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THE IMPACT OF HIGH YIELDING VARIETIES ON SMALL-HOLDER RICE FARMING IN EAST INDONESIA

by

© I WAYAN TJATERA

A THESIS

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled, "The Impact of High Yielding Varieties on Small-Holder Rice Farming in East Indonesia," submitted by I Wayan Tjatera in partial fulfilment of the requirements for the degree of Master of Science.

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DEDICATED

to

MY WIFE RAI

MY DAUGHTER LUH GEDE

AND

MY LATE SON PUTU

ABSTRACT

The present study presents empirical evidence on the impact of High Yielding Varieties (HYV's) on small-holder rice farming in Eastern Indonesia. The study is based on cross-sectional data of 567 paddy farmers gathered by the author in the summers of 1978 and 1979. The data are for wet-seasons 1977-78 and 1978-79, and were gathered in 30 villages throughout the rice producing areas in the provinces of Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur.

The analysis was conducted at three levels (i.e., regional, provincial and temporal). Attempts were made to examine factor use, resource use efficiency, and returns to scale in each level.

Based on *a priori* knowledge and the theory of production, land, human labor, bullock labor, fertilizer, other current inputs and capital flow are variables included in the equation. The results of the least square estimates based on the Cobb-Douglas production functions indicates that land, fertilizer, and other current inputs are statistically significant in almost every regression. High Yielding Varieties (HYV's) rely more heavily on modern inputs and land than Non-High Yielding Varieties (NHYV's), but use less labor per unit of output.

NHYV's and HYV's respond differently to the respective inputs, and the nature of the response also varies among Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur. There are significant differences in the role of land, labor, and capital when using NHYV's versus HYV's; and this also varies by region in East Indonesia. This is indicated by the differences between parameter estimates, as well as by differences in the intercept term.

The results also indicate that the HYV's coefficients are significantly higher than the NHYV's coefficients. From this result it is concluded that non-neutral technological change is in progress. With the shift from NHYV's to HYV's, there is a shift toward more capital intensive technology, encouraging the use of fertilizers, land and other current inputs relative to the use of labor.

The analysis of resource-use efficiency indicates a significant number of resource-use inefficiencies in rice production in East Indonesia. This implies that a reallocation of resources, such as a shift from NHYV's to HYV's, application of fertilizer, other current inputs, and uses of marginal land could have a significant impact on rice production.

The analysis of farm scale indicates constant returns to scale for rice production in Eastern Indonesia with one exception on HYV's in Bali. Apparent inconsistencies in Bali parameter estimates indicate that more study of production relationships on Bali is desirable.

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CHAPTER I

INTRODUCTION

Problem Definition

Since rice is the stable food for most of the Indonesian people, rice self-sufficiency has long been a national goal. Yet, during 1968-1978, rice imports still averaged about 1.1 million tons of milled rice per annum, equivalent to about 4.5 percent of average annual rice production during that period.[1] With continued population growth and limited arable land, self-sufficiency in rice is still not within Indonesia's grasp.[2] This situation exists despite the "green revolution" and a series of relatively successful programs to adopt the new HYV's to Indonesian conditions.[3]

---

[1] Calculated from Table 2.6 of Chapter II, and from Dibyo Probowo and A.J. Nyberg, "Irrigation and Rice Production in 1990: The Case of Indonesia, "Paper prepared for the XVII International Conference of Agricultural Economists, (Banff, Alberta, Canada: September 3-12, 1979), Table A.3.

[2] Similar doubt has been pointed out by: L.A. Mears, "Indonesia's Food Problem, Pelita II/III," Economics and Finance in Indonesia, Volume 24(2), (June 1976), p. 102.

[3] The "green revolution" is the rapid growth in Third World grain output associated with the introduction of a new package of tropical agricultural inputs. See H.M. Cleaver, Jr., "The Contradictions of the Green Revolution," American Economic Review, Volume 62(2), (1972), p. 177.

The arrival of the HYV's of rice was the starting point in this "revolution."[1] Indonesia quickly developed a farm-credit-extension-input supply "package" to exploit this seemingly unique opportunity to eliminate persistent rice shortages and to improve the socio-economic well-being of small farmers throughout Indonesia.

Initiated in 1968, this intensification program, the so-called Bimas Program (Bimbingan Massal--Mass Guidance), is basically a combination of extension and credit to encourage farmers to use a recommended package of rice technology. The input "package" included improved varieties of seeds, fertilizer, insecticides, weedicides, pesticides, improved irrigation facilities and better cultivation methods. By 1970-71, HYV's of rice covered 10 percent of the total rice area in the country.[2] By 1977-78, the Bimas Program covered 70 percent of the farms in all of Indonesia, and perhaps 45 percent of all farms in East Indonesia.

The overall impact is considerable. Yet it is readily apparent that this crop intensification program has had its limitations, basically because the prevailing policy has been formulated without fully understanding what the introduction of HYV's means to farmers operating under very different social, economic and environmental conditions throughout Indonesia. As Weisbat and Sandoval point

[1]High Yielding Varieties (HYV's) of rice, such as IR_5, IR_8, IR_{26}, etc., were first developed at the International Rice Research Institute (IRRI). IRRI was established in the Philippines in 1962. See H.M. Cleaver, op.cit., p. 178.

[2]Department of Information, Republic of Indonesia, Address of State on August 16, 1972 (Jakarta: 1972), pp. 208-209.

out:[1]

> ...Any program, therefore, that aim at reaching at least the self-sufficiency level of staples must be able to identify the sources of output growth. It must be able to delineate the problems which could become the bottlenecks in the attainment of the program objectives. This need for defining the problems of rice production has to be recognized before any policy be formulated.

In essence, the new rice technology has a number of economic implications for Indonesian farmers which have not been readily apparent under experimental conditions, as illustrated in Figure 1.1. Most of these same factors also constrain the rate of growth in aggregate production. In this context, the potential benefits of the HYV "package" are obviously very different for different farmers in different parts of the country. For example, to what extent can subsistence farmers be reached? Or, to what extent can farmers in rain-fed areas actually exploit this new technology?

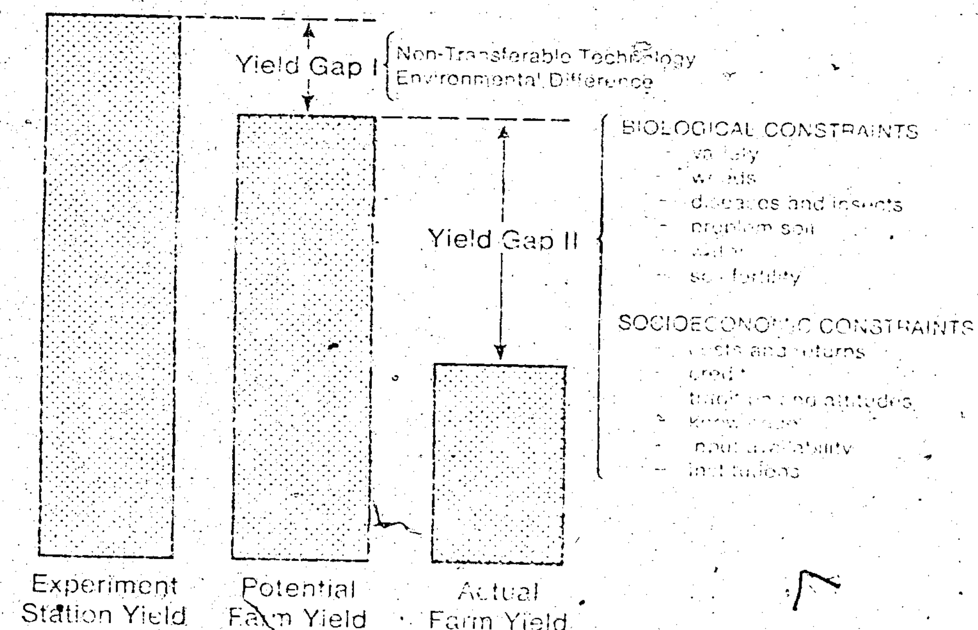
In short, the general problem of how to increase rice production in Indonesia should be re-examined by looking at location-specific input-output relationships and determining how efficiently Indonesian farmers are presently using their existing resources. Each farm is an elementary production unit where land, labor, capital and management are combined and utilized

---

[1] A.M. Wiesbat and P.R. Sandoval, "Rice Production, Institutional Factors and Economic Incentives," Paper presented at a Conference at the IRRI (Manila: December 8-9, 1967), p. 9.1.

[2] Sudir Sen, Reaping the Green Revolution (New Delhi: Tata McGraw-Hill Publishing Co., 1975), pp. 3-5.

Figure 1.1 Constraints to Technological Adaptation and Farm Production.[1]



[1]K.A. Gomez, "On Farm Assessment of Yield Constraints : Methodological Problem," in the International Rice Research Institute, Constraints to High Yields on Asian Rice Farms : An Interim Report. (Manila, 1978) : 2.

by the operator to produce crops and to raise livestock. Yet, so far, little effort has been made to do a comparative analysis of input-output relationships for rice production throughout Indonesia. For example, is the new rice technology biased towards labor-intensive or capital-intensive production?

An understanding of resource use efficiency is also important before recommending adjustments to optimize the use of existing factors of production.[1] In short, the relatively slow growth of rice production, even with the introduction of HYV's, suggests that there is a need to examine in more detail the real impact of the new technology introduced during the past decade. Ultimately, it is hoped that the results of this analysis would be useful as a basis for policy formulation in the on-going effort to further improve the socio-economic well-being of rural people and to further narrow the persistent supply-demand gap for rice throughout Indonesia.

Objectives of the Study

Consistent with the above, the major objectives of this study are as follows:

1. To describe and analyse the pertinent interrelationships which exist between rice production (output) and the various factors of production (inputs) for both Non-High

---

[1] S.S. Sidhu, "Economics of Technological Change in Wheat Production in the Indian Punjab," American Journal of Agricultural Economics, Volume 56(2), (May 1974), p. 217.

