Changes in rice farming in the Philippines: Insights from five decades of a household-level survey

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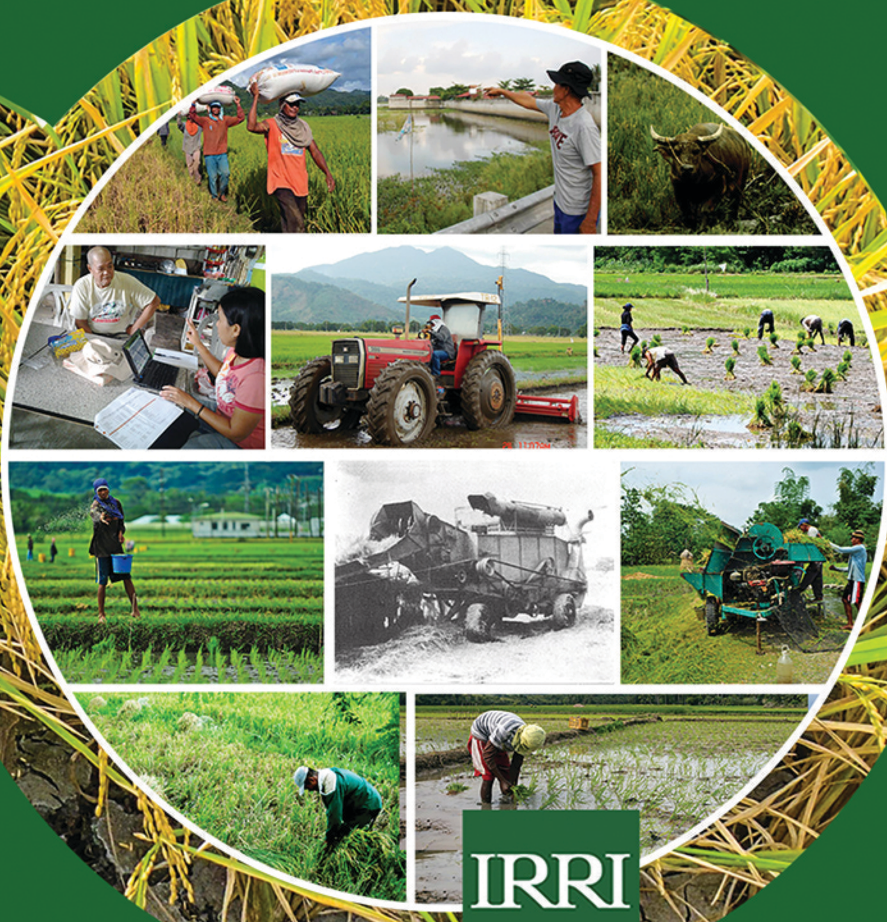

IRRI

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IRRI

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CONTENTS

List of tables

List of figures

PREFACE

This book centers around the structural and economic changes in rice farming that have occurred in the Philippines during the past five decades. As a researcher at the International Rice Research Institute (IRRI) for more than 30 years, I have been a witness to these changes through my involvement and encounters with farmers. This experience has given me a first-hand knowledge of what is actually happening in farmers' fields and with their family. Five years ago, Samarendu Mohanty, the head of the Social Sciences Division (SSD), gave me the responsibility to establish the social science database that involved the organization and consolidation of numerous farm-level data sets that SSD had accumulated over the years and make this available on the web (https//ricestat.irri.org/fhsd/php/panel.php).

The farm household survey database is a collection of farm-level data sets on rice productivity, fertilizer and pesticide use, labor inputs, prices, income, demographics, farm characteristics, and other related data on rice production in farmers' fields. One of those data sets is the Central Luzon Loop Survey data set; it is a rich and historical collection of detailed panel data covering many aspects of rice production systems and the farm family from 1966 to 2012. A lot of studies have made use of only some specific aspects and time periods of the data set; however, none of these numerous studies have organized, summarized, and presented the complete data set. Realizing the importance of this gold mine of information about rice production systems at the farmer level, I took upon myself to organize, analyze, integrate, and summarize all the data from 23 seasons of loop survey, which is conducted every four years. At this point, it came to my mind to write this book because of the enormous potential for use in future research and policy formulation.

The book came into being with the full support and encouragement of SSD head Samarendu Mohanty. On top of this, two respected agricultural economists, Randolph Barker and Kei Kajisa, agreed to participate in the writing of this book, for which I am particularly grateful. Randy was a former head of the Agricultural Economics Department (now Social Sciences Division) of IRRI and had been involved in these surveys in the late 1960s. Kei was a former senior agricultural economist in SSD and an expert in micro-level studies; he had also been involved in one or two rounds of the loop survey in the late 2000s. Also important is the participation of Fe Gascon, who has the institutional memory of a majority of the Central Luzon Loop Surveys and who knows a majority of the

farmers by heart. We are fortunate to have Mary Rose San Valentin on the team, who helped patiently in organizing, processing, and checking the data for accuracy and consistency.

The assistance provided by Maria Cristina Obusan in preparing some of the figures and formatting the tables is very much recognized. Similarly, Joel Reaño provided additional information because he had been involved in the survey and in the encoding of the data in the later years. I would also like to recognize the encouragement and support of David Dawe in the initial stage of the development of the Central Luzon database. I would also like to thank Gelia T. Castillo for patiently reviewing the manuscript and giving her helpful comments to further improve it. I would also like to express my thanks to all other colleagues from SSD such as Dehner de Leon, Esther Marciano, Shiela Valencia, Doris Malabanan, Mirla Domingo, and Maripi Caisip, who put up with my numerous requests and inquiries to finish this piece of work. We would also like to recognize all the researchers and scientists who made possible the conduct of this long-term periodic survey for the last five decades. Lastly, I would also like to thank my family and spouse for all the encouragement and patience they have provided me with during the writing of this book.

We would like to express our deepest gratitude to the men and women farmers who freely provided us with the detailed data on their rice production system and patiently put up with our long hours of repeated interviews. This book is dedicated to all of you.

The book consists of three major parts: (1) the main text that consists of eight chapters that deal with the quantitative data on rice production systems that present the trends and changes in yield, input use, and profitability of rice production over the years; (2) the last chapter consists of six case studies that focus on how the farm household and its family have changed over time; and (3) substantive Appendices that contain not only detailed tables mentioned in the text, but detailed survey data per observation that were processed on a per hectare basis for use by other researchers or anybody who would be interested in doing a more in-depth analysis. A brief summary of all studies published or presented in a forum is also included as one section of the Appendices.

Piedad F. Moya
May 2015

I. Introduction

This manuscript describes and analyzes a longitudinal survey of rice-farming households in Central Luzon, Philippines. Twenty-three rounds of survey were conducted every four to five years from 1966-67 to 2011-12, covering detailed records on the rice production systems in both the wet season (WS) and the dry season (DS) in one round of survey. The data set is called the "Central Luzon Loop Survey" or simply the "Loop Survey" because of the feature of its sampling strategy, which will be explained later.

The objective of the analysis is to document the structural and economic changes in rice farming in Central Luzon. Each of the major sections of the manuscript provides answers to questions such as: How have rice farms and farm families changed over time? Has rice production and yield continued to grow at a rapid rate beyond the initial impact of the Green Revolution? What changes have occurred in farm size, family and hired labor, mechanization, and the use of chemical inputs? How has the profitability of rice farming changed? Are producers or consumers reaping the benefits of technological change?

An earlier analysis using the same data set from 1965 to 1982 (Herdt 1987) tackled questions similar to ours and concluded that "real incomes of farmers and agricultural laborers have shown no dramatic change despite the substantial increases in production, but real rice prices have declined steadily over the period, thus permitting consumers to purchase their rice consumption needs at lower cost." In the 30 years since the analysis by Herdt, how have these observations changed? Seeking an answer to this question, a final section summarizes our findings and addresses the implications for the future of rice farming in Central Luzon and the Philippines generally.

Following this introduction, Chapter II provides the background of the survey. We explore the data from Chapter III to Chapter VIII, focusing on the changes in household and farm characteristics in Chapter III, trends in productivity in Chapter IV, crop management practices in Chapter V, labor use in Chapter VI, technology adoption in Chapter VII, and profitability in Chapter VIII. In Chapter IX, to give more depth to our analysis, we present a life story of six farmers in our sample. Chapter X discusses the implications of our findings.

A rather substantial set of Appendices is provided. Appendix A provides detailed summary tables cited in the text. Appendix B presents a similar type of farm-level studies conducted in the Philippines and other countries in order to facilitate our understanding of the history of data collection efforts and the position of the Loop Survey along the history. Appendix C summarizes previous studies that have made use of the Loop Survey data.

Appendix D contains detailed survey data by observations but processed on a per hectare basis and it contains data on farm characteristics, yield, input use, and costs and returns. We are happy to make these processed data available to scholars and any interested users.

II. The survey setting and sample farms

Evolution of the Central Luzon Loop Survey

In 1966, the Agricultural Engineering Department of IRRI initiated a study of the economics of rice mechanization. Lloyd Johnson, head of the department, and Stanley Johnson, an economist, initiated a weekly survey to determine the practices being followed in the use of labor and mechanization in rice farming. As shown in Figure 2.1, the survey covered 145 rice fields, most of them located along the main highway stretching north of Manila in a loop through four Central Luzon provinces, namely, Bulacan, Nueva Ecija, Pampanga, and Tarlac, plus Pangasinan and La Union, regarded as the rice granary of the Philippines.

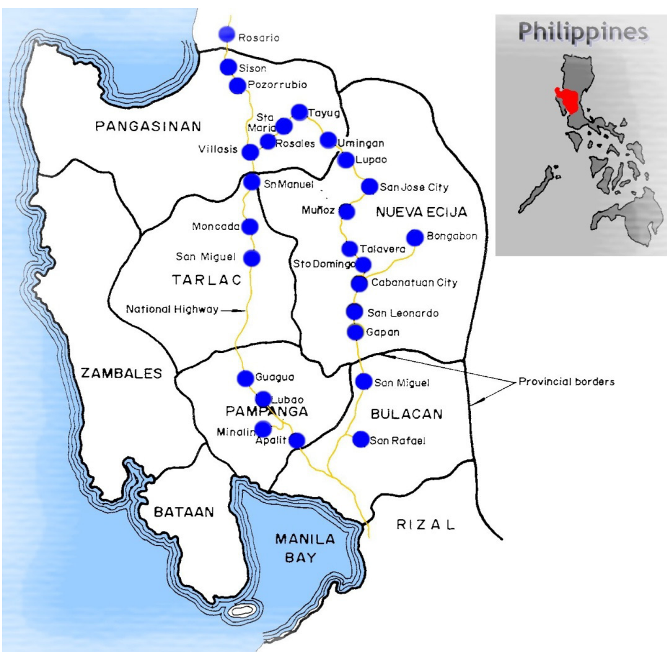


Fig. 2.1. Map of the Central Luzon Loop Survey.

Initially, a sample in Laguna Province south of Manila was also included because only 10% of the areas in Central Luzon were irrigated for the second crop. The so-called friar lands in Laguna had been irrigated during Spanish times when the land was owned by the friars or the church. During the American administration, these lands were purchased and turned over to farmers.

In the study undertaken by the IRRI engineers, the practice being undertaken by the farmers at the weekly visit were recorded (IRRI 1967) as the initial survey focused on power use and labor productivity. Weather records and soil conditions were also recorded. Subsequently, the farm households were interviewed to provide a complete picture of rice varieties, input use, costs and returns, etc. Paddy yield estimates were obtained by crop cuts.

In 1968, the two Johnsons left IRRI and left behind the survey data with the Agricultural Economics Department then headed by Randy Barker. The survey of 76 farmers in 1970-71 allowed a comparison with the practices on those same farms in 1966-67. It is at this point that the Loop Survey became a longitudinal survey allowing us to observe changes over time.

In 1979 (the fourth survey round), the decision was made to drop the farms in Laguna Province because of the increasing urban influence (Herdt 1987). At the same time, an additional 91 farms were added to the original sample of 68 farms surveyed in Central Luzon. With the occasional dropouts, the number of farms varied from one survey to the next (Table 2.1). The above adjustments notwithstanding, the Loop Survey conducted at regular intervals every four to five years has continued to provide a snapshot of the changes taking place in rice-farming practices and rice farm households.

The survey setting

Central Luzon has a distinct WS and DS, wherein the WS starts in May or June and ends in October, and the DS starts in November and ends in March or April. In the wet or monsoon season, crop losses are common because of flooding, typhoons, insects, and diseases, while in the DS, some periods have a lack of water because of drought. The most serious shortfall in rice production on record (Bureau of Agricultural Statistics) occurred in 1971 and 1972. In each year, approximately one-third of the rice crop was lost. The damage in 1971 was largely due to insects and diseases and in 1972 to heavy monsoon rains and flooding. This led to the government implementation of the Masagana 99 program in early 1973. Under this program, rice farmers were provided with easy access to low-cost inputs

Table 2.1. Central Luzon Loop Survey sample respondents, 1966-2012.

Year	Sample size (N)	Number of parcels	Number of farmers planting	
			Wet season	Dry season
1966-67	95	120	95	17
1970-71	62	89	62	13
1974-75	59	99	59	14
1979-80	148	338	147	81
1982	135	226	135	a
1986-87	120	232	114	64
1990-91	108	254	107	58
1994-95	100	212	99	56
1998-99	85	172	82	46
2003-04	116	263	115	71
2007-08	107	172	101	68
2011-12	95	209	93	66

[a]No dry-season survey was conducted during this crop year.

such as fertilizer and improved rice technology. The objective of the program, as the name connotes, was to harvest 99 cavans of paddy (roughly 5 tons) per hectare. It was an extension-credit-input package program intended to promote the diffusion of new rice technology. The main element was a system of supplying credit without collateral to farmers for the purchase of modern inputs under the supervision of government agricultural extension workers (Hayami and Kikuchi 2000).

The Loop Survey passes through six provinces (Fig. 2.1). This consists of the largest contiguous area of lowlands, and is otherwise known as the Central Plains of Luzon. The 480,000 hectares in rice in the 1960s was, to a large extent, rainfed. As noted earlier, only 10% of the rice area was irrigated for a second dry-season crop.

The completion of the Pantabangan Dam in 1975 and the establishment of the Upper Pampanga Integrated Irrigation System (UPRIIS) represented the first major irrigation project in the region. The area irrigated in Central Luzon rose from 250,000 ha in 1970 to 600,000 ha in 2012 (see Appendix Table 1.1). The rainfed area fell from 200,000 ha in 1970 to 75,000 in 2012. Rice production rose from 1 million to 3.2 million metric tons over the same period, with the rainfed area accounting for only a small fraction of the total.

The development of surface irrigation systems accounted for most of the early expansion of irrigated areas in Central Luzon. The Casecnan Irrigation and Hydroelectric Plant, which started service in 2002, diverts water from the Casecnan and Taan rivers of Nueva Vizcaya to the Pantabangan Reservoir through a 25-km-long tunnel in Nueva Ecija Province, and this further enhanced the expansion of irrigated area in the region (Diokno-Pascual 2014). However, in the past two decades, the adoption of low-lift pumps and shallow tube wells has provided perhaps the major source of irrigation expansion, particularly in the dry season.

The sample farms

The original Central Luzon samples included farms along a “loop” of the national highway passing through the six provinces as seen on the map. Randomization of the fields was achieved by specifying the fields to be observed at specific kilometer posts along the main highway (e.g., the 50th, 60th, 70th, etc.).

The number of households surveyed declined and then increased in the later years. It started with 95 sample farms in 1966 (Table 2.1) and it declined during the second and third rounds because of the refusal to be interviewed, conversion of land to other uses, non traceable respondents, and deaths–62 in 1970-71 and 59 in 1974-75.

The sample farmers for the first three periods are basically the same respondents. New households were added in the 1979-80 survey to increase the number of samples. These additional samples were taken in the same villages where the 59 sample farmers live (Herdt 1987).

It must be noted, however, that some farmers owned more than one parcel; hence, the number of sample parcels is higher than the number of sample households. Similarly, in some cases, samples were interviewed in only one season of the crop year. Nevertheless, the original sample size gradually declined for the above mentioned reasons. To avoid a further decline in the sample size because of changes in ownership or cultivator of the sample parcels, we tried to trace the current owner or operator of the parcel even though the residence was outside the village, and continue the survey. Therefore, this survey is characterized as the panel data of rice plots, although it still retains a feature of household-level panel data to some extent because owners and cultivators do not change often. The numbers of sample farmers during the DS were smaller relative to the WS because only those farmers who planted rice during the season were interviewed.

From 1966 to 1975, only a small proportion of the samples (20%) could plant a DS crop because of a lack of irrigation. These are the ones who have a source of water during the DS, either through a gravity system (canal system) or small tube-well pump irrigation system. However, after 1975, when the Upper Pampanga River Integrated Irrigation System (UPRIIS) (whose service area includes some of our samples) was built and became operational, a bigger proportion of the samples was able to plant a second rice crop, as evident in Table 2.2. It is also worth noting that the number of parcels dependent on rainwater during the WS gradually decreased throughout the years when water became available not only from the gravity irrigation system (UPRIIS) but also from small pump systems. Some of the sample farms that are not irrigated by the National Irrigation Administration (NIA) system bought their own small pumps to supplement rainfall during the WS and as the main source of water for the DS crop. However, farms that are included in the service area of the NIA system but where the supply of water from the system is insufficient also used small pumps as an additional and supplementary source of irrigation water during the dry season. As shown in Table 2.2, the area irrigated by the surface gravity system in the wet season remained at about 55% in the entire period while the area irrigated by pumps grew to 26% in 2011. For the dry season, the area irrigated by the surface gravity system had declined from 94% to 71% in 2012 while the area irrigated by pumps had climbed steadily from 6% to 29%, indicating the replacement of degraded gravity systems by pump systems.

Table 2.2. Source of water for rice production, sample parcels, Central Luzon Loop Survey, 1966-2012.

Season	No. of parcels	Irrigation water										Rainwater				
		Gravity					Pump									
		Count	%	Area (ha)			Count	%	Area (ha)			Count	%	Area (ha)		
				Mean	Min.	Max.			Mean	Min.	Max.			Mean	Min.	Max.
Wet																
1966	103	57	55	2.07	0.10	9.0	5	5	1.55	0.75	2.5	41	40	1.74	0.25	5.3
1970	74	28	38	2.37	0.33	6.0	11	15	2.42	0.25	7.0	35	47	1.83	0.25	6.0
1974	80	35	44	1.85	0.20	7.0	9	11	2.61	0.50	6.0	36	45	1.67	0.10	5.0
1979	227	133	59	1.21	0.03	4.0	25	11	1.42	0.50	5.0	69	30	1.19	0.10	6.0
1982	226	140	62	1.08	0.10	3.0	11	5	1.29	0.17	2.5	75	33	0.97	0.05	2.5
1986	148	84	57	1.41	0.18	4.0	19	13	1.25	0.50	2.5	45	30	1.43	0.10	4.8
1990	170	86	51	1.18	0.02	3.0	30	18	1.00	0.16	2.6	54	32	1.08	0.18	3.0
1994	138	80	58	1.27	0.10	2.6	24	17	1.07	0.25	3.5	34	25	1.16	0.20	3.0
1999	108	49	45	1.25	0.25	2.5	23	21	0.97	0.12	1.6	36	33	1.19	0.20	2.8
2003	166	109	66	1.26	0.20	7.0	25	15	1.23	0.23	3.25	32	19	1.06	0.20	3.0
2008	102	64	63	1.22	0.20	3.2	18	18	1.09	0.40	2.0	20	20	1.02	0.25	2.0
2011	119	60	50	1.38	0.06	3.2	31	26	1.20	0.23	2.7	28	24	0.90	0.10	2.0

Cont...Table 2.2

Season	No. of parcels	Irrigation water										Rainwater				
		Gravity					Pump									
		Count	%	Area (ha)			Count	%	Area (ha)			Count	%	Area (ha)		
				Mean	Min.	Max.			Mean	Min.	Max.			Mean	Min.	Max.
Dry																
1967	17	16	94	1.56	0.20	3.0	1	6	0.25	0.25	0.25					
1971	15	11	73	2.07	0.92	4.0	4	27	1.34	0.25	2.5					
1975	19	15	79	1.77	0.20	3.5	4	21	0.64	0.25	1.3					
1980	111	107	96	1.39	0.09	5.0	4	4	1.21	0.50	2.0					
1987	84	78	93	1.35	0.23	4.0	6	7	1.02	0.50	1.7					
1991	84	73	87	1.28	0.15	3.5	11	13	0.89	0.10	2.0					
1995	74	59	80	1.22	0.10	2.5	15	20	0.99	0.23	2.0					
1998	64	49	77	1.20	0.25	2.5	15	23	0.85	0.20	1.5					
2004	97	78	80	1.39	0.20	6.0	19	20	1.11	0.40	3.0					
2007	70	57	81	1.27	0.20	3.2	13	19	0.96	0.30	2.0					
2012	90	64	71	1.40	0.10	4.8	26	29	1.13	0.20	2.7					

III. Household and farm characteristics

This section presents a brief description of the socioeconomic characteristics of the farm operators and their families and how they have evolved over time, for almost five decades.

Farm operator profile

Table 3.1 presents a summary of the basic socioeconomic characteristics of the farm operators from crop year 1966-67 to 2011-12. The active participation of women in rice farming was negligible in the 1960s and 1970s. However, in the early '70s, female farmers started to emerge and their share increased from about 4% in the 1990s to about 19% in 2011-12. The majority of women farmers take over rice farming after the death of their husbands. Adult sons who could possibly take over the cultivation of the farm usually have off-farm jobs. The increasing participation of Central Luzon women in rice farming is consistent with the trend that has been witnessed in other parts of Asia.

Since this is a longitudinal panel survey, the age of respondents increases over time. However, even in 1966, when the mean age of farmers was 46 years, they still belong to the somewhat older population, which suggests that only older members of the population would like to continue farming. Except in 1979-80 and 1982, wherein the age slightly decreased because of additional new samples, the average age of the farm operator continually increased until 2012. As of 2012, the mean age of farmers is 59 years even though many of the original sample farmers in 1966 have been continually replaced over the years of the survey. Rice farming is being undertaken by older members of the population and the younger members are involved in nonfarm work although in some cases a sibling takes over the management. However, the aging of the farm operators as a whole is a common phenomenon in other developing countries as economic development opens more nonfarm jobs and the Philippines' rice farming is not an exception. On average, the number of years of schooling of the farm operators in Central Luzon has improved: from 5 years in 1966 to 9 years in 2012. A closer look at the distribution of the sample in terms of educational level

Table 3.1. Socioeconomic characteristics of farm operators, Central Luzon Loop Survey, 1966-2012.

	1966-67	1970-71	1974-75	1979-80	1982-83	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Sex												
Male	100	100	98	99	99	98	96	94	89	85	87	81
Female			2	1	1	2	4	6	11	15	13	19
Age	46	49	53	43	45	49	53	53	57	56	57	59
Education												
No education	8	11	7	1	1	1	1	1	1	2	1	1
Elementary	73	71	71	64	59	62	57	52	48	41	36	34
High school	15	13	15	29	34	32	34	39	40	42	41	39
College	3	5	5	7	6	6	7	8	11	16	21	25
Average education	5	5	5	7	7	7	7	7	8	8	9	9
Marital status												
Married	71	84	86	88	93	94	91	86	84	86	80	80
Single				11	4	3	3	3	1	1	1	1
Widow	2			1	2	3	6	11	15	13	19	19
Data not available	27	16	14		1							
Primary occupation												
Farming	100	100	100	100	100	98	100	100	100	100	99	84
Housekeeping												3
Service nonprofessional											1	9
Service professional						2						1
Trading/buy and sell												3
Number of samples	95	62	59	148	135	120	108	100	85	116	107	95

reveals that more than 70% had completed the elementary level or 6 years in school in 1966. A smaller but significant proportion, 15%, had almost 10 years in school (high school) and a few had attended college. In 2012, a fourth of the total farmers had college education and only 1% didn't have any education at all. Generally, those farmers who have a limited number of years in school are among the oldest in our sample.

As expected, the majority of the farm operators are married. As the average age has increased from the mid-40s in 1966 to the late 50s in 2012, it is natural that the number of widowers has increased over time.

Data on the occupation of the farmers showed that, from 1966 to 2004, with the exception of 1986, 100% of the farmers considered farming as their primary occupation. However, that trend has changed in recent years, with 16% of the farmers considering non farming as their main occupation in 2011-12. The most common off-farm works are construction laborer, service and company worker, and buy and sell activities. These figures underestimate the increasing popularity of nonfarm activities in the area because the Loop Survey has been tracking farmers who manage sample plots and not tracking the farmers that completely exited from farming and engaged in nonfarm activities.

The farm household demographic profile

Table 3.2 summarizes the data on the demographic characteristics of the farm households, which became available from 1979. In spite of the changes in the sample size, the size of the household remained at 6 from 1979 to 2004 and then declined to 5 in 2007. In terms of sex, the household members were equally divided between males and females until 2004 but, in recent years, the ratio has tilted in favor of females, with a 60-40 ratio. On average, only about 30% of the household members are in the labor force and the remaining 70% of the household members are considered dependent within the family.

A more detailed presentation of the distribution of the family members by age and sex is shown by the population pyramids in Figure 3.1 (constructed from Appendix Table 2). The aging of rice farmers is also suggested from this figure.

Farm characteristics

Farm size as defined here includes the sum of the physical area of all parcels owned or operated by the sample farmer; however, it must be noted that a few farmers operate more than one parcel. On the other hand, area

Table 3.2. Family labor force and number of economically active family members, Central Luzon Loop Survey sample households, 1966-2012.

		1979-80	1982-83	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Mean household size		6	6	6	6	6	6	6	5	5
Males		3	3	3	3	3	3	3	2	2
Females		3	3	3	3	3	3	3	3	3
Economically active members										
Males	15 to 64	1.19	1.14	1.48	1.23	1.20	1.29	1.16	1.07	1.47
	65>	0.07	0.08	0.13	0.20	0.18	0.20	0.15	0.21	0.26
Females	15 to 64	0.47	0.53	1.07	0.75	0.62	1.17	0.76	0.69	1.41
	65>	0.01	0.01	0.08	0.05	0.04	0.04	0.03	0.07	0.23
Total economically active		1.74	1.76	2.75	2.23	2.04	2.70	2.10	2.04	3.37
Years in school of economically active										
Males		7	7	8	8	8	9	9	9	10
Females		8	8	7	9	9	9	9	10	10
Working family members										
Head		148	135	120	108	100	85	116	107	95
Son		30	24	61	43	41	42	49	34	51
Daughter		26	26	42	39	26	30	24	27	41
Spouse		36	40	78	37	31	49	44	28	67
In-law		3	8	13	8	5	8	8	16	41
Parent		2	1	4	4	1	1		1	3
Sibling		12	4	4	2		4	1	1	1
Relative		1		2		1		1		7
Other		1	1	2						1
Grandchild		1		3		1	2	1	5	6
No data available				5	1					
Total working		260	239	334	242	206	221	244	219	313
Mean		1.76	1.77	2.78	2.24	2.06	2.06	2.10	2.05	3.29
Nonworking family members										
Son		233	242	174	147	137	92	113	66	28
Daughter		221	206	142	109	120	82	104	79	40
Spouse		90	83	29	55	49	19	52	56	2
In-law		14	8	9	14	14	5	39	28	4
Parent		33	28	12	7	7	9	6	6	6
Sibling		39	24	8	3	4	2	4	12	1
Relative		2	2	8	4	4	5		7	8
Other		7	6	10	2	8		3	5	2
Grandchild		26	18	39	43	52	45	96	101	83
Blank				1	7			3		
Total working		665	617	432	391	395	259	420	360	174
Mean		4.49	4.57	3.60	3.62	3.95	3.05	3.62	3.36	1.83
Total population		925	856	766	633	601	480	664	579	487

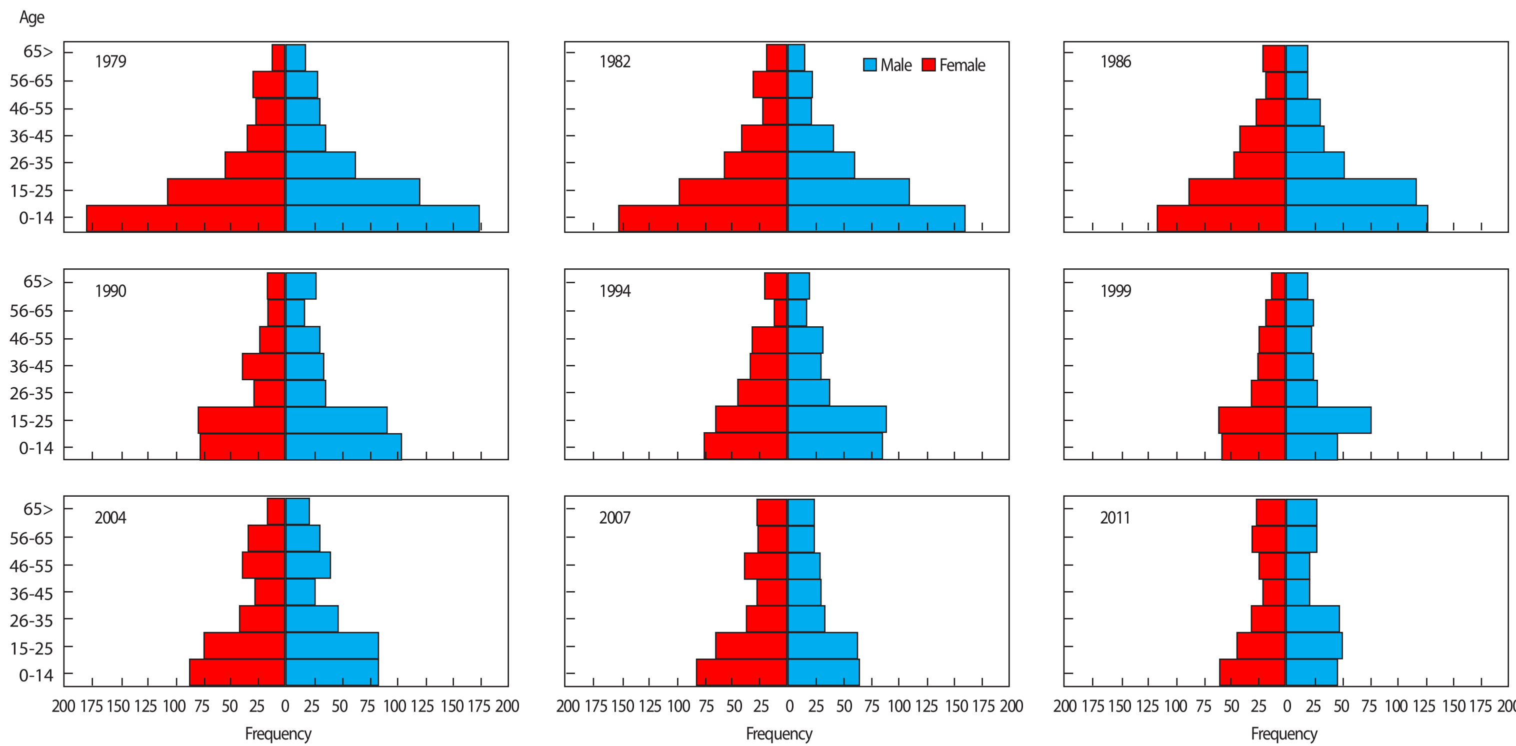


Fig. 3.1. Household composition by age and by sex, 1979-2011.

planted refers to the area planted to rice per season for each of the parcels cultivated by the farmer.

In five decades, the average farm size showed no dramatic change around mean size of 2 ha (Table 3.3).On the other hand, the area planted to rice in the wet season (Table 3.4) showed a sharp decline from around 2 ha in the 1970s to about 1.2 ha in the 1990s. The area planted to rice in the dry season has shown a somewhat less dramatic drop.

The above decline in area planted to rice could possibly be attributed to recurring flooding and/or the unavailability of irrigation water, and the decline in profit in the wet season. Detailed data on area cultivated showed that only a few of the sample parcels were planted to other crops and hence crop diversification is not common in Central Luzon. The farmers plant vegetables for home consumption in only a very small area of the farm, usually around the farm house and along the rice bunds. Whichever the above causes, for the Philippine rice-farm economy, the issue of farm size is important. One might expect that, as labor leaves the farm, economic efficiency would call for more mechanization and larger farms (Otsuka 2010).

Land ownership and tenure distribution

Data on land tenure are presented here in terms of parcels rather than by farm households because it was found that some farmers cultivated several parcels under different tenurial arrangements (Table 3.5).

The land tenure distribution has undergone significant changes over the five decades of study. In 1966, 75% of the sample parcels were under the share tenancy arrangement and the remaining 25% were equally distributed between the owner and the leaseholder. The proportion of tenants gradually declined to as low as 6% of the samples in 2007-08. This is in contrast with the increasing proportion of landowners from 13% in 1966 to 63% in 2012. This could be attributed to the comprehensive implementation of the land reform law in the Philippines, particularly in the Central Luzon area where our sample farms are located. This law, called the Agricultural Land Reform Code (RA 3844),[1] was a major advancement of land reform in the Philippines and it was enacted in 1963 to abolish tenancy and establish a leasehold system in which farmers paid fixed rentals to landlords, rather than a percentage of the harvest.

In September 1972, the second presidential decree that Marcos issued under martial law declared the entire Philippines a land reform area. A month later, he issued Presidential Decree No. 27, which contained the

[1] Philippine Law and Jurisprudence Databank, Law Phil Project, Arellano Law Foundation.

Table 3.3. Trends in farm size in hectares, Central Luzon Loop Survey sample farms, 1966-2012.

	1966-67	1970-71	1974-75	1979-80	1982-83	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Farm size												
Area	2.09	2.54	2.60	1.89	1.78	1.81	1.81	1.70	1.59	1.90	1.75	1.94
Min.	0.20	0.50	0.20	0.20	0.40	0.40	0.25	0.10	0.20	0.20	0.20	0.10
Max.	9.00	7.00	7.00	7.80	5.00	6.00	5.00	4.20	3.75	11.50	10.20	16.00
Sample (n)[a]	95	62	59	148	135	120	108	100	85	116	107	95

[a]Some of the sample households operate two or more parcels.

Table 3.4. Long-term changes in area planted to rice by season, sample parcels, Central Luzon Loop Survey, 1966-2012.

