more successful patterns over time. Secondly, if there is a labour constraint, the logical choice is between his present TAP of about 23 days (with his own carabao) and 5 TAP depending on the availability of labourers. It is assumed that because of the pattern of the relationship, TAP's between 5 and 10, 10 and 20 and so on, that the points lie along the path between discrete TAPs.

Three points can be listed in reference to landscape position:

(i) Because of the consistent pattern between TAP and landscape position, if the farmer has three of these positions, the strategy recommended is to start establishing sideslope first followed by plateau and plain respectively depending on the water condition of the fields during land preparation, to increase the chances of getting more successful patterns and alternatively minimizing crop failures.

(ii) The differences in 10 TAP by landscape position, did not vary significantly and from the point of view of riskiness, the farmers may be better off using this strategy.

(iii) In supporting the first point, farmers can delay planting on the plain, (20 TAP in plain compared to 10 TAP on the plateau) and spend that time on another position.

In other words since on the plain (except for 30 TAP), the probability of getting a successful pattern is relatively higher compared to the other two positions, farmers may schedule their land preparation by giving priority to the upper positions (sideslope and plateau).

Another approach to tackling risk in crop intensification is by presenting the probability of getting a specified value of additional returns (Tables 4.9 to 4.11). The rationality of the farmer is assumed in that they do not think in terms of probability but choose among their limited alternatives based on their experience in farming (Roumasset, 1976). Now, the logic of presenting the probability of obtaining a specified AR is mainly on the grounds that stabilizing the farmers adoption of any technique and/or cropping strategy would depend on the likeliness of that technique giving better returns over time. Consider an average additional return of ₱ 2,000/ha which he can get by planting a pattern; the probability can be obtained by:

$$\text{Probability of getting ₱ 2,000/ha} = 1 - \frac{\text{CF at ₱ 2,000/ha}}{\text{total number of years(N)}}$$

where CF = cumulative frequency at ₱ 2,000/ha;

N = total number of years (31 years in the study).

TABLE 4.9

THE PROBABILITY OF GETTING MORE THAN ₱ 2,000/HA ($P \geq$ ₱ 2,000) OF ADDITIONAL RETURNS BY CROPPING PATTERNS AND TAP IN PLAIN POSITION, ILOILO (1949-1979)

TAP	Cropping Patterns		
	DSR-TPR-Mung	WSR-TPR-Mung	WSR-WSR-Mung
5	0.58	0.52	0.52
10	0.38	0.29	0.26
20	0.22	0.13	0.09
30	0.12	0.10	0.06

TABLE 4.10

THE PROBABILITY OF GETTING MORE THAN ₱ 2,000/HA OF ADDITIONAL RETURNS BY CROPPING PATTERNS AND TAP IN PLATEAU POSITION, ILOILO (1949-1979)

TAP	Cropping Patterns		
	DSR-TPR-Mung	WSR-TPR-Mung	WSR-WSR-Mung
5	0.26	0.38	0.32
10	0.12	0.16	0.13
20	0.16	0.06	0.06
30	0.06	0.06	0.06

TABLE 4.11

THE PROBABILITY OF GETTING MORE THAN ₱ 2,000/HA OF ADDITIONAL RETURNS BY CROPPING PATTERNS AND TAP IN SIDESLOPE POSITION, ILOILO (1949-1979)

TAP	Cropping Patterns		
	DSR-TPR-Mung	WSR-TPR-Mung	WSR-WSR-Mung
5	0.22	0.16	0.13
10	0.19	0.10	0.06
20	0.06	0.06	0.06
30	0.03	0.03	0.03