Yielding Varieties (NHYV) and High Yielding Varieties (HYV).

2. To analyse the nature of the shift in the production function from Non-High Yielding Varieties (NHYV) to High Yielding Varieties (HYV).

3. To investigate resource use efficiency at the farm level for both Non-High Yielding Varieties (NHYV) and High Yielding Varieties (HYV).

4. To investigate the return to scale in rice farming with both Non-High Yielding Varieties (NHYV) and High Yielding Varieties (HYV).

The area under investigation is Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT), the three provinces which lie directly east of the principle rice-producing island of Java.

Hypotheses

Salter[1] points out that a good hypothesis is constructed out of the suggestions and ideas by which the problem has been tentatively formulated. In this study, the hypotheses which will be tested are:

1. That there are statistically and economically significant differences in the fundamental roles of land, labor, fertilizer, other current inputs, and capital when using Non-High Yielding Varieties (NHYV) versus High Yielding

---

[1] L.A. Salter, Jr., A Critical Review of Research in Land Economics (Madison: The University of Wisconsin Press, 1967), p. 57.

8

Varieties (HYV) in East Indonesia, and that these also vary within the region.

2. That the technological change is a non-neutral type and is biased toward modern input usage and less labor-intensive production techniques.

3. That there are existing resource use inefficiencies in both High Yielding Varieties (HYV) and Non-High Yielding Varieties (NHYV).

4. That rice farms in East Indonesia exhibit constant returns to scale irrespective of the technology employed.

Scope and Organization of the Study

Scope

The study covers three provinces in Eastern Indonesia, namely Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT). These specific provinces have been selected because very little farm research has been conducted in this area even though the social, economic, and environmental conditions are very different from other parts of Indonesia.

Organization

The study is divided into five chapters. Chapter II identifies recent major developments in the agricultural sector throughout the country. This chapter also outlines government rice policy and provides a description of corresponding changes in rice production over time. Chapter III outlines the methodology employed in this study and identifies the various factors which determine productivity at the farm level. This is complemented by a discussion of the economic theory which underlies production function analyses and a summary of sample farmer characteristics. Chapter IV then presents the results of the analyses followed by a summary, conclusions, and some policy implications (Chapter V). Chapter V also includes future research priorities.

CHAPTER II

RICE AND RECENT DEVELOPMENTS IN AGRICULTURE

Introduction

Agriculture is by far the most important sector in Indonesia's economy. Rice is the basic staple of most Indonesians, although corn, cassava, soybeans, and peanuts are important supplementary foodstuffs. Of the total population of 135 million, approximately 63 percent are members of families engaged directly in the agricultural sector.

This chapter gives a general outline of the performance of the agricultural sector in Indonesia. The chapter briefly discusses the role of export commodities in Indonesia's economic growth and then outlines current government policy in the agricultural sector.

Agriculture in Indonesia's Economy

As in many other developing countries, the agricultural sector in Indonesia contributes the highest percentage to the Gross Domestic Product (GDP). But from 1971 to 1975, the contribution of the agricultural sector to the GDP dropped from 44.8 percent to 33.2 percent, while mining (including petroleum) increased from 8 percent to 20.4 percent. This clearly reflects the rapid growth in the relative importance of petroleum *vis-a-vis* agriculture. At the same time, most other sectors remained relatively stable (see Table 2.1).

In international trade policy, the country's principle concern is diversification through the encouragement of non-traditional exports such as handicrafts and industrial goods. Efforts have also been made to establish new foreign markets and improve product quality.[1] However, most exports are still primary products--agricultural commodities and minerals, including petroleum.

As a result of this dependence on primary products, Indonesia has periodically experienced balance of trade deficits and unstable export revenues. Fluctuating international prices are one of the major reasons for fluctuations in export earnings. During the past decade, Indonesia also faced an increasing demand for food imports, especially rice.

Figure 2.1 shows price indexes for exports and imports during the period 1965 to 1974 (1968 = 100). These figures suggest that during the pre-1972 period, manufactured goods' prices from industrialized countries tended to rise faster than Indonesian export prices. After 1972, however, the reverse occurred--export prices tended to increase faster than import prices.

---

[1]Department of Information, Government of Indonesia, Presidential Address, August 16, 1972 (Jakarta: 1972), pp. 160-161.

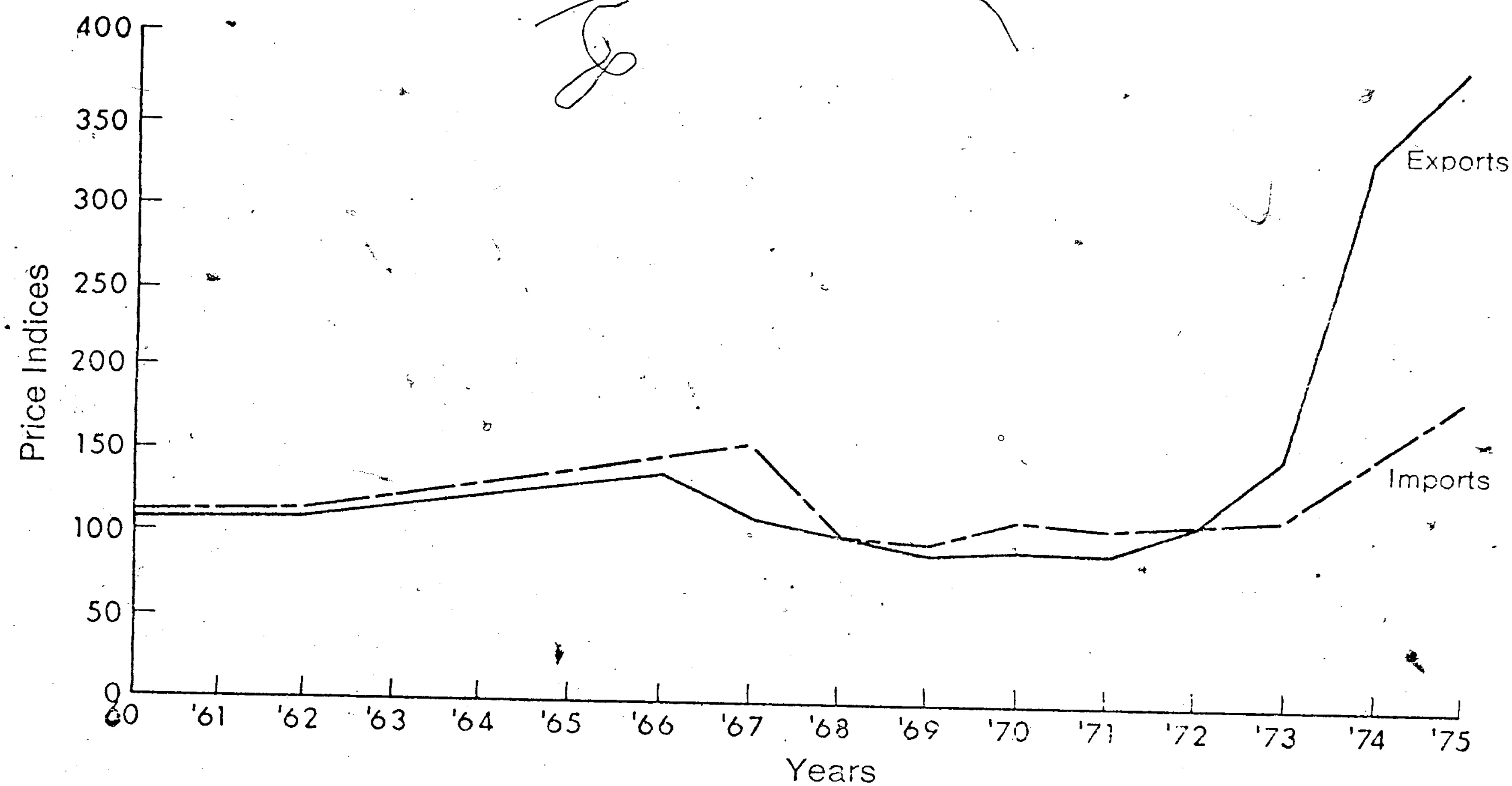
Table 2.1

Distribution of Gross Domestic Product at Current Market Prices, 1971 - 1975 (In Percentage)

	1971	1972	1973	1974	1975
Gross Domestic Product by Industrial Origin					
1. Agriculture	44.8	40.3	40.1	32.5	33.2
2. Mining	8.0	10.8	12.3	22.0	20.4
3. Manufacturing	8.4	9.8	9.6	8.3	8.8
4. Electricity, Gas & Water	0.5	0.4	0.5	0.5	0.5
5. Construction	3.5	3.8	3.9	3.8	4.5
6. Transport & Communication	4.4	4.0	3.8	4.1	4.3
7. Trade and Other Financial Institution Services	30.4	30.9	29.8	28.8	28.3
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0
Gross Domestic Product by Type of Expenditure					
1. Private Consumption Expenditure	77.1	74.5	70.9	65.1	66.0
2. General Government Consumption Expenditure	9.3	9.1	10.6	10.6	12.6
3. Gross Domestic Capital for Nation	15.8	18.8	17.9	16.7	20.3
4. Net Export	-2.2	-2.4	+0.6	+7.6	+1.1
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0

Source: Government of Indonesia, Statistical Year Book, 1975, Table XIX.5 (Jakarta: 1976), p. 1146.

Figure 2.1 Indonesia's Price Indices of Exports and Imports 1965-1974 (1968 = 100)



Source : Central Bureau of Statistics, Statistical Yearbook of Indonesia, Various Years, Jakarta.