	1966-67	1970-71	1974-75	1979-80	1982-83	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Area planted to rice by season												
Wet season												
Area	1.91	2.12	1.86	1.23	1.05	1.40	1.12	1.21	1.17	1.22	1.16	1.22
Min.	0.10	0.25	0.10	0.03	0.05	0.10	0.02	0.10	0.12	0.20	0.20	0.06
Max.	9.00	7.00	7.00	6.00	3.00	4.75	3.00	3.50	2.75	7.00	3.20	3.20
Dry season												
Area	1.49	1.88	1.53	1.38		1.32	1.23	1.18	1.12	1.33	1.21	1.32
Min.	0.20	0.25	0.20	0.09		0.23	0.10	0.10	0.20	0.20	0.20	0.10
Max.	3.00	4.00	3.50	5.00		4.00	3.50	2.50	2.50	6.00	3.20	4.80
Cropping intensity	1.13	1.18	1.20	1.55		1.54	1.54	1.52	1.56	1.64	1.72	1.82
Sample (n)[a]												
Wet season	103	74	80	227	226	148	170	138	108	166	102	119
Dry season	17	15	19	111		84	84	74	64	97	70	90

[a]Sample parcels.

Table 3.5. Land tenure distribution of sample parcels, Central Luzon Loop Survey, 1966-2012.

Years	Owner		Leaseholder		Share tenant		Borrowed		Mortgaged		Rented in	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
1966-67	13	12.62	13	12.62	77	74.76	0	0.00	0	0.00	0	0.00
1970-71	6	8.11	25	33.78	43	58.11	0	0.00	0	0.00	0	0.00
1974-75	12	15.00	47	58.75	21	26.25	0	0.00	0	0.00	0	0.00
1979-80	63	27.75	135	59.47	29	12.78	0	0.00	0	0.00	0	0.00
1982	59	26.11	144	63.72	23	10.18	0	0.00	0	0.00	0	0.00
1986-87	54	36.49	67	45.27	22	14.86	2	1.35	3	2.03	0	0.00
1990-91	77	45.29	70	41.18	13	7.65	1	0.59	9	5.29	0	0.00
1994-95	68	49.28	52	37.68	11	7.97	1	0.72	6	4.35	0	0.00
1998-99	64	59.26	35	32.41	8	7.41	0	0.00	1	0.93	0	0.00
2003-04	94	56.63	41	24.7	20	12.05	2	1.20	9	5.42	0	0.00
2007-08	55	53.92	33	32.35	6	5.88	3	2.94	5	4.90	0	0.00
2011-12	75	63.03	32	26.89	6	5.04	2	1.68	3	2.52	1	0.84

specifics of his land reform program. The reform attempted to convert share tenants to leaseholders when the landlord owned less than 7 ha of land or to amortizing owners when the landlord owned more than 7 ha of land. The reform procedures as summarized by Hayami and Kikuchi (2000) involved two steps. The first, Operation Leasehold, converted share tenancy to leasehold tenancy with rent fixed at a rate of 25% of the average harvest for the three normal years preceding the Operation. The second step, Operation Land Transfer, transferred land ownership to tenants. In the latter Operation, the government expropriated the area in excess of the landlord retention limit, with compensation to the landlord being 10% of the land value in cash and the rest in interest-free redeemable Land Bank bonds. The land was resold to the tenants for annual mortgage payments over 25 years, and they were granted a "Certificate of Land Transfer" (CLT). Upon completion of the mortgage payments, the CLT holders were given "Emancipation Patents" (EP) on the land, that is, a land ownership title with the restricted right of land sale. The program was the most comprehensive ever attempted in the Philippines, notwithstanding the fact that only rice and corn land were included. It succeeded in breaking up many of the large haciendas in Central Luzon, where our sample farms are located.

The data generally showed a decreasing pattern for share tenancy and increasing pattern for ownership. It is noticeable, however, that, starting in crop year 1986-87, different forms of land cultivation arrangement emerged. Some farmers started to mortgage their land and quite a few borrowed. This trend is associated with the increasing popularity of overseas work because mortgaging is one of the major ways to finance the placement fee paid to the employment agency. In mortgage out, the farmer borrowed a certain amount of money in exchange for the right to cultivate the land until such time that the loan was repaid. In some cases, some farmers lend their field for a certain period when they had no time to cultivate the land, either for free or for a certain seasonal payment. On the other hand, there are cases in which some well-off farmers are the ones who gave or lent money for a certain period to co-farmers in exchange for the right to cultivate the land. This is what we call mortgage in. This emerging pattern could possibly cause changes in the size of area cultivated without necessarily causing any change in the ownership of land.

Changes in cropping intensity

Cropping intensity is generally defined as the number of times a crop is grown in the same area in a year. Since our farmers plant only a portion of the same area, cropping intensity is not necessarily an integer. The mean cropping intensity is estimated with the weighted area planted for the wet season and dry season.

Cropping intensity showed an increasing trend for the past five decades (Table 3.4). In 1966, when short-duration varieties were not yet available, only limited numbers of parcels were planted for a second rice crop, resulting in a very low cropping intensity of only 1.12. This slowly increased to 1.18 and 1.20 in 1970-71 and 1974-75 when short-duration rice varieties were introduced. It further improved to 1.5 when UPRIIS was built and became fully operational, providing irrigation water to many of our sample farms in the dry season in the provinces of Bulacan and Nueva Ecija. In addition, the use of small pumps for irrigation was also becoming popular during that period. This trend continued and the intensity further increased to 1.82 in 2012 upon the completion of the Casecnan irrigation project that further increased the area irrigated in the Central Luzon area covering some of our sample sites.

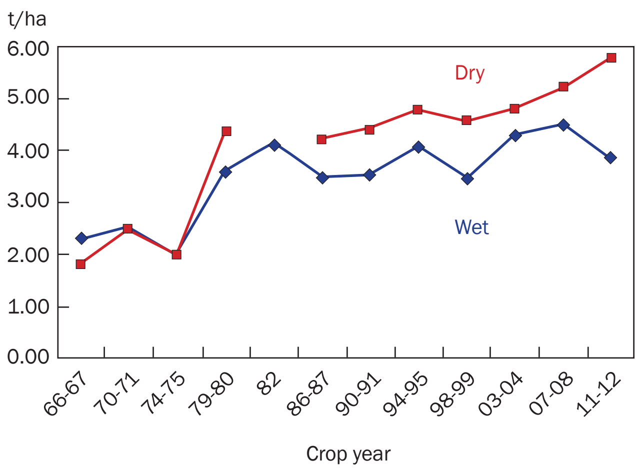
IV. Trends in rice productivity

Input-output data and management practices for rice are collected by parcel for each sample farmer. Thus, if one farmer has two or more parcels, information on rice production processes is collected separately for each parcel. This is on the assumption that each parcel will have different inherent productivities and farmers may have different practices for each of their parcels, particularly if they are located in different locations and ecosystems. This will result in varying yields, input use, and crop management practices not only inter-households but also intra-households. All analyses presented from hereon are on a parcel basis.

A comparison and analysis of trends in rice productivity are made in terms of yield per hectare and presented across seasons, ecosystems, and land ownership.

Trends in yield by season

Wet-season paddy yields exhibited an increasing trend, particularly in the 1960s and '70s (Fig. 4.1). Yield rose from a mere 2.3 t/ha in the 1966 WS, in which 100% of the area was planted to traditional low-yielding varieties, to almost 4 t/ha by the 1980s. The growth in yield continued as farmers



Years	Yield (t/ha)	
	Wet	Dry
66-67	2.30	1.79
70-71	2.50	2.48
74-75	2.04	1.97
79-80	3.61	4.39
82	4.09	
86-87	3.50	4.23
90-91	3.51	4.39
94-95	4.07	4.82
98-99	3.45	4.59
03-04	4.28	4.80
07-08	4.51	5.22
11-12	3.88	5.76

Fig. 4.1. Trends in yield per ha, sample farms, Central Luzon Loop Survey, 1966-2012.

continued to adopt high-yielding varieties and a majority of the parcels became irrigated (see Table 2.2). However, some fluctuations occur in some years. Yield dipped in 1974 to only 2.0 t/ha because of typhoon damage. Yield became relatively stagnant from 1982 onward, reaching its highest level of 4.5 t/ha in 2008 (see Fig. 4.1). Individually, the sample parcels exhibited much variability in yield, ranging from as low as zero when the crop was totally damaged to as high as 11 t/ha for progressive farms (Appendix Table 4.1). However, the variation in yield has been declining over time as indicated by the coefficient of variation (CV) in Table 4.1, implying the standardization of Green Revolution technology over five decades.

We now move to a discussion of DS productivity. Central Luzon is one of the regions in the Philippines where there is a distinct wet season and dry season in which the rainfall during the DS is minimal; without any source of water, the rice crop cannot survive. Meanwhile, the DS has an advantage in terms of higher solar radiation and less pest and insect prevalence, thus allowing higher yield as long as irrigation water is properly provided. Rainfed farms that depend on rainwater alone have no DS rice crop. Only irrigated parcels are planted in the DS; hence, a much smaller sample is obtained than for the WS.

Yield grew from 1.79 t/ha in the 1967 DS during the pre-Green Revolution period to 5.75 t/ha in the 2012 DS. There are, however, some years when yield showed some minor ups and downs such as in 1998, when it dropped to 4.59 t/ha from 4.82 t/ha in 1995. Otherwise, yield showed a steadily growing trend as depicted in Figure 4.1. This is a contrasting difference from the trend of WS yield. DS yield already reached more than 4.0 t/ha in 1980 and then increased to more than 5 t/ha in 2007. As in the wet season, a reduction in yield variations is observed in the dry season, as indicated by the CV.

On average, the mean yields of the sample are comparable with those of the Central Luzon region from the Bureau of Agricultural Statistics (BAS); in fact, the values are slightly higher (Table 4.2). Also, the BAS data show that annual growth in yield was 3% during the spread of the high-yielding varieties, slowed to 1% in the decade from 1985 to 1995, and then increased to more than 2% in the following decade (Table 4.3). This trend is exemplified also in the DS yield of the Loop Survey. Mataia et al (2011) attribute the increase for the Philippines on the whole to irrigation and expanded use of certified seed.

Table 4.1. Trends in yield by season, sample farms, Central Luzon Loop Survey, 1966-2012.

Season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Wet	Yield (kg/ha)	2,303	2,500	2,042	3,607	4,093	3,497	3,512	4,073	3,454	4,284	4,510	3,879
	(S.D.)	891	1,008	1,162	1,843	1,668	1,202	1,522	1,763	1,475	1,162	1,080	1,165
	CV	0.39	0.40	0.57	0.51	0.41	0.34	0.43	0.43	0.43	0.27	0.24	0.30
		1967	1971	1975	1980		1987	1991	1995	1998	2004	2007	2012
Dry	Yield (kg/ha)	1,789	2,481	1,973	4,390		4,227	4,393	4,819	4,588	4,798	5,224	5,760
	(S.D.)	846	1,828	1,747	1,910		1,365	1,748	2,141	1,717	1,569	1,401	1,719
	CV	0.47	0.74	0.89	0.44		0.32	0.40	0.44	0.37	0.33	0.27	0.30

Table 4.2. Trends in yield (t/ha) by season, Central Luzon region, Philippines.

Year	2012	2011	2008	2007	2004	2003	1999	1998	1995	1994	1991	1990	1987	1986	1982	1980	1979	1975	1974	1971	1970
Wet season	4.43	3.51	4.22	4.39	4.23	4.09	3.26	2.62	2.86	3.20	2.96	3.46	2.86	2.94	3.35	2.40	2.47	1.90	1.67	1.58	2.23
Dry season	5.18	5.06	4.99	4.90	4.55	4.38	3.79	3.85	3.78	4.04	4.55	4.14	3.81	3.81	3.82	3.24	4.41	2.93	2.79	2.57	2.61

Source of data: Bureau of Agricultural Statistics, Philippines.

Table 4.3. Growth rates (%) in production, area, and yield, Central Luzon, Philippines.

Years	Production	Area	Yield
1975-85	3.80	0.73	2.94
1985-95	1.99	0.90	1.09
1995-2005	3.39	1.31	2.04

Bureau of Agricultural Statistics: Growth rate per annum computed as follows using end-year's method: From mid-1970s (average of 1970-79) to mid-'80s (1980 to 1989). From mid-1980s to average for 1990-99.

Trends in yield by ecosystem

Comparatively, irrigated farms produced a higher yield than rainfed farms because of assured water supply throughout the cropping season (Table 4.4). On average, over the years, irrigated farm yield is higher than rainfed farm yield.

Wet-season yields on irrigated farms showed a significantly fluctuating trend from 1966 to 2011. Yields oscillated in the range of 3.47 to 4.66 t/ha from 1979 to 2011. The highest mean yield of 4.66 tons was obtained in 2008 and the lowest mean yield was 2.28 in 1966. By simply looking at the 1966 and 2011 mean yields, we can say that yields increased by about 1.6 tons or 70% per hectare in almost five decades.

Rainfed farms were planted to rice only during the wet season, when there was enough rainfall to provide water for the rice crop. They also showed an increasing but slightly fluctuating trend in yield from 1966 to 2011, starting at 2.34 tons in 1966 and ending at 4.0 tons in 2011 as modern varieties and modern rice technologies were adopted (see Table 7.1 on adoption).

Surprisingly, regardless of ecosystem, there are years when the maximum yield attained by any farmer in the sample was as high as 10 to 11.2 t/ha and the minimum yield was practically zero (Appendix Table 4.1). The high yielders are the small well-managed parcels and the zero yielders are those whose crop was totally destroyed by typhoon or disease and pest infestation such as tungro virus or brown planthopper.

Trends in yield by land ownership

The Philippines has been under land reform since 1963, and Central Luzon has been strongly influenced by that as it is the birthplace of the land reform initiative. The reform affects the land rental market twofold. First, the reform has endeavored to eliminate share tenancy; thus, it restricts the available spectrum of contracts. Second, it makes landlords hesitant to rent out their land for fear of land confiscation by the land reform office. Under such restrictions, observed tenure statuses may suffer following efficiency losses.

- Share tenancy: To reduce expected loss of confiscation, landlords may rent out less productive land when they have to rent out the land under share tenancy. Also, share tenancy might suffer so-called Marshallian inefficiency unless tenants' efforts are effectively monitored through the long-term and intensive landlord-tenant relationship in a small agrarian community.
- Leaseholder (fixed-rent): A tenant who wishes to share production risk with the landlord by sharecropping may have to enter into this contract under land reform regulation. This would make the risk-averse tenant refrain from operating the farm at full scale.
- Owner: Landlords who wish to rent out their land (presumably because of their aging or exiting to nonagricultural work) may have to continue farm management by themselves for fear of land confiscation. Managing the farm with limited capacity of their own or managing the farm with permanent laborers could result in inefficient production. In fact, Hayami and Otsuka (1993) detected economic loss under the permanent labor arrangement in Central Luzon. This emerging form of permanent labor will be explained later in another section.

There is much discussion in the economic literature about the efficiencies of various forms of tenure. However, although it is beyond the scope of this book to conduct formal statistical analysis with our sample, it would appear from Table 4.5 that there is no discernible and systematic difference in yield over time among various tenure forms. Detailed statistical analysis of a tenancy effect on productivity is left for future studies.

Table 4.4. Trends in yield (t/ha) by ecosystem and season, Central Luzon Loop Survey, 1966-2012.

Season and ecosystem	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Wet												
Irrigated	2.28	2.67	2.25	4.17	4.44	3.63	3.66	4.10	3.47	4.35	4.66	3.84
Rainfed	2.34	2.32	1.79	2.32	3.39	3.18	3.19	4.00	3.42	4.00	3.88	3.99
Dry												
Irrigated	1.79	2.48	1.97	4.39	0.00	4.23	4.39	4.82	4.59	4.80	5.22	5.76

Table 4.5. Trends in yield (t/ha) by tenure status and season, WS and DS, Central Luzon Loop Survey, 1966-2012.

	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Wet												
Leaseholder	2.32	2.72	1.89	3.54	4.04	3.64	3.68	4.04	3.60	4.59	4.46	3.62
Owner	2.72	3.00	2.72	3.81	4.35	3.42	3.61	4.04	3.49	4.18	4.57	4.02
Share tenant	2.23	2.30	2.00	3.50	3.98	3.24	3.10	3.96	2.82	4.05	4.28	3.58
Others						3.53	3.67	4.76	1.08	4.42	4.45	3.77
Dry												
Leaseholder	1.59	2.88	1.73	4.50		4.38	4.22	4.36	4.24	4.33	5.01	5.31
Owner			3.15	4.87		4.35	4.42	5.27	4.90	4.96	5.16	6.08
Share tenant	1.83	2.03	1.83	3.14		3.49	5.56	4.74	4.06	5.14	5.67	5.30
Others						3.31	4.41	4.37		5.32	6.64	5.75

V. Changes in crop management practices and input use

A lot of changes in crop management practices and input use for rice production occurred after the introduction of modern rice technologies or the advent of the so-called Green Revolution. These changes are reflected in the amount, frequency, and timing of fertilizer use, pesticide use, and intensity of labor use for rice production. This chapter aims to present and describe these changes that occurred in rice farming after almost five decades.

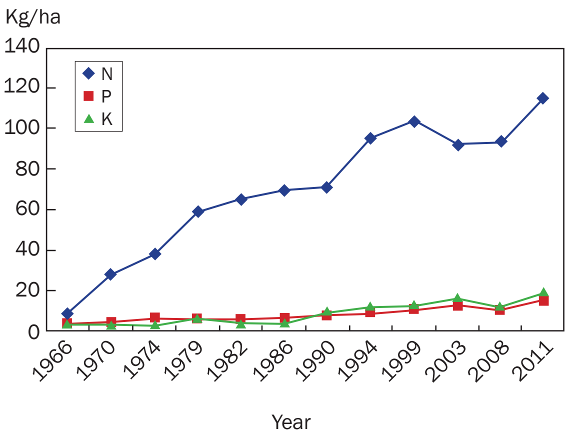
Fertilizer use

Aside from water, fertilizer is the second most important input that determines the yield of the rice crop. The most common fertilizer nutrients that farmers apply are nitrogen (N), phosphorus (P), and potassium (K). N fertilizers are commonly applied as urea at 46% N and as a component of complete fertilizer, which is 14% N, P, and K elements (usually noted as 14-14-14). Additional sources of P and K are ammonium phosphate (16-20-0) and muriate of potash (0-0-60).

To facilitate comparison among farmers, we converted the fertilizer applied to the amount of N, P, and K elements by using the percent component of each element of the particular brand or type of fertilizer that the farmers used.

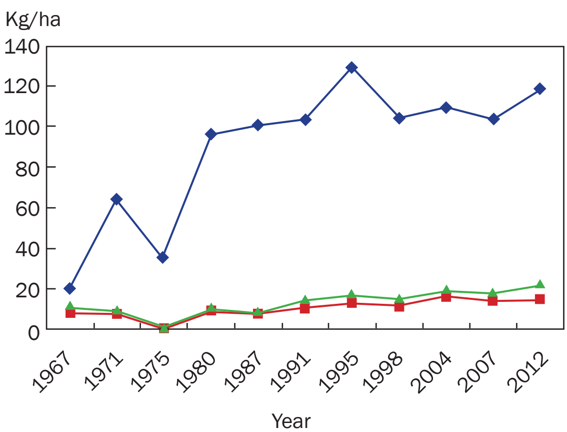
Comparative fertilizer use by season

Even before the start of the Green Revolution, farmers in Central Luzon were already using a small amount of chemical fertilizer. The amount of fertilizer applied by farmers varies across cropping seasons. Generally, they apply a bigger amount of fertilizer in the dry season than in the wet season (Figs. 5.1 and 5.2). The reason for this is twofold: (i) the higher solar energy in the DS results in a higher yield response to fertilizer and (ii) farmers face a lower risk of crop loss in the DS due to extreme weather, pests, and diseases. The amount applied in the WS in the later years already reached the recommended level, which is 100 kg N, but for the DS the recommended level is higher, 125 kg N (Sebastian 2000); thus, the amount applied by the farmers is still a little bit less than the recommended rate. However, the P and K rates of farmers are much lower than the recommended rate of 30 kg for both elements.



Year	N	P	K
	kg/ha		
1966	9	4	5
1970	28	4	3
1974	38	6	3
1979	59	6	6
1982	65	6	5
1986	70	6	5
1990	71	8	10
1994	95	9	12
1999	104	11	12
2003	92	13	16
2008	93	10	12
2011	115	15	19

Fig. 5.1. Trends in fertilizer use per ha, WS, Central Luzon Loop Survey, 1966-2012.



Year	N	P	K
	kg/ha		
1967	20	7	11
1971	64	6	8
1975	35	0	0
1980	96	8	10
1987	100	7	7
1991	103	10	14
1995	130	13	16
1998	104	11	14
2004	110	16	18
2007	103	13	17
2012	119	15	21

Fig. 5.2. Trends in fertilizer use per ha, DS, Central Luzon Loop Survey, 1966-2012.

Dry-season data showed a steady increase in N application from 20 kg in 1967 to 120 kg by 2012 (Fig. 5.1). This quickly jumped to 100 kg by the 1980s and since then has fluctuated between 100 and 120 kg. A similar trend is shown in the wet season but at a lesser amount. It is worth noting that the increase in fertilizer use occurred, despite an increase in the nitrogen to rice price ratio in the 1970s (see Fig. 5.4), thus indicating an overwhelming demand increase effect due to the variety shift from traditional varieties to fertilizer-responsive MVs.

The amount of P and K application is much lower than that of N fertilizer. P application ranged from around 4 kg to 15 kg from 1966 to 2011. A similar pattern is shown by K fertilizer, wherein the lowest application was around 3 kg/ha and the highest was 19 kg/ha in 2011. Some farmers still made no fertilizer application at all during the wet season, not only during the early period (1966) but also up to 2011 (Appendix Table 5.1).

Comparative fertilizer use by ecosystem

Since rainfed farms are planted to rice during the wet season only, the comparison will be confined to the WS. The data clearly showed that irrigated farms applied more N fertilizer than rainfed farms for the WS (Table 5.1), reflecting the complementarity between fertilizer and irrigation water. On average, N use of irrigated farms is higher than that of rainfed farms on the order of 18 kg. Excluding 1966, the difference in N application by year ranged from around 7 kg/ha to as high as 43 kg/ha. After the introduction of modern varieties in 1966, the amount applied by irrigated farms during the WS increased from about 33 kg/ha to around 125 kg/ha.

Table 5.1. Comparative fertilizer use (kg/ha), WS, irrigated and rainfed farms, Central Luzon Loop Survey, 1966-2012.

	Irrigated			Rainfed		
	N	P	K	N	P	K
1966	9.46	4.22	5.25	8.27	2.65	3.52
1970	32.70	4.07	3.23	22.93	3.47	2.23
1974	47.18	5.90	2.30	26.43	6.82	3.66
1979	65.46	7.00	7.15	44.39	4.02	4.97
1982	74.62	5.95	5.73	45.78	5.39	3.08
1986	74.30	7.24	5.92	59.38	4.01	2.08
1990	72.97	9.25	11.52	65.97	6.14	7.10
1994	100.45	9.25	12.41	79.82	9.56	11.34
1999	101.74	10.92	12.58	107.5	10.46	10.75
2003	95.20	13.23	16.67	76.66	11.10	14.63
2008	96.88	10.60	12.54	78.19	7.49	8.23
2011	124.81	16.11	21.40	82.18	10.94	12.58

Since 1994, N application rates on irrigated farms have been on average 100 kg/ha.

On rainfed farms, the application of N fertilizer also rose rapidly but reached a plateau of 70 to 80 kg/ha.

Application rates for P and K fertilizer are similar in magnitude between the two ecosystems, even though irrigated farms use a slightly higher amount.

Central Luzon farmers' fertilizer application rates are much higher than the average for the whole country. According to Mataia et al (2011), the mean N application rates for irrigated farms in the Philippines were about 70 kg/ha for both the WS and DS in crop year 2006-07.

A major factor for the rise in fertilizer application in the past five decades could be attributed to the widespread adoption of the modern fertilizer-responsive varieties. Therefore, regardless of an increase in real nitrogen price, as shown in Figure 5.3 in real terms or in Figure 5.4 in terms

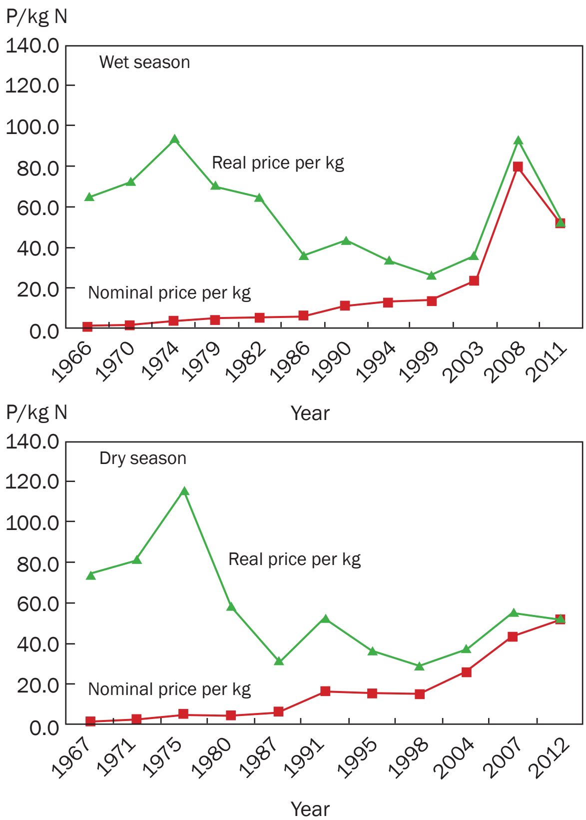
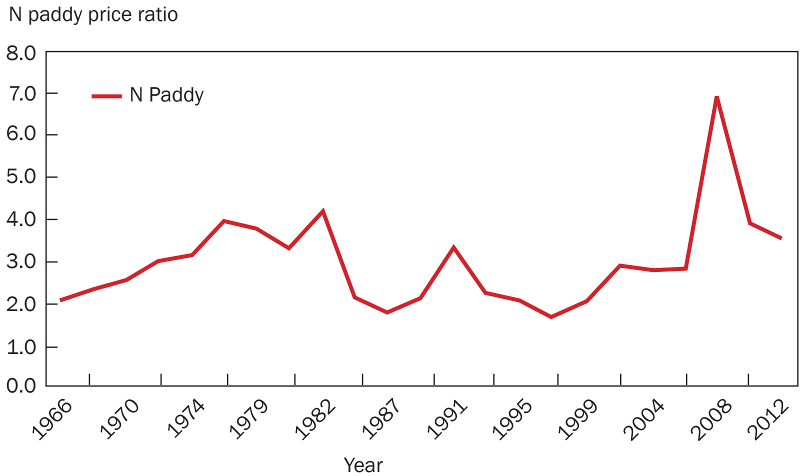


Fig. 5.3. Trends in N fertilizer price, WS and DS, Central Luzon Loop Survey, 1966-2012.



Source of raw data: Bureau of Agricultural Statistics

Fig. 5.4. Trends in nitrogen–paddy price ratio, 1966-2012.

of nitrogen-paddy price ratio, the amount of application increased in the 1960s. Moreover, since the late 1970s, the decline in real fertilizer prices (except in 2008 when the oil price surged in response to the commodity crisis) has also been responsible for the rise in fertilizer use.

Fertilizer management practices

It has been known that the timing and frequency of fertilizer application aside from the quantity applied affect yield. For instance, the leaf color chart (LCC)-based fertilizer application (timing of fertilizer application is based on the color of the leaf) is proven to attain higher yield at a lower fertilizer rate. Data from farmers' fields showed that a given target yield can be attained with a significantly lower fertilizer rate (Sebastian 2000).

Table 5.2 summarizes the timing and frequency of fertilizer application of Central Luzon farmers. The timing of fertilizer application is expressed in terms of number of days after transplanting (DAT). This is much easier for farmers to remember than the actual dates; in addition, recommended practices are expressed in reference to the crop establishment date.

A very small proportion of farmers practiced basal fertilizer application (0 or <0 DAT); in contrast, many or a majority of them applied fertilizer 16 to 45 DAT. Next in frequency are those who applied it from 1 to 15 DAT, and slightly more than 10% applied it between 46 and 60 days. A similar practice is shown in the dry season.

The data reveal that the majority of the farmers applied fertilizer once in the early period of the study (1966-74); however, this gradually

Table 5.2. Timing and frequency of fertilizer application by season, Central Luzon Loop Survey, 1966-2012.

Season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Wet													
Timing (%)													
	0 or <0	2		0	5	7	3	3	7	3	3	4	2
	1-15	33		100	42	29	35	27	23	29	38	27	30
	16–45	46		0	45	53	52	49	53	51	44	52	49
	46–60	9		0	6	7	8	15	12	11	11	10	10
	>60	9		0	2	3	2	6	4	6	4	8	9
Frequency (%)													
	1x	81	99	94	47	56	34	40	37	29	27	17	17
	2x	19	1	6	45	41	60	49	56	59	56	60	63
	3x	0	0	0	8	2	5	11	7	12	16	17	15
	>3x	0	0	0	0	1	0	0	0	0	1	7	4
Total % users		48	77	94	92	92	98	95	99	100	99	100	99
		1967	1971	1975	1980		1987	1991	1995	1998	2004	2007	2012
Dry													
Timing (%)													
	0 or <0	0			1		2	1	5	1	0	2	0
	1–15	40			44		26	20	16	26	36	27	33
	16–45	40			47		54	63	60	54	47	49	53
	46–60	0			8		17	14	12	11	10	14	11
	>60	20			1		0	2	7	8	6	7	3
Frequency (%)													
	1x	86	93	84	27		63	21	15	16	10	4	10
	2x	14	0	16	67		32	55	56	53	44	49	52
	3x	0	7	0	6		5	24	25	27	41	43	28
	>3x	0	0	0	0		0	0	4	5	4	4	10
	Total % users	88	100	100	100		100	99	97	100	100	100	100

decreased to as low as 17% by the 2011 WS and to 10% in the DS. On the contrary, an increasing percentage of farmers over the years practiced split application. From 1966 to 1974, more or less 10% split their fertilizer application for both seasons, but it gradually increased to 63% and 52% for the WS and DS, respectively. A significant proportion of the farmers not only split their fertilizer application, but, since the 1990s, they opted to apply fertilizer three times. Very few farmers applied it four times and they most probably applied it only on certain portions of the field where crop growth was not good.

Pesticide use

Pesticides as used in this section are all plant protection products used by rice farmers to protect the rice plants from weeds, diseases, insects, fungus, and snails. The use of pesticides is broadly grouped into two main categories: herbicides are all products to control weeds that will compete with the rice crop and insecticides and others are all chemicals used to control insects, diseases and other pests such as snails and fungus.

Farmers in Central Luzon have been using various forms of pesticides to control pests and diseases. It could be in the form of liquid or wettable powders that were sprayed on the rice crop by diluting them in water and granules that were applied directly to the plants through broadcasting. These chemicals are of different chemical composition, form, and effectiveness and thus it is not easy to group them and analyze them to make a meaningful comparison on the amount of use across farms and across seasons. To facilitate comparison, the data on pesticide use, which were reported in terms of volume (ml/L) and weight (g/kg), are converted into kilogram active ingredients[2] (kg ai) per hectare by using their

[2]Active ingredients are the chemicals in pesticide products that kill, control, or repel pests. For example, the active ingredients in a herbicide are the ingredient(s) that kill weeds. Often, the active ingredients make up a small portion of the whole product. Pesticide product labels include the name of each active ingredient and its concentration in the product (Center 2014).

percent concentration, which is usually found on their labels or in the list of registered pesticides provided by the Fertilizer and Pesticide Authority of the Republic of the Philippines.[3] To simplify the analysis, we combine all insecticides and pesticides but separate herbicides.

Trend in insecticide applications

Three methods are used to control insect pests and diseases: (1) use of insecticides, (2) breeding for host-plant resistance, and (3) use by farmers of cultural practices. These are not mutually exclusive but are now seen as components of integrated pest management (IPM). Cultural control of agricultural pests can be loosely defined as "ecological manipulations through certain farm operations to make the environment least favorable for the development of pests but compatible with rice production" (Oka 1979). This includes practices such as crop rotations, spacing of plants, fertilizer management, and the time of planting, etc. Needless to say, adopting the right practices to control a given pest attack is complicated.

Farmers use insecticide to control pests and diseases such as stemborer, leafhopper, blast, tungro, and others in Central Luzon. Aside from insecticide, farmers are applying molluscicide to control snails that eat the rice plant in its early crop growth stage.

In the 1960s and '70s, insecticides were sold as part of the Green Revolution package (i.e., modern varieties, fertilizer, and insecticides). Of the numerous insects, by far the most destructive in Central Luzon and in Asia in general has been the brown planthopper (BPH)(IRRI 1979). This insect feeds directly on the rice plant and in large numbers, causing so-called "hopper-burn." BPH is also a carrier of ragged stunt and grassy stunt viruses. BPH also has the ability to develop new biotypes that gain resistance to insecticides.

As shown in Figure 5.5 and as reflected in the number of applications of insecticides in Table 5.3, a peak in insecticide use among our surveyed farmers occurred around 1980, followed by a steady decline until around 2000. Farmers started using a very small amount in the 1966 WS (0.06 kg ai) and then this sharply increased to about 0.47 kg ai in 1982 and remained high until 1990. Then, it slowly declined to 0.16 and to 0.19 kg ai in 1999 and onward. A similar trend is found in the dry season except that the decline to a low level started earlier: in the 1995 DS.[4]

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[3]The list is available at http://fpa.da.gov.ph/List%20of%20registered%20pesticides%20as%2001January%202010.pdf.

[4]Central Luzon farms had by far the lowest pesticide use compared with that of other countries such as Vietnam, Thailand, Indonesia, and China as reported by Moya et al (2004).

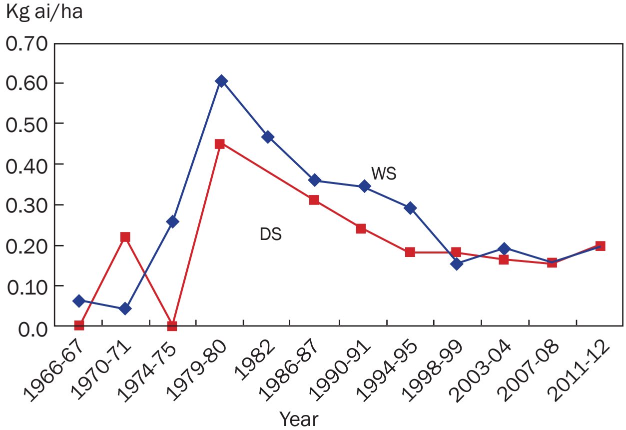


Fig. 5.5. Trends in insecticide use in kg active ingredients per ha, WS and DS, Central Luzon Loop Survey, 1966-2012.

Year	WS	DS
1966-67	0.06	0.00
1970-71	0.04	0.22
1974-75	0.26	0.00
1979-80	0.61	0.45
1982	0.47	
1986-87	0.36	0.31
1990-91	0.35	0.24
1994-95	0.29	0.18
1998-99	0.16	0.18
2003-04	0.19	0.16
2007-08	0.16	0.16
2011-12	0.19	0.20

These are indeed very encouraging results considering the damaging effects of pesticides on human health and the environment (Rola and Pingali 1993, Rogers and Pingali 1995). The question is, Why did this occur not just in Central Luzon but in the Philippines in general? Dawe (2006a) mentioned in his analysis that two main factors appear to account for the low insecticide use by Filipino farmers. First, education campaigns based on research findings from entomologists at UPLB, PhilRice, IRRI, and other organizations appear to have enjoyed some success in convincing farmers of the dangers of insecticide use and also because of higher insecticide prices in the Philippines.