The estimation shows that the shorter the TAP, the greater the probability of getting ₱ 2,000/ha. Moreover, the lower the landscape position, the higher the chances of obtaining that value of AR. These findings were similarly consistently obtained in the simulated productivity levels and profitability estimations. This, however, does not in any way presuppose that farmers should concentrate on investing resources in lower positions nor using the strategy of shorter TAP because it has wider implications for the whole farming system which will be discussed in the next chapter.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study evaluates the importance of timeliness in crop intensification in the rainfed farms of Iloilo, Central Philippines. It specifically tackles firstly, the simulation of rice crop growth and productivity by empirically incorporating local physical and environmental factors and its associated management decision rules to reflect on-farm variability. Secondly, an economic analysis of cropping strategies in terms of reducing the delay in establishment of crop (TAP) or alternatively hastening up the land preparation, is done, to determine the benefits that can be derived to the proposed change by using a partial budgeting technique.

5.1 Summary

The nature and importance of timeliness in rainfed farms were discussed in Chapter 2. The farmers in these areas are perenially bounded by unpredictable weather conditions which vary both inter and intra seasonally which affect to a great extent the scheduling of field operations and eventually crop performance. Agronomically, it is hypothesized that an earlier first crop establishment and a rapid TAP would increase and stabilize the yield of the succeeding crops through drought avoidance. To test the hypothesis requires estimates of yield response to planting dates for a number of years (31 in this study) so as to determine not only the average yield response but also the degree of variability.

Moreover, because of the location specificity of the study, a simulation model was conceived to capture the environmental factors affecting crop growth and productivity levels. In this context, the landscape position in relation to the water management regime was incorporated to establish a fairly acceptable simulation process. The economic hypothesis is that the additional returns of reducing the TAP would at least conpensate for the additional costs. To test this, a partial budgeting technique was used to determine the benefits derived in shortening the delay in crop establishment.

Chapter 2 dealt with the farmers present cropping strategies based on IRRI CSP research activities. This is the section where the ground work in terms of critically conceptualizing the problem of timeliness was done. Emphasis was given to quantifying and describing both the physical and socio-economic variables that are considered relevant to the problem, mainly to highlight the practical application of the study. A discussion of rainfall and other climatic factors such as solar radiation and temperature and landscape position in the toposequence was supplemented by the findings of the research testing phase of the program at IRRI. The turnaround period between crops was specifically singled out to have a critical implication on crop intensification.

The succeeding chapter on the methodological framework of the study includes two sections, one on the simulation model of crop growth and the other on economic evaluation techniques. In the simulation model, discussion of its biophysical components from the crop growth functional relationship was reviewed and the specification of the management decision rules in the model was explained. The economic evaluation section includes the time budgets from the historical activity analyses of farm-households in the area and partial budgeting of introducing a change by specifying alternative cropping strategies (TAP) to speed up or save labour costs in land preparation through the use of power tillers or carabao. In addition, the derivation of the shadow wage rates of labour (SWR) was discussed together with the charge on the use of inputs (CCI).

The results and discussions on the findings of the study were presented in Chapter 4. Firstly, simulated productivity estimates were calculated by landscape position, TAP and planting dates. This implies that higher yields, more often than not, imply better net returns. Secondly, profitability estimates were obtained using the measure of additional returns (AR) as an index of the farmers' adoption. The comparative results between the use of power tillers and carabao were evaluated and infer how farmers chose the best alternative strategy. Lastly, an initial attempt to investigate risk in crop intensification was made to explore the ground of farmers' rejection of strategy by presenting the variability of yields and AR over time.

5.2 Conclusions from the Study

The following conclusions can be drawn from the study:

(i) There was a consistent pattern of relationship between grain yield by landscape position and turnaround period. Crops performed better in lower positions (plain) followed by plateau and sideslope respectively. Furthermore, there was an inverse relationship between the yield of the crops and the turnaround period, where the shorter the TAP the better yields were obtained. The results obtained were due to the positive interaction of water availability in field positions and early establishment of crops.