At the same time, the total value of exports declined between 1965 and 1967 from U.S. $707.7 million to U.S. $665.4 million and then trended upward, increasing from U.S. $730.7 million in 1968 to U.S. $7,102.5 million in 1975.[1] This is generally attributed to the increasing export value of crude oil and timber. Without crude oil exports, Indonesia's trade balance would be increasingly negative (see Appendix A.2.1). Moreover, international price fluctuations and yearly changes in export volume continue to generate relatively large trade balance fluctuations. This has also given rise to a shift in the relative importance of various export commodities (excluding petroleum). Rubber and timber have become much more important; tin, tea, and pepper have become slightly more important; while coffee, copra, and palm oil kernels have declined in importance (see Tables 2.2 and 2.3). However, all these changes have been dwarfed by the rapid increase in the value of petroleum exports during the post-1972 period.[2]

On the other hand, the country's import policy at the present time continues to be directed toward supporting production and infra-structure in the country. Priority is given to the importation of required capital, particularly intermediate goods. In addition, to maintain price stability, government policy is directed toward facilitating the flow of food

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[1]Biro Pusat Statistik, <u>Statistical Pocket Book Indonesia</u> (Jakarta: 1976), p. 1975.

[2]See Appendix A.2.2.

Table 2.2

Value of Ten Commodity Exports
1969 - 1974 (millions U.S. $)

Commodity	1969	1970	Percentage Change 1969-1970	1971	Percentage Change 1970-1971	1972	Percentage Change 1971-1972	1973	Percentage Change 1972-1973	1974	Percentage Change 1973-1974
Rubber	307.7	290.6	-5.9	223.1	-23.2	159.2	-15	391.4	+[illegible]	479.2	+22
Timber	52.0	117.3	+125.6	163.7	+43.8	228.7	+36	573.6	+1[illegible]	724.7	+26
Tin	52.9	62.2	+17.6	60.0	-3.5	64.2	+7	93.1	+45	175.4	+[illegible]
Coffee	51.9	65.8	+26.8	55.0	-15.4	77.2	+40	[illegible]	+[illegible]	93.2	+27
Palm Oil	23.1	36.8	+59.3	46.3	+15.8	41.3	-11	70.2	+70	157.3	+124
Tea	16.0	18.7	+16.9	28.2	+50.8	30.6	-9	26.1	-1[illegible]	47.3	+77
Pepper	10.8	3.1	-71.3	24.0	+674.2	21.5	-10	[illegible].9	+34	24.3	-16
Tobacco	16.5	12.5	-24.2	19.7	+[illegible].6	29.9	+52	[illegible].7	+[illegible]	35.4	-11
Copra	26.7	32.1	+20.2	14.3	-55.5	4.3	-70	[illegible].3	+[illegible]	--	--
Palm Kernels	4.2	5.1	+21.4	5.5	+7.3	3.7	-33	4.9	-32	9.6	+96
Total	561.80	644.20	+15.0	644.80	+0.09	690.60	+7.10	1,[illegible].80	+89.81	1,750.40	+33.54

Sources: 1969-1972: Department of Information, Government of Republic of Indonesia, Presidential Address (Jakarta: August 16, 1972).

1973-1974: Government of Indonesia, Statistical Year Book, 1975, Table XI.1.56 (Jakarta: 1976), pp. 706-708.

Table 2.3

Prices of Selected Export Commodities in World Markets
1967 - 1974

Commodity	Unit	1967	1968	1969	1970	1971	1972	1973	1974
Rubber (¢)	1) US $/kg	43.83	43.70	58.48	46.65	39.90	40.21	78.51	86.54
	2) Pence/kg	38.55	41.78	55.95	45.35	15.53	15.05	32.53	33.95
Coffee (¢)	1) US $/lb	37.65	37.40	40.24	55.99	44.70	51.08	66.43	67.73
Copra	2) US $/m.ton	203.00	232.00	202.00	215.00	138.00	141.00	344.00	670.00
Pepper (¢)	1) US $/lb	--	30.93	35.60	58.22	49.92	45.56	--	--
Palm Oil	2) £/long ton	82.00	71.00	79.00	110.00	109.00	89.00	153.00	291.00
Lead (¢)	1) US $/lb	14.00	13.22	13.57	15.75	14.25	15.47	16.27	22.39
Tin (Kassa) (¢)	2) US $/m.ton	1,227	1,323	1,451	1,532	1,440	1,507	1,967	3,499
Copper (¢)	2) US $/m.ton	562	650	782	767	602	585	917	1.070

Notes: 1) Average wholesale prices of export commodities in New York Market.
2) Average wholesale prices of export commodities in London Market.

Source: Government of Indonesia, Statistical Year Book 1975, Tables XVI.5 and XVI.6 (Jakarta: 1976), p. 982.

imports--rice and wheat flour--while, at the same time, encouraging the use of farm inputs, particularly fertilizer. Import policy has also supported domestic assembling and processing industries to expand employment opportunities in the manufacturing sector.

Rice imports remain relatively large, generally about 10 percent of the value of all commodity imports (see Table 2.4). But during 1968-1974, the relative importance of imports for immediate consumption generally declined, while the import of raw materials and capital goods increased significantly.

Government Policy Toward Rice Self-Sufficiency

The Rice Self-Sufficiency Program

Indonesia has long been seeking an economic means of achieving self-sufficiency in rice. In order to be able to achieve this goal, the government has introduced a number of nation wide programs.

The well known Bimas Program has existed since the wet-season 1964-65, when the Bogor Agricultural Institute sent their senior students to conduct a mass demonstration program in Krawang.[1] This program consisted of demonstrations and extension, the distribution of farm inputs, credit,

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[1]Bimas is an abbreviation for Bimgingan Massal, which means "Mass Guidance" in agriculture, especially in rice production.

Table 2.4

Imports by Economic Group, 1968 - 1974
(c.i.f. million U.S. $)

Commodity	1968 Value	% of Total	1969 Value	% of Total	1970 Value	% of Total	1971 Value	% of Total	1972 Value	% of Total	1973 Value	% of Total	1974 Value	% of Total
1. Food & Drink	364.4	43.3	308.5	34.5	380.6	32.9	249.0	21.0	297.9	19.1	613.9	22.5	669.0	17.4
1.1 Rice	221.1		159.5		206.2		102.3		131.0		381.6		374.2	
1.2 Wheat Flour	38.4		32.1		33.1		14.8		2.5		16.5		16.0	
1.3 Others	104.9		116.9		141.3		132.1		163.5		[illegible]		278.8	
2. Raw Material & Auxiliary goods	283.9	33.8	344.6	38.5	397.0	34.4	468.5	39.5	631.2	38.4	1004.7	36.8	[illegible]	42.1
2.1 Fertilizers	31.3		30.6		18.8		28.8		47.3		63.3		227.[illegible]	
2.2 Yarns	43.8		48.8		43.0		23.0		28.9		31.8		22.1	
2.3 Others	208.8		265.2		335.2		410.8		555.0		909.6		[illegible]	
3. Capital Goods	192.2	22.9	242.0	27.0	377.9	32.7	467.4	39.5	714.8	43.5	1110.5	40.7	[illegible]	40.5
3.1 Transport equipment	21.1		30.6		47.4		66.0		79.2		71.3		34.6	
3.2 Machines for Industrial & commercial equipment	48.3		59.3		112.8		154.7		226.2		328.5		426.1	
3.3 Others	122.8		152.1		217.7		246.7		299.4		710.2		1034.2	
Total	840.5	100	895.1	100	1155.5	100	1185.0	100	[illegible]	100	2729.1	100	[illegible]	100

Sources: Calculated from Government of Indonesia, Statistical Year Book, 1975 Tables XI.2.6, XI.2.7, XI.2.8, Jakarta, 1976, pp. 738-740.

marketing and processing, and was generally very successful.[1]

About 10,000 hectares of rice were originally covered by this program. The project was expanded and to give the project more authority, responsibility was taken over by the Department of Agriculture. Thus, by 1970-71, the total area under the program had increased to some 1.6 million hectares.

The Bimas Program basically coordinated extension and credit to encourage farmers to use a recommended "package" of rice technology. It consisted of: (1) improved rice varieties; (2) fertilizers; (3) pesticides; (4) improved irrigation facilities; and, (5) application of better cultivation methods. Leading roles were given to various government agencies to support the farmer in carrying out these recommendations. The government bank--Bank Rakyat Indonesia--was made responsible for credit facilities; a government-owned enterprise (Pertani) was made responsible for input distribution; the Directorate of the Cooperatives was made responsible for rice processing and rice marketing; and the Government Rice Procurement Board (BULOG) administered the rice stabilization programs. Bank Rakyat Indonesia and Pertani were responsible for the distribution of credit in both forms, i.e. cash and inputs. Credit was advanced on a village basis, either through the village cooperative or the village headman. The credit package consisted of seed, fertilizer, insecticides, and operating

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[1] Badan Pengendalian Bimas, Government of Indonesia, Progress Report on Bimas (Jakarta: 1975).

credit. The amount of credit extended to individual farmers was based on the size of their holding, and also varied with the variety of rice planted.[1] For example, the amount of credit given to HYV growers was higher than for NHYV growers.

The rapid expansion of the Bimas Program was faced with an increasing demand for fertilizers and other inputs. In order to fulfil this requirement, foreign companies were contracted by the government to provide the necessary inputs.

Beginning in the Wet-Season 1970-71, this program was improved by the so-called "Perfected Bimas," which is still operating in 1980. Under the "Perfected Bimas," the individual loan application made by the farmer must be counter-signed by the village headman to become a bona-fide application. The release steps enable farmers to obtain inputs-in-kind from the village cooperatives. Loans are released by the village and mobile units organized and maintained by the Bank Rakyat Indonesia. Each village unit must consist of four adjoining villages, with 600 to 1,000 hectares of rice field operated by 1,800 to 3,000 farmers.

The Bimas Program has been a successful program in that it has motivated the farmer to use the new rice technology. The area covered by the program has been increasing season by season. By 1978, the area covered was some 5.6 million hectares. Average yields have increased by

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[1] See Appendix A.2.5.

about 4 percent per year.