Another significant factor that might have influenced the reduction in the use of insecticides among rice farmers is the introduction of integrated pest management (IPM) in the Philippines. An article in the public education series of the Asia Rice Foundation reported that training conducted by FAO for several hundred thousand farmers to adopt community-level IPM showed that farmers no longer applied pesticides unnecessarily, resulting in a reduction in their number of spray applications per season (Velasco 2004). Coupled with the adoption of IPM is the introduction and adoption of second- and third-generation MVs with multiple resistances to pests and diseases that further enhanced the reduction in the use of pesticides. More recently, in the mid-1990s, the Fertilizer and Pesticide Authority of the Philippines passed a new set of pesticide regulations that restricted the import and sale of highly toxic chemicals that are commonly used in rice. However, enforcement and adoption of these regulations have taken time (Norton et al 2010).

Table 5.3. Frequency and timing of insecticide application by season, Central Luzon Loop Survey, 1966-2012.

	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Frequency (no. of applications)												
Wet season												
1x	79	87	99	31	25	17	30	42	43	43	54	43
2x	18	13	1	20	27	33	37	29	46	43	30	40
3x	4	0	0	25	28	28	21	19	7	9	14	13
>3x	0	0	0	24	21	21	12	9	4	6	1	4
Dry season												
1x	90	91	95	24		40	20	47	49	49	47	55
2x	10	9	5	35		22	43	36	43	28	37	23
3x	0	0	0	13		22	30	15	4	15	16	17
>3x	0	0	0	28		17	7	2	4	8	0	5
Timing (days after transplanting) *												
Wet season												
0 or <0	0			0	0	0	0	0	2	0	0	1
1–15	3			25	24	20	13	16	10	14	10	22
16–45	68			52	54	57	53	45	53	50	46	39
46–60	16			14	13	17	20	23	18	27	24	23
>60	14			8	10	6	14	16	18	9	20	14
Dry season												
0 or <0				0		0	0	0	0	0	0	0
1–15				20		16	11	13	12	21	12	16
16–45				65		48	54	62	38	48	40	57
46–60				12		19	17	17	24	21	18	15
>60				3		17	19	8	27	10	30	12
Wet season												
Insecticide user	28	38	68	198	199	138	147	119	84	124	69	83
Total sample (N)	103	74	80	227	226	148	170	138	108	166	102	119
Dry season												
Insecticide user	10	11	19	106		78	70	55	51	72	49	65
Total sample (N)	17	15	19	111		84	84	74	64	97	70	90

*For some farmers, data on timing are not available.

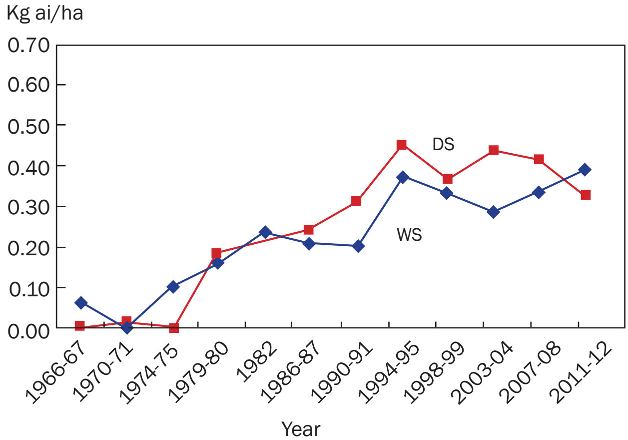
Weed control practices

The two most popular methods of controlling weeds in Central Luzon are hand weeding and herbicide application. In hand weeding, weeds are pulled manually from the rice field to avoid competition with the rice crop. But, with the advent of the Green Revolution, chemical control of weeds became popular, although less than 10% of the farmers used herbicides initially in 1966.

Herbicide use

In contrast to the declining trend in insecticide use, the amount of herbicide use by the farmers has shown an increasing trend after 1974-75 (Fig. 5.6). The primary reason for the rising use of herbicide is the declining availability of farm labor in the area and the increasing wage rates. It started from 0.10 kg ai in WS 1974 and then it gradually increased up to more or less 0.30 to 0.40 kg ai in 1991 for the DS and in 1994 for the WS. The amount of use stayed at that level until 2012. Direct seeding was introduced in the Central Luzon area and has become popular since then, reflecting the increasing labor and water shortage. Hence, in later years, the use of herbicide is slightly higher in the dry season than in the wet season because direct seeding of some farmers in the dry season makes herbicide application a must to control weeds.

It is also apparent in Table 5.4 that a majority of the farmers apply herbicide in the early crop growth period of the rice crop and the number of users increased after 1975.



Year	WS	DS
1966-67	0.06	0.01
1970-71	0.00	0.01
1974-75	0.10	0.00
1979-80	0.16	0.19
1982	0.24	
1986-87	0.21	0.24
1990-91	0.20	0.31
1994-95	0.37	0.45
1998-99	0.33	0.37
2003-04	0.29	0.44
2007-08	0.34	0.42
2011-12	0.39	0.33

Fig. 5.6. Trends in herbicide use in kg active ingredients per ha by season, Central Luzon Loop Survey, 1966-2012.

Table 5.4. Frequency and timing of herbicide application by season, Central Luzon Loop Survey, 1966-2012.

	1966 -67	1970 -71	1974 -75	1979 -80	1982	1986 -87	1990 -91	1994 -95	1998 -99	2003 -04	2007 -08	2011 -12
Frequency (no. of applications)												
Wet season												
1x	100	100	98	93	86	85	92	77	88	89	75	87
2x	0	0	2	3	13	15	8	21	12	11	21	12
3x	0	0	0	3	1	0	0	2	0	1	4	1
Dry season												
1x	100	100	75	90		94	87	79	88	81	71	84
2x	0	0	25	10		6	11	19	8	19	26	14
3x	0	0	0	0		0	1	2	4	0	3	3
Timing (days after transplanting) *												
Wet season												
0 or <0	0			0	0	0	0	6	0	0	0	3
1–15	14			78	70	75	83	72	77	74	71	72
16–45	57			18	28	23	17	20	20	24	26	23
46–60	0			4	1	2	0	2	2	2	3	2
>60	29			0	0	0	0	0	0	0	0	1
Dry season												
0 or <0				0		0	0	0	0	0	0	3
1–15				89		100	91	92	82	79	78	72
16–45				10		0	9	8	17	21	20	24
46–60				1		0	0	0	2	0	2	0
>60				0		0	0	0	0	0	0	0
Wet season												
Herbicide user (%)	9	16	52	54	69	76	63	75	69	69	70	80
Total sample (N)	103	74	80	227	226	148	170	138	108	166	102	119
Dry season												
Herbicide user (%)	24	33	42	70		83	83	72	81	86	89	81
Total sample (N)	17	15	19	111		84	84	74	64	97	70	90

Hand weeding

As an alternative or supplement to herbicide use, farmers pull out the weeds from the rice field manually. Unlike in other areas such as Laguna, they don't use a rotary weeder or even a crude tool to control weeds.

The result of our analysis showed that on average farmers in our sample do hand weeding only once during the cropping season. Very few farmers do it more than once, as shown in Table 5.5. In fact, the person-days spent for hand weeding are very low, less than 5 person-days throughout the years except in the WS and DS of 1974-75, when chemical prices were so high because of the oil crisis. This was reflected in DS 1975 when herbicide use was zero (Fig. 5.6). This is very low compared with that of other areas such as Laguna where weeding labor was as high as 31.6 person-days per hectare in 1975 (Smith 1979).

Table 5.5. Amount of labor use (person-days/ha) and frequency of hand weeding by season, Central Luzon Loop Survey, 1966-2012.

Season	1966	1970	1974	1979	1982	1986	1990	1994	1999*	2003	2008	2011
Wet												
Frequency of HW	1.16	1.02	1.23	1.02	1.03	1.19	1.10	1.00		1.06	1.05	1.24
Person-days/ha												
Mean	6.07	7.38	12.08	4.99	3.02	2.59	1.85	1.65	0.23	1.48	0.76	1.31
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	76.00	41.00	60.00	50.00	56.00	32.67	49.00	62.50	8.00	29.17	9.63	33.33
	1967	1971	1975	1980		1987	1991	1995	1998*	2004	2007	2012
Dry												
Frequency of HW	1.07	1.00	1.41	1.02		1.00	1.25	1.00		1.00	1.00	1.00
Person-days/ha												
Mean	8.09	9.82	12.94	4.78		2.40	1.58	1.89	0.18	1.31	0.50	0.13
Minimum	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	26.67	48.00	45.00	34.62		22.50	42.00	50.00	8.00	21.00	7.50	5.00

*Only two farmers weeded in 1999WS and six farmers in 1998DS.

VI. Labor use for rice production

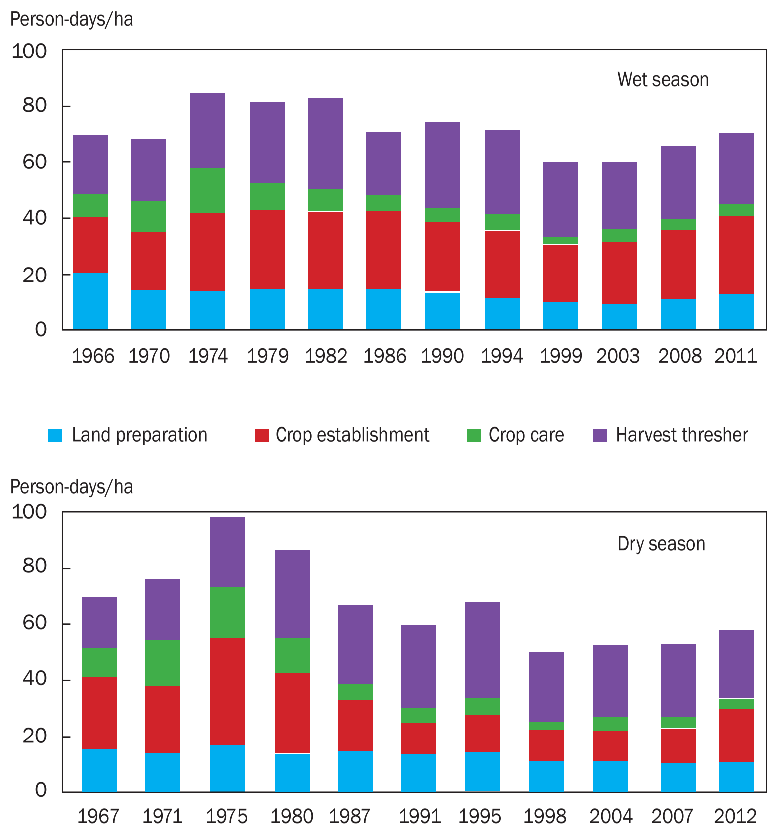
This chapter will present the patterns in labor use in rice production in terms of quantity of labor use by major activities: land preparation, crop establishment, crop care, harvesting and threshing, and postharvest activities, and source of labor: family, exchange or hired, and changes in its proportion through time. It will also include information on wage rates and different labor arrangement practices that affect labor payments.

Labor use by activity

Rice production requires a lot of labor starting from land preparation to the time the paddy is ready for milling or for sale. Labor requirements in terms of person-days vary across activities and season, and by level of mechanization. Labor use here was quantified in terms of person-days, which consist of an eight-hour work day. Labor data have been collected by individual activities, such as plowing, harrowing, transplanting, weeding, harvesting, threshing, and other crop care and postharvest activities. This individually collected labor use was then summarized and grouped by major activities: (1) land preparation—consisting of plowing, harrowing, land clearing and cleaning, and repair of dikes and leveling; (2) crop establishment—including all activities from seedbed preparation and care of seedlings to seeding, transplanting, replanting, and direct seeding; (3) crop care—all labor spent for fertilization, weeding, application of pesticides, irrigation, and other crop management activities; and (4) harvesting and threshing, which consist of harvesting, threshing, winnowing/cleaning of paddy, hauling, and drying.

We can see from Figure 6.1 that the trend in the wet season and dry season showed a similar pattern, with more obvious changes in the dry season. Hence, our discussion on labor input does not distinguish seasons unless clearly stated. Total labor use was around 70 person-days in 1966 and then it increased to about 80 days from 1974 to 1982. Afterwards, it went down to 70 in 1986 and even as low as 60 person-days in 1999 before it reverted back again to above 70 person-days in 2011. In short, labor input increased in the 1970s, decreased in the 1980s and 1990s, and then started increasing again gradually in the 2000s (Fig. 6.1).

In the 1970s, the increase in labor input was attributed mainly to the introduction of labor using MV technology. The thinner leaf cover of short-stalked MVs, together with increased fertilizer use, encourages the growth of



Wet	LP	CE	CC	HT	Total
1966	21	20	8	21	69
1970	15	21	11	22	68
1974	15	27	16	27	85
1979	15	28	10	29	82
1982	15	28	8	32	83
1986	16	26	6	23	71
1990	13	26	5	30	74
1994	12	24	6	29	71
1999	11	20	3	26	60
2003	10	22	5	24	61
2008	12	24	4	26	66
2011	13	27	4	25	71

Dry	LP	CE	CC	HT	Total
1967	15	26	10	19	70
1971	14	24	17	22	76
1975	16	38	18	25	98
1980	13	30	12	32	86
1987	14	18	6	28	67
1991	13	11	5	30	59
1995	14	13	6	34	68
1998	10	12	3	25	50
2004	11	11	5	26	52
2007	10	12	4	26	53
2012	10	18	4	25	57

Fig. 6.1. Trends in labor use for rice production (8-h person-days/ha), Central Luzon Loop Survey, 1966-2012.

weeds compared with TVs. Thus, labor for crop care (particularly weeding, see Table 5.5 in Chapter 5) increased during this period. To a lesser extent, labor for crop establishment and harvesting also increased probably because crop density increased. Note that the increase in labor input happened regardless of the increasing trend of real wage in this period (Fig. 6.2), showing a strong increase in labor demand. This surpassed the labor-saving effect caused by the wage increase.

We now examine changes in labor input for each of the four activities: land preparation, crop establishment, crop care, and harvesting and threshing.

Land preparation: Because of the shift from the carabao to largely a hand tractor, the labor input for land preparation decreased by roughly 5 person-days per hectare.

Fig. 6.2. Trends in farm wage rate, WS and DS, Central Luzon Loop Survey, 1966-2012.

Crop establishment: The major change here occurred in the DS beginning in the 1980s when the majority of farmers started adopting direct seeding to establish the rice crop instead of transplanting (see Table 7.3 in Chapter 7). In the direct-seeding method, pregerminated rice seeds (seeds were soaked in water overnight) are sown directly in the wet rice fields through broadcasting. The average number of person-days required for sowing is 1−1.5. This eliminates seedbed preparation activities such as pulling, bundling, and hauling of seedlings, which are also time-consuming. Direct seeding results in a dramatic decrease in crop establishment labor from about 30 person-days to about 10 person-days per hectare in the DS. This is similar to the findings of Otsuka (1999), Velasco (2000), and Aragon (1985) that the adoption of direct seeding decreased labor requirements.

Crop care: Labor use for crop care showed a rapidly declining trend. The major cause of this trend is the gradual adoption of herbicides (Fig. 5.6 and Table 5.5, Chapter V). This resulted in a reduction in labor input from 12−15 person-days to 4−5 person-days per hectare for both seasons.

Harvesting and threshing: Different from the above-mentioned declining trend, the amount of labor use for harvesting and threshing was quite stable over the years, with minor fluctuations throughout the period of the study. The significant development in this operation was the change in the type of thresher machine use in threshing, which was the use of a small portable thresher after 1974. In the early period (1966-74), the big thresher called "Tilyadora" was the one used for threshing, although some manual threshing was done in the same period, until it was totally replaced by the small portable thresher in 1986. This mechanization effect reduced the manual labor input, resulting in relatively stable person-days in this activity, regardless of higher yield and thus a higher demand for harvesting and threshing. Note that on average harvesting and threshing activities require the most person-days compared with other activities and this is mostly provided by hired labor (Appendix Table 6.1).

Another factor affecting labor use is the diffusion of the second round of modern varieties (MV2 characterized by shorter growth duration) in the 1980s, which contributed to the reduction in labor input as well (see Table 7.1 for the adoption of modern varieties). For example, the average growth period declined from about 150 days in the 1960s and '70s to 120−110 days in the 1980s and '90s. Of course, for many farmers, this provided an opportunity for growing a second crop of rice or a non rice crop.

A detailed analysis in terms of labor use by different activities in the early years (1966-99) is found in the following studies: Otsuka et al (1994) and Estudillo and Otsuka (1999, 2001).

Labor use by source

Labor use for all rice production activities comes from three major sources: family members, including the farmer himself; hired labor; and exchange labor. The first two sources are self-explanatory, whereas exchange labor is an arrangement wherein the farmer or any member of the family will work on other neighboring farms without any compensation in exchange for a similar labor coming from their farmer neighbor; this is locally known as "bayanihan." However, the amount of exchange labor is not that significant compared with the actual family labor and, since it is repaid by the family in terms of labor hours, we combine it with family labor in the analysis.

Figure 6.3 shows a declining trend in the proportion of family labor spent for rice production for both the wet season and dry season. Family and hired labor are almost of equal magnitude in the early years (1966-71). After the 1970s, the total labor requirement declined in both the wet season and dry season as discussed in the previous section. But, the portion of the total supplied by hired labor has increased. This relates to the earlier findings that farmers by the turn of the century no longer considered farming as their primary occupation. They were engaged in off-farm activities or employment, prompting them to hire landless workers for most farm activities. Similarly, other members of the household who also worked on the farm before, having received an education were seeking employment elsewhere. Aging of the farm owners is another reason for the increased dependency on hired labor. This is similar to the findings of Dawe (2006b) that more than 70% of the labor spent for rice production in Nueva Ecija and Pangasinan (two of our provincial sites) is supplied by hired labor. This is also true for the other major rice-producing provinces in the country.

Fig. 6.3. Labor use by source, person-days per hectare, WS and DS, Central Luzon Loop Survey, 1966-2012.

VII. Historical changes in the adoption of new technologies in rice production

In this chapter, we discuss the trends in the adoption of modern varieties and of labor-saving technologies. Earlier (Chapter II), we discussed the expansion of gravity irrigation and the adoption of low-lift pumps (see Table 2.2) and the increase in inputs such as fertilizer and pesticides (Chapter V). In short, there has been a high degree of complementarity among various farm practices and the adoption of new technologies in increasing rice production over the past half century.

Varietal adoption through time

A detailed study on varietal adoption and its impact on rice yields and income has been done by Estudillo and Otsuka (2001) using the Central Loop data from 1966 to 1999. It reported the trends in the adoption of three generations of MVs up to 1999. The three generations of MVs as defined by Estudillo and Otsuka (2001) follow. MV1 refers to the first generation of modern varieties released from the mid-1960s to mid-1970s. It consists of C4 developed by the UP College of Agriculture (now UP Los Baños) and IR5 to IR34 developed by IRRI. These were released from the mid-1960s to the mid-1970s. In this analysis, we also include the varieties released by the Bureau of Plant Industry, the most popular of which were BPI 76 varieties. As described, these were potentially higher-yielding than the traditional varieties. MV2 or the second generation of modern varieties were released from the mid-1970s to mid-1980s. They were designed to ensure yield stability by incorporating multiple pest and disease resistance. They consist of varieties from IR36 to IR62. The shorter growth period is another important agronomic feature of the MV2 varieties. The earlier varieties required about 150 days, which decreased to 110–120 days with MV2. The third generation of MVs (MV3) refers to varieties released from the mid-1980s up to the mid-1990s, consisting of IR64 to IR74 and PSBRc2 to PSBRc74.[5] These add value to rice production by incorporating better grain

[5]PSB varieties are those varieties released by the Philippine Seed Board; however, a majority of them originated from lines developed by IRRI.

quality and contribute to a reduction in labor and water inputs by facilitating the adoption of the direct-seeding method of crop establishment. They are superior to MV2 in terms of grain quality but not so much in physical yield. MV4, as classified by Launio et al (2008), are those varieties released after 1995. They include RC varieties released by PhilRice. Some of these varieties are more adaptable to harsh environments, such as the drought-resistant varieties and submergence-tolerant varieties.

In 2001, the Philippine government introduced hybrid rice and aggressively promoted its adoption through the Hybrid Rice Commercialization Program, initially providing farmers with subsidies for seed and other costs (Cororaton 2008).[6] The released varieties include Mestiso 1 or PSBRC-72 H (released in 1997), Mestiso 2 or NSIC-RC 114H, Mestiso 3 or NSIC-RC 116 H, Mestiso 4 (popularly known as Bigante), and more than 20 others. However, as their report and our survey show (Table 7.1), adoption has been very low. Because of the high incidence of insects and diseases in the WS, hybrids have been adopted in the DS. Seed supply and the quality of the rice have also been a problem. In this analysis, we examine in detail the different varieties planted by the sample farmers in each of their parcels, carefully classifying them in the above four MV categories, plus hybrid and traditional varieties. It is a common practice among farmers to plant more than one variety in a parcel or field so, if the farmers plant two or more varieties, we treat these varieties separately. Our findings are similar to what Estudillo and Otsuka (2001) found from 1966 to 1999, with some minor deviations. As expected in the WS of 1966, only traditional varieties (TVs) were planted, but, in the following DS of 1967, 6% of the sample had already planted MV1 consisting of IR8 (Table 7.1), which was released in 1966. The use of TVs gradually decreased in the WS compared with a much faster downward movement in the DS. TVs ceased to be planted in the DS of 1991, while their use in the WS continued until 2011 at a very negligible 1%. Farmers grew TVs such as glutinous rice for their home consumption. There was a very rapid adoption of MV1 in the 1970s and 1974, and then adoption declined drastically in the 1979-80 WS and DS when MV1 were replaced by MV2, the most popular of which were IR36 and IR42. The widespread adoption of MV2 continued until crop year 1986-87, when MV2 were slowly replaced by MV3. The percent adoption of MV3 is higher in the DS than in the WS. By 1999, MV3 adoption was

[6] *Hybrid rice* was developed by the Chinese in the 1970s. A hybrid rice variety is the direct product of crossing two genetically different parents. In hybrids, the positive qualities of both parents are combined, resulting in a phenomenon called “hybrid vigor” or “heterosis,” in which young seedlings are highly developed and the mature plant has better reproductive characteristics. These factors result in higher yields than those of ordinary rice, also called inbreds. This can raise farmers’ yield by 15% (AgriPinoy 2008). Hybrid rice varieties are now grown on about 50% of the rice land area in China and the United States.

Table 7.1. Trends in adoption of modern varieties by season, Central Luzon Loop Survey, 1966-2012.

Season and variety		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Wet	%												
	TV	100	34	36	9	7	4	5	3	1			1
	MV1		77	86	14	10	11	4		2	2		3
	MV2				88	95	43	18	10	6	1	1	0
	MV3					1	65	88	93	43	12	4	2
	MV4									60	89	95	98
	Hybrid										1	1	
		1967	1971	1975	1980		1987	1991	1995	1998	2004	2007	2012
Dry	%												
	TV	94	8	7	6		3						
	MV1	6	92	100	10		9	9	2	13	1		
	MV2			7	89		20	12	7	2	3	1	
	MV3						78	83	91	46	6	3	8
	MV4									43	90	96	92
	Hybrid												5

dwindling and MV2 were largely being replaced by MV4, whose rate of adoption started at 60% and 43% for the WS and DS, respectively. This rate of adoption continued to increase up to almost 100% until 2012.The above trends indicate farmers' willingness to change their rice variety as long as this will improve their income.

Besides simply looking at the different generations of rice varieties, we document the changing trend of popular rice varieties. Table 7.2 shows that, of all the rice varieties ever developed, IR64 is the most popular for the longest period of time. It belongs to the top five varieties planted by farmers for almost two decades (1986-2004). From 1986 to 1999, it was the consistently number-one variety among our samples and it remained a top five variety up to 2004. It is just right to call it the mega-variety. The performance of IR64 in terms of adoption is followed by IR36, although it was only on top of the list from 1979 to 1982; nevertheless, it stayed in the top five until 1990. Starting in 2007, the most popular varieties belong to the MV4 generation such as RC128, RC222, and RC82.

Adoption of labor-saving technologies

Several studies have been undertaken with regard to the adoption of labor-saving technologies such as the use of tractors for land preparation, threshers for threshing, and direct seeding for crop establishment. Some of these studies used the earlier years of the Central Luzon Loop Survey data, foremost among them Estudillo and Otsuka (2001), Cordova et al (1981b), and Jayasuriya et al (1982). All of them found that the adoption of tractors, mechanical threshers, and direct-seeding technology reduced the labor requirement for rice production. However, their studies included data on the earlier years, the latest of which was 1999.

Table 7.3 showed the trends in the adoption of these new technologies for almost five decades. In general, there is a growing trend in the adoption of labor-saving technologies such as tractors and threshers. The percent adoption of tractors (big and small [power tiller, two-wheel]) started at a very low level, 11% in 1966, until the full adoption (100%) of hand tractors in 2011. Their full adoption, however, does not mean that the farmers fully abandoned the use of big tractors (four-wheel) and the use of a carabao for some


Dukit

Table 7.2. Top five varieties planted over time by season, Central Luzon Loop Survey, 1966-2012.

Wet	1966	1970	1974	1979	1982	1986	1990	1994	1998	2003	2008	2011
1	Tjeremas	IR5	IR20	IR36	IR36	IR64	IR64	IR64	IR64	PSBRC82	RC128	216
2	Binato	IR20	IR1561	IR42	IR42	IR42	IR72, IR66	RC14, RC10, IR60, IR66	RC28	RC18	PSBRC82	RC222
3	BE3	Wagwag	IR28, Raminad, C4	IR44	IR50	IR36	IR70	RC4	RC18	Angelica	RC18	RC224, 160
4	Intan	BE3, Inano	BE3	IR48, IR29	IR54	IR10, IR48	IR74	RC2	IR74	RC64, IR64	RC28	RC128
5	Raminad	IR28	IR747, IR5, Tjeremas, IR12	BE3	IR48	IR62	IR36	IR36, IR74	RC64,RC54, IR52, RC74	RC28	Angelica	Super82
Dry	1967	1971	1975	1980		1987	1991	1995	1999	2004	2007	2012
1	Intan	IR20	IR1561	IR36		IR64	IR64	IR64	IR64	PSBRC82	RC128	SL8
2	Wagwag	IR8	IR20	IR42		IR36	IR72	RC14	RC28	RC14	PSBRC82	216
3	Tjeremas, Serup Ketchel, Binonton, IR8, Macam	IR5	IR1529, IR579, IR5, BPI76, IR747, Binato, IR26	IR2307, IR247		IR22, IR66, IR42	IR66	RC4	PSBRC	RC18	RC28	224
4		Intan		IR44		Dakot, Momong, IR10, IR68	R10	R10, IR60	IR28, RC52	IR64, RC28	RC18, RC130, Superingo, Angelica, PJ25	222
5		IR22		IR23		Tunnel, 13	IR74	IR66	IR32, IR52, IR20	RC60	PG25, PSBRC10, PG7, Bigante, RC1163	PSBRC10, Hybrid, 160, 128

detailed activities in land preparation. In early years, carabao were used for plowing and harrowing; lately, farmers use carabao simply for plowing the sides and corners of the field (locally termed "dukit") that could not be reached by the tractor. Of course some opted not to do this as shown by the smaller number of farmers who used carabao for land preparation. Those who did hired a carabao and labor on a daily basis.

From 1999 to 2012, some farmers used a large four-wheel tractor in combination with a small tractor. They used the large tractor for initial plowing and a small hand tractor for harrowing. Quite a few farmers used the so-called rotavator that also did plowing. This explains why the total adoption figures when summed up surpass 100%.

Rotavator

Even in the early period of the study, a majority of the threshing activity was done by a thresher (87%) and only 13% of the farms were dependent on manual threshing. The thresher then was a big threshing machine called a "tilyadora." It has a long history in Central Luzon as discussed by Estudillo (2001) and quoted in Hayami (1982). As early as the 1920s, the "tilyadora" was used on large haciendas to monitor the sharing of output between the landlord and share tenant. The use of a big thresher started to decline in the 1970s after the full implementation of the land reform law when the large tracts of land called haciendas were subdivided and distributed to the tenants tilling the land. Farmers then switched back to manual threshing as shown in the increase in the adoption rate from 13% in 1966 to 51% in 1974 (Table 7.3). However, this increase in manual threshing was halted by the introduction of portable machine threshers. The small threshers became so popular that by 1990 practically

Tilyadora

Table 7.3. Adoption (%) of new rice technologies by season, Central Luzon Loop Survey, 1966-2012.

Season and technology	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Wet												
Animal	96	90	98	72	67	90	89	75	74	56	59	52
Power tiller (2W)			17	47	56	58	85	93	96	99	99	100
Large tractor (4W)	11	42	36	30	24	14	18	16	28	26	31	30
Rotavator							2		2			4
Manual threshing	13	26	51	46	10	4						
Small thresher	0	0	5	21	73	96	100	100	100	100	100	100
Big thresher	87	74	44	31	17							
Direct seeding				1	16	15	22	24	21	14	7	8
Transplanting	100	100	100	100	90	95	85	81	80	87	94	92
	1967	1971	1975	1980		1987	1991	1995	1998	2004	2007	2012
Dry												
Animal	100	100	79	53		69	98	77	67	58	65	65
Power tiller (2W)	6	0	43	79		88	90	100	93	100	100	100
Large tractor (4W)	47	62	43	9		6	2	9	17	17	18	8
Rotavator												15
Manual threshing	23	31		37		3						
Small thresher			36	44		98	100	100	100	100	100	100
Big thresher	71	69	64	20								
No data available	6											
Direct seeding				9		48	71	63	54	63	57	30
Transplanting	100	100	100	91		59	33	41	48	41	44	73

nobody was using manual threshing. The use of the big thresher stopped earlier, in 1986.

Direct-seeding technology was already being adopted by some of our samples as early as 1979. Moreover, its adoption was higher in the dry season. In 1979, 9% of the farmers had already adopted the technology and it increased abruptly to 71% in 1990, but then declined to as low as 54% in 1999 until it again recovered in 2003, but eventually dropped to 30% in 2011. Adoption is much lower in the wet season; the adoption rate was only 7−8% in 2008-11.

The adoption of direct seeding had a direct effect on the following activities as already mentioned earlier: labor use for crop establishment, manual weeding, and herbicide application.

As summarized in Table 7.3, manual transplanting is still the most popular method of crop establishment. All farmers used this method from the late 1960s to the ‘80s. Its practice decreased in the dry season because of the adoption of direct seeding.

In short, we seem to have reached a plateau or saturation point when it comes to most labor-saving technologies, but one must wonder whether greater efficiencies in labor (economies of scale) could be achieved by increases in farm size, which now averages about 2 ha (Table 3.3).

VIII. Profitability analysis

Methodology

In order to compare the changes in revenue, cost, income, and profit over time, we report these values in real terms using 2012 CPI outside of Metro Manila as the base year price. All values are reported on a per-hectare basis. Gross revenue is computed by multiplying yield by the farm-gate price. Gross revenue minus paid-out cost is called net return over paid-out cost. Paid-out costs are all cash and noncash costs that are actually paid by the farm manager, which could be the cost of inputs paid in cash or in credit or thresher rental and labor costs that are paid in paddy. Since we can regard the payment to own factors such as family labor and owned machines as returns to the own factors, we can regard this value as the rice income of the farm-managing household. Revenue minus paid-out and imputed costs is net profit. Family labor costs are imputed by the average wage rates over different activities paid by farmers in cash. For the imputation of land rent, we use the average leasehold rental rate. Table 8.1 shows these figures by item and season (figures by detailed item are available in Appendix Table 8a, those in nominal price in Appendix Table 8b, and those by land tenure in Appendix Table 8c in Appendix A).

Rice price and gross revenue

As we have seen already, the progress of the Green Revolution increased paddy production per ha (yield) dramatically (Fig. 4.1). This increase, however, at the macro level together with a similar increase in rice production in the other regions in the country as well as in other countries resulted in a dramatic reduction in the real price in the rice market in the 1970s and '80s. The real price has remained at a relatively low level since the 1980s except for the year of recent commodity price crises in the 2008 DS (Fig. 8.1). Therefore, an increase in revenue depends on the yield increase effect relative to the offsetting price reduction effect. In the wet season, yield improvement practically stopped in the mid-1980s at around 4 t/ha. Hence, the offsetting mechanism worked effectively until the 1980s, keeping revenue basically unchanged (Fig. 8.2). Because the price and yield have not changed much since the 1990s, gross revenue was unchanged as well at the level of the 1980s with some fluctuations.

Table 8.1. Costs and returns of rice production, WS and DS, at 2012 constant price (PHP/hectare), Central Luzon Loop Survey, 1966-2012.

Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue	71,580	69,685	60,534	67,000	63,617	59,051	71,276	61,115	44,028	52,415	60,821	53,519
Yield (kg/ha)	2,303	2,500	2,042	3,607	4,093	3,497	3,512	4,073	3,454	4,284	4,510	3,879
Price (PHP/kg)	31	28	30	19	16	17	20	15	13	12	13	14
Material input costs	6,123	8,003	12,494	12,613	12,559	12,083	13,500	13,061	11,345	11,934	20,528	16,121
Labor costs												
Harvester and thresher	5,056	6,336	6,655	8,752	7,116	6,089	8,364	6,842	5,535	6,401	7,023	5,927
Hired labor	5,401	4,491	4,681	5,202	5,260	4,901	6,218	6,599	6,552	8,531	8,895	7,918
Permanent labor	95	243	206	163	395	546	1,233	1,280	257	3,146	3,056	2,032
Imputed family labor	5,612	6,587	5,859	6,405	5,745	3,843	5,485	4,713	267	2,676	2,819	3,509
Power costs												
Machine rental paid out	2,167	2,617	2,399	2,771	4,138	3,552	5,040	3,423	3,356	3,676	5,427	4,371
Machine rental imputed	20	157	327	1,170	1,170	823	1,157	1,266	1,521	1,326	1,936	2,582
Machine rental paid out and imputed	2,187	2,773	2,727	3,941	5,308	4,375	6,197	4,688	4,876	5,002	7,363	6,953
Animal rental paid out	286	148	470	329	304	589	285	254	163	126	141	102
Animal rental imputed	2,074	1,145	2,469	872	975	941	454	351	202	92	90	95
Animal rental paid out and imputed	2,360	1,293	2,939	1,201	1,279	1,530	739	605	365	218	231	197
Fuel and oil	0	30	94	1,045	1,080	750	722	994	793	1,067	2,167	2,181
Land rent paid out	22,366	18,564	15,484	8,175	7,746	8,420	7,141	5,399	2,794	3,604	3,963	1,939
Land rent imputed	3,421	2,000	2,742	3,139	1,919	2,602	5,277	4,448	4,067	5,175	5,059	5,559
Land rent paid out and imputed	25,788	20,565	18,226	11,314	9,666	11,022	12,418	9,847	6,861	8,779	9,021	7,497
Interest on capital	191	216	306	463	515	408	647	481	416	269	208	125
Total paid-out costs	41,494	40,431	42,483	39,051	38,597	36,931	42,503	37,851	30,794	38,487	51,202	40,591
Total costs	52,812	50,536	54,188	51,099	48,922	45,548	55,523	49,110	37,267	48,025	61,314	52,460
Net return over paid- out costs	30,086	29,253	18,051	27,949	25,020	22,120	28,773	23,265	13,234	13,928	9,620	12,928
Net profit	18,768	19,148	6,347	15,900	14,695	13,503	15,752	12,005	6,761	4,390	(492)	1,059
Cost/kg of paddy	23	20	27	14	12	13	16	12	11	11	14	14
CPI	0.0138	0.0172	0.0360	0.0570	0.0820	0.1652	0.2488	0.3802	0.5331	0.6459	0.8499	0.9689

Cont...Table 8.1

Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Gross revenue	56,341	66,574	56,932	78,365	73,372	68,754	83,518	75,126	63,007	103,333	83,455
Yield (kg/ha)	1,789	2,481	1,973	4,390	4,227	4,393	4,819	4,588	4,798	5,224	5,760
Price (PHP/kg)	32	27	29	18	17	16	17	16	13	20	14
Material input costs	7,678	11,042	16,036	16,310	15,208	17,635	15,682	13,300	14,030	17,925	17,621
Labor costs											
Harvester and thresher	7,834	6,367	4,646	10,024	8,206	9,674	10,070	9,626	8,279	11,103	10,012
Hired labor	4,584	5,133	5,694	5,522	3,519	3,236	6,506	6,257	7,087	10,547	9,971
Permanent labor	0	0	0	324	659	1,221	2,886	438	4,003	6,927	5,605
Imputed family labor	5,033	11,455	5,255	5,815	3,840	3,943	4,792	4,002	2,180	2,680	2,481
Power costs											
Machine rental paid out	2,395	4,004	5,884	3,640	4,764	3,779	4,199	3,975	3,950	7,614	5,141
Machine rental imputed	0	0	2,475	1,955	1,660	1,706	1,928	2,130	1,593	2,815	3,201
Machine rental paid out and imputed	2,395	4,004	8,359	5,595	6,424	5,485	6,127	6,105	5,542	10,428	8,342
Animal rental paid out	196	257	240	156	392	153	251	73	100	156	92
Animal rental imputed	1,922	960	1,053	535	247	257	130	113	52	57	65
Animal rental paid out and imputed	2,118	1,217	1,293	690	639	410	381	186	152	214	157
Fuel and oil	0	0	402	2,032	1,655	2,144	1,194	2,809	1,771	3,030	2,863
Land rent paid out	16,162	13,497	8,735	9,112	8,103	6,406	5,393	4,527	3,479	5,042	2,213
Land rent imputed	4,050	883	13,719	2,179	1,892	3,827	5,316	4,111	5,564	7,068	5,964
Land rent paid out and imputed	20,212	14,381	22,455	11,291	9,995	10,233	10,710	8,638	9,044	12,109	8,177
Interest on capital	215	290	400	544	239	663	530	655	271	194	115
Total paid-out costs	38,848	40,300	41,636	47,119	42,506	44,248	46,180	41,006	42,699	62,344	53,518
Total costs	50,069	53,890	64,538	58,147	50,385	54,643	58,877	52,017	52,359	75,158	65,345
Net return over paid- out costs	17,493	26,274	15,296	31,245	30,866	24,506	37,339	34,120	20,308	40,990	29,937
Net profit	6,273	12,685	(7,606)	20,218	22,987	14,111	24,641	23,109	10,649	28,175	18,110
Cost/kg of paddy	28	22	33	13	12	12	12	11	11	14	11
CPI	0.0145	0.0208	0.0377	0.0669	0.1735	0.2971	0.4057	0.5032	0.6778	0.7809	1.0000

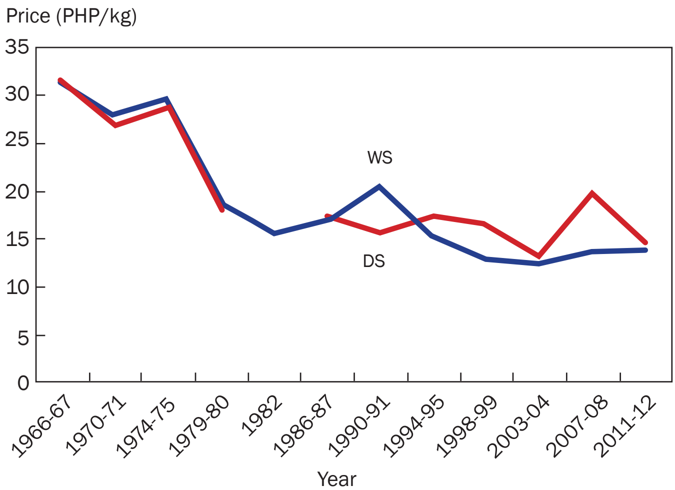


Fig. 8.1. Trends in paddy price at constant 2012 prices, Central Luzon Loop Survey, 1966-2012.

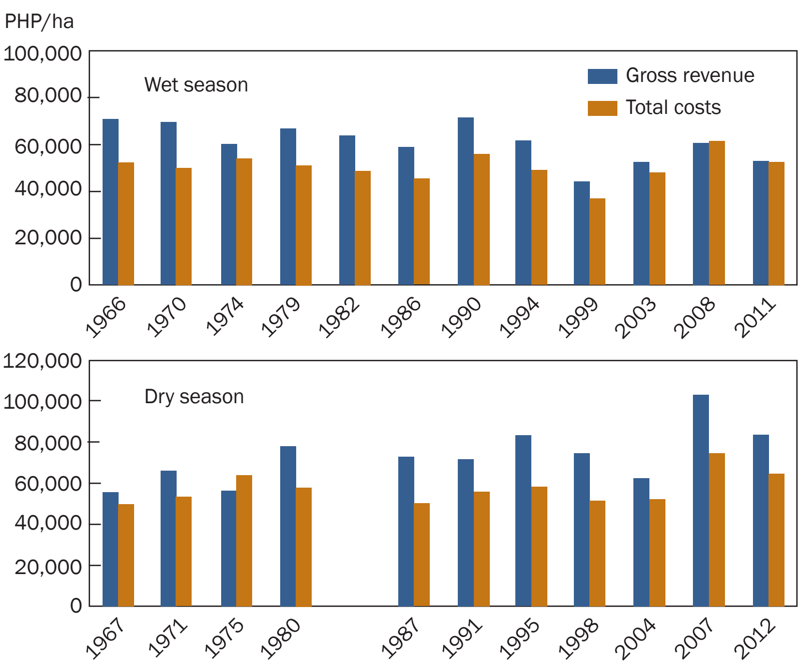


Fig. 8.2. Trends in gross revenue and total costs, WS and DS, Central Luzon Loop Survey, 1966-2012.

Meanwhile, revenue has been increasing over time in the DS because the yield improvement continued in the DS and reached 6 t/ha in the 2000s (Fig. 8.2). This marks a sharp contrast in revenue structure between the WS and the DS.

Cost, income, and profit

Compared to the trend of gross revenue, total paid-out costs and total costs in real terms have not changed much over time. The former is about PHP 40,000 and the latter about PHP 50,000, except in the 2007 WS and DS and 2012 DS, which are the years suffering from an increase in fertilizer price (more details later). Because of these differential features in the trend of revenue and costs, WS income and profit have been discernibly declining over time, while those of the DS have been relatively stable, with an initial increase in the 1970s (Fig. 8.3). It is worth noting that, in the last two rounds of the WS (in 2008 and 2011, respectively), the sample farmers generated little profit from rice farming, although they still obtained positive income as the returns to their own labor and machines, thus raising concern about the economic sustainability of rice farming in Central Luzon in the WS.

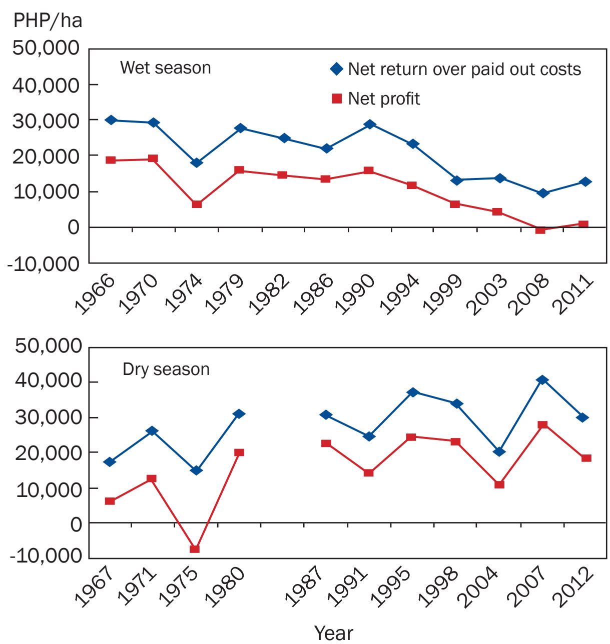


Fig. 8.3. Trends in income and profit, WS and DS, Central Luzon Loop Survey, 1966-2012.

Although the total cost has not changed dramatically, its composition has changed noticeably, reflecting the changes in technology, endowments, and market price. This means that, facing these changes, farmers are actively optimizing their farming practices with the knowledge and skills available at hand.

In the 1970s, shifting from TVs to MVs, farmers increased current input regardless of the rising trend of material prices in that period. This results in a sharp increase in current input cost in the '70s, particularly fertilizer cost. Although the price of fertilizer increased in the '70s (Fig. 5.3), the effect of its increasing demand because of the introduction of Green Revolution technology was stronger. Accordingly, fertilizer expenditure increased from PHP 1,600 in 1966 to PHP 3,300 in 1970, PHP 6,300 in 1974, and then PHP 5,700 in 1979 in the WS, while it was PHP 3,300 in 1967, PHP 6,300 in 1971, and PHP 6,300 in 1975, and then finally PHP 5,700 in 1980 in the DS (see Appendix Table 8a).

In the 1980s and '90s, the cost of current inputs was quite stable. This is partly attributed to the offsetting effect of the real price decrease in fertilizer against the increase in its use (Fig. 5.3). However, because of the price hike of fertilizer since 2008 in the international market, the cost increased again as mentioned previously.

It is interesting to note that seed cost was not a major component in the past but it has increased its share since the 1990s (see Appendix Table 8a). This is because some farmers are now using commercial seeds that they buy from stores or co-farmers rather than using their own harvest (Mataia et al 2011).

Irrigation cost is higher in the dry season because of the increased use of low-lift pumps (see Table 2.2) but is not relatively large in total costs because NIA's irrigation service, which is the major source of irrigation in Central Luzon, has been provided at the very low regulated rate.

The change in labor cost shows a pattern similar to the pattern observed in labor input: an initial increase in the 1970s, followed by a decrease in the '80s and '90s, and then a gradual increase in the 2000s (Fig. 8.4). Another similarity is the reduction in imputed family labor cost and the associated increase in hired or permanent labor cost. The emergence of permanent labor is a noticeable feature in the 2000s. Although it is called permanent labor, it is not the traditional attached labor. The current labor arrangement is called "Porcientuhan." Under this arrangement, agricultural workers are regularly hired by farmers to work on their rice farm for one or more seasons to supervise the day-to-day activities in rice production (from land preparation to harvesting), with an agreement that they will receive a certain

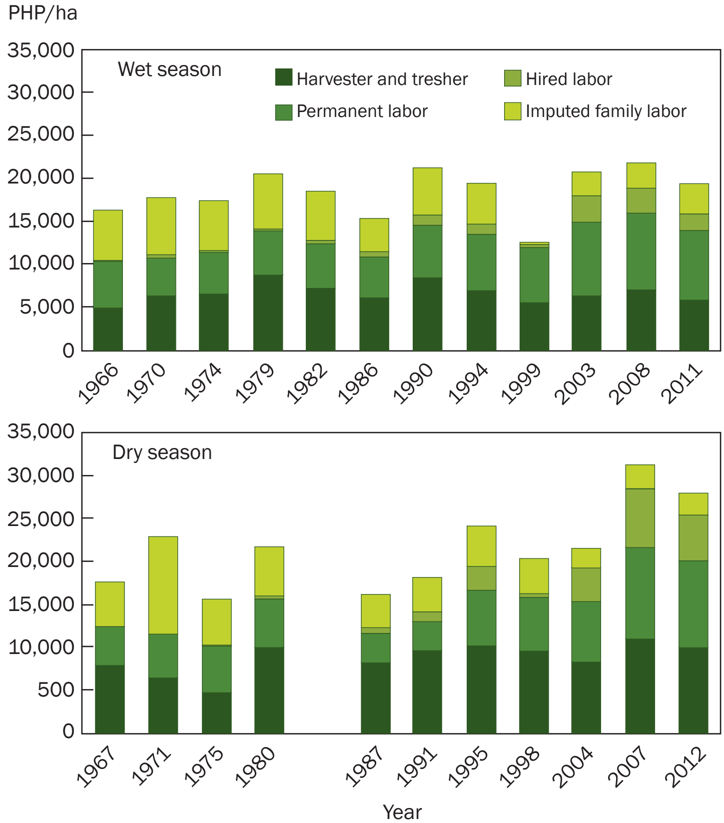


Fig. 8.4. Trends in labor cost, WS and DS, Central Luzon Loop Survey, 1966-2012.

proportion of the gross harvest, usually 10%, at the end of the season. In addition to supervision, they provide the labor for crop care activities such as fertilizer and chemical application and weeding. The emergence of this arrangement could be related to two factors: the exit of original farmers from farming and land reform regulations. Many farmers are becoming older and their children moving to off-farm sectors. Hence, they would like somebody to manage their farm. In such a case, the farmers could have rented out their land. However, under the land reform code, which is still valid in the country, this arrangement has the risk that the tenants go to a land reform office to claim land transfer to the tenants.[7] Meanwhile, under the Porcientuhan contract, the farmers can still claim that they just hired labor for farm operations. In this regard, under the land reform, the preference of the contract is biased toward Porcientuhan even when that contract is not an optimal one, which could be regarded as an emerging inefficiency issue in farming.

[7]See some details of the land reform code in Chapter II, land ownership and tenure status section.

We observe two features in capital costs (Fig. 8.5). The first feature is the significant decline in animal input cost for rice production. The second one is very active machine rental markets (high paid-out costs to capital service) even in the early stage of the Green Revolution in the 1970s.

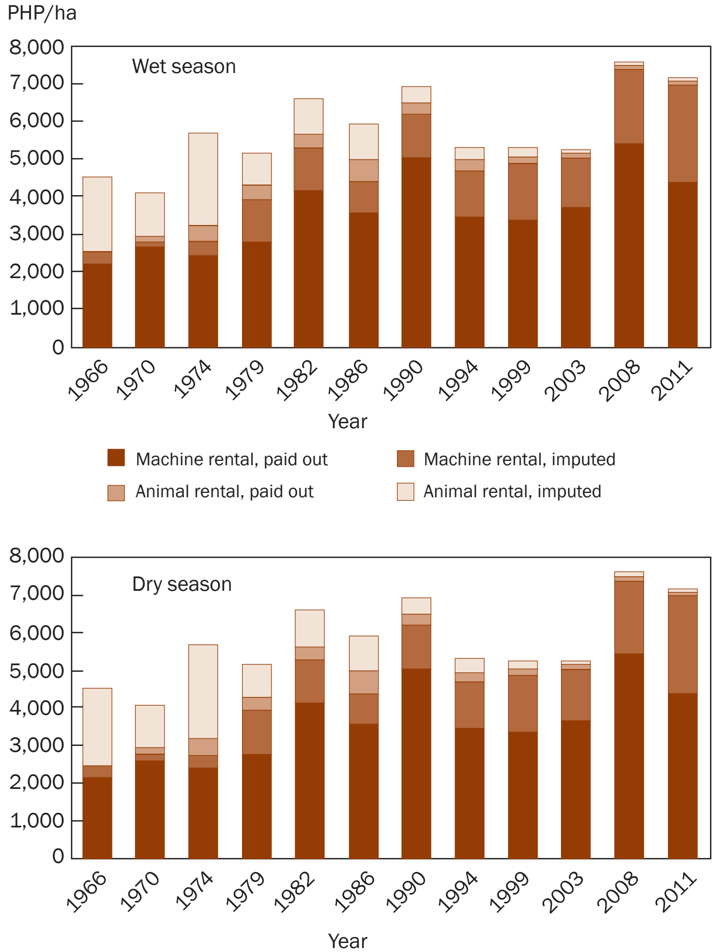


Fig. 8.5. Trends in capital cost, WS and DS, Central Luzon Loop Survey, 1966-2012.

A significant decline in land rent is another important feature in Central Luzon (Fig. 8.6). There are two reasons for this trend. First, the dissemination of land-saving technology resulted in a decline in land value for rice production. Second and more directly, the land reform law fixed the leasehold rent and amortization fees at a rate much lower than the rate prevailing in the markets (see more details in Chapter II). This contributed to the increase in residual surplus captured by land reform beneficiaries.

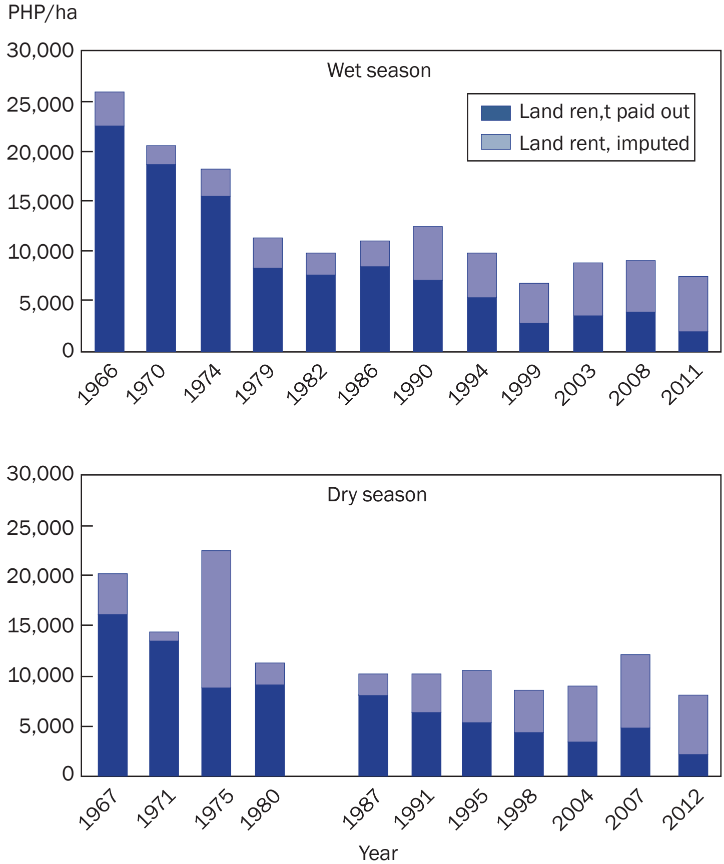


Fig. 8.6. Trends in land rent, WS and DS, Central Luzon Loop Survey, 1966-2012.

In order to investigate the variation among farmers, we computed the coefficient of variation (CV). We have already seen the reduction in CV of yield, indicating the standardization of Green Revolution technology (Fig. 8.7). Gross revenue and yield show a similar declining trend, with increasing similarity among farmers in revenue. On the other hand, the CV of cost has changed little over time. This indicates that, although the standardization of agronomic management skills has proceeded, the variation in economic management skills has remained unchanged.

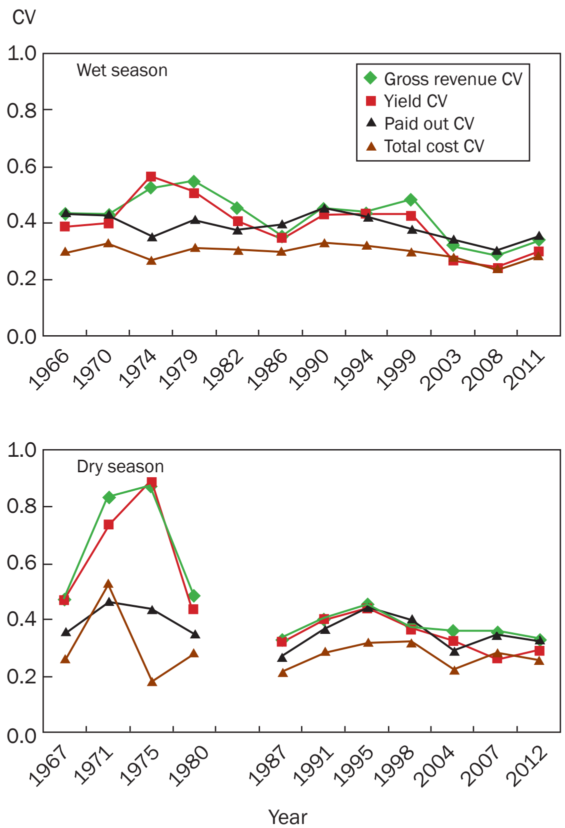


Fig. 8.7. Trends in the coefficient of variation (CV), WS and DS, Central Luzon Loop Survey, 1966-2012.

Factor share analysis

Changes in factor shares show changes in distribution among the factors. Thus, they indicate who gains from an increase in the value of rice production. Changes are caused by two elements: by the changes in the use of a particular factor relative to others and by the changes in the price of a particular factor relative to others. Since a change in factor use reflects the bias in technological change, we can use factor share figures to discuss how the technological bias generated by the Green Revolution affects distribution. If the elasticity of substitution is not one, changes in relative price also change factor shares. The factor share can also be used for discussion about the impact of a price change on distribution. Figure 8.8 and Table 8.2 (for more detailed figures by item) show the changes in factor share overtime by season.

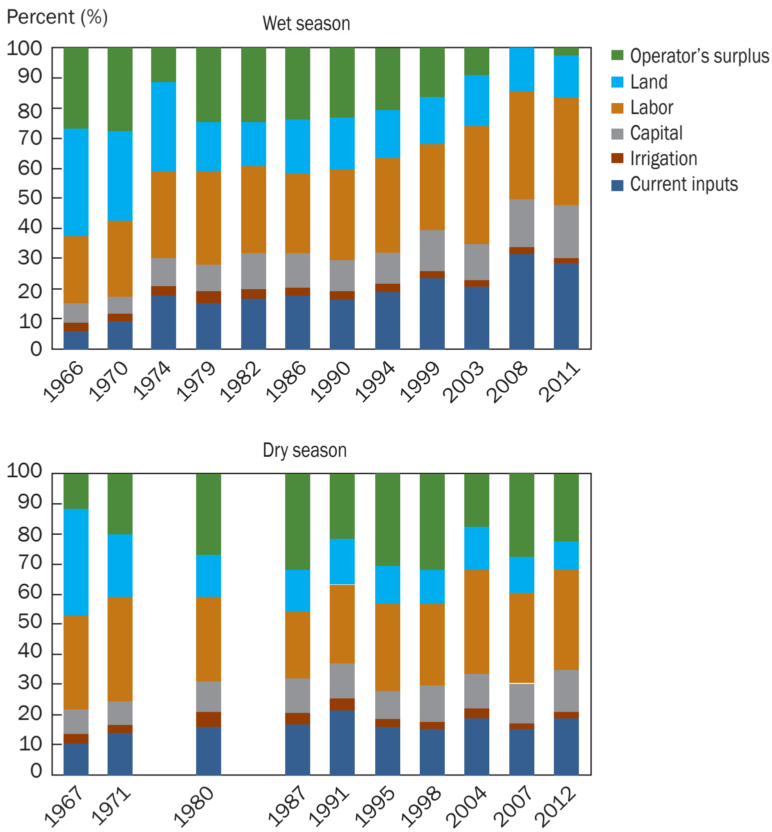


Fig. 8.8. Changes in payments for factors of production in terms of kg paddy and factor shares (%) in rice production per ha, WS and DS, Central Luzon Loop Survey, 1966-2012.

Table 8.2. Changes (%) in factor share distribution, WS and DS, Central Luzon Loop Survey, 1966-2012.

Wet season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
	Current inputs	6	9	18	15	17	18	16	19	23	20	31	28
	Irrigation	3	2	3	4	3	3	3	2	2	3	2	2
	Capital (owned)	3	2	5	3	3	3	2	3	4	3	3	5
	Capital (hired)	3	4	5	6	9	8	8	8	10	9	13	12
	Labor (family)	8	9	10	10	9	7	8	8	1	5	5	7
	Labor (hired)	15	16	19	21	20	20	22	24	28	34	31	30
	Land	36	30	30	17	15	19	17	16	16	17	15	14
	Operator's surplus	26	28	11	24	24	24	23	20	16	9	0	2
Dry season		1967	1971		1980		1987	1991	1995	1998	2004	2007	2012
	Current inputs	11	14		16		17	21	16	16	19	15	19
	Irrigation	3	2		5		4	4	3	2	3	2	2
	Capital (owned)	3	1		3		3	3	2	3	3	3	4
	Capital (hired)	5	6		7		9	9	7	9	9	10	10
	Labor (family)	9	17		7		5	6	6	5	3	3	3
	Labor (hired)	22	17		20		17	21	23	22	31	28	31
	Land	36	22		14		14	15	13	11	14	12	10
	Operator's surplus	12	19		26		32	21	30	32	17	27	22

The changes in factor shares are basically consistent with the direction stimulated by the technological changes experienced in Central Luzon: toward land saving and current inputs and labor using direction The sharp increase in the factor share of current inputs in the 1970s stems from the adoption of fertilizer-responsive MVs and the associated increase in fertilizer use. The stable share in the 1980s and '90s can be attributed to the offsetting effect of the real fertilizer price reduction against the increase in fertilizer input. A rise in the share in the 2000s is caused by a surge in fertilizer price in the international market associated with the commodity price crisis in 2008. An increase in expenditure for seeds also contributed to the increasing trend of current input factor share. Among current inputs, the expenditure for pesticide and herbicide changed in such a way as explained earlier. Nevertheless, herbicide and pesticide consist of small components in the share compared with fertilizer.

Expenditure for capital increased in the 1970s and '80s. However, the momentum of mechanization was not so strong so the factor share has been stable at around 10% to 15% since then. This is probably because labor is not severely scarce yet (see wage rate and labor use over time).

After a sharp increase in the labor share in the 1960s and '70s because of the introduction of labor using MVs, it has been stable around 30% in both the WS and DS with a few exceptions.[8] This can be attributed to the two different offsetting mechanisms. In the 1980s and '90s, the real wage rate increased (see Fig. 6.2) and labor input decreased with the introduction of labor-saving technologies such as the tractor, thresher, varieties with a short growth period, and direct seeding. In the 2000s, the real wage went down in the WS and was stable in the DS (see Fig. 6.2) and labor input increased slightly. Through this substitution mechanism in the labor market, the share has remained stable.

Although the total share of labor has been relatively constant, the distribution between family and hired labor changed (see Table 8.2). A notable feature is the substitution of hired labor for family labor, reflecting increasing opportunity costs among the members of farm-managing households compared with members of landless households. The result is a continuous increase in the share of hired labor. Since the hired labor comes mostly from landless households, which usually consist of the lowest strata in society, this implies that the Green Revolution has generated more returns to poor households.

[8]Note that the DS sample size in the early period is very small and thus it is better to refrain from interpreting it as representative rice farming in that period; rather, it shows a highly advanced case in the period.

The factor share of land decreased dramatically from around 30% in the 1960s and ’70s to 10−15% in the 2000s. This is consistent with the land-saving bias in technological change. Land reform regulation is another key reason for the reduction in land rent share.

The share of operator’s surplus has been declining sharply in the WS. As discussed earlier, one of the reasons for this is the stagnated yield increase in that season.

Central Luzon Loop farmer cooperators

IX. Case studies: looking beyond the survey data to family and farming issues

Up to now, we have viewed Central Luzon primarily from the view of rice crop production and performance. In this chapter, we report on six case studies. The studies involved a series of interviews in 2013 and 2014 focusing on the farm household, how the farm household and rice farming have changed over time, and what this portends for the future of rice farming in Central Luzon and in other parts of the Philippines where similar patterns of change can be observed. Because of the small number of households interviewed, it is difficult to generalize. But, in fact, the major changes are reflected in the broader sample and in some other research findings.

First, we can say that the families are typically large, and that parenting includes the older children helping with the younger ones even when it comes to schooling. Education receives a high priority. The children, although once helping on the farm, are leaving the farm for higher education and sometimes jobs overseas. But, the family remains a family, with the siblings remitting money to improve the parents' household or purchase inputs for rice production. Table 9.1 summarizes the change over time in sources of income (rice, nonfarm, remittances).

The farm as a family enterprise has changed. In the 1960s and '70s, the children were involved in rice farming and the major source of household

Table 9.1. Changes in sources of household income (%), six selected case studies, Central Luzon Loop farmers, 1960 to 2000.

Sources of income	1960s	1970s	1980s	1990s	2000s
			Percent		
Rice	67.9	86.1	37.3	37.8	17.1
Nonrice crop			16.2	9.7	5.0
Livestock and poultry			7.2	26.6	6.2
Off-farm employment	32.1	13.9	34.3	21.8	33.6
Remittances			3.3	4.1	27.9
Other sources (rentals, etc.)			1.7		10.2

income was rice production. In the 1980s and '90s, income from nonfarm activities increased. For many families today, remittances from overseas workers are an important part of family income, as reflected in Table 9.1, which is usually used for the improvement of the respondents' housing (see Fig. 9.1 Small houses made of semi-permanent materials are now replaced by big concrete houses with lots of home appliances.

As most of the siblings leave the farm for jobs elsewhere, often one of the siblings takes over the management from aging parents with the help of full-time hired laborers.

Respondents report that mechanization has made farming easier, and the purchase of pumps beginning in the 1980s has facilitated the growing of a DS crop. But, risks still exist. Poor drainage and flooding in the WS are perhaps the most damaging to both the farm and household. Sometimes, the construction of a highway has exacerbated the drainage problem as will be illustrated in two of the case studies.

Fig. 9.1. Concrete houses of the Central Luzon Loop farmers.

Case 1: An enterprising woman farmer

On 19 November 2013, we met with Maria's daughter, Fely, who is now in charge of the farm of 3.5 hectares. The family living quarters are on the second story of a house behind their *sari-sari* store. We were surprised to learn that there had been a flood in October, with the water rising to knee-deep in their two-story living quarters. They had planned to harvest the rice on a Friday but, like a *tsunami,* the flood arrived without warning on Thursday. Fortunately, it lasted only a couple of days, so they were able to harvest most of the rice. In the house, they lost the Christmas decorations and were trying to recover photographs from a couple of family albums. Despite these unpleasant intervals, for the Santos family, growing rice and educating siblings have had their rewards.

The setting

At the time of our first survey (1966), paddy fields were level with the national highway and were rainfed with only one crop of rice. The road was mostly made of temporary materials (gravel and sand) covered by asphalt that often needed repair after the rainy season.

Road widening and improvement of drainage and bridges along the concrete road are a sign of progress in this barangay. Access to markets and elsewhere became easier. Residential houses and small commercial and food establishments are now quite visible along the national highway.

However, road construction resulted in farms and houses lying lower than the newly constructed concrete road. This resulted in poor drainage and periodic flooding. Sometimes, development is detrimental to the lives of those who are unfortunate enough to live in the wrong place. The situation of the Santos family described above is a typical example of this phenomenon, in which a portion of their farm and residential house are almost always flooded in the wet season.

The family

When we first surveyed the farm in 1966, the Santos family, Juan and Maria, already had five children, all of them girls. Another girl and finally a boy arrived a short time later. One and a half hectares of rainfed rice was hardly enough to support such a large family. Maria explained that, aside from rice farming, she indulged in hog raising while her husband acquired a truck for hire in loading logs for timber from far north, in Isabela.

A major effort went into seeing that each of the seven children received a good education. In this effort, the older three helped the younger ones and now all seven have obtained training beyond high school and are gainfully employed. The siblings, in their birth order, their educational attainment, and their occupation, are listed below.

1) First daughter, chemical engineering graduate, married and residing in Bataan.
2) Second daughter, BS in nursing, married and residing in the U.S.
3) Third daughter, BS in accountancy, third-year undergraduate.
4) Fourth daughter, BS in accountancy, married and residing in the U.S.
5) Fifth daughter, medical technology graduate, residing in Cagayan.
6) Sixth daughter, BS in accountancy, married and residing in Muntinlupa, Rizal.
7) Youngest child, a son, BS in nursing, working in Singapore.

Fely, an accountant, also manages the farm. Three of the children live overseas. By the 1990s, the parents' investment in education was paying dividends. When the first three obtained their jobs, they started renovating the old house. With family support at home and abroad, the house we used to see in the late 1960s to mid-1990s became very much improved. A complete renovation was done in late 2000s after the parents (Juan and Maria) came back from a visit to the U.S., where two daughters reside permanently. The house decor and displays and some appliances and furniture are evidence of the children's appreciation for their parents. Occasional flooding notwithstanding, the house is well maintained to accommodate siblings coming home on special occasions.

The farm enterprise

The Santos farm enterprise deals with both the production of paddy and the marketing of rice.

Management

The management of the farm has changed over time. Initially, Juan made the major decisions, but, when Juan passed away in 2007, there was a sudden decline in yield. The daughter, Fely, who says she has been involved in farming activities since she was 15, has taken over most of the management decisions. Recently, Fely and her mother acquired 3 hectares of land, which she manages. Two permanent laborers receive 10% of the crop at harvest, with bonuses at the end of the year. Meanwhile, the mother, who is managing the sari-sari store established in 2007, is encouraging her daughter to learn postharvest and marketing activities, about which more will be said below.

Landholdings and farm practices

The original 1.5 hectares of land were rainfed. The land was located at the end of the irrigation canal near the highway and, as noted earlier, there was often too much water. In fact, in our first survey (WS 1966), they did not harvest anything because the land was washed out by flood (Table 9.2).

By 1970, they were planting the high-yielding IRRI varieties, switching to PhilRice varieties in the 1990s. But, yield did not increase until the 1980s. At this point, they acquired two small pumps and began planting a hectare of rice in the dry season. The three-ton-plus yields in the DS were matched by similar yields in the wet season. The pumps were used for drainage in the wet season, Fely indicates, and in the dry season, for supplementing the irrigation water supplied by the Peñaranda Irrigation System. The common practice now is to transplant rice in the wet season and broadcast (a kind of direct seeding by which farmers broadcast seeds directly on the field, locally called *sabog tanim*) in the dry season. Replacing the carabao, the family also obtained a small tractor for land preparation and threshing, which are mechanized.