(ii) The early establishment of a first crop led to the earliness of the succeeding crops and consequently showed overall higher and stable yields for the pattern. The DSR-TPR-Mung performed better than WSR-TPR-Mung and WSR-WSR-Mung respectively across three landscape positions which underlines the importance of timeliness agronomically since DSR was planted early enough to establish the subsequent crops with ample time.

(iii) In using carabao, additional returns were higher in the shorter TAP from 5, 10, 20 and 30 respectively. Again, an inverse relationship was found between TAP and AR. However, by relaxing the assumption of availability of hired labour, farmers may face difficulty in getting these additional labour inputs; thus there is a trade-off between higher additional returns and reducing the cost of land preparation.

(iv) In similar fashion, the use of power tillers increased the benefits in shortening the delay in TAP from 10 days, which is a realistic minimum with carabao, to 7 days, which is a realistic minimum with a power tiller. This indicates that the additional costs of the power tiller are offset by the additional returns from early-sown crops.

(v) By cropping patterns, DSR-TPR-Mung appeared to be the most profitable cropping pattern as shown by its higher AR, and WSR-WSR-Mung was relatively profitable because of the longer duration standing in the field which led to difficulty for a second or third crop to have better and stable yields due to drought conditions.

(vi) By landscape position, more profitable patterns were obtained in lower positions because of water availability which was less critical compared to upper ones.

(vii) The investigation on risk in crop intensification showed some indications that the greater variability, both in the probability of successful patterns and obtaining a specific level of AR (₱ 2,000/ha), may affect the farmers' adoption of the strategy. There was an inverse relationship between TAP and probability of successful cropping patterns. Because of the relatively high cost associated with shorter TAP, the best or most feasible strategy that the farmer can choose is between the shortest TAP (5) and his present TAP (23). Moreover by landscape position, the farmer can afford to delay his establishment in lower positions and give priority to upper areas.

The overall conclusion of the study is that by reducing the delay in TAP, the farmers have alternatives, depending on the constraints they are faced with, to choose the best strategy by landscape position and cropping patterns.

5.3 Potential for Extrapolation and for Future Research

One of the basic limitations of the study is the "location specification" of the variables and related criteria incorporated in the analysis. This has a direct bearing on extrapolating the methodology and findings to areas similar to Iloilo. A closer look at the assumptions and the rigorous collection of relevant information needed would undoubtedly help any attempt for extrapolation. Since on-farm testing of technology, not only in multiple cropping but also in many agricultural and rural development projects, has been recognized as an integral vector of farmers' adoption, the cropping strategies in this study (TAP) can be treated as the key link of solving one particular problem of crop intensification.

In the above context, a similar approach can be taken in some agricultural areas that require research on a specific environment which allows farmers to participate and should provide a clear identification of the different tasks to be executed by the researchers.

For future research, more quantitative analysis can be done in terms of the economic methodological framework to stabilize benefits over time. Agronomically, because of the fact that the vectors of technology can dramatically change the level of productivity, a constant testing of new production methods in relation to environmental factors is recommended to allow readjustment of the parameters in the model. The risk associated with crop intensification must be explored using relevant economic techniques to explain variability and farmers' choice of the best available strategy.

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APPENDIX A.1

LABOUR AND DRAUGHT POWER REQUIREMENTS (mh/ha) OF FIRST CROP OF WET-SEEDED RICE (WSR), ESTIMATED FROM 4 YEARS FARM RECORD KEEPING STUDY, ILOILO 1975-1978

Operation	Man-Hours Per Hectare	Animal Hours Per Hectare
Land Preparation		
Plowing (1st)	50	50
(2nd)	38	38
Harrowing (1st)	22	22
(2nd)	16	16
Levelling	24	24
Planting	32	-
Weeding	120	-
Herbicide Application	20	-

APPENDIX A.2

LABOUR AND DRAUGHT POWER REQUIREMENTS (mh/ha) OF SECOND CROP OF WSR ESTIMATED FROM 4 YEARS OF FARM RECORD KEEPING, ILOILO 1975-1978