An increase in rice production should eventually lead to a more than proportionate increase in the marketed surplus. Toquero, Duff, Anden-Lacsina, and Hayami,[1] however, pointed out that with the allocation of rice output between home consumption and market, production may not be very sensitive to price changes. On the other hand, another study on rice and corn in the Philippines by Mangahas, Recto, and Ruttan[2] found that the Philippine farmers were reasonably responsive to changes in the price of corn. A study by Mubyarto[3] suggests that this may also be true of rice production in Indonesia.

Government's Rice Procurement Program

The food situation has received particular attention because of the importance of food in maintaining economic and political stability in order to create a favourable climate for development activities. The main policy in this regard involves the sale and purchase of rice by the government to maintain a balance between supply and demand. Their policy objective is to maintain a price

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[1]Zainada Toquero, Bart Duff, Teresa Anden-Lacsina, and Yijiro Hayami, "Marketable Surplus Functions for a Subsistence Crop: Rice in the Philippines," American Journal of Agricultural Economics, Volume 57(4), (November 1965), p. 709.

[2]Mahar Mangahas, A.E. Recto, and V.W. Ruttan, "Price and Market Relationships for Rice and Corn in the Philippines," Journal of Farm Economics, Volume 48 (1966), p. 701.

[3]Mubyarto, "The Elasticity of the Marketable Surplus of Rice in Indonesia," Unpublished Ph.D. Thesis, Iowa State University, 1965.

level which is fair to both producers and consumers, while still maintaining market incentives for traders in the rice marketing process. Consequently, two kinds of price were introduced: a floor price and a ceiling price. Then, in order to maintain the necessary stock to keep the rice price between these two prices, the government established the operation agency "BULOG," the Board of Logistic Affairs.[1]

Bulog has carried out the following three important responsibilities related to rice:[2] (1) stabilize nine essential consumer goods' prices, including rice, salted fish, salt, sugar, cooking oil, kerosene, soap, batik and low quality clothing materials; (2) encourage rice production, control the rice marketing system, and augment rice marketing facilities for processing, storage, quality control and price control; and, (3) coordinate the general food prices stabilization program. BULOG also provides a regular rice ration to the armed forces and most government services.

To stabilize prices between the floor price and the ceiling price, rice is generally purchased during the harvest season (when prices drop) and sold during the following pre-harvest season (when prices rise). At the same time, BULOG tries to maintain a margin between the floor price and the cieling price which is adequate to encourage growth in the rice trade.

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[1]BULOG was set up based on a Decree of Presidium Cabinet No. 114/4/Kep/5/1967, on May 10, 1967. Later it was renewed through Presidential Decree No. 11, dated January 22, 1969.

[2]BULOG, unpublished letter.

The amount of rice purchased by the agency has varied from period to period, as shown in Table 2.5. The agency purchases rice domestically either from cooperatives[1] or from private milling enterprises. Despite large fluctuations in domestic rice production and procurement, relatively stable rice prices during this period can basically be attributed to the ability of the government to maintain sufficiently large stocks of rice (domestic plus imports) as well as to better communication and transportation facilities.

Although total annual rice production has increased during the last decade, large imports are still needed in orde[illegible]fy the growing demand for rice.[2] In fact, the deman[illegible]ce and food commodities in general has been increa[illegible]apidly due to a growing population and increasing per [illegible]ita incomes. The relatively stable rice prices of recen[illegible] years may have also contributed to the increase in the per [illegible]pita consumption of rice. Clearly, efforts toward increasing rice production should be accelerated in order to meet the growing demand for rice and to reduce large foreign exchange expenditures on rice imports.

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[1]These cooperatives, the so-called B.U.U.D./K.U.D., are Village Unit Cooperatives with two functions--processing and marketing.

[2]Rice imports consist of both food aid (20 percent) and commercial imports (80 percent). Most food aid comes from P.L. 480 supplied by the U.S.A. See: "Survey of Recent Development," Bulletin of Indonesian Economic Studies, Volume XII, No. 3), (November 1976), p. 7.

Table 2.5

Domestic Rice Procurement and Rice Imports
1968/69 to 1977/78 (In Thousand Tons)

Period	Domestic Procurement[a]	Imports[b]	Total
1968/69	n.a.	730	n.a.
1969/70	208	796	1,004
1970/71	493	764	1,257
1971/72	549	524	1,073
1972/73	138	1,234	1,372
1973/74	268	1,225	1,493
1974/75	536	1,137	1,673
1975/76	588	668	1,256
1976/77	401	1,493	1,894
1977/78	404	2,313	2,717

Notes: [a] = Domestic rice procurement by BULOG.
[b] = Aid and commercial imports.

Sources: 1968-72: Government of Indonesia, Lampiran Pidato Kenagaraan 1972 (Jakarta: 1972)

1972-75: Bulletin of Indonesian Economics Study, Volume XII (3), (November 1976), p. 6.

1975-78: Bulletin of Indonesian Economics Study, Volume XIV (2), (July 1978), p. 7.

The Country's Rice Production

A major agricultural objective of the present government is to increase rice production to meet the increasing demand for rice in the country and to save on foreign exchange by reducing the rice import requirements. During the years 1968-1975, increases in the area harvested, yield per hectare, and total production were about 1.2 percent, 3.3 percent and 4.8 percent per year, respectively (see Appendix A.2.3). Although very little empirical evidence is available, this yield improvement has generally been due to the introduction of new rice varieties, better cultivation practices, and better infrastructure, including improved irrigation systems. In short, a gradual process of "capital-deepening" is taking place.

Java and Madura are the largest rice paddy producers, followed by the island of Sumatra. About 5 percent of national production is produced in the three provinces included in the study area--Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur (see Table 2.6).

Characteristics of Small Holder Rice Farming in Indonesia

The agricultural sector in Indonesia still dominates the national economy. In 1973, about 63 percent of the population was engaged in primary agriculture. Most farms are relatively small, relatively labor intensive, and are primarily intended to fulfill the farm family's own

Table 2.6

Production of Paddy in Indonesia, Selected Islands and Provinces, 1968 - 1974

(tons)

Islands	1968	1969	1970	1971	1972	1973	1974
Java and Madura	13,603,161	14,430,709	15,165,455	16,228,348	15,588,076	17,047,115	18,312,569
Sumatra	4,787,412	2,282,264	5,503,278	5,558,931	5,665,601	6,044,103	6,274,482
Kalimantan	1,183,778	1,072,220	1,234,774	1,182,336	1,249,306	1,383,538	1,472,624
Sulawesi	1,736,686	1,627,258	2,109,765	2,128,423	1,610,874	2,053,960	1,943,745
Maluku & Irian Jaya	7,169	8,050	13,994	16,012	13,789	13,738	13,220
Study Area:	1,116,839	1,135,346	1,242,092	1,273,125	1,284,504	1,549,384	1,698,461
Bali	487,456	551,471	536,281	633,495	676,642	668,620	768,973
Nusa Tenggara Barat	482,107	435,487	509,007	445,049	465,371	646,328	718,189
Nusa Tenggara Timur	147,276	148,388	196,804	199,581	142,491	233,436	211,299
Others	8,931,839	9,125,138	10,103,783	10,163,827	9,763,074	11,043,734	11,402,532
TOTAL	22,435,047	23,555,347	25,269,238	26,392,175	25,351,110	28,090,849	29,715,101

Source: Adjusted from Government of Indonesia, Statistical Year Book 1975, Table IX.1.46, Jakarta, 1976, p. 433.

consumption requirements.

Farm agriculture is operated by small holder farmers and ordinarily there is no need to apply any specified, practical ways and well organized management. During 1963-1973, the number of farms in the country increased from 12.3 million to 14.4 million, and the area under cultivation increased from 12.9 million hectares to 14.2 million hectares. Rice fields alone account for about one-third of the total area under cultivation.

Table 2.7 presents the structure of agriculture in the study area as compared with Indonesia as a whole. In Indonesia as a whole, the average farm size in 1963 was 1.1 hectares. The average size for the study area was 1.7 hectares, 1.1 hectares and 0.9 hectares for the provinces of Nusa Tenggara Timur, Nusa Tenggara Barat and Bali, respectively.

Table 2.7

The Structure of Agriculture in the Study Area, 1963

Province	No. of Holdings	Total Area (Hectares)	Average Size (Hectares)
Bali	265,854	251,227	0.9
Nusa Tenggara Barat	250,535	265,508	1.1
Nusa Tenggara Timur	252,850	427,281	1.7
TOTAL	769,239	944,016	1.23
INDONESIA	12,263,470	12,883,868	1.1

Source: Calculated from: Government of Indonesia, Statistical Year Book of Indonesia (Jakarta: 1976), Table IX.1.1.

The sharp contrast in the size distribution of farms between Java and the Outer Islands has been pointed out by Booth and Sundrum.[1] About 70 percent of all farms consist of one hectare or less (Appendix A.2.7). Differences in the size of farms in the various regions have also been noted by Booth and Sundrum.[2]

The actual cropping intensity[3] in rice farming, however, is largely dependent upon the existence of reliable irrigation facilities. For example, in the province of Bali (where irrigation is relatively good) the rice cropping intensity reached as high as 1.53, while the provinces of Nusa Tenggara Barat and Nusa Tenggara Timur were 1.0 and 0.78, respectively.[4] Outside of Java and Bali, the cropping intensity averages 1.16.[5] This effectively alters farm size accordingly.

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[1]Anne Booth and R.M. Sundrum, "The 1973 Agricultural Census," Bulletin of Indonesian Economics Studies, Volume II (July 1976), p. 94.

[2]Ibid.

[3]"Cropping intensity" is defined by the ratio

$$\frac{\text{Annual Area Seeded to Rice}}{\text{Total Rice Area}},$$

with two crops per year, the maximum is 2.0.