Referring to Table 9.2, Fely indicates that the low yield in the 1994-95 DS was due to tungro virus. As mentioned earlier, the decline in yield after 2007-08 followed the death of Juan Santos.

Table 9.2. Trends in yield (t/ha), 1966 -2012, for a sample rice farm in Bulacan.

Season	1966-67	70-71	74-75	79-80	82	86-87	90-91	94-95	98-99	2007-08	11-12
Wet	0*	1.88	1.66	2.40	4.87	4.50	2.92	3.58	4.50	4.20	3.13
Dry						3.07	3.65	1.90	3.35	5.31	2.06

*Because of flood.

Marketing

Maria's *sari-sari* store was opened around 2007, at the same time the family built a palay stockroom to accommodate 100 cavans of paddy (1 cavan is equivalent to 50kg of rice). It is currently being renovated after this October's flood, in which some of the stock became wet.

Some time ago, a rice mill was put up by a rice dealer in this area. This prompted the family not to sell its paddy and instead the paddy was taken to the local mill and the miller kept the bran as payment for the milling. The milled rice is now sold in their *sari-sari* store. As of our last visit in October 2013, the price in the market for palay was PHP 15.50 kg dried. However, the price of milled rice was PHP 35/kg, a handsome profit for the *sari-sari* store.

Case 2: Living with natural disasters and development

The Cruz family was added to the survey in 1979-80. We include this in the case studies because it illustrates the sort of extreme problems that some rice farming families encounter through no fault of their own. The original respondents were dropped from the survey due to soil salinity problems brought about by the sea water that intrudes in the area during the wet season. In fact, flooding was a perennial problem in some parts of the province of Pampanga and in these areas some rice farms were switching to fishponds. So, we sought a location for the new farm survey site that we thought would be relatively free of these problems. But, in our choice of the Cruz family farm, we were proved wrong.

The setting

The Cruz farm is situated in the municipality of Lubao in Pampanga. This is one of the areas affected by the eruption of Mt. Pinatubo in June 1991. Rice fields were covered with *lahar*, which impaired the farming activities and income of farmers in the area. Three to four years saw no rice crop at all. But, the long-term effect, with flooding that occurred every wet season, meant that farmers could grow rice only in the dry season.

Infrastructure was damaged and the road, on the same level as the rice fields, was not passable in the wet season. The road was reconstructed at an elevation above the rice fields. For the widening of the road, the government took about half a hectare of the Cruz farm without compensation.

The study village is along the national road, close to the town proper for marketing and other activities. The noticeable business structures that rose up in the area are hotels, resorts, and other establishments related to tourism. This road network leads to the tourist areas of Zambales and Bataan.

The family

The original respondent, Guillermo, died in 1990 at the age of 72. Ruben, his son, had been helping his father manage the farm since 1977. Ruben, now 75, has six children, five males and one female. All are married and living separately from their parents.

Before becoming a full-time farmer, Ruben and his sons were involved in a guitar-making business and the old respondent as well was involved in this activity for an additional source of income since rice farming was no longer profitable in their area. However, recently, they stopped their business since the Chinese entered the market and the family was unable to compete.

The farm enterprise

The farm is under a leasehold arrangement with land rent of 12 cavans (552 kg) a year. The total farm area before reconstruction of the highway was 2 hectares. The residential area is approximately 0.3 hectare, which leaves more than 1 hectare planted to rice in the dry season.

Before the eruption of Mt. Pinatubo, there was a period when the cropping pattern consisted of two crops of rice plus watermelon after the second crop of rice. Because the farm was located too far from the irrigation source, the second rice crop frequently failed. After Mt. Pinatubo, and as mentioned above, the road was reconstructed and it was elevated such that the elevation of the farm was much lower than the road. Thus, the farm is usually flooded during the wet season. This situation forced Ruben to stop planting rice during the wet season starting in 1995. Since the irrigation water supply is unreliable, Ruben purchased a second-hand Chinese pump for PHP 3,500 to assure the dry-season crop.

So far, he is doing fine with his dry-season crops, with an average yield of about 5 tons per hectare during the last three years and with a minimum amount of fertilizer.

Case 3: Three generations of rice farmers: the case of fully irrigated rice farm in Nueva Ecija

On 19 November 2013, we visited the farm of Andres Enriquez. He is the 35-year-old grandson of Pedro Enriquez, whom we first interviewed in 1967. The farm is located at the head of Lateral C of the Peñaranda Irrigation System.

We were familiar with this area because in the 1974 and 1975 dry season we (IRRI) had been given permission by the National Irrigation Administration (NIA) to manage water distribution in the 6,000-hectare lateral. By allocating more water to the tail end of the system and allowing the tail to plant first, we were able to double the area irrigated and increase production by more than 100% without affecting production at the head of the system. But, when we withdrew, the plan collapsed. Commenting on the current situation, Andres said that politics still dominates when it comes to the head-tail problem in water distribution for irrigation.

The setting

The farm is located in one of the more favorable areas of Central Luzon and is close to the bustling town of Gapan. A main complaint in this area is about the heavy traffic moving to and from Manila to the provincial capital of Nueva Ecija, Cabanatuan. This contrasts with the four-lane north-south McArthur Highway running through provinces to the west.

Surface irrigation is dependable, but, as noted above, not toward the tail-end section of lateral C, where farmers can now use low-lift pumps in the dry season. The area does not face drainage problems although wet-season losses because of typhoons are common.

The family

When we first interviewed Pedro, he was 45 years old with a wife, Natividad, and four boys. Two more boys and two girls were added in the 1970s. One of the sons, Faustino, took over the management of the farm in the late 1990s when Pedro became sick and was too old to farm. Pedro died in 2012 at the age of 88. In Faustino's family, there were seven children, one of whom was Andres. Andres recalls that, beginning when he was 12 years old, he grew up assisting his father and grandfather on the farm.

According to Andres, his grandfather, Pedro, was a strict disciplinarian, disciplining not only his children but his grandchildren also, and putting a high value on education. The children were for the most part good students, doing well in universities in Manila and Nueva Ecija.

His father's income from construction work and his grandfather's income from rice farming allowed Andres's two brothers to finish school first. They joined the military and unfortunately both were killed. The parents received pensions for the deaths that partly supported other siblings to obtain college degrees. Two are geodetic engineers in Bahrain and one is a seaman. One of the girls is working and the other is still a student. Andres's two brothers working abroad have been able to finance the construction of two small houses to replace the old house, one for their parents and one for relatives who come to visit.

The farm enterprise

As mentioned earlier, the farm lies at the head of Lateral C of the Peñaranda Irrigation System. Roughly 2.5 hectares were planted to rice in the wet season and in the dry season, although varying somewhat from year to year. The farm was acquired by Pedro Enriquez through a *certificate of land transfer* (CLT) and is now owned by Pedro's sons.

Management

The farm was managed by Pedro until the late 1990s when his son Faustino took over. However, around 2004, Andres began to assist his father, who was often absent on business. In 2007, Faustino had a mild stroke and Andres became the full-time manager assisted by one permanent laborer.

Farm practices

The Enriquez farm seemed quick not just to adopt modern varieties but to improve yield, which increased from more than 2 tons per hectare in the 1960s to more than 5 tons per hectare in the 1970s (see Table 9.3 below), aided and abetted by the favorable environment.

Andres seems interested in moving further ahead. He belongs to the local farmers' cooperative, where he obtains credit and new ideas about technology. He also sent his laborer to PhilRice in Muñoz to receive training on hybrid rice. He seeks information about hybrids from the agro-chemical dealers in Muñoz. Since 2009, he has been planting hybrid rice, variety Mestizo. In crop year 2011-12, he planted the Chinese HR variety (SL series).

Table 9.3. Trends in yield (t/ha), 1966-2012, for a sample rice farm in Gapan, Nueva Ecija.

Crop year	1966-67	70-71	74-75	79-80	82	86-87	90-91	94-95	98-99	2003-04	07-08	11-12
Wet season	2.64	5.74	5.60	7.16	4.58	6.25	3.90	4.57	4.30	3.73	7.11	5.13
Dry season	2.05	5.46	3.50	6.98		5.40	5.33	5.00	3.91	3.77	3.93	5.90

Case 4: A diversified rainfed farm in Pangasinan

The setting

Pilar is a barangay of Sta. Maria, Pangasinan. It is about 5 km to the town proper. The municipality is quite far from Lingayen, the provincial capital. Newly constructed diversion roads provided the farmers with easier access to Urdaneta City, about 18 km away, the center of agricultural and commercial activities for municipalities on the eastern side of Pangasinan.

This part of Pangasinan is a rainfed area, mostly growing rice during the wet season and non-rice crops in the dry season. Pangasinan is noted for a good variety of mango aside from tobacco during the early years and corn for the livestock market lately. Most farms have diesel tube-well pumps installed on their farm for initial land preparation in the wet-season rice and to irrigate the dry-season nonrice crops.

The family

Mr. Marcos Galang is one of the original respondents interviewed in every round of the Central Luzon Loop Survey from 1966 to 2013. He is in his early 80s, narrating that he feels no longer capable of working on the farm. His health, according to him, is deteriorating. Thus, he decided to retire from farming after 2012.

He has five children, with one son, Roberto, who has two years of college education, and four daughters, all degree holders (the first daughter, with a BS in nursing; the second daughter, with a BS in nutrition; the third daughter, with a BS in education; and the youngest daughter, a vocational course graduate). However, none of the daughters are practicing their profession. Instead, they opted to be plain housewives.

After his retirement, Marcos sold his 1.5 hectares planted to rice and mango and another residential lot that he inherited. This parcel was not declared during the surveys conducted for every round of visit.

From the total sales of these two parcels, he purchased 1.0 hectare of riceland and a small tractor and had his house repaired. At this point in his life, he had distributed his remaining properties to his children. His son inherited 0.5 hectare, the eldest daughter’s share was 0.9 hectare, the second daughter was given a jeep for income, and the third got 1.0 hectare and the youngest 1.5 hectares for farming.

The current household now consists of his wife, himself, and an adopted grandson who is an engineering graduate.

The farm enterprise

The farm size reported by the respondent in the early years was 1.0 hectare, the area planted to rice only. About 500 m^2 were deducted due to road improvement. Thus, the area he recently planted to rice was 0.9 hectare. The changing farm area recorded in some years is due to the non declaration of other parcels he was cultivating. He revealed that, aside from the parcel he tills, he borrowed or he was offered additional area planted either to rice or a nonrice crop. He also had a parcel planted to a nonrice crop and a portion to mango.

The farm depends on rain for rice in the wet season and his own pump for tobacco and later corn for the dry-season crop. From 1966 until 1990, he grew rice in the wet season, followed by tobacco for the dry season. He shifted to corn for a DS crop after 1990 when the price of tobacco in the market went down. Though tobacco was a good income-generating crop before, he never went back to planting it. According to him, it is laborious and the input cost is high compared with that of corn.

From a hectare of tobacco, he could obtain net income of about PHP 150,000 in a good crop year and lately about PHP 60,000 because of the lower price in the market. For corn, he could also realize about PHP 120,000 and there was a good market as feed for livestock.

The first rice variety he planted was IR8. In the 1990s, for a number of years, he planted IR64. After that, he planted the latest PhilRice varieties such as RC28 and RC29. Table 9.4 shows the yield of his farm over the years.

Table 9.4. Trends in yield (t/ha), 1966-2012, for a sample rice farm in Pangasinan.

	1966	70	74	79	82	86	90	94	98	2003	07	11
Wet season	2.29	3.11	3.32	3.72	4.06	4.00	4.85	3.89	4.54	4.30	5.00	3.82

Case 5: A self-financing farm: conversion of fallow land to commercial use

The setting

The municipality of San Leonardo is almost 24 km from the provincial capital of Nueva Ecija, Cabanatuan City. The original respondent's house located in San Anton, a barangay in San Leonardo, is about 3.5 km away from the farm situated along the National Highway and 6 km from the town of San Leonardo. The area is served by UPRIIS, and their farm is situated in the middle close to the lateral canal.

The farm lies very close to the National Highway and, because of poor drainage, a portion is always left fallow because of floodwater that stays during the wet season. Because of national road improvement, stones accumulated and made the land unfavorable for growing rice. This part of the farm was converted to commercial area that provided capital for operating the rice farm.

One of the unusual features of this farm is that a small piece of uncultivated land is rented out to a commercial operation, with the rents used to finance rice production. There also seems to be a common problem in family decisions as to who does what and who gets what.

The farm family

Joe is the tenth child of the original respondent, Mr. Sebastian Fosadas, who passed away in early 2000. Mang Sebastian had been a widower since the 1980s. He took the responsibility of the wife, taking care of his 12 children upon her death. The older children helped him take care of the younger ones and the household.

Joe, who currently manages the farm, is 47, married with three children: two sons, one with a two-year vocational course certificate and the other a high school graduate, and a daughter, a fourth-year college student. His brothers and sisters are mostly high school graduates, including him. Only three of the 12 obtained a college degree.

Before Joe took over, another younger brother, Eleazar, was the one farming. At that time, Eleazar and family lived close to Mang Sebastian's house. Eleazar was then closely supervised by his father. His father, for health reasons, gave up farming and at the same time employment responsibilities in a construction supplier's store in another town.

Joe and Eleazar were both trusted to continue the farm work. But Eleazar decided to give up farming and thus in 2005 Joe started managing the farm, up to the present. Another brother, Sebastian Jr., also assisted in the farm activities but Joe is still in charge of the farm and rentals of the commercial area communally owned by the siblings.

The farm enterprise

According to our present respondent, Joe, the area declared by his father in 1966 was 1.5 hectares, the actual area planted to rice. It was a rainfed area until the mid-1970s, growing one crop of rice a year. Then, UPRIIS expanded the service area, which enabled the family to grow a second crop of rice.

The area specified in the Emancipation Patent, an official document from the Agrarian Reform Office, shows that the physical area of the whole plot they had been cultivating is 1.94 hectares, but 0.44 ha was never planted. It was left fallow before but now they are renting it out. The income they use to finance farm expenses. Joe occupies a portion where he constructed his house, close to the farm and to the rented-out commercial area that he oversees. From the net harvest, all 12 siblings obtain an equal share of palay after harvest, which is mostly for home consumption.

In the late 1970s and early ‘80s, his father temporarily farmed an additional parcel, which was offered to him without any obligation. From 1986 to 2012, 1.5 hectares were consistently planted to rice.

Land preparation is fully mechanized. Their own hand tractor is usually operated by their permanent laborer and a brother. They planted IRRI varieties, particularly IR64 in the dry season, until the 1990s, and then switched to PhilRice varieties. The variety used for the past three seasons is the popular RC222. Table 9.5 shows the yield of their farm.

Table 9.5. Trends in yield (t/ha), 1966-2012, for a sample rice farm in San Leonardo, Nueva Ecija.

Season	1966-67	70-71	74-75	79-80	82	86-87	90-91	94-95	98-99	2003-04	07-08	11-12
Wet	2.26	3.02	3.82	2.48	5.13	3.01	5.00	4.67	2.00	3.93	5.55	3.74
Dry				4.31		3.04	5.67	3.95	4.67	3.57	5.00	4.54

Case 6: A fulfilled father and a farmer

The setting

The Torres farm is located far from the source of irrigation water, so it is rainfed and many farmers now use a pump to irrigate the dry-season rice crop. It is a typical rainfed area situated along the San Miguel national road. It is flooded most of the time during the wet season since the farm lies lower than the road. In fact, in the 2013 WS, they experienced flash flood affecting the residential area down to the rice field right at the back of their house.

The family

Mang Roberto is 74 years old and he was consistently interviewed for all 11 surveys. He was 27 years old when interviewed, when the Central Luzon Loop Survey started in 1966, and he got married a decade later. He has been a fulltime farmer with rice as the major enterprise. Hog raising and small backyard poultry have been a secondary source of income to help support the education of the children. Roberto's wife, though, has some hearing impairment, but she has been a dedicated wife and mother to her children. Every time we visited, she was either in the kitchen preparing food for the children or taking food for lunch to her husband on the farm. She also assists in raising their backyard piggery and in poultry farming. The other older children who finished school have financially helped the other siblings in their studies.

Roberto has nine children, six sons and three daughters. Eight are married and the youngest daughter, single, stays with them. Five of his sons took a three-year marine engineering course. All of them are now working as seamen. It seems that the younger children were influenced by the older brother's good salary from this kind of job. All of them are successfully raising their family and enjoying the lifestyle of a dollar earner. In fact, the big house in the compound is the great proof of farmers' desire for children to obtain a college degree. The daughters are also all degree holders but two opted to be housewives and the single daughter is practicing her profession as a dentist who stays with them and supports them, since Roberto is farming 1.0 hectare and obtaining less rice income because the WS crop is usually affected by flood.

The farmer has an aura of a fulfilled father. His children are settled with their own family and residing beside them in the residential lot that is part of the farm. About 700 m^2 were divided among five children and big and beautiful houses were constructed for the family of the sons working as seamen. One building serves as a dental clinic for the daughter. Now, they (farmer and wife) receive financial support from their sons working as seamen. Normally, the parents of seamen receive a monthly allotment once they are regularly employed in a shipping company.

The farm enterprise

In 1966, the farm size was 1.0 hectare under a leasehold arrangement. After some years, two of Roberto's siblings gave up farming 2.0 hectares of land, which he continuously tilled until 1980. Because of some development in the area, almost half a hectare was converted to road and the rest remained fallow. At some point, the farm size increased because of parcels pawned-in to him. From 2008 until the last survey year, he was again farming just 1.0 hectare.

Farm practices

Around 1990, a tube-well pump was installed on his farm for the dry-season crop and for initial land preparation for the wet-season rice. Normally, the family uses a pump to get started with dry plowing and have the land ready for secondary land preparation at the onset of the rain in May to June.

Roberto follows the now common practice of transplanting in the wet season and broadcasting in the dry season. But, he has difficulty giving up the old practices: the shift from animal power and labor to mechanization. He keeps a carabao for initial land preparation, but has to admit that land preparation with a power tiller is a lot faster and particularly a lot easier for someone his age.

Mechanical harvesting and threshing are slowly being adopted in the area. But, farmers are not in favor of mechanization in general because of the labor displacement for these activities, which are the main source of income for hired agricultural labor. Furthermore, the mechanical harvesters tend to work poorly, particularly during the flooded conditions in the wet season.

X. Conclusions and implications

The loop survey of approximately 100 farmers in Central Luzon conducted every four or five years since the early 1960s has provided vital information to policymakers and researchers on the dynamic changes happening in rice farming and their impact on the lives of rural communities. It is perhaps the longest continuous survey of rice farming and rice farm families in existence.

Rice farming in the Philippines is markedly different now from what it was five decades ago. Rice farming used to be a family affair, that is, all family members were involved in rice farming, as this was the primary source of family income. But, as off-farm income and remittances became a major source of income, the involvement of young family members in rice farming has declined significantly over time. The family farm is now managed by one member of the family (usually by an aged parent remaining on the farm) who primarily relies on hired casual or permanent labor for farm operations. The role of women in rice farming has also been changing with a greater share of women as owner-operators.

Rice yields for the sampled farmers in the Loop Survey have more than doubled in the past five decades with the adoption of modern high-yielding varieties, chemical fertilizer, improved production practices, and better irrigation infrastructure. Irrigation facilities have enabled farmers to grow a second rice crop in the dry season. Although wet-season rice yields have plateaued in the past decade, dry-season yields have continued to rise, with average yield reaching 6 t/ha. Although the average farm size has remained at about 2 hectares, wet-season rice area per family has declined to 1.2 hectares because of declining profitability.

In the 1980s and '90s, the increase in returns was captured by the owner-operators created by the land reform. However, this benefit is disappearing, particularly in the wet season, because the payment into current input share has been sharply increasing in the 2000s with little increase in revenue.

The groups of hired laborers also were initially the beneficiaries of the Green Revolution. Their share increased through the introduction of labor-using technology as well as by the substitution of hired labor for expensive family labor. From a macro point of view, rice consumers (including net buyers among farming households) benefited from the Green Revolution through a rice price reduction up to the early 2000s. However, after the rice price surge on the international market in 2008, the real price has not returned to the previous level, raising concern about the sustainability of the benefit to consumers.

On the positive side, the use of insecticides has declined since 1980. In fact, the Philippines has by far the lowest use of insecticides among other Asian countries such as Thailand, Vietnam, Indonesia, and China and has avoided major losses due to brown planthopper elsewhere through the successful adoption of integrated pest management practices.

We would like to conclude the book with three implications for the future path of the Philippines' rice sector development. First, there is much discussion in the literature about the need for Asian economies to expand farm size to take advantage of the scale economies of large mechanization (Otsuka and Estudillo, 2010). However, this transition must be accompanied by rising wage rates and an active land market. Slow industrial development, a rapid population growth, and prolonged land reform had slowed down this transition in the Philippines so far. In the 2010s, the economy has started growing rapidly and if this growth is pro-poor and raises the wage rates of agricultural laborers, an incentive for mechanization will increase. Meanwhile, the process may not work smoothly as long as the land market is still inactive. We have to pay attention how recent economic growth affects three related factors, namely, labor arrangement, activeness of land market, and mechanization. Second, declining profitability in the wet season is another crucial issue. Research on sustainable rice production in agroecologically unfavorable conditions is a very important research agenda. The last but not the least issue is related to the environment. The new varieties released since 1997 have much less resistance to pests and diseases than those released previously (Laborte et al 2015). Should resistance traits be added again in future varieties? Are there alternative approaches to avoid pests and diseases without using chemical inputs? To maintain the advantage of the country's low insecticide use, we have to include these issues on the list of our agenda.

XI. References

AgriPinoy. 2008. What is hybrid rice? Agripinoy.net.

Aragon CT. 1985. Policy Issues Related to the Introduction of Mechanical Technologies and the Direct Seeding Technology in Rice Production. Philipp. J. Crop Sci. 10 (Special Issue):197-206.

Barker R, Cordova VG. 1978. Labor utilization in rice production. In: Economic consequences of the new rice technology. International Rice Research Institute, Los Baños, Laguna, Philippines.

Barker R, Meyers W, Crisostomo C, Duff B. 1973. Employment and Technological Chnge in Philippine Agriculture. In: International Labor Office. Mechanization and employment in agriculture; Case Randolph Barker, 1972. Labor Absorption in Philippine Agriculture. Paper prepared for the workshop on Manpower and Human Resources, Continuing Education Center, Los Baños, Laguna, Oct.13-15, 1972. Studies from four continents. U.N. Geneva, Switzerland.

Binswanger HP. 1974. Hypotheses and priorities for the village level studies in the semi-arid tropics of India. Hyderabad, India: Economics Department, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Center N. 2014. Pesticide Active Ingredients. http/npicorst.edu/ingred/active html. 1/26/14.Cordova V,Herdt RW, Gascon FB, Yambao LD. 1981a. Changes in rice production technology and their impact on rice farm earnings in Central Luzon, Philippines, 1966-79. Department Paper No.81-19, Department of Agricultural Economics, International Rice Research Institute, Los Baños, Laguna, Philippines.

Cordova V, Papag A, Sardido S, Yambao L. 1981b. Changes in practices of rice farmers in Central Luzon, 1966-1979. Paper presented for the 12th Annual Scientific Meeting of the Crop Science Society of the Philippines, Bacnotan, La Union, 22-24 April 1981.

Cordova V, Mandac A, Gascon F.1980. Some considerations on energy costs of rice production in Central Luzon. Paper presented at the PAEDA 26th annual convention, CLSU, Muñoz Nueva Ecija, 6-8 June 1980.

Cordova V, Barker R. 1977. The effect of modern technology on labor utilization in rice production. Paper presented at the Saturday Seminar, 28 May 1977, IRRI, Los Baños, Laguna, Philippines.

Cororaton CA. 2008. Philippine agricultural and food policies: implications for poverty and income distribution. Research Report 161. Washington, D.C.(USA): International Food Policy Research Institute.

David C, Barker R. 1982. Labour demand in the Philippine sector. In: Gooneratne W, editor. Labor absorption in rice -based agriculture: case studies from South-East Asia. Bangkok, Asian Employment Programme, ILO. p 119-157.

Dawe DC. 2006a. A second green revolution in the Philippines: insecticide use on rice declines to a low level. In: Dawe D, Moya P, Casiwan C, editors. Why does the Philippines import rice? Meeting the challenge of trade liberalization. Manila (Philippines): International Rice Research Institute and Philippines Rice Research Institute. p 85-88.

Dawe D. 2006b. Farm laborers, not palay farmers, do the bulk of the work producing the nation's rice. In: Dawe D, Moya P, Casiwan C, editors. Why does the Philippines import rice? Meeting the challenge of trade liberalization. Manila(Philippines): International Rice Research Institute and Philippines Rice Research Institute. p 23-25.

Dawson P, Woodford CH. 1991. A generalized measure of farm specific technical efficiency. Am. J.Agric. Econ. p 1098-1104. November 1991.

Dawson P, Lingard J. 1991. Approaches to measuring technical efficiency on Philippine rice farms. J. Int. Dev. 3(3):211-228.

Dawson P, Lingard J. 1989. Measuring farm efficiency over time on Philippine rice farms. J. Agric. Econ. 40(2):168-177.

Diokno-pascual MTI. 2014. The controversial Casecnan Project. http://eca-watch.org/problems/asia-pacific/Philippines/Casecnan. Field Report, 29 June 2014.

Estudillo J, Otsuka K. 1999. Green Revolution, human capital and off-farm employment:changing sources of income among farm households in Central Luzon, 1966-94. Econ. Dev. Cult. Change 47(3):497-523.

Estudillo J, Otsuka K. 2001. Has the Green Revolution ended? A review of long-term trends in MV adoption, rice yields, and rice income in Central Luzon, 1966-99. Jpn. J. Rural Econ. 3:51-64.

Estudillo JP,Otsuka K. 2006. Lessons from three decades of green revolution in the Philippines. Dev. Econ. 44(2):123-148.

Estudillo J, Fujimura M, Hossain M. 1999. New rice technology and comparative advantage in rice production in the Philippines. J. Dev. Studies 35(5):162-184.

Hayami Y, Kikuchi M. 1982. Asian village economy at the crossroad. Baltimore, Md. (USA): Johns Hopkins University Press.

Hayami Y, Kikuchi M. 2000. A rice village saga:three decades of green revolution in the Philippines. Baltimore, Md. (USA): Barnes and Noble in association with IRRI.

Hayami Y, Otsuka K. 1993. The Economics of Contract Choice: An Agrarian Perspective, Clarendon Press, Oxford (1993) 228 pp. [SD-008].

Herdt RW. 1987. A retrospective view of technological and other changes in Philippine rice farming, 1965-1982. Econ. Dev. Cult. Change 35(2): 329-349.

Herdt RW. 1978. Cost and returns for rice production. In: Economic consequences of new rice technology. Los Baños (Philippines): International Rice Research Institute. p 63-80.

Hossain M. 2009. Rural economy and livelihoods: insights from Bangladesh. Dhaka: A.H. Developement Publishing House.

IRRI (International Rice Research Institute). 1979. Brown planthopper in Asia. Los Baños (Philippines): IRRI.

IRRI (International Rice Research Institute). 1967. IRRI annual report. Los Baños (Philippines): IRRI. p 228-230.

Jayasuriya SK, Te A, Herdt R. 1982. Mechanization and cropping intensification: economic viability of power tillers in the Philippines. Agricultural Economics Department Paper 82-10. Department of Agricultural Economics, International Rice Research Institute, Los Baños, Philippines.

Laborte A, Paguirigan N, Moya P, Nelson A, Sparks A, and Gregorio G. Farmers' preference for rice traits: Insights from five decades of farm surveys in Central Luzon, Philippines. Social Sciences Division, International Rice Research Institute (IRRI), Los Baños, Laguna, Philippines. (In process).

Launio CC, Redondo GO, Beltran JC, Morooka Y. 2008. Adoption and spatial diversity of later generation modern rice varieties in the Philippines. Agron. J. 100:1380-1389.

Liao D. 1968. Studies on adoption of new rice varieties. Paper presented at the IRRI Saturday Seminar, 9 November 1968. IRRI, Los Baños, Laguna, Philippines.

Lingard J, Castillo L, Jayasuriya S. 1983. Comparative efficiency of rice farms in Central Luzon, Philippines. J. Agric. Econ. 34(2):163-173.

Mataia A, Jamora N, Moya P, Dawe D, Francisco S. 2011. Sources of decade rice yield growth in the Philippines. Philipp. J. Crop Sci. 36(2):20-29.

Meyers W, Guino R. 1971. Effect of new technology on farm employment and mechanization. Saturday Seminar Paper, Agricultural Economics Department, IRRI, 4 December 1971.

Moya PF, Dawe D et al. 2004. The economics of intensively irirgated rice in Asia. In: Witt C, Dobermann A. Increasing productivity of intensive rice systems through site-specific nutrient management. Enfield N.H. (USA) and Los Baños (Philippines): Science Publishers Inc. and IRRI. p 29-58.

Moya PF, Pingali PL. 1989. Can we close the yield gap between the "best" and "ordinary" farmers in Luzon? Paper presented at the Saturday Seminar, March 1989. IRRI, Los Baños Laguna, Philippines.

Norton GW, Heong KL, Johnson D, Savary S. 2010. Rice pest management: issues and opportunities. In: Pandey S, Byerlee D, Dawe D, Dobermann A, Mohanty, Hardy B, editors. Rice in the global economy: strategic research and policy issues for food security.Los Baños (Philippines): International Rice Research Institute. p 297-332

Oka IN. 1979. Cultural control of brown planthopper. In: brown planthopper, threat to rice production in Asia. Los Baños (Philippines): International Rice Research Institute. p 357-369.

Oppenfeld V. 1957. Farm managemnet, land use and tenancy in the Philippines. Laguna.

Otsuka K, Gascon F. 1994. Green Revolution and labour demand in rice farming: the case of Central Luzon, 1966-90. J. Dev. Studies 31(1):82-109.

Otsuka K, Estudillo JP. 2010. Economic development, land tenure, and the changing optimum farm size. In: Pandey S, Byerlee D, Dawe D, Dobermann A, Mohanty S, Hardy B, editors. Rice in the global economy: strategic research and policy issues for food security. Los Baños(Philippines): International Rice Research Institute. p 191-212

Otsuka K, Gascon F, Asano S. 1994. Second-generation MVs and the evolution of the Green Revolution: the case of Central Luzon, 1966-90. Agric. Econ. 10:283-295.

Otsuka K, Gascon F. 1990. Two decades of Green Revolution in Central Luzon: a study of technology adoption and productivity changes. A paper presented at IRRI Research Seminar, 23 August 1990. IRRI, Los Baños, Laguna, Philippines

Philippine Rice Research Institute. 2012. Rice-based farm household survey:manual of operations. March 2012 survey round. Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Ranade CG, Herdt RW. 1978. Shares of farm earnings from rice production. In: Economic consequences of new rice technology. Los Baños (Philippines): International Rice Research Institute. p 87-104.

Rola A, Pingali P. 1993. Pesticides, rice productivity: an economic assessment and farmer's health. Los Baños (Philippines): World Resources Institute and IRRI.

Rogers P, Pingali P, editors. 1995. Impact of pesticides on farmers' helath and the rice environment. Norwell, Mass. (USA): Kluwer Academic Publishers and the International Rice Research Institute. Ricehopper.net. 22 January 2014.

Sebastian L, Alviola P. 2000. Bridging the rice yield gap in the Philippines. Bangkok: FAO Corporate Document Repository.

Smith JA. 1979. The effect of new rice technology on family labor utilization in Laguna. Manila (Philippines): IRRI Research Paper Series. Number 42, Nov. 1979.

Takahashi K, Otsuka K. 2009. Human capital investment and poverty reduction over generations: a case from the rural Philippines, 1979-2003. A book chapter of Rural Poverty and Income Dynamics in Asia and Africa, edited by Otsuka, Estudillo, and Sawada 2009.

Takahashi K, Otsuka K. 2009. The increasing importance of nonfarm income and the changing use of labor and capital in rice farming: the case of Central Luzon, 1979-2003. Agric. Econ. 40:231-242.

Tiongco M. 2002. Is the green revolution sustainable? Long-term productivity trends in a sample of Philippine rice farms. In: Acharya SS, Singh S, Sagau V, editors. Sustainable agriculture, poverty and security: agenda by Asian economies.Ill. Ref. Jaipur, India. p 112-119.

Tiongco M, Dawe D. 2002. Long-term evolution of productivity in a sample of Philippine rice farms: implications for sustainability and future research. World Development 30(5):891-898.

Unnevehr LJ, Balisacan AM. 1983. Changing comparative advantage in Philippine rice production. Report to the Impact of Economic Policies on Agricultural Development Project, PIDs and PCARRD.

Velasco LP. 2000. Dry seeding rice: the emerging trends in fully irrigated areas. Social Sciences Division, International Rice Research Institute.

Velasco LR. 2004. IPM and rice:quo vadis. In: All about rice. Vol. 1, No. 2, June 2004. Asia Rice Foundation, Los Baños, Philippines.

Appendix A

Appendix Table 1.1. Area, production, and yield by ecosystem and season, Central Luzon 1970-2013, Philippines.