Operation	Man-Hours Per Hectare	Animal Hours Per Hectare
Land Preparation		
Plowing (1st)	41	41
(2nd)	30	30
Harrowing (1st)	18	18
(2nd)	12	12
Levelling	20	20
Planting	36	-
Weeding	90	-
Herbicide Application	16	-

APPENDIX A.3

LABOUR AND DRAUGHT POWER REQUIREMENTS (mh/ha) OF FIRST CROP OF TRANSPLANTED RICE (TPR) ESTIMATED FROM 4 YEARS OF FARM RECORD KEEPING, ILOILO 1975-1978

Operation	Man-Hours Per Hectare	Animal Hours Per Hectare
Land Preparation		
Plowing	88	88
Harrowing (1st)	34	34
(2nd)	26	26
(3rd)	19	19
Levelling	20	20
Transplanting	200	-
Weeding	48	-
Herbicide Application	8	-

APPENDIX A.4

LABOUR AND DRAUGHT POWER REQUIREMENT (mh/ha)
OF SECOND CROP OF TPR ESTIMATED FROM 4 YEARS
OF FARM RECORD KEEPING, ILOILO 1975-1978

Operation	Man-Hours Per Hectare	Animal Hours Per Hectare
Land Preparation		
Plowing	56	56
Harrowing (1st)	27	27
(2nd)	20	20
(3rd)	15	15
Levelling	16	16
Transplanting	186	-
Weeding	32	-
Herbicide Application	5	-

APPENDIX A.5

LABOUR AND DRAUGHT POWER REQUIREMENT (mh/ha)
OF FIRST CROP OF DRY SEEDED RICE (DSR) ESTIMATED
FROM FARM RECORD KEEPING, ILOILO 1975-1978

Operation	Man-Hours Per Hectare	Animal Hours Per Hectare
Land Preparation		
Plowing (1st)	65	65
(2nd)	45	45
Harrowing (1st)	25	25
(2nd)	18	18
Planting	32	-
Weeding	150	-
Herbicide Application	38	-

APPENDIX A.6

MONTHLY FARM GATE PRICES OF MATERIAL INPUTS
TAKEN FROM FARM RECORD KEEPING STUDY, ILOILO 1976-1977

Month	Material Inputs	
	Seeds (₱/Kg)	Herbicides [a/]
April	1.79	-
May	1.85	-
June	1.88	-
July	1.90	-
August	1.76	-
September	1.78	-
October	1.82	-
November	1.80	-
December	1.78	-
January	1.75	-
February	1.75	-
March	1.75	-

Note: a/ Because of varied herbicide use (too many brands), obtaining and using an average figure was considered inappropriate. Instead using the average herbicide cash cost was alternatively used.

APPENDIX A.7

MONTHLY FARM GATE PRICE OF PALAY (RICE) RECEIVED BY FARMERS FROM RECORD KEEPING STUDY, ILOILO 1976-1977

Month	Palay ₱/Kg
April	1.25
May	1.28
June	1.25
July	1.28
August	1.15
September	1.15
October	1.15
November	1.16
December	1.18
January	1.20
February	1.15
March	1.17

APPENDIX A.8

BUDGETS OF RELAYED MUNG CROP TAKEN FROM RECORD KEEPING STUDY, ILOILO 1976-1977

Operation	Labour Requirements (manday/ha)	Source Family	Source Hired	SWR ₱/day	Cost/ha ₱/ha
Seeding	1	1	-	5.00	5.00
Harvesting	1/6 of yield	X Price of Mung		(₱ 5.00)	144.50
Seed Costs	7.5 Kgs	X Price of Seeds		(₱ 5.80)	43.50
			Variable Costs		228.00
Plus charge on input use (30%)					88.55
			Variable Cost		316.55
Gross Revenue	Yield (170Kg/ha) X Price (₱ 5.00)				850.00
Returns (₱/ha)					₱ 433.45