[4]Dibyo Prabowo and A.J. Nyberg, "Irrigation and Rice Production in 1990; The Case of Indonesia," paper prepared for the XVII International Conference of Agricultural Economists (Banff, Alberta, Canada: September 3-12, 1979), p. 27.

[5]Ibid., p. 6.

CHAPTER III

METHODOLOGY

Introduction

The principal objective of this chapter is to outline the methodology employed to investigate the real impact of the new rice technology on the smallholder rice farmer in East Indonesia. More specifically, this chapter details: (1) the sampling procedure employed; (2) the relevant economic theory and model specification; (3) the analytical techniques used in this particular study; and, (4) statistical methodology. The chapter concludes with a summary of sample farm characteristics.

Data Collection and Sampling Procedures

Data Collection

Cross-sectional data from small holder rice farms were collected from three provinces in the eastern part of Indonesia, namely Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT). The data pertain to the wet-season 1977-78 and wet-season 1978-79. Each of the three provinces have distinct demographic, social, economic and environmental characteristics. Most importantly, while Bali and the west part of NTB are predominantly rice producing areas with intensive irrigation facilities, rain-fed rice cultivation dominates the eastern part of NTB and all of NTT.

During the course of this survey, the author interviewed a total of 567 rice farmers throughout the sample area:

	1977-78	1978-79	Total
Bali	149	79	228
NTB	120	64	184
NTT	104	51	155
TOTAL	373	194	567

Sampling Procedure

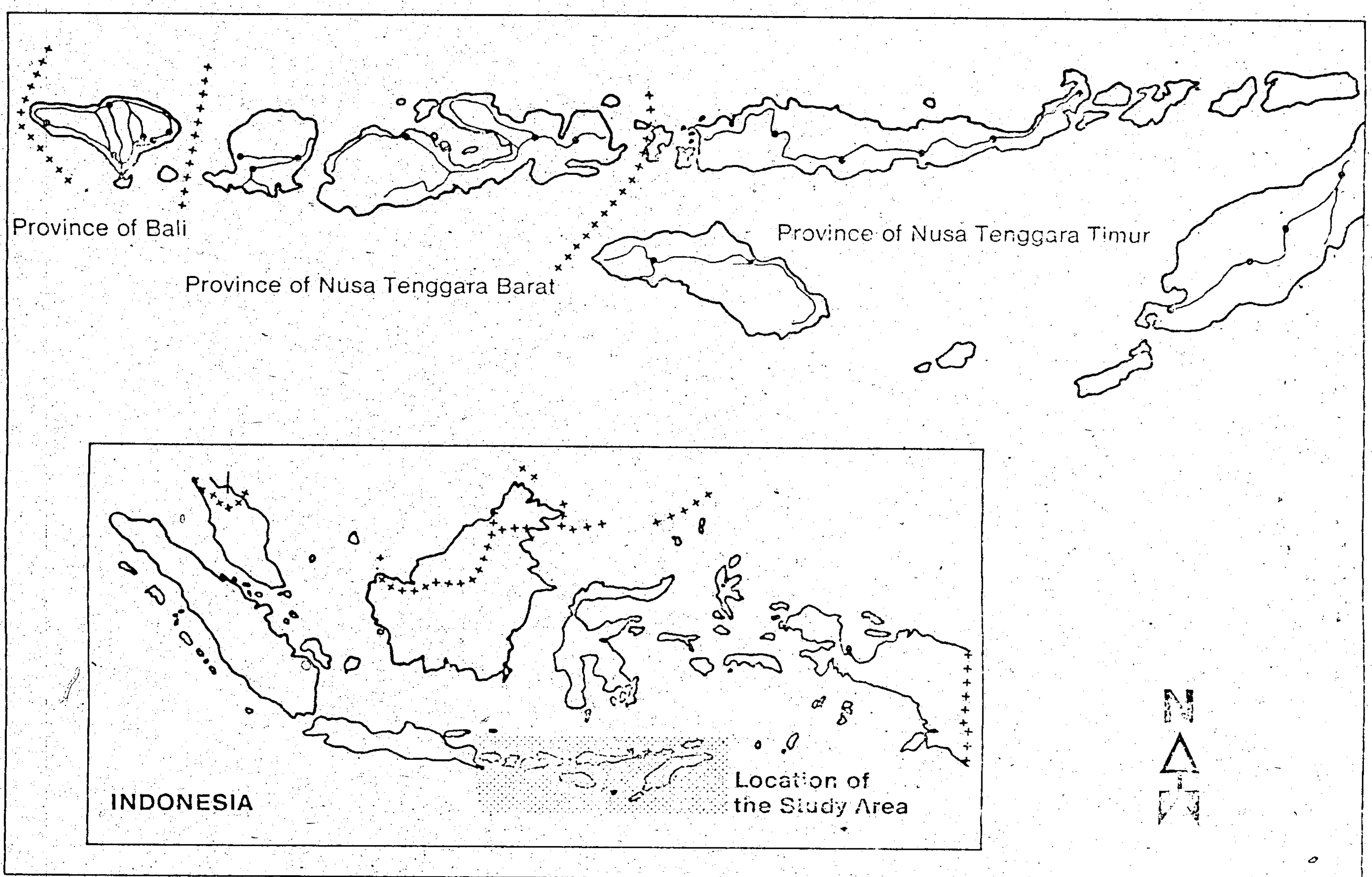
The villages included in the sample were grouped into lowland and upland and were identified by administrative boundaries. Various "Kabupaten" (Regencies) were first selected as representative of major rice producing areas. From each "Kabupaten," two villages with relatively good irrigation systems were subsequently identified. Then 10 sample farmers were randomly selected from each sample village. Due to a time limitation, the number of sample villages was reduced in the wet-season 1978-79. The sample villages are identified in Table 3.0, and the geographic location of the study area is indicated on Map 3.1.

For the purpose of this study, the sample farmers are grouped into two categories: (1) the growers of Non-High Yielding Varieties (NHYV); and (2) the growers of

Table 3.0

Selected Kabupatens and Villages,
Provinces of Bali,
Nusa Tenggara Barat and Nusa Tenggara Timur

Province	Kabupaten Selected	Village Selected
Bali	Buleleng	Bt. Banua, Ringdikit
	Jembrana	Mendoyo, Pergung
	Tabanan	Pd. Bandung, Kuwum
	Badung	Mengwitani, Sading
	Gianyar	Sukawati, Lebih
	Bangli	Selati, Kutabali
	Klungkung	Br. Angkan, Akah
	Karangasem	Jasi, Perasi
Nusa Tenggara Barat	Lombok Barat	Lingsar, Nurlembang
	Lombok Tengah	Mt. Gamang, Bt. Kumbung
	Lombok Timur	Montongbaan, Praya
	Bima	Kendal, Kaleo
Nusa Tenggara Timur	Kupang	Tarus, Ps. Panjang
	Timor Tengah Selatan	Oesao, Fukdale
	Ende	Wonda, Wolowaru
	Ngada	Boawae, Raja



Map 3.1 : Geographic Location of Study Area

High Yielding Varieties (HYV). In this study, the "IR-type" of rice varieties such as IR_5, IR_8, IR_{26}, etc. were classified as HYV, while all other rice varieties were classified as NHYV. Furthermore, if a sample farmer planted NHYV as well as HYV, then he is included in both sub-samples. The sample farmers for which data were incomplete were totally excluded from the final analysis.

Economic Theory and Model Specification

Theory of Production

To examine whether there has been any significant shift in the rice production function with the introduction of the new rice technology into East Indonesia, a Cobb-Douglas power function is employed. The Cobb-Douglas function is a simple functional form which is computationally economical yet yields statistically significant parameter estimates without making excessive demands on the available data.[1] With farm sample data, Heady and Dillon have recommended the use of the Cobb-Douglas input-output relationship in agriculture because of the smaller number of degrees of freedom involved in estimating the parameters, and because a multiplicative model seems logically appropriate.[2]

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[1] P.A. Yotopoulos and J.B. Nugent, Economics of Development and Empirical Investigations (New York: Harper & Row, 1976), p. 52.

[2] E.O. Heady and J.L. Dillon, Agricultural Production Functions (Ames: Iowa State University Press, 1964), pp. 97-98.

In particular, within the relevant data range the marginal product of the Cobb-Douglas function decreases at an increasing rate, a statistical imperative which is fully consistent with the law of diminishing returns. Without imposing restrictions on the parameter estimates, the Cobb-Douglas production function is also a convenient form to use to determine the existence of economies of scale. Martin[1] also pointed out that the logarithmic transformation of the Cobb-Douglas production function has been widely used because of its convenience in interpreting elasticities of production.

Numerous quantitative studies using the Cobb-Douglas type of function are readily available: Singh,[2] Sidhu,[3] Hopper,[4] Saini,[5] McCarthy,[6] and Sahota.[7]

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[1]L.R. Martin (Ed.), "Traditional Field of Agricultural Economics, 1940's to 1970's," A Survey of Agricultural Economics Literature, Volume I (Minneapolis: The University of Minnesota Press, 1977), pp. 129.

[2]J.P. Singh, "Resource Use, Farm Size and Returns to Scale in a Backward Agriculture," Indian Journal of Agricultural Economics, Volume 30(2), (April-June 1975), pp. 33-34.

[3]S.S. Sidhu, "Economics of Technical Change in Wheat Production in the Indian Punjab," American Journal of Agricultural Economics, Volume 56 (2), (May 1974), pp. 217-225.

[4]W.D. Hopper, "Allocation Efficiency in a Traditional Indian Agriculture," Journal of Farm Economics, Volume 47 (3) (August 1965), p. 613.

[5]G.R. Saini, "Resource-Use Efficiency in Agriculture," Indian Journal of Agricultural Economics, Volume 24(2), (April-June 1969), pp. 1-2.

[6]W.D. McCarthy, "Production Function Analysis of a Fertilizer Trial on Barley," The Australian Journal of Agricultural Economics, Volume 3(2), (December 1959), p. 2.