Production (tons)	Area (ha)			Production (tons)			Yield (t/ha)		
	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Both ecosystems
1970	246,320	209,580	455,900	599,170	451,985	1,051,155	2.43	2.16	2.31
1971	222,450	169,330	391,780	448,335	262,475	710,810	2.02	1.55	1.81
1972	239,900	212,770	452,670	451,654	299,141	750,795	1.88	1.41	1.66
1973	293,380	203,680	497,060	679,470	360,625	1,040,095	2.32	1.77	2.09
1974	290,020	211,870	501,890	663,680	329,780	993,460	2.29	1.56	1.98
1975	302,010	176,760	478,770	739,145	327,685	1,066,830	2.45	1.85	2.23
1976	293,330	132,040	425,370	750,865	269,750	1,020,615	2.56	2.04	2.40
1977	290,240	128,440	418,680	863,455	287,310	1,150,765	2.97	2.24	2.75
1978	271,650	126,290	397,940	840,335	260,565	1,100,900	3.09	2.06	2.77
1979	296,400	114,240	410,640	1,107,115	227,235	1,334,350	3.74	1.99	3.25
1980	326,160	150,260	476,420	967,265	331,260	1,298,525	2.97	2.20	2.73
1981	341,790	143,190	484,980	1,178,500	387,445	1,565,945	3.45	2.71	3.23
1982	366,710	142,970	509,680	1,380,600	411,320	1,791,920	3.76	2.88	3.52
1983	332,580	131,010	463,590	1,130,795	295,790	1,426,585	3.40	2.26	3.08
1984	282,150	119,130	401,280	911,770	313,415	1,225,185	3.23	2.63	3.05
1985	326,980	138,070	465,050	1,051,990	371,140	1,423,130	3.22	2.69	3.06
1986	352,800	143,760	496,560	1,217,475	389,600	1,607,075	3.45	2.71	3.24
1987	368,460	115,500	483,960	1,268,918	271,317	1,540,235	3.44	2.35	3.18
1988	343,740	121,310	465,050	1,013,510	257,325	1,270,835	2.95	2.12	2.73
1989	401,170	116,220	517,390	1,377,707	307,243	1,684,950	3.43	2.64	3.26
1990	387,300	134,070	521,370	1,437,626	473,304	1,910,930	3.71	3.53	3.67
1991	376,900	122,970	499,870	1,405,118	343,373	1,748,491	3.73	2.79	3.50

Cont..Appendix Table 1.1

Production (tons)	Area (ha)			Production (tons)			Yield (t/ha)		
	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Both ecosystems
1992	353,200	118,390	471,590	1,390,193	345,743	1,735,936	3.94	2.92	3.68
1993	333,850	143,160	477,010	1,220,135	384,207	1,604,342	3.65	2.68	3.36
1994	424,980	126,250	551,230	1,595,653	345,396	1,941,049	3.75	2.74	3.52
1995	447,838	120,244	568,082	1,502,350	319,739	1,822,089	3.35	2.66	3.21
1996	452,037	110,444	562,481	1,668,115	283,038	1,951,153	3.69	2.56	3.47
1997	453,314	109,416	562,730	1,744,925	328,665	2,073,590	3.85	3.00	3.68
1998	368,029	80,327	448,356	1,191,124	179,136	1,370,260	3.24	2.23	3.06
1999	454,508	95,512	550,020	1,652,584	260,151	1,912,735	3.64	2.72	3.48
2000	461,473	90,788	552,261	1,712,113	248,119	1,960,232	3.71	2.73	3.55
2001	465,258	92,712	557,970	1,866,233	307,604	2,173,837	4.01	3.32	3.90
2002	466,138	88,738	554,876	1,919,829	320,550	2,240,379	4.12	3.61	4.04
2003	482,850	86,879	569,729	2,095,908	299,553	2,395,461	4.34	3.45	4.20
2004	480,517	85,235	565,752	2,149,102	317,339	2,466,441	4.47	3.72	4.36
2005	488,997	82,023	571,020	2,254,494	291,359	2,545,853	4.61	3.55	4.46
2006	509,619	83,414	593,033	2,365,130	312,503	2,677,633	4.64	3.75	4.52
2007	556,385	84,528	640,913	2,628,489	313,624	2,942,113	4.72	3.71	4.59
2008	580,358	85,951	666,309	2,710,433	303,914	3,014,347	4.67	3.54	4.52
2009	579,905	84,216	664,121	2,537,528	267,939	2,805,467	4.38	3.18	4.22
2010	599,573	82,328	681,901	2,712,810	245,605	2,958,415	4.52	2.98	4.34
2011	544,198	72,689	616,887	2,386,583	229,500	2,616,083	4.39	3.16	4.24
2012	599,891	75,890	675,781	2,939,815	280,792	3,220,607	4.90	3.70	4.77
2013	631,664	79,153	710,817	3,093,762	315,706	3,409,468	4.90	3.99	4.80

Source data: Bureau of Agricultural Statistics, Philippines.

Appendix Table 2.1. Household composition by age, sex, and family relationship, 1966-2012.

Relation	Sex	Age group	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Head	Male	0–14												
		15–25	2	1		14	5			1			1	
		26–35	19	9	5	38	34	20	7	1		3	2	4
		36–45	29	17	13	34	40	32	31	24	16	14	16	7
		46–55	21	16	19	28	21	32	30	32	21	34	27	16
		56–65	17	12	9	23	22	20	14	18	24	31	24	26
		65 >	7	7	11	10	11	14	22	18	15	17	23	24
	Female	0–14												
		15–25												
		26–35					1			2	1			
		36–45				1					2	1	1	3
		46–55							2	3	3	4	4	4
		56–65			1			2	1		1	9	6	3
		65 >					1		1	1	2	3	3	8
Spouse	Female	0–14												
		15–25				12	15	4	1			2	2	1
		26–35		2		35	30	23	11	10	3	5	4	3
		36–45		7		33	33	34	32	23	18	21	14	10
		46–55		10		22	18	22	22	25	21	32	32	18
		56–65		1		18	23	13	13	10	18	26	18	26
		65 >				6	4	11	13	12	8	10	14	11
Son	Male	0–14		11		159	148	103	77	59	31	43	26	8
		15–25		35		85	96	103	88	83	70	74	44	31
		26–35		5		19	19	26	23	29	25	31	19	29
		36–45		1			2	3	2	6	7	9	9	8
		46–55					1				1	4	2	2
		56–65												1
		65 >								1				
Daughter	Female	0–14		6		158	139	96	56	52	38	48	32	24
		15–25		14		75	73	70	69	59	49	48	40	27
		26–35				14	16	17	17	25	19	24	22	20

Cont... Appendix Table 2.1

Relation	Sex	Age group	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
		36–45					4	1	6	9	4	7	9	8
		46–55								1	1	1	3	2
		56–65												
		65 >												
Grandchild	Male	0–14				11	11	21	22	26	14	40	35	35
		15–25		1		2		4	1	1	4	6	11	11
		26–35				1				1		2	3	
		36–45												
		46–55												
		56–65												
		65 >												
	Female	0–14				13	7	14	19	19	20	39	47	35
		15–25						2	1	1	3	10	9	8
		26–35						1		3	6		1	
		36–45								1				
		46–55								1				
		56–65												
		65 >												
In-law	Male	0–14										1		
		15–25				2	1	4	2		1	3	4	5
		26–35				1	6	1	3	5	2	11	9	12
		36–45				1		1	1			4	6	6
		46–55				1								2
		56–65							2					
		65 >				1	2	1	1					
	Female	0–14				2				2		1		1
		15–25				4	3	6	6	4	7	13	8	6
		26–35				2	3	3	2	4	2	10	9	8
		36–45					1	1	2	1	2		4	2
		46–55				1		2				1		1

Cont... Appendix Table 2.1

Relation	Sex	Age group	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
		56–65				1			1	1				
		65 >				1		3	2	2		2	4	2
Parent	Male	0–14												
		15–25												
		26–35						1						
		36–45												
		46–55				1								
		56–65				5	2		1					
		65 >				7	5	6	4	2	4	3	1	1
	Female	0–14												
		15–25												
		26–35						1						
		36–45												
		46–55				5	2		1					
		56–65				11	7	1	2	1	1		1	2
		65 >				6	13	7	3	5	5	3	5	6
Relative	Male	0–14				1		3	3	3	1		2	2
		15–25				1		2		1			1	2
		26–35												3
		36–45												
		46–55												
		56–65												
		65 >												1
	Female	0–14				1	2	2	1		1		2	
		15–25						3		1	3	1	2	3
		26–35												2
		36–45												
		46–55												
		56–65												1
		65 >												1

Cont... Appendix Table 2.1

Relation	Sex	Age group	1966-67	1970-71	1974-75	1979-80	1982	1986-87	1990-91	1994-95	1998-99	2003-04	2007-08	2011-12
Sibling	Male	0–14				4	1							
		15–25				15	8	2			1		2	1
		26–35				2	4	1	1	2			1	
		36–45				2					1			
		46–55				1	1				1	1		
		56–65												
		65 >												
	Female	0–14				7	2					1		
		15–25				14	4		1				4	
		26–35				4	5	1		1	1	1	1	
		36–45				1	2	5	1		1		1	
		46–55				1	1	1	1	1	1	1		
		56–65						2	1			1	2	1
		65 >											2	
Others	Male	0–14					2	2					2	
		15–25				1	2	4	1	3				
		26–35				2		1		1				
		36–45												
		46–55										1	1	1
		56–65												
		65 >												
	Female	0–14					2	5	1	3			2	1
		15–25				2	1			1		1		1
		26–35												
		36–45												
		46–55												
		56–65												
		65 >												

Appendix Table 4.1. Long-term yield (kg/ha), sample parcels, Central Luzon Loop Survey, 1966-2012.

Season	Total no. of parcels	Yield (kg/ha)		
		Mean	Min.	Max.
Wet				
1966	103	2,302.52	0.00	5,318.18
1970	74	2,500.06	396.00	5,739.13
1974	80	2,041.85	230.00	7,288.75
1979	227	3,606.86	0.00	8,763.64
1982	226	4,092.83	621.00	9,000.00
1986	148	3,496.59	645.00	6,250.00
1990	170	3,511.51	0.00	10,063.75
1994	138	4,072.57	0.00	11,250.00
1999	108	3,453.61	752.00	8,220.00
2003	166	4,283.69	974.60	7,080.00
2008	102	4,509.80	2,020.00	7,800.00
2011	119	3,878.68	971.11	7,833.33
Dry				
1967	17	1,788.60	0.00	3,725.33
1971	15	2,481.44	422.40	6,131.30
1975	19	1,972.83	0.00	5,414.06
1980	111	4,390.04	1,350.00	10,833.33
1987	84	4,226.74	480.00	7,567.00
1991	84	4,392.97	0.00	8,800.00
1995	74	4,819.36	0.00	9,024.00
1998	64	4,588.45	1,167.57	11,287.50
2004	97	4,797.54	1,312.50	7,869.33
2007	70	5,223.54	1,800.00	10,269.23
2012	90	5,759.91	1,960.78	11,200.00

Appendix Table 5.1. Comparative fertilizer use per ha (in kg), WS and DS, for sample farms, Central Luzon Loop Survey, 1966-2012.

Season	Total no. of parcels	N			P			K		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Wet										
1966	103	8.99	0.00	66.24	3.60	0.00	29.92	4.56	0.00	27.89
1970	74	28.08	0.00	118.96	3.78	0.00	30.75	2.75	0.00	22.41
1974	80	37.85	0.00	103.50	6.31	0.00	31.42	2.91	0.00	28.02
1979	227	59.06	0.00	230.00	6.09	0.00	34.91	6.49	0.00	58.11
1982	226	65.05	0.00	311.00	5.76	0.00	44.96	4.85	0.00	50.20
1986	148	69.76	0.00	221.00	6.26	0.00	52.37	4.75	0.00	46.49
1990	170	70.74	0.00	322.28	8.26	0.00	41.89	10.12	0.00	45.19
1994	138	95.37	0.00	258.40	9.33	0.00	36.37	12.15	0.00	62.58
1999	108	103.66	11.67	396.25	10.76	0.00	42.11	11.97	0.00	51.27
2003	166	91.62	0.00	370.43	12.82	0.00	49.10	16.28	0.00	58.46
2008	102	93.22	2.10	248.60	9.99	0.00	35.44	11.70	0.00	43.58
2011	119	114.78	0.00	483.91	14.89	0.00	67.21	19.33	0.00	127.84
Dry										
1967	17	19.92	0.00	45.00	7.10	0.00	23.57	10.78	0.00	37.35
1971	15	64.22	7.56	180.00	6.44	0.00	32.99	8.37	0.00	62.76
1975	19	34.88	0.00	103.50	0.08	0.00	0.79	0.16	0.00	1.51
1980	111	96.05	8.40	336.00	8.31	0.00	26.18	10.03	0.00	50.91
1987	84	99.99	11.50	217.24	7.19	0.00	29.09	7.41	0.00	46.49
1991	84	103.36	4.60	306.67	9.81	0.00	70.64	13.70	0.00	61.74
1995	74	129.81	0.00	399.68	12.54	0.00	31.17	16.43	0.00	58.11
1998	64	104.30	14.19	321.00	11.14	0.00	30.55	14.21	0.00	58.11
2004	97	109.95	23.00	237.75	15.77	0.00	41.46	17.93	0.00	111.30
2007	70	103.32	39.43	196.73	12.91	0.00	37.09	17.42	0.00	66.41
2012	90	118.97	24.03	402.67	14.52	0.00	104.74	21.44	0.00	116.21

Appendix Table 5.2. Comparative fertilizer use (in kg) per ha, WS, for irrigated and rainfed farms, Central Luzon Loop Survey, 1966-2012.

Ecosystem	Year	N			P			K		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Irrigated										
	1966	9.46	0.00	54.86	4.22	0.00	29.92	5.25	0.00	27.89
	1970	32.70	0.00	118.96	4.07	0.00	22.29	3.23	0.00	22.41
	1974	47.18	0.00	103.50	5.90	0.00	31.42	2.30	0.00	26.15
	1979	65.46	0.00	230.00	7.00	0.00	34.91	7.15	0.00	58.11
	1982	74.62	0.00	311.00	5.95	0.00	26.39	5.73	0.00	50.20
	1986	74.30	0.00	221.00	7.24	0.00	52.37	5.92	0.00	46.49
	1990	72.97	0.00	215.68	9.25	0.00	41.89	11.52	0.00	45.19
	1994	100.45	0.00	241.50	9.25	0.00	32.90	12.41	0.00	62.58
	1999	101.74	14.19	291.00	10.92	0.00	30.00	12.58	0.00	51.27
	2003	95.20	0.00	370.43	13.23	0.00	37.97	16.67	0.00	46.49
	2008	96.88	23.69	248.60	10.60	0.00	31.61	12.54	0.00	43.58
	2011	124.81	24.41	483.91	16.11	0.00	67.21	21.40	0.00	127.84
Rainfed										
	1966	8.27	0.00	66.24	2.65	0.00	11.70	3.52	0.00	19.92
	1970	22.93	0.00	60.30	3.47	0.00	30.75	2.23	0.00	15.75
	1974	26.43	0.00	63.00	6.82	0.00	23.57	3.66	0.00	28.02
	1979	44.39	0.00	161.43	4.02	0.00	21.46	4.97	0.00	33.90
	1982	45.78	0.00	184.00	5.39	0.00	44.96	3.08	0.00	35.22
	1986	59.38	4.40	138.00	4.01	0.00	19.75	2.08	0.00	17.43
	1990	65.97	0.00	322.28	6.14	0.00	23.50	7.10	0.00	44.70
	1994	79.82	0.00	258.40	9.56	0.00	36.37	11.34	0.00	46.49
	1999	107.50	11.67	396.25	10.46	0.00	42.11	10.75	0.00	29.29
	2003	76.66	3.50	178.75	11.10	0.00	49.10	14.63	0.00	58.46
	2008	78.19	2.10	165.00	7.49	0.00	35.44	8.23	0.00	24.40
	2011	82.18	0.00	202.20	10.94	0.00	43.64	12.58	0.00	43.58

Appendix Table 6.1. Trends in labor use for rice production (8-h person-days/ha), Central Luzon Loop Survey, 1966-2012.

Season	Land preparation		Crop establishment		Crop care		Harvest thresher	
	Family	Hired	Family	Hired	Family	Hired	Family	Hired
Wet								
1966	18.84	2.10	3.51	16.02	5.26	2.78	2.64	18.24
1970	12.50	2.17	4.50	16.58	9.75	0.77	5.23	16.57
1974	11.68	3.39	6.32	20.62	12.54	3.33	4.00	22.70
1979	11.71	3.66	5.85	21.88	7.58	1.99	3.46	25.46
1982	10.58	4.62	5.28	22.24	5.76	2.04	5.99	26.44
1986	10.00	5.81	4.22	22.20	4.50	1.53	4.07	18.44
1990	7.11	5.80	6.46	19.63	4.07	1.22	7.11	23.06
1994	5.82	5.98	2.85	21.57	4.60	1.13	5.78	23.70
1999	5.65	4.97	2.51	17.83	1.83	0.90	5.16	21.31
2003	3.30	6.50	1.93	20.12	2.39	2.17	3.43	21.03
2008	4.03	7.69	2.60	21.76	2.25	1.71	2.91	22.80
2011	5.78	7.62	3.52	23.89	2.48	1.87	3.95	21.40
Dry								
1967	12.90	1.84	5.77	20.25	10.01	0.19	1.40	17.51
1971	11.98	1.81	6.09	17.44	16.51	0.12	3.45	18.17
1975	14.12	2.28	5.20	32.65	14.66	3.82	1.57	23.83
1980	8.98	3.96	5.16	24.37	9.24	2.89	2.38	29.13
1987	9.74	4.11	5.03	13.40	4.83	1.30	4.54	23.92
1991	8.58	4.78	3.80	6.96	4.51	0.83	3.09	26.78
1995	6.85	7.05	2.35	10.79	4.36	2.06	5.13	29.28
1998	5.50	4.81	2.08	9.46	1.81	0.98	4.10	20.94
2004	2.62	7.96	1.73	8.97	2.77	2.20	2.11	23.59
2007	2.62	7.65	2.57	9.52	1.77	2.35	2.29	23.82
2012	3.09	7.40	2.51	15.87	2.07	1.57	2.98	21.76

Appendix Table 8a. Costs and returns of rice production, at 2012 constant price (PHP/hectare), Central Luzon Loop Survey, 1966-2012.

Wet season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue		71,580	69,685	60,534	67,000	63,617	59,051	71,276	61,115	44,028	52,415	60,821	53,519
	(S.D.)	31,171	30,159	32,000	36,660	28,851	20,821	32,183	26,752	21,219	17,042	17,377	18,056
	Gross rev. CV	0.44	0.43	0.53	0.55	0.45	0.35	0.45	0.44	0.48	0.33	0.29	0.34
Yield (kg/ha)		2,303	2,500	2,042	3,607	4,093	3,497	3,512	4,073	3,454	4,284	4,510	3,879
	(S.D.)	891	1,008	1,162	1,843	1,668	1,202	1,522	1,763	1,475	1,162	1,080	1,165
	Yield CV	0.39	0.40	0.57	0.51	0.41	0.34	0.43	0.43	0.43	0.27	0.24	0.30
Price (PHP/kg)		31.09	27.87	29.65	18.58	15.54	16.89	20.30	15.01	12.75	12.24	13.49	13.80
Material input costs													
	Fertilizer	1,636	3,375	6,314	5,699	5,787	4,117	5,038	4,890	4,354	5,208	13,347	9,630
	Insecticide	99	487	1,186	1,428	1,333	1,687	1,196	1,187	1,070	762	559	639
	Herbicide	25	49	409	575	541	594	554	791	609	594	532	664
	Other pesticide	3	0	0	0	0	0	93	83	0	236	486	245
	Seeds*	1,394	1,530	1,405	1,844	2,045	2,714	3,408	3,300	3,406	2,561	3,017	2,822
	Irrigation cost	1,969	1,689	1,870	2,378	2,057	1,664	1,858	1,424	1,050	1,323	1,391	927
	Others **	998	873	1,310	689	795	1,308	1,352	1,386	856	1,251	1,197	1,194
Labor costs													
	Harvester and thresher	5,056	6,336	6,655	8,752	7,116	6,089	8,364	6,842	5,535	6,401	7,023	5,927
	Hired	5,401	4,491	4,681	5,202	5,260	4,901	6,218	6,599	6,552	8,531	8,895	7,918
	Permanent	95	243	206	163	395	546	1,233	1,280	257	3,146	3,056	2,032
	Imputed family	5,612	6,587	5,859	6,405	5,745	3,843	5,485	4,713	267	2,676	2,819	3,509
Power costs													
	Machine rental												
	Paid out	2,167	2,617	2,399	2,771	4,138	3,552	5,040	3,423	3,356	3,676	5,427	4,371

Cont… Appendix Table 8a

Wet season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
	Paid out and Imputed	2,187	2,773	2,727	3,941	5,308	4,375	6,197	4,688	4,876	5,002	7,363	6,953
	Animal rental												
	Paid out	286	148	470	329	304	589	285	254	163	126	141	102
	Imputed	2,074	1,145	2,469	872	975	941	454	351	202	92	90	95
	Paid out and Imputed	2,360	1,293	2,939	1,201	1,279	1,530	739	605	365	218	231	197
	Fuel and oil	0	30	94	1,045	1,080	750	722	994	793	1,067	2,167	2,181
Land rent													
	Paid out	22,366	18,564	15,484	8,175	7,746	8,420	7,141	5,399	2,794	3,604	3,963	1,939
	Imputed	3,421	2,000	2,742	3,139	1,919	2,602	5,277	4,448	4,067	5,175	5,059	5,559
	Paid out and Imputed	25,788	20,565	18,226	11,314	9,666	11,022	12,418	9,847	6,861	8,779	9,021	7,497
Interest on capital	191	216	306	463	515	408	647	481	416	269	208	125	
Total paid-out costs	41,494	40,431	42,483	39,051	38,597	36,931	42,503	37,851	30,794	38,487	51,202	40,591	
	(S.D.)	17,912	17,348	14,974	16,166	14,724	14,540	19,329	15,941	11,664	13,226	15,239	14,304
	Paid-out CV	0.43	0.43	0.35	0.41	0.38	0.39	0.45	0.42	0.38	0.34	0.30	0.35
Total costs	52,812	50,536	54,188	51,099	48,922	45,548	55,523	49,110	37,267	48,025	61,314	52,460	
	(S.D.)	15,560	16,737	14,575	15,970	14,798	13,629	18,432	15,841	11,159	13,552	14,725	14,855
	Total cost CV	0.29	0.33	0.27	0.31	0.30	0.30	0.33	0.32	0.30	0.28	0.24	0.28
Net return over paid-out costs	30,086	29,253	18,051	27,949	25,020	22,120	28,773	23,265	13,234	13,928	9,620	12,928	
	(S.D.)	23,408	25,325	26,753	27,795	22,823	17,592	31,585	22,385	18,212	13,894	14,704	18,760
	Income CV	0.78	0.87	1.48	0.99	0.91	0.80	1.10	0.96	1.38	1.00	1.53	1.45
Net profit	18,768	19,148	6,347	15,900	14,695	13,503	15,752	12,005	6,761	4,390	(492)	1,059	
	(S.D.)	22,098	23,800	25,690	28,444	22,272	16,611	30,670	20,953	17,857	14,061	14,272	19,119
	Profit CV	1.18	1.24	4.05	1.79	1.52	1.23	1.95	1.75	2.64	3.20		18.05
Cost/kg of paddy		23	20	27	14	12	13	16	12	11	11	14	14
CPI		0.0138	0.0172	0.0360	0.0570	0.0820	0.1652	0.2488	0.3802	0.5331	0.6459	0.8499	0.9689

Cont... Appendix Table 8a

Dry season		1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Gross revenue		56,341	66,574	56,932	78,365	73,372	68,754	83,518	75,126	63,007	103,333	83,455
	(S.D.)	27,494	55,500	49,732	37,752	24,326	27,856	38,154	28,520	22,886	37,292	27,540
	Gross rev. CV	0.49	0.83	0.87	0.48	0.33	0.41	0.46	0.38	0.36	0.36	0.33
Yield (kg/ha)		1,789	2,481	1,973	4,390	4,227	4,393	4,819	4,588	4,798	5,224	5,760
	(S.D.)	846	1,828	1,747	1,910	1,365	1,748	2,141	1,717	1,569	1,401	1,719
	Yield CV	0.47	0.74	0.89	0.44	0.32	0.40	0.44	0.37	0.33	0.27	0.30
Price (PHP/kg)		32	27	29	18	17	16	17	16	13	20	14
Material input costs												
	Fertilizer											
	Insecticide	3,319	6,316	9,614	7,630	5,198	7,952	6,707	4,895	6,500	9,695	9,670
	Herbicide	270	873	1,006	1,606	1,872	1,048	754	948	749	629	525
	Other pesticide	42	33	279	663	866	1,000	913	808	816	822	603
	Seeds*	0	0	0	0	0	10	29	364	152	530	576
	Irrigation cost	1,524	1,499	1,768	2,141	3,410	3,774	3,613	3,742	2,696	3,380	3,230
	Others **	1,501	1,653	1,745	3,700	2,888	2,856	2,279	1,636	2,063	1,950	1,813
		1,023	669	1,624	570	973	995	1,387	906	1,053	920	1,204

*Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8a

Dry season		1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Labor costs												
	Harvester and thresher	7,834	6,367	4,646	10,024	8,206	9,674	10,070	9,626	8,279	11,103	10,012
	Hired	4,584	5,133	5,694	5,522	3,519	3,236	6,506	6,257	7,087	10,547	9,971
	Permanent	0	0	0	324	659	1,221	2,886	438	4,003	6,927	5,605
	Imputed family	5,033	11,455	5,255	5,815	3,840	3,943	4,792	4,002	2,180	2,680	2,481
Power costs												
	Machine rental											
	Paid out	2,395	4,004	5,884	3,640	4,764	3,779	4,199	3,975	3,950	7,614	5,141
	Imputed	0	0	2,475	1,955	1,660	1,706	1,928	2,130	1,593	2,815	3,201
	Paid out and Imputed	2,395	4,004	8,359	5,595	6,424	5,485	6,127	6,105	5,542	10,428	8,342
	Animal rental											
	Paid out	196	257	240	156	392	153	251	73	100	156	92
	Imputed	1,922	960	1,053	535	247	257	130	113	52	57	65
	Paid out and Imputed	2,118	1,217	1,293	690	639	410	381	186	152	214	157
	Fuel and oil	0	0	402	2,032	1,655	2,144	1,194	2,809	1,771	3,030	2,863
Land rent												
	Paid out	16,162	13,497	8,735	9,112	8,103	6,406	5,393	4,527	3,479	5,042	2,213
	Imputed	4,050	883	13,719	2,179	1,892	3,827	5,316	4,111	5,564	7,068	5,964
	Paid out and Imputed	20,212	14,381	22,455	11,291	9,995	10,233	10,710	8,638	9,044	12,109	8,177
Interest on capital		215	290	400	544	239	663	530	655	271	194	115
Total paid-out costs		38,848	40,300	41,636	47,119	42,506	44,248	46,180	41,006	42,699	62,344	53,518
	(S.D.)	13,843	18,847	18,440	16,836	11,514	16,229	20,767	16,567	12,718	21,694	17,260

Cont... Appendix Table 8a

Dry season		1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Total costs	50,069	53,890	64,538	58,147	50,385		54,643	58,877	52,017	52,359	75,158	65,345	
	(S.D.)	13,274	28,524	11,942	16,499		10,846	15,728	19,085	16,757	11,962	21,832	17,158
	Total cost CV	0.27	0.53	0.19	0.28		0.22	0.29	0.32	0.32	0.23	0.29	0.26
Net return over paid-out costs		17,493	26,274	15,296	31,245		30,866	24,506	37,339	34,120	20,308	40,990	29,937
	(S.D.)	26,347	43,597	47,100	30,853		22,198	20,096	32,474	21,301	18,612	29,970	17,251
	Income CV	1.51	1.66	3.08	0.99		0.72	0.82	0.87	0.62	0.92	0.73	0.58
Net profit		6,273	12,685	(7,606)	20,218		22,987	14,111	24,641	23,109	10,649	28,175	18,110
	(S.D.)	24,216	41,638	49,445	30,588		23,729	19,061	32,005	20,430	18,068	28,995	17,821
	Profit CV	3.86	3.28		1.51		1.03	1.35	1.30	0.88	1.70	1.03	0.98
Cost/kg of paddy		28	22	33	13		12	12	12	11	11	14	11
CPI		0.0145	0.0208	0.0377	0.0669		0.1735	0.2971	0.4057	0.5032	0.6778	0.7809	1.0000

Appendix Table 8b. Costs and returns of rice production, by ecosystem at nominal prices (PHP/hectare), Central Luzon Loop Survey, 1966-2012.

Irrigated Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue (yield ×price)	981.51	1,297.39	2,404.48	4,456.49	5,664.74	10,201.27	18,195.65	23,428.08	23,329.12	34,748.67	53,566.90	52,973.04
Yield (kg/ha)	2,277.69	2,665.99	2,248.68	4,170.33	4,440.97	3,633.48	3,662.05	4,096.73	3,467.94	4,351.42	4,663.33	3,844.90
Price (PHP/kg)	0.43	0.49	1.07	1.07	1.28	2.81	4.97	5.72	6.73	7.99	11.49	13.78
Material input costs												
Fertilizer	24.53	67.58	259.23	363.81	533.40	734.58	1,331.25	1,938.96	2,326.49	3,505.55	11,921.52	10,133.59
Insecticide	1.18	12.33	50.18	90.14	130.52	320.86	322.23	488.65	549.80	527.63	494.08	696.92
Herbicide	0.25	1.43	17.99	40.13	47.40	115.74	175.82	327.89	322.28	370.02	451.41	636.40
Other pesticide	0.06	0.00	0.00	0.00	0.00	0.00	32.84	41.83	0.00	186.74	499.10	231.58
Seeds*	18.38	25.97	49.87	114.00	183.35	480.48	897.24	1,304.78	1,899.69	1,693.23	2,498.02	2,895.16
Irrigation cost	27.17	29.11	67.35	135.47	168.75	274.82	462.42	541.52	559.83	854.81	1,182.36	898.43
Others **	12.80	17.37	44.73	38.65	61.01	224.81	334.77	543.84	454.25	810.14	957.43	1,150.63
Labor costs												
Harvester and thresher	67.09	122.19	272.26	610.44	652.29	1,044.72	2,246.87	2,597.11	3,132.84	4,297.03	6,305.16	6,031.62
Hired	74.21	78.86	181.63	323.53	452.28	873.07	1,579.55	2,553.29	3,455.07	5,527.49	7,968.89	8,399.50
Permanent	0.00	0.00	13.47	13.34	48.45	118.91	374.48	557.08	182.37	2,031.31	2,835.71	2,490.44
Imputed family	68.27	119.93	199.52	345.09	414.30	656.54	1,404.61	1,786.35	142.43	1,616.78	2,147.48	3,293.02
Power costs												
Machine rental												
Paid out	29.77	48.18	97.86	166.40	387.51	598.02	1,211.59	1,220.67	1,702.12	2,350.19	4,506.79	4,196.94
Imputed	0.46	2.31	21.43	89.27	123.07	177.01	356.94	587.49	946.84	923.10	1,934.25	2,600.39
Paid out and imputed	30.23	50.49	119.29	255.68	510.58	775.03	1,568.53	1,808.17	2,648.96	3,273.29	6,441.04	6,797.33
Animal rental												
Paid out	3.82	2.67	14.15	12.74	21.62	94.48	57.43	61.21	78.22	80.01	111.72	97.74
Imputed	28.75	22.39	74.29	40.07	62.81	138.87	117.00	94.50	74.55	53.48	72.98	66.88
Paid out and imputed	32.57	25.06	88.43	52.81	84.43	233.35	174.44	155.71	152.78	133.49	184.70	164.62

Cont... Appendix Table 8b

Irrigated Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Fuel and oil	0.00	0.00	5.57	67.98	111.63	164.64	226.62	470.44	528.51	778.19	2,089.98	2,475.00
Land rent												
Paid out	292.41	297.58	623.23	478.77	682.46	1,315.58	1,861.11	1,872.15	1,790.04	2,426.71	3,398.37	1,526.24
Imputed	49.45	29.08	99.46	177.35	145.65	403.87	1,331.33	1,732.05	1,907.52	3,318.88	4,437.32	5,755.00
Paid out and Imputed	341.86	326.66	722.70	656.12	828.10	1,719.44	3,192.44	3,604.20	3,697.56	5,745.59	7,835.69	7,281.24
Interest on capital	2.63	4.07	12.07	29.11	46.04	73.25	169.38	190.06	219.51	177.20	183.70	130.38
Total paid-out costs	551.69	703.27	1,697.51	2,455.42	3,480.69	6,360.72	11,114.22	14,519.40	16,981.51	25,439.06	45,220.54	41,860.20
Total costs	701.25	881.05	2,104.29	3,136.30	4,272.55	7,810.25	14,493.48	18,909.85	20,272.37	31,528.49	53,996.27	53,705.88
Net return over paid-out costs	429.82	594.12	706.97	2,001.07	2,184.05	3,840.55	7,081.43	8,908.68	6,347.61	9,309.61	8,346.36	11,112.84
Net profit	280.26	416.34	300.19	1,320.19	1,392.18	2,391.02	3,702.17	4,518.23	3,056.74	3,220.18	−429.37	−732.84
Cost/kg of paddy	0.31	0.33	0.94	0.75	0.96	2.15	3.96	4.62	5.85	7.25	11.58	13.97

Cont... Appendix Table 8b

Irrigated Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Gross revenue (yield × price)	818.08	1,383.59	2,145.54	5,246.34	12,727.52	20,423.60	33,881.45	37,804.53	42,705.50	80,692.50	83,454.65
Yield (kg/ha)	1,788.60	2,481.44	1,972.83	4,390.04	4,226.74	4,392.97	4,819.36	4,588.45	4,797.54	5,223.54	5,759.91
Price (PHP/kg)	0.46	0.56	1.09	1.20	3.01	4.65	7.03	8.24	8.90	15.45	14.49
Material input costs											
Fertilizer	48.19	131.26	362.29	510.80	901.61	2,362.05	2,720.71	2,463.00	4,405.83	7,570.69	9,670.00
Insecticide	3.91	18.14	37.91	107.51	324.73	311.26	305.76	477.23	507.41	491.11	524.90
Herbicide	0.61	0.68	10.52	44.40	150.24	297.07	370.46	406.82	553.25	641.53	602.63
Other pesticide	0.00	0.00	0.00	0.00	0.00	3.01	11.84	183.35	103.29	413.95	576.25
Seeds*	22.13	31.16	66.63	143.35	591.60	1,121.04	1,465.73	1,883.19	1,827.35	2,639.14	3,229.89
Irrigation cost	21.79	34.35	65.76	247.73	501.02	848.52	924.66	823.24	1,398.47	1,523.05	1,812.83
Others **	14.85	13.90	61.19	38.14	168.81	295.61	562.55	455.84	713.57	718.27	1.,204.44
Labor costs											
Harvester and thresher	113.75	132.31	175.07	671.06	1,423.49	2,873.66	4,085.02	4,844.10	5,,611.25	8,670.13	10,012.03
Hired	66.55	106.69	214.57	369.71	610.35	961.23	2,639.33	3,148.46	4,803.63	8,236.01	9,971.24
Permanent	0.00	0.00	0.00	21.67	114.40	362.72	1,170.63	220.66	2,713.40	5,409.50	5,604.96
Imputed family	73.08	238.07	198.03	389.27	666.18	1,171.14	1,944.20	2,013.96	1,477.50	2,093.18	2,480.98
Power costs											
Machine rental											
Paid out	34.77	83.21	221.74	243.69	826.38	1,122.67	1,703.33	2,000.48	2,676.97	5,945.56	5,141.28
Imputed	0.00	0.00	93.26	130.90	288.04	506.69	782.26	1,071.65	1,079.62	2,197.89	3,201.17
Paid out and imputed	34.77	83.21	315.00	374.59	1,114.42	1,629.36	2,485.59	3,072.13	3,756.59	8,143.45	8,342.45
Animal rental											
Paid out	2.85	5.34	9.03	10.42	68.04	45.36	101.89	36.61	68.00	122.16	91.90
Imputed	27.90	19.95	39.70	35.80	42.87	76.33	52.64	56.90	35.04	44.76	65.08

Cont... Appendix Table 8b

Irrigated Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Fuel and oil	0.00	0.00	15.16	136.01	287.07	636.88	484.29	1,413.69	1,200.30	2,365.73	2,862.52
Land rent											
Paid out	234.67	280.51	329.20	610.04	1,405.57	1,902.90	2,187.82	2,278.22	2,358.15	3,937.11	2,212.97
Imputed	58.81	18.36	517.03	145.88	328.22	1,136.84	2,156.77	2,068.76	3,771.50	5,519.13	5,964.29
Paid out and imputed	293.48	298.87	846.24	755.92	1,733.79	3,039.75	4,344.60	4,346.98	6,129.66	9,456.24	8,177.25
Interest on capital	3.12	6.04	15.06	36.42	41.49	196.98	215.15	329.69	183.51	151.60	115.23
Total paid-out costs	564.08	837.55	1,569.09	3,154.54	7,373.32	13,143.97	18,734.02	20,634.90	28,940.88	48,683.93	53,517.84
Total costs	727.00	1,119.97	2,432.17	3,892.80	8,740.12	16,231.95	23,885.05	26,175.87	35,488.06	58,690.49	65,344.59
Net return over paid-out costs	254.00	546.04	576.45	2,091.81	5,354.19	7,279.63	15,147.43	17,169.63	13,764.62	32,008.56	29,936.80
Net profit	91.08	263.63	−286.63	1,353.54	3,987.40	4,191.65	9,996.40	11,628.66	7,217.44	22,002.00	18,110.05
Cost/kg of paddy	0.41	0.45	1.23	0.89	2.07	3.69	4.96	5.70	7.40	11.24	11.34

Cont... Appendix Table 8b

Rainfed Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue (yield × price)	997.03	1,096.17	1,907.80	2,392.95	4,319.91	8,744.03	16,712.79	22,651.51	23,755.75	30,244.40	44,080.63	48,032.17
Yield (kg/ha)	2,340.07	2,315.17	1,789.06	2,316.58	3,391.89	3,183.25	3,190.90	3,998.66	3,424.94	4,000.09	3,880.34	3,988.44
Price (PHP/kg)	0.43	0.47	1.07	1.03	1.27	2.75	5.24	5.66	6.94	7.56	11.36	12.04
Material input costs												
Fertilizer	19.84	48.24	188.64	236.92	360.91	558.95	1,087.29	1,615.36	2,310.75	2,771.54	8,971.16	6,722.14
Insecticide	1.62	4.22	33.62	61.62	68.40	184.91	244.33	336.32	611.49	342.33	396.64	366.39
Herbicide	0.50	0.24	10.76	16.27	38.61	58.74	56.05	217.32	330.04	442.20	456.00	665.06
Other pesticide	0.00	0.00	0.00	0.00	0.00	0.00	2.31	0.00	0.00	7.87	60.68	257.13
Seeds*	20.42	26.81	51.54	85.03	137.43	376.47	742.46	1,100.52	1,648.52	1,491.04	2,833.00	2,212.89
Irrigation cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others **	15.23	12.46	50.18	40.70	73.71	195.86	340.32	475.24	459.81	797.82	1,262.84	1,175.39
Labor costs												
Harvester and thresher	73.81	94.74	199.97	242.66	445.89	916.03	1,725.70	2,613.13	2,586.91	3,454.24	4,591.30	4,803.92
Hired	75.01	75.77	152.76	234.11	389.38	663.61	1,478.22	2,372.81	3,569.41	5,440.84	5,881.98	5,307.24
Permanent	3.28	8.87	0.00	0.00	0.00	24.54	161.16	270.59	46.32	2,037.04	1,621.71	272.39
Imputed family	91.31	106.39	225.16	410.20	585.90	584.80	1,279.72	1,809.26	142.43	2,195.86	3,416.12	3,746.06
Power costs												
Machine rental												
Paid out	30.09	41.66	72.46	138.42	242.66	560.55	1,345.27	1,547.83	1,963.03	2,476.50	5,045.73	4,359.49
Imputed	0.00	3.14	0.00	14.79	41.41	41.99	139.83	155.98	538.59	578.71	460.96	2,179.84
Paid out and imputed	30.09	44.80	72.46	153.20	284.08	602.54	1,485.10	1,703.81	2,501.63	3,055.20	5,506.69	6,539.33
Animal rental												
Paid out	4.13	2.41	20.34	32.58	31.51	103.68	100.10	204.65	104.31	88.74	154.43	103.85

Cont...Appendix Table 8b

Rainfed Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Imputed	28.43	16.78	106.88	71.65	114.56	193.21	104.09	253.07	173.61	82.93	89.65	172.41
Paid out and imputed	32.57	19.19	127.22	104.23	146.06	296.88	204.19	457.73	277.92	171.67	244.08	276.26
Fuel and oil	0.00	1.05	0.74	40.60	44.02	33.30	78.71	95.57	211.15	317.60	825.64	938.14
Land rent												
Paid out	333.21	344.90	477.76	435.84	540.58	1,562.47	1,596.20	2,604.00	889.00	1,916.21	3,242.05	3,022.34
Imputed	43.81	40.50	97.96	182.26	181.12	488.87	1,274.07	1,565.71	2,689.46	3,441.95	3,734.42	4,186.20
Paid out and imputed	377.02	385.40	575.72	618.09	721.70	2,051.35	2,870.27	4,169.70	3,578.45	5,358.17	6,976.47	7,208.54
Interest on capital	2.35	3.11	8.75	19.02	32.53	49.09	130.85	148.96	206.42	147.36	137.82	83.87
Total paid-out costs	577.14	661.38	1,258.78	1,564.74	2,373.10	5,239.11	8,958.12	13,453.34	14,730.73	21,583.96	35,343.15	30,206.38
Total costs	743.04	831.29	1,697.52	2,262.66	3,328.62	6,597.06	11,886.69	17,386.32	18,481.24	28,030.78	43,182.12	40,574.75
Net return over paid-out costs	419.89	434.80	649.03	828.21	1,946.81	3,504.92	7,754.67	9,198.17	9,025.02	8,660.44	8,737.48	17,825.79
Net profit	253.99	264.88	210.28	130.30	991.29	2,146.97	4,826.10	5,265.19	5,274.51	2,213.63	898.51	7,457.42
Cost/kg of paddy	032	0.36	0.95	0.98	0.98	2.07	3.73	4.35	5.40	7.01	11.13	10.17

* Includes value of own and purchased seeds.

** Food, sacks, and other minor expenditures.

Appendix Table 8c. Costs and returns of rice production, by land ownership at nominal prices (PHP/hectare), Central Luzon Loop Survey, 1966-2012.

Owner Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue (yield × price)	1,215.92	1,453.73	2,764.92	4,134.09	5,642.79	9,733.68	17,424.10	23,368.17	23,903.51	33,680.14	53,756.45	55,889.41
Yield (kg/ha)	2,720.02	2,998.32	2,715.54	3,808.24	4,349.68	3,422.44	3,405.07	4,044.38	3,489.17	4,182.65	4,572.40	4,019.86
Price (PHP/kg)	0.45	0.48	1.02	1.09	1.30	2.84	5.12	5.78	6.85	8.05	11.76	13.90
Material input costs												
Fertilizer	19.06	96.35	314.27	306.22	520.12	686.17	1,293.37	1,921.13	2,601.75	3,601.94	11,894.02	9,240.39
Insecticide	1.58	16.28	26.07	100.41	114.78	253.03	308.25	494.54	521.59	415.30	456.70	543.18
Herbicide	0.00	0.92	24.18	43.33	54.18	105.08	143.37	325.60	325.99	385.72	482.16	656.92
Other pesticide	0.00	0.00	0.00	0.00	0.00	0.00	12.96	5.29	0.00	158.46	368.63	205.42
Seeds*	17.78	27.86	47.10	104.22	190.81	490.19	912.25	1,256.82	1,917.24	1,740.47	2,558.17	2,856.89
Irrigation cost	26.28	7.78	10.92	82.60	111.15	197.88	344.44	393.66	431.30	720.77	968.24	663.14
Others **	22.92	4.56	54.23	35.29	70.39	215.03	345.50	523.29	482.56	817.48	941.59	1,117.25
Labor costs												
Harvester and thresher	62.15	40.18	273.84	502.65	654.11	820.69	2,308.60	2,537.73	2,914.25	4,231.99	6,208.53	5,953.02
Hired	98.56	96.33	265.30	354.66	458.29	910.55	1,580.91	2,355.56	3,710.80	5,746.80	7,615.41	7,600.73
Permanent	4.18	10.27	10.83	11.08	50.18	159.70	370.74	647.68	190.47	2,329.31	2,630.63	2,051.35
Imputed family	82.02	59.29	125.67	291.33	386.11	580.09	1,383.97	1,950.82	142.43	1,842.00	2,612.54	3,679.53
Power costs												
Machine rental												
Paid out	48.21	39.58	83.26	204.18	338.70	562.21	1,139.04	1,276.27	1,784.00	2,205.23	4,604.02	4,047.27
Imputed	2.20	0.00	47.50	45.84	131.91	118.65	337.42	481.17	870.49	988.98	1,866.64	2,533.06
Paid out and imputed	50.41	39.58	130.76	250.02	470.60	680.86	1,476.46	1,757.44	2,654.49	3,194.21	6,470.66	6,580.33

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Owner Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Animal rental												
Paid out	15.61	16.60	52.88	23.27	18.43	109.03	52.53	98.73	70.78	71.97	101.77	87.60
Imputed	25.31	7.72	61.69	42.35	69.14	182.64	137.45	127.36	105.17	44.70	99.49	121.65
Paid out and imputed	40.92	24.32	114.56	65.62	87.56	291.66	189.97	226.09	175.94	116.67	201.25	209.25
Fuel and oil	0.00	0.00	1.06	51.59	131.83	129.88	206.44	400.06	378.27	835.55	1,947.99	2,354.24
Land rent												
Paid out	0.00	0.00	0.00	241.35	314.84	845.31	526.37	1,063.96	328.02	188.74	211.64	194.20
Imputed	253.93	283.53	587.78	374.92	436.24	814.79	2,191.35	2,404.48	3,314.26	4,811.05	7,197.24	6,548.00
Paid out and imputed	253.93	283.53	587.78	616.26	751.07	1,660.10	2,717.73	3,468.44	3,642.28	4,999.79	7,408.88	6,742.20
Interest on capital	3.20	4.85	14.62	28.32	46.06	70.86	150.03	181.69	349.51	180.64	178.00	119.99
Total paid-out costs	316.33	356.69	1,163.94	2,060.84	3,027.80	5,484.76	9,544.78	13,300.31	15,657.01	23,449.75	40,989.49	37,571.60
Total costs	682.98	712.08	2,001.19	2,843.60	4,097.25	7,251.79	13,745.00	18,445.83	20,438.87	31,317.12	52,943.40	50,573.84
Net return over paid-out costs	899.59	1,097.04	1,600.98	2,073.25	2,614.99	4,248.92	7,879.32	10,067.85	8,246.50	10,230.39	12,766.96	18,317.81
Net profit	532.94	741.65	763.73	1,290.48	1,545.54	2,481.89	3,679.11	4,922.33	3,464.64	2,363.02	813.05	5,315.57
Cost/kg of paddy	0.25	0.24	0.74	0.75	0.94	2.12	4.04	4.56	5.86	7.49	11.58	12.58

Cont... Appendix Table 8c

Owner Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Gross revenue (yield × price)			3,431.53	5,680.07	13,024.00	19,948.39	36,951.13	40,867.48	44,323.62	82,032.00	89,331.04
Yield (kg/ha)			3,145.57	4,868.00	4,345.56	4,415.80	5,274.30	4,904.67	4,959.05	5,156.79	6,082.85
Price (PHP/kg)			1.09	1.17	3.00	4.52	7.01	8.33	8.94	15.91	14.69
Material input costs											
Fertilizer			373.67	533.94	928.83	2,472.65	2,996.42	2,829.81	4,761.38	8,361.47	10,906.79
Insecticide			55.42	148.06	270.05	299.21	289.66	460.72	457.00	468.82	614.18
Herbicide			12.53	55.45	166.98	284.68	427.44	440.28	550.01	556.50	683.93
Other pesticide			0.00	0.00	0.00	0.00	24.35	214.50	87.17	466.99	577.91
Seeds*			54.17	167.13	620.92	1,031.02	1,639.07	2,040.46	1,950.86	2,946.09	3,370.05
Irrigation cost			147.27	267.59	523.40	724.44	712.18	952.44	1,392.01	1,621.46	1,844.16
Others **			41.48	38.12	184.40	286.26	546.79	469.88	672.22	723.82	1,264.79
Labor costs											
Harvester and thresher			156.40	672.00	1,321.48	2,650.09	4,280.29	4,511.01	5,831.15	8,950.88	10,805.99
Hired			170.88	424.35	544.67	1,036.79	2,006.18	3,486.17	5,007.22	7,031.85	10,937.86
Permanent			0.00	13.72	116.11	486.03	924.99	279.41	3,020.25	4,526.41	6,266.72
Imputed family			136.87	418.71	666.76	1,080.21	1,874.83	2,135.57	1,206.87	2,607.42	2,479.27
Power costs											
Machine rental											
Paid out			234.60	300.36	778.76	974.35	1,731.55	2,037.98	2,547.11	6,270.02	5,730.05
Imputed			175.15	114.04	299.39	519.14	794.67	1,170.62	1,265.47	1,831.13	2,993.03
Paid out and imputed			409.75	414.41	1,078.15	1,493.49	2,526.23	3,208.60	3,812.59	8,101.14	8,723.08
Animal rental											
Paid out			0.00	17.77	63.91	34.80	81.33	24.65	60.60	136.33	103.35
Imputed			0.00	34.81	44.07	75.46	66.17	58.44	23.52	50.67	61.72

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Owner Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Paid out and imputed			0.00	52.58	107.98	110.26	147.50	83.09	84.12	187.00	165.07
Fuel and oil			56.25	118.25	392.48	707.45	366.61	1,504.94	1,111.09	3,316.58	3,497.03
Land rent											
Paid out			0.00	251.34	793.16	729.42	736.14	468.32	220.33	618.73	241.40
Imputed			893.55	376.78	483.37	1,729.56	3,069.26	3,658.12	5,145.66	8,163.21	7,861.88
Paid out and imputed			893.55	628.12	1,276.54	2,458.97	3,805.39	4,126.44	5,365.99	8,781.94	8,103.28
Interest on capital			14.16	41.01	41.01	199.16	211.25	242.28	191.63	152.32	126.75
Total paid-out costs			1,302.67	3,008.09	6,705.15	11,717.19	16,763.01	19,720.56	27,668.42	45,995.94	56,844.21
Total costs			2,522.41	3,993.44	8,239.76	15,320.72	22,779.19	26,985.59	35,501.58	58,800.68	70,366.85
Net return over paid-out costs			2,128.87	2,671.99	6,318.84	8,231.20	20,188.12	21,146.92	16,655.20	36,036.05	32,486.83
Net profit			909.13	1,686.63	4,784.24	4,627.67	14,171.94	13,881.88	8,822.04	23,231.31	18,964.19
Cost/kg of paddy			0.80	0.82	1.90	3.47	4.32	5.50	7.16	11.40	11.57

Cont... Appendix Table 8c

Tenant Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Gross revenue (yield × price)	941.05	1,088.69	2,145.61	3,442.81	4,586.79	9,087.27	15,448.70	22,124.76	20,044.01	31,511.86	48,166.14	46,570.65
Yield (kg/ha)	2,229.88	2,302.82	2,004.00	3,495.24	3,754.31	3,237.05	3,103.85	3,963.72	2,823.10	4,054.28	4,281.43	3,582.36
Price (PHP/kg)	0.42	0.47	1.07	0.99	1.22	2.81	4.98	5.58	7.10	7.77	11.25	13.00
Material input costs												
Fertilizer	24.49	44.71	253.37	338.79	419.00	634.27	1,413.45	1,687.17	2,186.89	3,376.86	11,639.36	16,700.40
Insecticide	1.52	6.38	19.30	37.01	62.51	91.73	198.03	200.89	347.52	173.26	164.70	121.32
Herbicide	0.42	0.52	11.97	22.01	40.68	124.64	122.43	268.68	177.81	351.63	518.85	384.83
Other pesticide	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.00	444.76	569.70
Seeds*	18.92	24.08	50.75	116.08	140.73	382.27	766.05	1,060.15	1,805.24	1,555.62	3,235.31	3,043.58
Irrigation cost	12.75	15.41	56.71	115.67	93.78	129.21	239.12	356.14	119.69	700.43	1,811.38	877.27
Others **	10.96	14.32	56.00	45.26	54.40	224.15	365.01	360.84	228.06	694.15	1,018.06	1,654.25
Labor costs												
Harvester and thresher	69.47	101.50	265.90	506.86	458.01	1,096.86	1,213.89	1,813.02	2,189.29	2,819.20	4,763.07	5,083.65
Hired	71.21	79.54	160.56	320.29	495.44	715.67	1,614.16	1,721.79	2,810.04	5,656.18	7,878.04	11,846.26
Permanent	1.04	5.79	22.02	0.00	19.00	9.37	200.96	236.09	0.00	2,175.15	1,113.64	3,026.52
Imputed family	75.96	114.93	219.32	357.13	486.72	634.40	1,187.73	1,330.13	142.43	1,300.11	1,401.56	7,556.81
Power costs												
Machine rental												
Paid out	27.32	46.10	75.32	139.82	306.27	701.47	1,058.00	1,142.45	1,800.38	2,533.52	5,399.09	7,638.69
Imputed	0.00	1.28	6.25	92.14	71.30	59.29	140.89	451.20	652.97	702.30	1,113.98	521.74
Paid out and imputed	27.32	47.38	81.56	231.95	377.57	760.76	1,198.89	1,593.66	2,453.35	3,235.82	6,513.08	8,160.42

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Tenant Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
Animal rental												
Paid out	1.64	1.73	19.03	48.98	31.47	62.37	91.10	107.39	138.13	132.58	52.36	83.33
Imputed	29.26	19.01	86.90	48.73	76.44	159.28	134.45	306.26	136.57	99.56	31.45	0.00
Paid out and imputed	30.89	20.73	105.93	97.70	107.90	221.65	225.55	413.65	274.69	232.14	83.80	83.33
Fuel and oil	0.00	0.00	1.27	96.29	58.24	14.43	74.12	110.05	266.24	450.42	1,010.51	522.73
Land rent												
Paid out	370.00	405.57	809.33	420.52	1,145.95	2,554.98	4,908.52	4,746.48	4,713.40	8,599.56	10,687.22	8,151.34
Imputed	20.27	0.00	40.47	392.49	241.25	121.67	892.46	474.65	673.34	2,149.89	2,137.44	8,151.34
Paid out and imputed	390.27	405.57	849.80	813.01	1,387.21	2,676.64	5,800.98	5,221.13	5,386.74	10,749.45	12,824.67	16,302.68
Interest on capital	2.55	3.39	11.04	26.38	39.66	57.88	146.20	139.91	276.23	166.86	182.26	185.33
Total paid-out costs	609.80	745.65	1,801.53	2,207.58	3,325.48	6,741.41	12,264.83	13,811.14	16,782.68	29,295.56	49,736.34	59,703.86
Total costs	737.84	884.26	2,165.50	3,124.44	4,240.85	7,773.93	14,766.55	16,513.30	18,664.22	33,714.27	54,603.04	76,119.07
Net return over paid-out costs	331.25	343.04	344.08	1,235.24	1,261.31	2,345.86	3,183.88	8,313.62	3,261.33	2,216.30	−1,570.20	−13,133.21
Net profit	203.21	204.43	−19.89	318.37	345.94	1,313.34	682.15	5,611.46	1,379.79	−2,202.41	−6,436.90	−29,548.42
Cost/kg of paddy	0.33	0.38	1.08	0.89	1.13	2.40	4.76	4.17	6.61	8.32	12.75	21.25

Cont... Appendix Table 8c

Tenant Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Gross revenue (yield × price)	842.32	1,087.94	1,833.33	4,195.43	10,404.46	25,261.47	33,023.64	34,516.07	48,882.87	101,972.73	69,330.76
Yield (kg/ha)	1,831.97	2,030.82	1,833.33	3,138.72	3,485.58	5,564.20	4,740.24	4,060.71	5,136.55	5,665.15	5,299.17
Price (PHP/kg)	0.46	0.54	1.00	1.34	2.99	4.54	6.97	8.50	9.52	18.00	13.08
Material input costs											
Fertilizer	47.31	104.66	293.33	389.96	933.52	2,235.25	2,984.35	2,829.64	4,749.21	7,532.14	8,964.75
Insecticide	2.18	21.60	35.39	48.83	59.39	230.57	249.67	295.65	201.59	211.09	130.58
Herbicide	0.46	1.05	2.45	44.90	167.96	296.06	469.55	547.86	567.35	1,112.04	177.08
Other pesticide	0.00	0.00	0.00	0.00	0.00	34.56	0.00	0.00	0.00	45.45	156.25
Seeds*	18.90	29.33	51.67	131.60	645.65	1,382.00	1,552.50	1,964.29	2,065.04	2,406.57	3,831.25
Irrigation cost	24.75	51.28	144.00	354.00	358.65	278.42	624.59	1,289.29	2,946.47	1,373.48	1,600.00
Others **	12.96	19.49	71.33	53.29	104.18	214.00	641.16	695.71	793.23	2,003.70	1,018.97
Labor costs											
Harvester and thresher	114.56	84.31	275.00	456.59	1,356.37	3,304.66	4,991.36	3,773.57	5,800.59	6,643.21	5,941.71
Hired	67.10	126.55	159.42	391.53	616.28	564.73	683.45	2,723.57	3,328.65	17,848.12	9,603.22
Permanent	0.00	0.00	0.00	0.00	134.44	0.00	0.00	0.00	0.00	14,417.80	2,806.69
Imputed family	75.63	327.41	223.26	514.99	711.08	1,158.71	1,096.53	654.65	1,909.33	175.05	5,748.75
Power costs											
Machine rental											
Paid out	35.43	58.04	268.17	295.86	759.45	1,300.26	1,557.46	2,545.00	3,728.01	7,209.96	2,291.94
Imputed	0.00	0.00	0.00	36.48	387.42	540.76	1,182.19	541.25	489.56	1,646.15	4,526.10

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Tenant Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
Paid out and imputed	35.43	58.04	268.17	332.34	1,146.87	1,841.02	2,739.65	3,086.25	4,217.57	8,856.11	6,818.05
Animal rental											
Paid out	3.46	2.98	5.69	16.00	25.90	8.00	74.41	0.00	219.17	37.88	31.25
Imputed	27.38	27.46	50.83	35.58	28.57	128.66	0.00	0.00	58.81	0.00	190.17
Paid out and imputed	30.84	30.44	56.52	51.58	54.48	136.66	74.41	0.00	277.98	37.88	221.42
Fuel and oil	0.00	0.00	0.00	105.42	245.39	628.81	495.33	178.57	629.50	317.16	1,675.22
Land rent											
Paid out	261.83	325.73	0.00	1,425.15	2,179.42	7,479.67	13,829.61	12,783.93	11,609.87	6,000.00	1,500.00
Imputed	71.41	0.00	593.87	101.80	934.04	1,869.92	0.00	0.00	5,804.94	12,000.00	7,500.00
Paid out and imputed	333.24	325.73	593.87	1,526.95	3,113.46	9,349.58	13,829.61	12,783.93	17,414.81	18,000.00	9,000.00
Interest on capital	2.98	6.05	12.27	31.80	38.16	182.47	175.31	220.71	166.33	230.89	106.75
Total paid-out costs	588.95	825.02	1,306.45	3,713.14	7,586.60	17,956.98	28,153.44	29,627.08	36,638.70	67,158.62	39,728.91
Total costs	766.35	1,185.94	2,186.69	4,433.78	9,685.88	21,837.50	30,607.47	31,043.69	45,067.65	81,210.71	57,800.69
Net return over paid-out costs	253.37	262.92	526.88	482.28	2,817.86	7,304.48	4,870.20	4,888.99	12,244.18	34,814.11	29,601.85
Net profit	75.97	−98.00	−353.36	−238.36	718.59	3,423.97	2,416.17	3,472.38	3,815.22	20,762.02	11,530.07
Cost/kg of paddy	0.42	0.58	1.19	1.41	2.78	3.92	6.46	7.64	8.77	14.34	10.91

Cont... Appendix Table 8c

Leaseholder	Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
	Gross revenue (yield × price)	1,044.78	1,339.50	2,036.72	3,752.79	5,150.02	9,999.31	18,400.75	22,659.15	23,793.81	34,985.32	49,874.61	44,182.56
	Yield (kg/ha)	2,315.30	2,719.75	1,886.76	3,536.86	4,041.65	3,639.08	3,679.73	4,040.32	3,600.45	4,590.07	4,460.33	3,623.38
	Price (PHP/kg)	0.45	0.49	1.08	1.06	1.27	2.75	5.00	5.61	6.61	7.62	11.18	12.19
	Material input costs												
	Fertilizer	14.78	72.15	193.73	330.27	464.88	694.19	1,203.08	1,781.22	1,875.63	2,837.28	10,583.31	7,957.84
	Insecticide	0.18	9.94	48.35	68.08	107.11	316.33	284.61	415.48	608.61	528.51	459.74	681.61
	Herbicide	0.28	1.41	13.56	30.16	41.00	88.82	131.39	272.16	355.27	411.64	385.23	587.54
	Other pesticide	0.00	0.00	0.00	0.00	0.00	0.00	39.30	76.73	0.00	157.36	473.02	270.28
	Seeds*	22.57	29.97	51.46	103.10	162.55	446.43	797.66	1,311.79	1,659.90	1,l527.36	2,567.08	2,521.44
	Irrigation cost	27.80	17.04	34.93	95.16	116.43	215.12	299.71	436.40	324.05	639.20	767.74	738.54
	Others **	21.23	18.82	41.45	39.84	64.84	214.25	334.39	570.21	459.12	797.78	1,029.51	1,175.62
	Labor costs												
	Harvester and thresher	79.10	139.02	219.33	495.01	574.87	1,120.98	2,078.88	2,924.49	3,240.23	4,524.22	5,785.20	5,450.84
	Hired	70.15	69.18	147.57	264.00	410.16	774.03	1,514.37	2,911.05	3,294.74	4,534.11	7,309.19	7,205.47
	Permanent	0.00	0.00	0.00	10.44	27.21	67.50	299.76	394.17	74.51	1,100.64	2,522.61	1,599.26
	Imputed family	81.62	124.12	229.17	400.87	503.66	678.36	1,321.11	1,703.94	142.43	1,833.04	2,473.82	2,208.83
	Power costs												
	Machine rental												
	Paid out	26.85	44.70	92.20	140.18	345.05	572.10	1,426.66	1,349.71	1,846.94	2,666.56	4,700.87	4,175.17
	Imputed	0.00	5.80	5.15	70.85	85.19	162.82	257.53	472.71	701.01	648.68	1,272.53	2,772.49
	Paid out and imputed	26.85	50.49	97.35	211.03	430.23	734.93	1,684.19	1,822.42	2,547.95	3,315.24	5,973.40	6,947.66

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Leaseholder	Wet season	1966	1970	1974	1979	1982	1986	1990	1994	1999	2003	2008	2011
	Animal rental												
	Paid out	5.97	0.59	6.82	10.18	26.51	105.06	86.29	100.36	107.21	88.10	176.46	138.51
	Imputed	28.19	23.87	96.84	53.29	84.99	138.74	73.76	114.17	108.42	76.40	54.33	55.94
	Paid out and imputed	34.16	24.46	103.65	63.47	111.50	243.80	160.05	214.53	215.63	164.50	230.79	194.44
	Fuel and oil	0.00	1.52	4.94	55.36	75.73	151.76	178.91	397.99	544.30	517.71	1,434.33	1,081.50
	Land rent												
	Paid out	253.93	249.50	587.78	580.14	685.15	1,515.45	2,573.91	2,924.95	2,919.60	4,606.02	7,468.84	4,204.62
	Imputed	0.00	34.02	0.00	41.44	29.79	176.80	285.99	877.48	376.72	363.63	0.00	2,522.77
	Paid out and imputed	253.93	283.53	587.78	621.58	714.94	1,692.25	2,859.90	3,802.43	3,296.33	4,969.65	7,468.84	6,727.40
	Interest on capital	2.58	4.03	9.92	25.06	40.89	67.51	140.51	193.74	301.74	151.55	166.95	110.16
	Total paid-out costs	522.84	652.32	1,437.17	2,166.57	3,025.76	6,130.27	11,070.00	15,468.72	16,765.80	24,418.78	44,228.81	36,706.75
	Total costs	635.23	845.68	1,783.19	2,813.43	3,846.01	7,506.26	13,327.80	19,228.76	18,940.42	28,009.79	49,630.77	45,458.44
	Net return over paid-out costs	521.94	687.18	599.55	1,586.22	2,124.26	3,869.05	7,330.75	7,190.42	7,028.02	10,566.55	5,645.80	7,475.81
	Net profit	409.55	493.82	253.54	939.36	1,304.01	2,493.05	5,072.95	3,430.38	4,853.39	6,975.54	243.85	−1,275.88
	Cost/kg of paddy	0.27	0.31	0.95	0.80	0.95	2.06	3.62	4.76	5.26	6.10	11.13	12.55

Cont... Appendix Table 8c

Leaseholder	Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
	Gross revenue (yield × price)	708.99	1,658.45	1,927.11	5,288.22	13,235.56	20,206.48	31,097.43	34,391.79	37,435.29	73,137.65	75,810.04
	Yield (kg/ha)	1,586.22	2,875.73	1,734.38	4,501.58	4,382.02	4,219.83	4,356.40	4,242.16	4,332.10	5,009.43	5,311.65
	Price (PHP/kg)	0.45	0.58	1.11	1.17	3.02	4.79	7.14	8.11	8.64	14.60	14.27
	Material input costs											
	Fertilizer	52.31	154.55	375.58	528.42	851.97	2,197.90	2,245.46	1,991.40	3,556.74	6,305.70	7,l870.16
	Insecticide	12.01	15.12	42.01	101.80	300.89	305.77	349.96	483.91	569.31	443.75	468.62
	Herbicide	1.30	0.35	11.92	41.01	127.09	307.99	317.93	356.11	550.76	753.68	547.85
	Other pesticide	0.00	0.00	0.00	0.00	0.00	2.05	0.00	158.62	162.52	416.27	685.02
	Seeds*	37.21	32.76	72.96	138.66	576.28	1,165.20	1,268.22	1,686.44	1,472.64	2,303.24	3,012.37
	Irrigation cost	8.00	19.54	28.90	220.29	514.40	1,054.56	1,160.02	633.08	1,195.23	1,456.37	1,839.18
	Others **	23.67	9.00	63.39	35.07	169.04	297.44	565.93	421.66	728.15	589.90	1,185.95
	Labor costs											
	Harvester and thresher	109.93	174.32	156.32	714.26	1,516.75	2,996.73	4,026.67	5,325.03	4,923.11	7,885.78	9,458.45
	Hired	63.99	89.31	237.38	349.05	616.20	977.69	3,574.86	2,768.75	3,973.79	6,914.48	8,034.89
	Permanent	0.00	0.00	0.00	28.43	88.75	320.14	1,632.67	165.08	2,055.00	4,174.52	4,624.39
	Imputed family	61.19	159.91	206.32	355.04	654.65	1,309.83	2,106.63	1,963.38	2,052.07	2,034.97	2,120.27
	Power costs											
	Machine rental											
	Paid out	31.69	105.23	208.05	216.27	867.54	1,205.82	1,781.48	1,916.05	2,652.68	5,706.46	5,073.23
	Imputed	0.00	0.00	95.89	155.05	268.40	506.39	731.35	989.37	783.14	2,405.60	3,138.09
	Paid out and imputed	31.69	105.23	303.94	371.31	1,135.94	1,712.21	2,512.83	2,905.42	3,435.83	8,112.06	8,211.32

* Includes value of own and purchased seeds.
** Food, sacks, and other minor expenditures.

Cont... Appendix Table 8c

Leaseholder	Dry season	1967	1971	1975	1980	1987	1991	1995	1998	2004	2007	2012
	Animal rental											
	Paid out	0.00	7.40	11.89	7.10	78.27	60.61	115.75	53.74	54.95	92.75	89.79
	Imputed	30.35	13.38	46.29	36.14	44.84	74.90	38.60	59.11	50.00	50.39	51.74
	Paid out and imputed	30.35	20.78	58.17	43.25	123.11	135.50	154.35	112.84	104.95	143.13	141.53
	Fuel and oil	0.00	0.00	9.18	147.49	257.37	610.80	663.47	1,391.11	1,328.61	1,402.64	1,874.75
	Land rent											
	Paid out	107.91	240.95	481.14	551.46	1,551.50	1,956.41	2,904.24	3,725.55	4,864.99	7,645.85	5,652.71
	Imputed	0.00	34.42	412.41	86.16	105.78	504.88	1,188.10	286.58	561.34	1,592.88	2,543.72
	Paid out and imputed	107.91	275.37	893.55	637.62	1,657.28	2,461.29	4,092.34	4,012.13	5,426.33	9,238.73	8,196.43
	Interest on capital	3.81	6.02	16.06	35.82	39.89	193.40	221.71	191.72	156.51	131.36	97.47
	Total paid-out costs	448.03	848.51	1,689.55	2,931.80	7,258.69	12,848.31	19,943.20	19,685.43	26,759.87	44,688.75	48,542.59
	Total costs	543.37	1,062.24	2,475.70	3,747.50	8,629.62	16,048.51	24,893.05	24,566.69	31,691.54	52,306.58	58,368.63
	Net return over paid-out costs	260.96	809.93	237.56	2,356.43	5,976.87	7,358.16	11,154.23	14,706.36	10,675.42	28,448.91	27,267.44
	Net profit	165.62	596.21	−548.60	1,540.72	4,605.94	4,157.97	6,204.37	9,825.10	5,743.74	20,831.07	17,441.41
	Cost/kg of paddy	0.34	0.37	1.43	0.83	1.97	3.80	5.71	5.79	7.32	10.44	10.99

Appendix B

History of farm-level surveys: past and present

Long-term experimental trials have been conducted at a number of research stations around the world. At Rothamstead Experiment Station in England, seven of the experiments that started in the mid-19th century are still being conducted today. Long-term experiments in rice conducted twice a year for the wet season and dry season began in 1968 at the International Rice Research Institute. The value of such experiments is well recognized.

Long-term farm household and village-level surveys are less common. But they provide information on technological adoption and socioeconomic changes useful for both academics and policymakers. As such, they provide not only a window to the past but insights regarding the future direction of change.

One of the largest surveys of Philippine agriculture, *Farm Management, Land Use, and Tenancy in the Philippines* (Oppenfeld 1957), was conducted in the mid-1950s. The survey was undertaken by the Agricultural Economics Department of the University of the Philippines with support from the Agricultural Development Council and Cornell University.