[7]G.S. Sahota, "Efficiency and Resource Allocation in

Model Specification

In the present study, the following basic model is employed:

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} \text{ exp. } U \qquad (3.1)$$

where:

Y = rice production in quintals of "gabah"[1] per farm.

X_1 = land, in hectares of rice harvested per farm.

X_2 = total human labor, in man-days per farm.

X_3 = total bullock labor days per farm.

X_4 = fertilizer expenditure, in thousands of rupiahs.

X_5 = capital flow of durable equipment (excluding buildings) for each crop per farm, in thousands of rupiahs; defined as the total value of capital (such as plough, sickle, hoe, and other small equipment) divided by the estimated remaining life of each piece of equipment plus interest.[2]

X_6 = expenditures for current inputs other than fertilizer, such as seeds, insecticides, irrigation fees, etc., in thousands of rupiahs.

exp. = logarithm to the base 10.

U = a disturbance term.

b_i = $(i = 1, 2, \ldots, 6)$ are parameter estimates.

Indian Agriculture," American Journal of Agricultural Economics, Volume 50 (3), (1968), p. 584.

[1]Gabah is threshed stalk paddy; roughly 1 quintal of stalk paddy was converted into 0.8 quintal of gabah.

[2]Assume a zero salvage value. The rate of interest employed is 2 percent per annum, similar to current rates on government agricultural loans to farmers throughout Indonesia.

The flow of non-land capital services, such as buildings and trees, that are going into rice production are not incorporated into the model because of data limitations and the problems involved in converting non-land capital stocks into a flow variable.

Following Heady and Dillon,[1] a number of alternative models were also specified:

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_5^{b_5} X_7^{b_7} \exp.\ U \qquad (3.2)$$

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_7^{b_7} \exp.\ U \qquad (3.3)$$

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_7^{b_7} \exp.\ (b_8 X_8 + b_9 X_9 + U) \qquad (3.4)$$

where:

Y = rice production as defined in equation (3.1);

X_1 = land input as defined in equation (3.1);

X_2 = human labor as defined in equation (3.1);

X_5 = capital flow of durable equipment as defined in equation (3.1);

X_7 = expenditure on fertilizer and current inputs as defined by X_4 and X_6 in equation (3.1);

X_8 = a dummy variable taking the value of one for NHYV and zero otherwise;

X_9 = a dummy variable taking the value of one for HYV and zero otherwise;

exp. = logarithm to the base 10;

U = a disturbance term;

b_i = (i = 1, 2, ...9) parameter estimates.

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[1] E.O. Heady and J.L. Dillon, op.cit., p. 203.

Analytical Techniques

Measuring Technological Change

Using a Cobb-Douglas production function framework, technological change can be measured by evaluating changes in the respective parameter estimates. For instance, in the case of two factors inputs, let us say, capital (K) and labor (L), this can be estimated for two or more sets of data to obtain:

$$\text{Log}\ . = \text{Log}\ bo + b_1 \log K + b_2 \text{Log}\ L \qquad (3.5)$$

Then a fall in the value of b_1 relative to b_2 would indicate that a labor-using technology has been adopted, whereas if the elasticity of production of capital (b_1) rises relative to the labor coefficient (b_2), this would indicate that a capital-using technology has been adopted.[1] Thus, any non-neutral technological change is represented by a change in the ratio of b_1 to b_2. On the other hand, if the constant term log bo changes significantly, while the ratio b_1/b_2 remains constant, then we would have a neutral technological change. By a similar procedure, one might describe the nature of technological change using the Cobb-Douglas production function involving more than two factor inputs.

The test employed to determine whether the coefficients (for two different sets of data) are significantly

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[1] Murray Brown, *On the Theory and Measurement of Technological Change* (Cambridge: University Press, 1966), p. 42.

different from one another is as follows:[1]

$$F\alpha = \frac{Q_3/k}{Q_2/(m + n - 2k)}$$

with degrees of freedom (k, m + n - 2k) where:

$Q_3 = Q_1 - Q_2$;

Q_1 = computed from the sum squared residuals of m + n observations;

Q_2 = total sum of squared residuals of separate m and n observations.

If $F\alpha > F_S$, we reject the hypothesis $\beta_1 = \beta_2 = \ldots\ldots = \beta_k$.

Determining Resource Use Efficiency

This analysis will involve the measurement of Marginal Physical Products (MPP), Marginal Value Products (MVP), and Factor (Acquisition) Costs.

Economic theory indicates that a resource is used most efficiently if the Marginal Value Product (MVP) of the input in question is just sufficient to offset its cost. This is a necessary condition for profit maximization.

The Marginal Physical Product of an input is defined as a ratio of the percentage change in output to the percentage change in input, with all other inputs held constant at their geometric mean. In common algebraic form, the Marginal Physical Product (MPP) of the i^{th} input is given by

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[1] J. Johnston, Econometric Methods (New York: McGraw-Hill, 1963), pp. 136-137.

the following equation:

$$MPP_{x_i} = \frac{dy}{d_{x_i}} = b_i(\frac{Y}{x_i}) \quad (3.6)$$

where:

b_i = the coefficient measuring the proportional relationship between specific input changes and output changes when all other variables are being held constant;

Y = the level of ouput estimated at the geometric mean of each input;

X_i = the i^{th} input at its geometric mean.

The Marginal Value Product (MVP) is obtained by multiplying the MPP by the price of "gabah" per quintal (P_y). That is:

$$MVP_{x_i} = MPP_{x_i} \cdot P_y \quad (3.7)$$

where:

MPP_{x_i} = Marginal Physical Product of input x_i;

P_y = the price of "gabah" per quintal.

The next step to determine resource use efficiency is to calculate the ratio of the Marginal Value Product (MVP) of the input to its factor cost (P_{x_i}). That is:

$$\text{Ratio} = MVP_{x_i} \div P_{x_i} \quad (3.8)$$

or

$$\text{Ratio} = b_i \frac{Y}{x_i} \cdot \frac{P_y}{P_{x_i}} \quad (3.9)$$

In order to be able to determine whether a particular input is being used efficiently, the ratio of MVP_{x_i} to P_{x_i} is then tested against unity. As Heady and Dillon,[1] and Sahota[2] have pointed out, however, the ratio is subject to standard error, defined as follows:

$$\sqrt{(\text{Var } b_i)(Y/x_i)^2 \cdot (P_y/P_{xi})^2} \qquad (3.10)$$

where:

var(b_i) = the variance of coefficient b_i.

Y = the estimated output of rice in quintals of "gabah;"

x_i = the input of x_i at its geometric mean level;

Py = the price of output per quintal of gabah;

P_{xi} = the price of input x_i.

Inputs are being used efficiently when the values are equal to unity, allowing for the estimated standard error of the ratio defined by equation (3.10).

In order to carry out this analysis, input prices must be well defined in terms of their opportunity cost should they be employed elsewhere. Consequently, the price of the various inputs considered here are determined in the following manner:

1. The price of land was estimated from the average per hectare rental value of wet rice land.
2. The daily wage rate was estimated from a weighted average of daily wage rates for both male and female labor.[3]

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[1]Heady and Dillon, op.cit., p. 231.

[2]G.S. Sahota, "Efficiency of Resource Allocation in Indian Agriculture," American Journal of Agricultural Economics, Volume 50(3), (August 1968), p. 599.

[3]One woman-day was converted into 0.6 man-days, based on the average ratio of male wages to female wages for all sample villages.

3. The prices of current inputs (expenditures) such as fertilizer, seeds, insecticides, etc. were established in terms of current farm prices, in thousands of rupiahs.
4. The daily bullock labor wage rate was measured in terms of current wage rates associated with buffalo rentals.
5. Fixed capital costs (converted to capital flows) were measured in terms of their current replacement value in thousands of rupiahs.

Returns to Scale

The concept of scale returns in production analysis refers to the input-output relationships that relate to the long-term when all inputs can be varied. Returns to scale apply to the behaviour of the production function when there are proportional changes made to all inputs. Hence, if the elasticities of production (i.e., the sum of b_i's) sum to 1.0, constant returns to scale are said to exist. In other words, an increase of one percent in all inputs will result in a one percent increase in total output. If the sum of the output elasticities is greater than 1.0, increasing returns to scale prevail and, in this case, the output is increased by a greater percentage than the percentage increase in inputs. In this case, the per unit cost of the output would decline. If the sum of the elasticities of output is less than 1.0, decreasing returns to scale are said to occur because output is increased by a smaller percentage than the percentage increase in inputs. This situation implies that the cost per unit of output is going up.

In order to be able to determine whether returns to scale are increasing, constant, or decreasing, the sum of the elasticity coefficients must be tested for their deviation from unity. To examine this condition, the t-test is needed to ascertain whether Σb_i is significantly different from unity.[1] This procedure is well-documented.[2]

Method of Analysis

In this study, the ordinary least squares technique is used to estimate the parameters of the regression equations specified in the preceding. The ordinary least squares technique is most appropriate because the parameter estimates have the highly desirable properties of being best, linear, unbiased estimators (BLUE) if a number of underlying assumptions are not violated.[3] These are:[4]

1. The error term U_i is an independent random variable with zero mean and constant variance (although the distribution may or may not be normal).

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[1] Heady and Dillon, op.cit., p. 230.

[2] See, for example: Bernard Ostle, Statistics in Research, 2nd edition (Ames, Iowa: The Iowa State University Press, 1969), p. 45; and C.R. Frank, Jr., Statistics and Econometrics (New York: Holt, Rinehart and Winston, Inc., 1971), p. 235.

[3] M. Dutta, Econometric Methods (New York: South Western Publishing Co., 1975), pp. 41-45.

[4] Ibid.

2. The explanatory variables x_i have fixed values.

3. The number of observations (n) exceeds the number of parameters (k) to be estimated.

4. No exact linear relations exist between any of the explanatory variables x_i.

The step-wise regression technique is used to facilitate the evaluation of numerous sub-models consistent with equation (3.1) through (3.4).

Characteristics of the Sample Farms

In Chapter II it was pointed out that the average farm size in 1963 in Indonesia as a whole was 1.1 hectares. The average size for the study area was 1.7 hectares, 1.1 hectares and 0.9 hectares for the provinces of Nusa Tenggara Timur, Nusa Tenggara Barat and Bali, respectively. However, the average sample farm size in terms of total land operated is somewhat different. The Bali sample farmers appeared to have smaller farms (0.48 hectares and 0.50 hectares for NHYV and HYV, respectively) than those of Nusa Tenggara Barat (0.63 hectares and 0.72 hectares for NHYV and HYV, respectively) and Nusa Tenggara Timur (1.20 hectares and 1.74 hectares for NHYV and HYV, respectively).

The percentage of sample farmers with one hectare or less also varied between provinces; that is, about 90 percent, 75 percent and 50 percent for Bali, Nusa Tenggara Barat (NTB) and Nusa Tenggara Timur (NTT), respectively (see Tables 3.1, 3.2 and 3.3).

Table 3.1

Distribution of Land Under Crop Among Sample Farmers
in the Province of Bali
Wet Season 1977/78 and Wet Season 1978/79
(in percentage)

Classification in Hectares	Non High Yielding		High Yielding	
	1977/78	1978/79	1977/78	1978/79
up to .50	65.8	50.0	60.3	56.4
.51 - 1.00	23.7	37.5	30.6	32.7
1.01 - 1.50	2.6	4.2	6.3	9.1
1.51 - 3.00	7.9	8.3	2.7	1.8
3.01 - 4.00	--	--	--	--
4.01 - 7.50	--	--	--	--
7.51 and up	--	--	--	--
TOTAL	100.0	100.0	100.0	100.0

Table 3.2

Distribution of Land Under Crop Among Sample Farmers in the Province of Nusa Tenggara Barat Wet Season 1977/78 and Wet Season 1978/79 (in percentage)

Classification in Hectares	Non High Yielding		High Yielding	
	1977/78	1978/79	1977/78	1978/79
up to .50	37.9	36.4	20.0	25.9
.51 - 1.00	42.0	57.6	56.0	54.9
1.01 - 1.50	11.6	6.0	4.0	12.9
1.51 - 3.00	7.4	--	20.0	6.5
3.01 - 4.00	--	--	--	--
4.01 - 7.50	1.1	--	--	--
7.51 and up	--	--	--	--
TOTAL	100.00	100.00	100.00	100.00

Table 3.[illegible]

Distribution of Land Under Crop Among Sample Farmers
in the Province of Nusa Tenggara Timur
Wet Season 1977/78 and Wet Season 1978/79
(in percentage)

Classification in Hectares	Non High Yielding		High Yielding	
	1977/78	1978/79	1977/78	1978/79
up to .50	28.6	3.0	20.0	5.6
.51 - 1.00	28.6	27.3	25.0	33.3
1.01 - 1.50	9.5	15.2	10.0	5.6
1.51 - 3.00	23.7	39.4	30.0	33.3
3.01 - 4.00	3.6	3.0	5.0	5.6
4.01 - 7.50	6.0	9.1	--	5.6
7.51 and up	--	3.0	10.0	11.0
TOTAL	100.0	100.0	100.0	100.0

At the same time, the adoption level for HYV of rice was the highest in the Bali sample farmers (72 percent), followed by the NTB sample farmers (30 percent), and then the NTT sample farmers (25 percent). This could be a reflection of the availability of irrigation facilities and related infrastructure in the respective provinces. This possibility has been pointed out by Sen[1] in his Indian study, where irrigated areas like the Punjab and Haryana are prospering and piling up surpluses while the rain-fed areas are not.

One of the most crucial inputs for the High Yielding Varieties is fertilizer. It is therefore necessary to have an efficient distribution system for fertilizers so that the farmers receive them in time and in adequate quantity. Table 3.4 gives the figures relating to the distribution of sample farmers based on their expenditure on fertilizer. It appears that a low percentage of all sample farmers (an average of 21 percent) spent more than Rp. 15,000 on fertilizer. But about 36 percent of the sample farmers with High Yielding Varieties spent more than Rp. 15,000 on fertilizer, clearly indicating a positive correlation between High Yielding Varieties and higher expenditures on fertilizer.

In the case of capital flow, however, no significant difference was found between the two groups of farmers (see Table 3.5). This could be due to the similarity of the

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[1] Sudhir Sen, Reaping the Green Revolution (New Delhi: Tata McGraw-Hill Publishing Co., 1975), p. 4.

Table 3.4

Sample Farmers Classified by Expenditures on Fertilizers
(In Percentages)

Classification of Expenditures on Fertilizers (in Rupiah)	Wet-Season 1977-78						Wet-Season 1978-79					
	NHYV			HYV			NHYV			HYV		
	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT
up to 2,500	10.5	3.2	19.0	0.9	—	5.0	—	—	3.0	—	—	—
2,501 - 5,000	31.6	16.8	19.0	21.6	4.0	—	20.8	12.1	6.1	10.9	12.9	5.6
5,001 - 7,500	23.7	31.6	8.3	44.2	28.0	15.0	33.3	27.3	6.1	41.8	16.0	—
7,501 - 10,000	5.3	14.7	4.8	2.7	12.0	15.0	16.7	27.3	3.0	9.1	32.3	11.1
10,001 - 12,500	5.3	7.4	2.4	9.9	20.0	—	8.3	18.2	3.0	10.9	9.7	11.1
12,501 - 15,000	15.8	14.7	3.6	12.6	4.0	—	8.3	12.1	6.1	10.9	12.9	16.7
15,001 - 20,000	2.6	3.2	11.9	1.8	8.0	15.0	—	—	12.1	10.9	6.5	5.6
20,001 - 25,000	2.6	4.2	2.4	4.5	4.0	—	4.3	3.0	21.2	5.5	3.2	—
25,001 - 30,000	2.6	—	7.1	0.9	8.0	10.0	8.3	—	15.1	—	6.5	16.7
30,001 - 40,000	—	1.1	4.8	0.9	—	15.0	—	—	6.1	—	—	11.1
40,001 - 50,000	—	2.0	2.4	—	12.0	5.0	—	—	6.1	—	—	—
50,001 and up	—	1.1	14.3	—	—	20.0	—	—	12.1	—	—	22.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: NHYV = Non-High Yielding Varieties.
HYV = High Yielding Varieties.
Bali = Province of Bali.
NTB = Province of Nusa Tenggara Barat.
NTT = Province of Nusa Tenggara Timur.

Table 3.5

Classification of the Sample Farmers Based on Capital Flow
(in percentages)

Classification of Capital Flow (in Rupiah)	Wet Season 1977-78						Wet Season 1978-79					
	NHYV			HYV			NHYV			HYV		
	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT
up to 1,000	--	1.1	3.6	--	4.0	--	--	--	--	--	--	--
1,001 - 2,000	13.1	32.6	35.7	14.4	28.0	30.0	29.2	15.2	15.2	7.3	9.7	5.6
2,001 - 3,000	81.6	60.0	33.3	73.0	48.0	50.0	62.5	78.8	27.3	56.4	74.2	55.6
3,001 - 4,000	5.3	4.2	14.2	9.0	4.0	15.0	8.3	6.0	36.4	34.5	9.7	16.6
4,001 - 5,000	--	2.1	3.6	2.7	12.0	--	--	--	12.1	1.8	6.4	--
5,001 - 7,500	--	--	6.0	0.9	--	5.0	--	--	9.0	--	--	5.6
7,501 - 10,000	--	--	2.4	--	4.0	--	--	--	--	--	--	5.6
10,001 and up	--	--	1.2	--	--	--	--	--	--	--	--	11.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes:
NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Bali = Province of Bali.
NTB = Province of Nusa Tenggara Barat.
NTT = Province of Nusa Tenggara Timur.

small amounts of equipment that are needed for the production of both varieties.

Table 3.6 presents the distribution of the sample farmers based on their expenditure on pesticides. Some 91 percent of the sample farmers with Non-High Yielding Varieties (NHYV) spent Rp. 4,000 or less on pesticides, while for sample farmers with High Yielding Varieties (HYV), this figure was 87 percent.

Similar proportions of sample farmers are found in the distribution of current expenditure (Table 3.7). An average of 89 percent of sample farmers with Non-High Yielding Varieties spent Rp. 15,000 or less on current expenditures, while for sample farmers with High Yielding Varieties it was only 82 percent.

Table 3.8 presents the proportion of sample farmers classified by gross income.[1] An average of 13 percent of the sample farmers with Non-High Yielding Varieties earned Rp. 500,000 or more. In the case of sample farmers with High Yielding Varieties, the percentage is 23 percent.

In general, sample farmers with High Yielding Varieties spent more cost and earned more gross income than did farmers with Non-High Yielding Varieties. However, more accurate data and research should be carried out before the net private benefit of High Yielding Varieties relative to Non-High Yielding Varieties is evaluated.

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[1]Gross income used in the present discussion is the total physical product of the farms valued at farm harvest prices.

Table 3.6

Sample Farmers Classified by Expenditures on Pesticides
(in percentages)

...ification of Expenditure on Pesticides (in Rupiah)	Wet Season 1977-78						Wet Season 1978-79					
	NHYV			HYV			NHYV			HYV		
	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT
up to 1,000	5.3	12.6	17.9	5.4	8.0	--	--	--	--	--	--	--
1,001 - 2,000	28.9	38.9	38.1	34.2	32.0	40.0	16.7	21.1	12.2	5.5	16.0	5.6
2,001 - 3,000	44.7	30.5	10.7	44.2	32.0	30.0	45.8	66.6	24.2	63.6	51.6	33.3
3,001 - 4,000	21.1	13.7	10.7	11.7	20.0	5.0	33.3	9.1	12.2	23.6	19.4	16.7
4,001 - 5,000	--	2.1	7.1	4.5	8.0	--	4.2	3.2	18.1	7.3	6.5	22.2
5,001 - 6,000	--	1.1	1.2	--	--	--	--	--	18.1	--	6.5	--
6,001 - 7,500	--	--	9.5	--	--	15.0	--	--	6.2	--	--	11.1
7,501 - 10,000	--	1.1	2.4	--	--	5.0	--	--	3.0	--	--	--
10,001 and up	--	--	2.4	--	--	5.0	--	--	6.0	--	--	11.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Bali = Province of Bali.
NTB = Province of Nusa Tenggara Barat.
NTT = Province of Nusa Tenggara Timur.