A total of 3,807 farms were surveyed covering the seven regions of the Philippines. Half of the households were in Central Luzon and Laguna. As we began to plan our own survey in the mid-1960s, we thought that a subset of data from this earlier survey might provide the benchmark or starting point for our own work. But, sad to say, the rats had gotten into the records.

A number of village-level studies have been conducted. One of the earliest of these was at the International Center for the Semi-Arid Tropics (ICRISAT)(Binswanger, 1974).The authors note:

"In the end, the usefulness of a village-level study will have to be judged by how well it answers the questions asked, by how useful the answers are to the biological scientists in establishing their research priorities, and by the impact of the answers on general economic and social policy for the semi-arid tropics."

The same statement would hold true for agricultural surveys such as our *Loop Survey,* which is the subject of this manuscript.

The most comprehensive set of longitudinal village-level studies has been conducted in Bangladesh by Mahabub Hossain and associates (Hossain 2009). These studies were carried out in 62 villages. The focus was on the impact on changes in livelihoods and impact on poverty of (1) the Green Revolution, 1987; (2) rice research, 2000; (3) spatial mapping of poverty, 2004; and (4) the food crisis, 2008. The methodology and sampling procedures differed from study to study.

In 2009,the project *Village dynamics in South Asia (VDSA)* began. The format was similar to the earlier studies in Bangladesh and included 12 of the 62 original Bangladeshi villages plus 42 in India. The sampling procedure was similar to that of the earlier Bangladesh studies, with 40 households surveyed in each village based on wealth distribution. Since the focus of each year was different, the questionnaire was slightly modified.

Perhaps closer in terms of objectives to the *Loop Survey* is the three-decade chronology of a single village in Laguna Province by Hayami and Kikuchi 2000. However, this study was extremely intensive, detailed, and of course site-specific. A dozen households kept daily records of income and expenses. The study included all aspects of the household economy as affected in particular by changes in the rice economy and the eventual move away from an agrarian community.

Finally, we take note of the Rice-based Farm Household Survey (RBFHS) initiated in 1996-97 and conducted every five years by the Philippine Rice Research Institute and the Bureau of Agricultural Statistics. RBFHS surveys have a large sample size of more than 2,000 covering all major rice-growing regions of the Philippines with the objective of "monitoring and establishing trends in the rice-farming landscape of the country" (RBFHS Manual of operations, PhilRice, March 2012 survey round).

Appendix C

Summary of studies that used the Central Luzon Loop Survey data sets

1. **Kazushi Takahashi and K. Otsuka. 2009.** Human capital investment and poverty reduction over generations: A case from the Rural Philippines, 1979-2003. *A book chapter of Rural Poverty and Income Dynamics in Asia and Africa, edited by Otsuka, Estudillo, and Sawada, 2009.*

   Objectives: To identify the pathway out of poverty over generations in the rural Philippines based on long-term panel data spanning nearly a quarter of a century. It also examines the determinants of schooling, subsequent occupational choices, and current nonfarm earnings for the same individual.

   Major findings:
   - An initial increase in rice income earned by the parental generation, brought about by land reform and the Green Revolution, among other things improves the schooling of the children, which later allows them to obtain remunerative nonfarm jobs.
   - These suggest that increased agricultural income, improved human capital through schooling, and the development of nonfarm sectors are the keys to reducing poverty in the long run.
   - The recent development of the rural nonfarm sector offers employment opportunities for the less educated, which also contributes to poverty reduction.

2. **Kazushi Takahashi and K. Otsuka. 2009.** The increasing importance of nonfarm income and the changing use of labor and capital in rice farming: the case of Central Luzon, 1979-2003. *Agricultural Economics 40:231-242.*

   Objective: This study attempts to identify the effect of increasing nonfarm income on the use of tractors and threshers and on the employment of hired labor as a substitute for family labor.

   Major findings:
   - Although the increased nonfarm income positively affects the ownership of tractors, it has no significant impact on the use of agricultural machines due presumably to the development of efficient machine rental markets.
   - The increased nonfarm income leads to the increased use of hired labor, thereby releasing family labor to nonfarm jobs.

- A critical factor underlying the increasing nonfarm income is the recent improvement of the educational levels of the working members of the household.

3. **Jonna P. Estudillo and K. Otsuka. 2006.** Lessons from three decades of green revolution in the Philippines. *Developing Economies* 44(2):123-148.

   Objective: This paper aims to assess the changing contribution of successive generations of modern varieties (MVs) of rice to yield increases and stability and changes in total factor productivity (TFP) in different ecosystems in the Philippines.

   Major findings:
   - The yield increase in the irrigated ecosystem has been by far the highest due to the diffusion of pest- and disease-resistant MVs, which also contribute significantly to yield stability.
   - The MV contribution to the yield increase in the rainfed ecosystem has been significant but much less while the upland environment has experienced an upward but slow trend in yield.
   - The contribution of MVs-cum-irrigation to TFP growth is about 50% in Central Luzon.

4. **Maritess Tiongco. 2002**. Is the Green Revolution sustainable? Long-term productivity trends in a sample of Philippine Rice farms. *In: Sustainable agriculture, poverty and security: agenda by Asian economies. Edited by S.S. Acharya, S. Singh, and V. Sagau. p 112-119, ill. Ref. Jaipur, India*.

   Objective: To investigate long-term productivity by estimating production functions that incorporate time dummy variables and estimate changes in technical efficiency overtime.

   Major findings:
   - The trend in productivity since 1980 shows no distinct temporal pattern. There is a decline in the Central Luzon (CL) data, but the differences between year dummies are small in terms of magnitude and statistically insignificant. Thus, there is no evidence for a trend decline in productivity on these farms.
   - Productivity clearly did decline between 1982 and 1994 in Central Luzon and between 1984 and 1995 in Laguna; these declines were due only to transitory weather shocks and are not suggestive of any long-term trends that might indicate problems with the sustainability of the cropping system.

- Estimates of technical efficiency showed that the technical efficiency of Laguna farmers increased from 87% in 1974 to 93% in 1995 and that of Central Luzon farmers was 99.8% in 1974 and 95% in 1994.
- The estimates of technical efficiencies suggest that these farmers are fully exploiting available technology. This is not surprising given that many farmers have been using modern varieties for 25 years.

5. **Maritess Tiongco and D. Dawe. 2002**. Long-term evolution of productivity in a sample of Philippine rice farms: implications for sustainability and future research. *World Development* 30(5):891-898.
   Objective: To investigate the long-term productivity trends in a representative intensive rice cropping system using periodic farm-level survey data spanning more than 20 years in two rice bowls of the Philippines.
   Major indings:
   - An estimation of production functions shows substantial declines in productivity from the early 1980s to mid-1990s.
   - An examination of secondary data shows, however, that the survey years were unrepresentative of long-term trends and were influenced by exogenous yield shocks.
   - Correction for these effects removes the productivity decline, but shows that productivity has stagnated.

6. **Jonna P. Estudillo and K. Otsuka. 2001.** Has the Green Revolution ended? A review of long-term trends in MV adoption, rice yields and rice income in Central Luzon, 1966-99. *Japan Journal of Rural Economics.* 3:51-64.
   Objective: To assess the impacts of successive generations of modern varieties (MVs) of rice on rice yields and income from1966-67 to1998-99.
   Major indings:
   - Yields rose modestly following the release of the first generation of MVs (MV1), which are potentially higher yielding than traditional varieties (TVs) but are susceptible to pests and diseases. Rice income per season did not rise with the adoption of MV1.
   - A major yield boost was achieved following the diffusion of the second generation of MVs (MV2) due to their resistance to multiple pests and diseases. This has a significant effect on rice income.
   - Yield began to stagnate with the diffusion of the third generation of MVs (MV3) because MV3 are superior with respect to grain quality but not yield. Rice income remains more or less the same.

7. **Jonna P. Estudillo and K. Otsuka. 1999.** Green Revolution, human capital, and off-farm employment: changing sources of income among farm households in Central Luzon, 1966-1994. *Economic Development and Cultural Change p 497-523.*

   Objective: To explore the changing roles of land and human capital in determining the income of farm households over the past three decades encompassing the pre- and post-Green Revolution periods.

   Major findings:
   - There has been a structural shift of household income away from land toward labor. The adoption of MVs made modest contributions to such a shift by increasing the labor demand and decreasing the return to land relative to other factors of production.
   - The increase in labor demand was largely offset by the widespread adoption of labor-saving technologies.
   - The most important cause for the structural change was the recent development of an urban labor market and the improvement in the access to such a market by the farm household.
   - There is a large nonfarm income accrued to children endowed with human capital acquired from schooling.

8. **Jonna P. Estudillo, M. Fujimura, and M. Hossain. 1999**. New rice technology and comparative advantage in rice production in the Philippines. *The Journal of Development Studies* 35(5):162-184.

   Objectives: To assess the comparative advantage in rice production in the Philippines for the last three decades since 1966.

   Major findings:
   - The country gained sharp improvement in comparative advantage in rice production in 1979, when yield rose because of the diffusion of pest- and disease-resistant modern rice.
   - Beginning in 1986, the country appears to slowly lose its comparative advantage because of the decline in rice prices, stagnation in yield, and rising cost of domestic factors.
   - By 1990, the country had completely lost its comparative advantage in rice production.

9. **Keijiro Otsuka, F. Gascon, and S. Asano.1994.**Green Revolution and labour demand in rice farming: the case of Central Luzon, 1966-90. *The Journal of Development Studies 31(1):82-109.*

   Objective: To determine whether the adoption of MVs caused the subsequent adoption of labor-saving technologies and to what extent MVs and labor-saving technologies affected the labor demand.

Major findings:

- The labor use per hectare in rice farming in Central Luzon increased only modestly during the early Green Revolution period and it even declined in the 1980s, returning to the level of the pre-Green Revolution period.
- There is no evidence that MV adoption caused the subsequent adoption of labor-saving technology.
- The second-generation MVs did not bring about a greater use of labor in rice farming.

10. **Keijiro Otsuka, F. Gascon, and S. Asano. 1994.** Second-generation MVs and the evolution of the Green Revolution: the case of Central Luzon, 1966-90. *Agricultural Economics 10:283-295*.

Objective: This study attempts to identify the changing impacts of "first-generation" and "second-generation" MVs on productivity in rice farming by estimating the yield function while correcting selectivity bias arising from the choice of varieties.

Major findings:

- The yield advantage of first-generation MVs over traditional varieties was limited; the yield-increasing effect of second-generation MVs over the first-generation MVs was highly significant.
- The adoption of improved MVs significantly contributed to yield growth under irrigated conditions and during the dry season.
- The Green Revolution would not have been revolutionary without the development and diffusion of the second-generation MVs.

11. **Philip Dawson and C.H. Woodford. 1991**. A generalized measure of farm specific technical efficiency. *American Journal of Agricultural Economics p 1098-1104. November 1991.*

Objectives: To calculate a single measure of farm-specific technical efficiency over time for rice farms from the residuals of a stochastic frontier production function embodying a composed error term.

Major findings;

- Results showed a narrow range of efficiency between 84% and 95% across the 22 farms, so that there is limited scope for increasing output by resource reallocation.
- A comparison is made with measures of technical efficiency using traditional covariance analysis.
- It was concluded that this sample of Philippine rice farmers adopted

the new technology rapidly in 1970 and 1984 and all quickly adopted their farming practices at a similar rate.
- There are no technological laggards within the sample and significant yield gaps do not exist between the best and average practice farmers.

12. **Philip Dawson and J. Lingard. 1991.** Approaches to measuring technical efficiency on Philippine rice farms. *Journal of International Development 3(3):211-228*.

    Objective: To review the three approaches to measuring technical efficiency and present empirical results using various data sets on Philippine rice farms over the period 1970-84.

    Major findings:
    - A production function is estimated using covariance analysis for panel data; second, cross- section data are used to estimate a stochastic production frontier; third, a stochastic production frontier is again estimated using panel data.
    - Large ranges of efficiency from the first two methods and a much narrower range from the third are observed.
    - Efficiency measurement is sensitive to methodology, the data period, and the sample.

13. **Keijiro Otsuka and F. Gascon. 1990.** Two decades of Green Revolution in Central Luzon: a study of technology adoption and productivity changes. A paper presented at IRRI Research Seminar, 23 August 1990. IRRI, Los Baños, Laguna, Philippines.

    Objective: This paper attempts to identify the causes and the consequences of the Green Revolution represented by the adoption of modern varieties by using farm-level data collected by periodic surveys in Central Luzon during the last two decades.

    Major findings:
    - Second-generation varieties significantly contributed to the acceleration of yield growth by reducing yield variability and possibly increasing expected yield.
    - Contrary to popular belief, the adoption of MVs did not cause a subsequent adoption of labor-saving technologies.

14. **Piedad F. Moya and P.L. Pingali. 1989.** Can we close the yield gap between the “best” and “ordinary” farmers in Luzon? Paper presented at the Saturday Seminar, 4 March 1989. IRRI, Los Baños Laguna, Philippines.

Objectives: To compare the “best“ farmer yields relative to the rice technology potential and to document changes in production, technology, and profits on the “best” farms relative to “ordinary” farms for the period 1966-88.

Major findings:

- There is a minimal gap between the experiment station and the “best” farmer yields. If the current yield frontier does not shift outward, the long-term prospects are for stagnation and/or decline in “best” farmer yields.
- Although both groups have experienced increasing yield trends, they have maintained a fairly constant yield gap of around 1.5 t/ha in Laguna and 1 t/ha in Nueva Ecija.
- The best and ordinary farms showed similar adoption patterns for MVs and no significant difference in terms of fertilizer, pesticide, and labor use.
- Farmers with better knowledge have an edge in achieving incremental yield gains because of their more effective use of technology, especially more intensive technologies.
- Real returns on the best farms are stagnant despite a steady increase in yields. Given the stagnant yield frontier and stagnant best farmer yields, the prospects are for future declines in the real returns to rice production on the best farms.

15. **Philip Dawson and J. Lingard. 1989.** Measuring farm efficiency over time on Philippine rice farms. *Journal of Agricultural Economics 40(2):168-177*.

Objectives: To measure the farm-specific technical efficiencies of rice farms in Central Luzon, Philippines.

Major findings:

- Stochastic production functions are estimated from the Central Luzon Loop Surveys for 1970, 1974, 1979, and 1982. A measure of technical efficiency was estimated for each farm per year.
- Results show that technical inefficiency is the major reason for deviation from the frontier production function.
- All four samples show a large range of inefficiency, but in general efficiency has improved, particularly between 1979 and 1983.

16. **Robert W. Herdt. 1987.** A retrospective view of technological and other changes in Philippine rice farming, 1965-1982. *Economic Development and Cultural Change 35:329-349.*

Objective: To document some of the changes at the farm level and measure their impact on the rice production process by examining the changes in rice production technology, income, and distribution of rice income to participants in the production process. It used the Central Luzon Loop Survey data from 1966 to 1982.

Major findings:

- Production of rice per hectare increased 92% over the period; labor used per hectare increased about 18%; double cropping increased from 19% to 59%; there was no increase in the number of large farms; if anything, there was a slight decrease in farm size.
- Small farms lagged behind larger ones in fully adopting modern varieties, but eventually caught up.
- New technologies were adopted as individual components but not as a package of technology, and biological technologies were generally adopted more than mechanical ones.
- Farm operators and hired laborers have both retained some portion of the benefits of technical change, but consumers have reaped the bulk of the benefits through lower rice prices.

17. **Corazon T. Aragon, V. Cordova, and F. Gascon. 1985. Policy issues related to the introduction of mechanical technologies and the direct seeding technology in rice production.** *Philippine Journal of Crop Science 10 (Special Issue):197-206.*

Objectives: To examine the employment and distribution effects of the introduction of mechanical technologies and direct-seeding technology in rice production and recommend some policies designed to raise labor absorption in the rice sector.

Major findings:

- The use of tractors and threshers was made privately profitable in the Philippines through government policies such as subsidies for credits and overvaluation of the peso.
- In general, the mechanization of land preparation and threshing has no significant positive effects on timeliness of operations, yields, and cropping intensity.
- Micro-level studies reveal that the quality of irrigation rather than machinery use was the major factor that determined cropping intensity.
- Mechanization of land preparation and threshing also caused a less favorable income distribution. It resulted in a transfer of income from laborers to the owners of machinery.

18. **Laurean J. Unnevehr and A.M. Balisacan. 1983.** Changing comparative advantage in Philippine rice production. *Report to the Impact of Economic Policies on Agricultural Development Project, PIDs and PCARRD.*

Objective: This paper examines the Philippine comparative advantage in rice production and whether government policies encourage the rice sector to exploit its advantage.

Major findings:

- Rice production grew at 6% annually in the 1970s. This growth was due to yield increases from newer modern rice varieties and more fertilizer and increases in irrigated area.
- Irrigation is heavily subsidized. Domestic rice prices are slightly below the world price and most input prices are above world levels. The net effect of government policy is to provide slightly positive protection to irrigated farms (3.6%) and slightly negative protection to rainfed farms (−4.7%)
- Rice production in both rainfed and irrigated environments was socially profitable in 1979. Although yields are higher on irrigated farms, costs per unit of output are similar on rainfed farms, but in social terms these farms are competitive. Rising yields have increased the Philippine comparative advantage in rice.
- Although the Philippines has a comparative advantage in rice production, exports were unprofitable for the government marketing agency in 1977-79.

19. **J. Lingard, L. Castillo, and S. Jayasuriya. 1983.** Comparative efficiency of rice farms in Central Luzon, Philippines. *Journal of Agricultural Economics 34(2):163-173*.

Objective: To estimate a bias-free agricultural production function with a view to examining efficiency differences among small rice farmers.

Major findings:

- Simultaneous equation bias is avoided if we assume that farmers maximize expected profits; specification bias, which commonly occurs when a management input is omitted from such functions, is circumvented by introducing farm-specific dummy variables into a combined cross-sectional and time-series dataset.
- Applying this model to data for 32 Philippine rice farms between 1970 and 1979, rather small production elasticities are obtained for the conventional inputs and an efficiency ranking of the farms is presented.

- Second-stage analysis shows that differences in soil type, land tenure, education, and access to credit are important factors explaining these efficiency differences.

20. **Cristina C. David and R. Barker. 1982**. Labour demand in the Philippine sector. *In: Labor Absorption in Rice-based Agriculture: Case Studies from South-East Asia. Edited by W.Gooneratne, p119-157. Bangkok, Asian Employment Programme, ILO, 1982*.
    Objectives: To investigate the potential employment capacity of the Philippine rice sector on the basis of cross-country comparison of the experience of other Asian rice economies.
    Major findings:
    - Real potential exists for increasing the labor absorption capacity of the Philippine rice sector.
    - Micro-level data suggest that labor input per hectare indeed increased, especially in weeding after the introduction of the new seed-fertilizer technology in 1966.
    - Trends in real wages showed a major strengthening of labor demand in rice during this time after a long period of declining real wages.
    - Wage and rice price, farm size, and yield-increasing technologies such as irrigation, the adoption of modern varieties, fertilizer, and "gama" weeding significantly increase labor demand per hectare.

21. **Sisira K. Jayasuriya, A. Te, and R.W. Herdt. 1982.** Mechanization and cropping intensification: economic viability of power tillers in the Philippines. *Ag. Econ. Dept. Paper 82-10. Department of Agricultural Economics, IRRI. Los Baños, Laguna, Philippines.*
    Objectives: This paper seeks to evaluate some of the evidence and arguments that bear on the question of the consequences of mechanization. Specifically, the emphasis of this paper is to examine the theoretical arguments and empirical evidence of the effect of power tillers on rice production.
    Major findings:
    - Given the prevailing relative prices and cost structures in the Philippines, power tillers are unlikely to generate any significant output effects; however, they do have a significant effect on employment and income distribution. When there are no offsetting output gains, the net effect on employment is negative. This results in a transfer of income from laborers to owners of machinery.
    - On the other hand, there appears to be substantial economic potential for machines, which can enhance the productivity of scarce land and capital. Such machines can induce farmers to expand output, improve

resource efficiency, and exploit by-products and crop and animal residues.

22. **Violeta Cordova, A. Papag, S. Sardido, and L.D. Yambao. 1981.** Changes in practices of rice farmers in Central Luzon, 1966-1979. *Paper presented for the 12th Annual Scientific Meeting of the Crop Science Society of the Philippines, Bacnotan, La Union, 22-24 April 1981.*
Objectives: To examine the changes in farming practices of a sample of rice farmers in Central Luzon, Philippines, by comparing data collected in 1966 and 1979.
Major findings:
- The introduction of new rice technology coupled with improvements in irrigation facilities has led to dramatic changes in farming practices.
- Traditionally, farmers grew only one rice crop per year, but with the operation of Pantabangan Dam, 56% of the sample grew two rice crops.
- Use is increasing of modern varieties, fertilizers, herbicides, insecticides, tractors, and crop care labor.
- A big increase occurred in rice yields and net returns to cash inputs.

23. **Violeta Cordova, R.W. Herdt, F.B. Gascon, and L.D. Yambao. 1981.** Changes in rice production technology and their impact on rice farm earnings in Central Luzon, Philippines, 1966-79. *Department Paper No.81-19, Department of Agricultural Economics, IRRI. Los Baños, Laguna, Philippines.*

Objective: To review the evidence and what has happened and how farmers and farm workers have been affected by the changes in rice farming technology and institutions that have occurred over the past 15 years.

Major findings:
- Land tenure arrangements have changed, resulting in a substantial decrease in the proportion of share tenants. This was due to the implementation of the land reform program in 1972.
- Substantial government investment in irrigation has permitted the average farm area to increase its dry-season rice area.
- There was rapid adoption of new varieties and increased use of chemical fertilizers, insecticides, herbicides, tractors, and small threshers.
- Rice yields increased from 2.2 t/ha in 1966 to 3.4 t/ha in 1979. The income of farmers, after taking into account the increased production inputs and cropping intensity, increased by 39%.

- The prices of most goods in the economy have been increasing rapidly, more than rice prices—a benefit to rice consumers, which shows that major beneficiaries of the changes in rice farming in Central Luzon are the rice consumers in the Philippines.

24. **J. Lingard, L. Castillo, S. Jayasuriya, and L. Garcia 1981**. The comparative efficiency of rice farms in Central Luzon. *Agricultural Economics Department Paper No. 81-38. Agricultural Economics Department, IRRI, Los Baños, Laguna, Philippines*.

    Objectives: To specify and estimate a bias-free agricultural production function and to examine efficiency differences among rice farmers.

    Major findings:
    - Co-variance analysis applied to cross-section and time-series data enables estimation of a bias-free production function.
    - When differences in efficiency are allowed between farms, one tends to obtain lower estimated production elasticities, marginal products, and equi-proportionate returns to all factors.
    - Preliminary correlation analysis suggests that tenure differences could be important reasons for these different efficiencies.
    - The results indicate the importance of managerial efficiency and perhaps the potential for improvement of rice farming through extension efforts.

25. **Randolph Barker and V.G. Cordova. 1978**. Labor utilization in rice production: economic consequences of the new rice technology. *International Rice Research Institute, Los Baños, Laguna, Philippines.*

    Objectives: To identify the contribution of modern technology and other factors to the change in labor input.

    Major findings:
    - The level of input of family and hired labor in rice production is influenced by a number of factors that vary across region or through time in a given region.
    - The introduction of MVs has, in general, increased labor input per hectare but decreased labor input per ton of rice produced.
    - There appears to be a decline in labor input because of mechanization and strong pressure from landless laborers to increase the level of employment.
    - The spread of the gama system suggests that, although traditional patterns of dependency between landlords and tenants are breaking down under land reform, new patterns of dependency among tenants, farm operators, and hired landless laborers are developing.

26. **Violeta G. Cordova, A. Mandac, and F. Gascon. 1980.** Some considerations on energy costs of rice production in Central Luzon. *Paper presented at the PAEDA 26thannual convention, CLSU, Muñoz, Nueva Ecija, 6-8 June 1980.*

    Objective: To discuss the impacts of rising energy costs on rice producers in Central Luzon.

    Major findings:
    - Despite the increasing trend in fertilizer price ratio because of high energy costs, farmers are still using high amounts of fertilizer compared with previous years.
    - The factors that lead to the increase in fertilizer consumption are the adoption of new varieties that are highly responsive to fertilizer application, the increase in irrigated area, and the Masagana 99 program that incorporates fertilizer in a package of inputs.
    - Yield and net returns to fertilizer use in rice production continuously increased.

27. **R.W. Herdt. 1978.** Cost and returns for rice production. In: Economic consequences of new rice technology. *International Rice Research Institute, Los Baños, Laguna, Philippines.* P *63-80.*

    Objectives: This paper aims to determine the changes that have occurred in costs and returns of rice production since 1966 and to speculate on the possible causes of those changes.

    Major findings:
    - Two quite different pictures emerge from the two study areas, Laguna and Central Luzon/Laguna (CL/L), despite the superficial similarities. In both, modern varieties were rapidly adopted.
    - In Laguna, where yields increased substantially, real gross farm family income per hectare between 1966 and 1995 nearly doubled. The amount of hired labor increased and family labor decreased.
    - The poor CL/L yield performance resulted in low income in 1974, especially because the level of inputs had gone above the 1970 level. The poor yield was related to the occurrence of a typhoon during the harvest season. The use of an increased amount of family and hired labor lowered returns per day of contributed family labor.

28. **Chandra G. Ranade and R.W. Herdt. 1978**. Shares of farm earnings from rice production. In: Economic Consequences of New Rice Technology. *International Rice Research Institute, Los Baños, Laguna, Philippines. p 87-104.*

Objectives: To study the factors affecting income distribution at the farm level and examine the distribution of income originating in rice production by calculating the share of output received by various earners.

Major findings:

- The relative share of landlords declined due partly to land reforms and the decline was transferred to tenants, and the income distribution originating from rice production is less skewed than before.
- Even though the relative share of total labor declined and because hired labor increased, hired laborers became relatively better off.
- The share of output used for purchasing current inputs increased substantially between 1966 and 1974.
- The changes in shares were caused simultaneously by biological and mechanical innovations.

29. **Violeta G. Cordova and R. Barker. 1977**. The effect of modern technology on labor utilization in rice production. *Paper presented at the Saturday Seminar, 28 May 1977, IRRI, Los Baños, Laguna, Philippines*.

Objectives: The aims of the paper are (1) to construct a simple graphic model of the factors influencing labor use in the Philippines, (2) to compare labor use in major rice-growing areas in Asia, and lastly (3) to estimate the contribution of selected variables to the change in labor input following the introduction of modern varieties.

Major findings:

- The factors directly affecting hired and family labor input in rice production are yield-increasing technology, labor-saving technology, farm and family size, tenure status, institutional factors, and farm and nonfarm wages.
- The degree of variability in labor use and productivity in rice is shown for seven rice-farming areas in Asia, namely, Central Korea, Central Taiwan, Central Luzon, Central Thailand, Sri Lanka, Malaysia, and Java.
- The introduction of modern varieties has resulted in a higher labor input per hectare but there appears to be a decline in labor input because of mechanization and, on the other hand, strong pressure on the part of landless laborers to increase the level of employment. The result has been a substantial gain in hired labor use, but a tendency for family labor to decline.

30. Randolph Barker, W. Meyers, C. Crisostomo, and B. Duff. 1973. Employment and Technological Change in Philippine Agriculture. *In: International Labor Office. Mechanization and employment in agriculture: Case studies from four continents. U.N., Geneva, Switzerland.*

Objectives: To establish the direction and magnitude of trends in mechanization and employment; to identify the relationship between seed-fertilizer technology, mechanization, and employment; and to examine government policies that affect mechanization and the degree to which they encourage labor displacement without productivity gains.

Major findings:

- The initial steps toward mechanization of the rice sector, stimulated by government policies and the introduction of new rice technology, have not yet resulted in any major labor displacement.
- Reduced labor requirements for land preparation have been more than offset by increased labor requirements for weeding, harvesting, and threshing.
- Several policies adopted by the Philippine government, such as higher minimum wage and providing credit, have influenced relative factor prices and credit availability and, through these, the rate of mechanization.

31. Randolph Barker, 1972. Labor absorption in Philippine agriculture. *Paper prepared for the workshop on Manpower and Human Resources, Continuing Education Center, Los Baños, Laguna, 13-15 October 1972.*

Objectives: This paper aims to determine the relationship between growth in agricultural output, increases in agricultural work force, and labor productivity, what are the implications of the new rice technology for labor absorption, what is the impact of mechanization on production and employment, and, lastly, what measures can be taken to encourage agricultural employment without reducing labor productivity.

Major findings:

- The growth in output and in labor productivity has not been uniform, being more rapid in the postwar recovery period and in the late 1960s than in the intermediate years. Agricultural output grew at about 4% annually, while growth in agricultural employment was 2−3% and growth in labor productivity was 1−2%.
- The introduction of tractors for land preparation constitutes a major source of labor displacement; however, the growth in tractor use can be more adequately explained by shifts in government policy than by the introduction of new seed-fertilizer technology.

- The labor absorption capacity of agriculture is more closely related to production in the nonagricultural sectors than to production in the agricultural sector itself.

32. **W. Meyers and R. Guino. 1971**. Effect of new technology on farm employment and mechanization. *Saturday Seminar Paper, Agricultural Economics Department, IRRI, 4 December1971.*

    Objectives: This paper examines recent trends in mechanization and employment in the Philippine rice sector, with particular emphasis on (1) the effects of the new rice technology and mechanization on farm labor use and (2) the factors influencing the rate of mechanization.

    Major findings:

    - It was the adoption of high-yielding varieties that made labor more intensive and in effect pushed up the total and hired labor simultaneously. This also has an even greater effect on labor productivity, and therefore one would expect higher wages and income in the rice sector.
    - Survey data indicate a rapid rise in the use of tractors for land preparation in the more progressive rice-growing areas in the Philippines.
    - The combination of forces that were at work to encourage or discourage tractor purchases and tractor use in the rice sector is higher incomes generated by the use of HYVs and the government program to promote farm mechanization.

33. **D. Liao. 1968.** Studies on adoption of new rice varieties. Paper presented at the IRRI Saturday Seminar, 9 November 1968. IRRI, Los Baños, Laguna, Philippines.

    Objectives: To analyze the factors affecting the spread of new rice varieties and to determine the impact of adoption on productivity, marketable surplus, consumption, and income.

    Major findings:

    - The factors affecting the spread of new varieties are communication, physical factors such as irrigation, sociological factors (e.g., farmers' education), economic factors, expected yield and costs, and the relative advantage of new varieties over local varieties.
    - The economic impacts of the adoption of new varieties are that full and partial adopters obtain higher yields, a higher marketable surplus, higher rice consumption, and an increase in farm income.

Appendix D

The data

The Loop Survey data are available for use by researchers, scholars, academicians, and policymakers. The summary data are presented on a per hectare basis or per household depending upon the type of data available. These will be available only on the web and not in a printed copy. The original parcel-or household-level raw data will also be available on the web for public access (https://ricestat.irri.org/research/index/php).

The processed data consist of eight major files:

Appendix D1: Basic socioeconomic characteristics of the farm operator (farmer) such as age, sex, years in school, major occupation, and household size.

Appendix D2: Detailed farm characteristics, sample parcels. The farm household may have one or more parcels. The data in these tables up to Appendix C8 apply to separate parcels. These consist of data on area planted, tenure, type of ecosystem, and name and type of variety planted, presented by season and by year. Season is coded as 1= wet season and 2= dry season. Tenure as presented is explained in detail in the text.

Appendix D3: Yield and input use, sample parcels, Central Luzon Loop Survey, 1966-2012. These tables present data on yield (kg); fertilizer use (kg) in terms of nitrogen (N), phosphorus (P), and potassium (K); and herbicide, insecticide, and molluscicide in terms of kilograms of active ingredient per hectare by season and by year.

Appendix D4: Labor use in rice production (8-hourperson-days/ha) by major activities, sample parcels, Central Luzon Loop Survey, 1966-2012. This summarized labor inputs by major crop activities: land preparation, crop establishment, crop care, and harvesting and threshing and postharvest, classified by source of labor (hired family and exchange). Again, this is presented on a seasonal basis from 1966 to 2012.
Individual parcel data on costs are presented in three major tables:

Appendix D5: Material input costs consist of fertilizer, insecticide, herbicide, other pesticides (molluscicide, rodenticide), seeds, irrigation, and food and miscellaneous costs, which are usually purchased by farmers in cash or with credit.

Appendix D6: Labor costs are presented in this table under four categories: (1) family and exchange labor, imputed using the current mean wage rate for major activities;(2) harvester and thresher wages that are paid in kind but converted into cash value using the paddy price; (3) hired labor—hired workers paid in cash; and (4) permanent labor or porcientuhan, paid in kind (paddy) but converted by the value of their share in the harvest.

Appendix D7: Paid-out and imputed costs of animal power, machine rental, fuel and oil, and land rent costs are presented in this table.

Appendix D8: Distribution of sample parcels by season and by year. Please note that the household code assigned to one parcel is consistent throughout the years within each survey. Example farm number 104 refers to the same farmer or parcel every time it appears, and, if it does not appear, then it means that the farmer cultivating that particular parcel was not interviewed for reasons mentioned in the text.

A large number of individuals have been directly responsible or participated in the conduct of the Central Luzon Loop Survey over the years. Some names may have been omitted but, according to some remaining records and to our best knowledge, the following individuals participated.

Years	Persons responsible	Researchers/enumerators that conducted the interviews
1966-67	Randolph Barker, Stanley Johnson, Ben Hur Aguila	Violeta Cordova
1970-71	Randolph Barker, Violeta Cordova	Fe Gascon, Geronimo Dozina Jr.
1974-75	Randolph Barker, Robert W. Herdt, Chandra Ranade	Ricardo Guino, Bonifacio Cayabyab
1979-80	Robert W. Herdt, Ricardo Guino, Violeta Cordova	F. Gascon, Dolor Palis, Sylvia Sardido, Perla Pantoja, Aida Papag
1982	Robert W. Herdt, Fe Gascon	Dolor Palis, Sylvia Sardido, Perla Pantoja, Leonida. Yambao
1986-87	Keijiro Otsuka, Fe Gascon	Dolor Palis, Luisa Bambo, Esther Marciano
1990-91	Cristina David,Fe Gascon	Joel Reaño, Alvaro Calara, Luisa Bambo, Milagros Obusan
1994-95	Mahabub Hossain, Fe Gascon	Esther Marciano, Joel Reaño
1998-99	Mahabub Hossain, Fe Gascon	Joel Reaño, Teodora Malabanan, Aida Papag, Nancy Palma
2003-04	David Dawe, Kazushi Takahashi, Fe Gascon	Maria Shiela Valencia, Milagros Obusan, Violeta Cordova, Mary Rose San Valentin
2007-08	Kei Kajisa, Pie Moya	Fe Gascon, Mary Rose San Valentin
2011-12	Sam Mohanty, Pie Moya	Joel Reaño, Mary Rose San Valentin, Teodora Malabanan