Table 3.7

Sample Farmers Classified by Current Expenditure[1]
(in percentages)

Classification of Expenditure of Current Input (in Rupiah)	Wet Season 1977-78						Wet Season 1978-79					
	NHYV			HYV			NHYV			HYV		
	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT
up to 5,000	47.4	38.9	44.0	34.3	8.0	35.0	20.8	15.2	—	23.6	3.2	5.6
5,001 - 7,500	13.2	13.7	23.8	22.5	16.0	15.0	20.8	24.2	9.1	29.1	22.6	5.6
7,501 - 10,000	13.2	26.3	7.1	15.3	24.0	15.0	20.8	30.3	15.2	14.5	19.4	16.7
10,001 - 15,000	10.5	12.6	16.7	18.9	28.0	15.0	20.8	27.3	24.2	20.0	32.3	33.2
15,001 - 20,000	7.9	5.3	3.6	5.4	4.0	10.0	4.2	3.0	30.3	9.2	16.0	16.6
20,001 - 25,000	2.6	2.1	3.6	0.9	16.0	—	4.2	—	9.1	1.8	—	5.6
25,001 - 35,000	5.2	1.1	1.2	1.8	4.0	5.0	8.4	—	6.1	—	6.5	—
35,001 and up	—	—	—	0.9	—	5.0	—	—	6.0	1.8	—	16.7
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Bali = Province of Bali.
NTB = Province of Nusa Tenggara Barat.
NTT = Province of Nusa Tenggara Timur.

[1] In current expenditure, included expenditure on seed, irrigation fee and taxes.

Table 3.8

Sample Farmers Classified by Gross Farm Income
(in percentages)

Classification of Gross Farm Income (in Rupiah)	Wet Season 1977-78						Wet Season 1978-79					
	NHYV			HYV			NHYV			HYV		
	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT	Bali	NTB	NTT
up to 50,000	7.9	1.1	11.9	0.9	--	--	--	--	--	--	--	--
50,001 - 100,000	36.8	11.6	9.5	34.2	12.0	5.0	4.2	--	--	--	--	--
100,001 - 150,000	31.6	16.8	11.9	24.3	4.0	20.0	33.3	12.1	--	14.5	3.2	--
150,001 - 200,000	10.5	18.9	10.7	12.6	16.0	--	25.0	24.2	--	10.9	9.7	--
200,001 - 250,000	2.6	21.1	13.1	7.3	16.0	--	16.7	9.1	6.1	18.2	3.2	5.6
250,001 - 350,000	2.6	18.9	9.5	14.4	20.0	10.0	8.3	33.3	6.1	16.4	16.0	11.0
350,001 - 500,000	5.4	5.3	8.3	1.8	12.0	20.0	4.2	18.2	18.2	16.4	45.2	16.7
500,001 - 750,000	2.6	4.2	15.5	4.5	8.0	30.0	8.3	3.1	18.2	20.0	6.5	16.7
750,001 - 1,000,000	--	2.1	3.6	--	4.0	--	--	--	9.0	3.6	9.7	11.0
1000,001 - 1500,000	--	--	4.8	--	8.0	5.0	--	--	30.2	--	6.5	16.7
1500,000 - 2000,000	--	--	1.2	--	--	--	--	--	6.1	--	--	--
2,000,000 and up	--	--	--	--	--	10.0	--	--	6.1	--	--	22.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Bali - Province of Bali.
NTB = Province of Nusa Tenggara Barat.
NTT = Province of Nusa Tenggara Timur.

The analysis which follows focuses on the unique production characteristics typical of sample farmers in Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur.

CHAPTER IV

EMPIRICAL ANALYSIS OF RICE PRODUCTION CHARACTERISTICS

Introduction

The preceding chapter outlined the analytical techniques which were used to estimate the unknown parameters of the production function estimates in the study area. These parameters were estimated through the use of the least squares technique of regression analysis.

This chapter summarizes the empirical results of this analysis and is divided into three main subsections:

1. Regional impact of HYV's;
2. Intraregional disparities; and,
3. Production variability over time.

Consistent with the hypotheses specified in Chapter I, the analysis in each subsection then focuses on: (a) factor use; (b) resource efficiency; and, (c) returns to scale. A qualitative assessment of the empirical estimates obtained is included thereafter.

Factor Use

This section provides an analysis of the different input-output relationships for NHYV's and HYV's, over two wet-seasons for the entire region.

The regression coefficients which were estimated from the regional observations are presented in Table 4.1. The estimated parameters represent the elasticity of total farm production with respect to land, human labor, bullock labor, capital flow, fertilizer and other current inputs. These coefficients indicate the percentage change in production if *ceteris paribus*, any one factor is increased by one percent. A one percent marginal increase in any one of these inputs, holding the other factors constant at their geometric mean, will add a certain percentage to current production.

The output elasticity of land is significant at the one percent level in all cases. Land, moreover, made the greatest relative contribution to rice output.

Fertilizer was the second most important factor in rice production. Its coefficients are also significant at the one percent level in all three regressions.

A third important factor to which output was highly responsive was other current inputs (seed, pesticides, irrigation fees). The parameter estimates accompanying this factor were also statistically significant at the one

Table 4.1

Regional Parameter Estimates for Non High Yielding Varieties and High Yielding Varieties, for the Wet-Season 1977-78 and the Wet-Season 1978-79

Regression Number	I	II	III
Varieties	NHYV's	HYV's	Pooled
Degree of Freedom	302	256	562
Constant Term	-0.5158	-0.6193	-0.8657
Land	0.4330 * (0.0437) {78.24%}	0.5030 * (0.0574) {83.23%}	0.3936 * (0.0357) {76.66%}
Human Labor	0.1485 * (0.0452) {0.59%}	---	0.0762 ** (0.0365) {0.13%}
Bullock Labor	---	---	---
Fertilizer	0.2037 * (0.0345) {3.75%}	0.2675 * (0.0480) {1.95%}	0.2458 * (0.0286) {4.36%}
Capital Flow	---	---	---
Current Expenses	0.2193 * (0.0501) {0.98%}	0.2862 * (0.0589) {1.25%}	0.3132 * (0.0381) {2.00%}
Standard Error of Estimate	0.1397	0.1228	0.1395
R^2	0.8355	0.8644	0.8315
F value	383.5685	543.7924	693.1323
Return to Scale	1.0045	1.0567	1.0238

Notes: Numbers in parentheses are the standard error of coefficient b_i. Percentages in square brackets represent the relative contribution of a particular input.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV and HYV.
* = Coefficients significant at the one percent level.
** = Coefficients significant at the five percent level.

percent level in all regressions.

The human labor coefficients, in contrast, are only significant for NHYV's and pooled variety data at the one percent and five percent levels, respectively. However, surprisingly, they are not significant for HYV's. In other words, labor seemingly made a zero marginal contribution to rice output in the case of HYV's. This evidence is consistent with the study by Srivastava and Heady.[1] They point out that there has been a decline in the relative importance of labor in value added.

The output elasticities of bullock labor and capital flow were not statistically significant, even at the 20 percent level. Consequently, for the purpose of this analysis, these two inputs are omitted.

The coefficient of determination, R^2, remained unchanged, and at the same time, the F-value increased significantly. Thus, it appears preferable to use the stepwise regression coefficients. The uses of alternative regressions are suggested by Heady and Dillon[2] (see Chapter III).

Finally, the nature of the recent technological change in rice production in East Indonesia can be examined

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[1] U.K. Srivastava and E.O. Heady, "Technological Change and Relative Factor Shares in Indian Agriculture: An Empirical Analysis," American Journal of Agricultural Economics, Volume 55(3), (August 1973), pp. 509-514.

[2] Heady and Dillon, op.cit., p. 203.

more closely by looking at the relative output elasticities for the respective sample farms (HYV's versus NHYV's). In this case, separate regressions, I and II, were compared with the pooled season, regression III (Table 4.1). Equality between the regression coefficients was tested using an F-test procedure, as suggested by Johnston.[1]

The results of the test are presented in Table 4.2. An F-ratio of 17.15 with 4 and 562 degrees of freedom is significant at the one percent level. Therefore, the hypothesis regarding the equality of the coefficients between NHYV's and HYV's should be rejected. The HYV's coefficients are significantly higher than the NHYV's coefficients.

From this test, it is also possible to conclude that non-neutral technological change is in progress. With the shift from NHYV's to HYV's, there is an apparent bias towards a relatively more capital intensive technology; a bias which encourages the use of fertilizers, land and other capital inputs and discourages the use of labor.

The coefficient of determination, R^2, indicates that 86 percent of HYV's output variation is determined by land, fertilizer and other current inputs, while for NHYV's, about 84 percent of the output variation is determined by these same three inputs and labor.

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[1] J. Johnston, op.cit., pp. 135-138; see also C.R. Frank, Jr., op.cit., pp. 232-3. An alternative procedure is outlined in E.O. Heady and D.L. Dillon, op.cit., pp. 115-116.

Table 4.2

Test of Equality of Regression Coefficients between NHYV's and HYV's, Study Area, Wet-Season 1977-78 and Wet-Season 1978-79

Sum of Squared Residual			F-Ratio	F-Statistics	Degree of Freedom
NHYV	HYV	Pooled			
5.89013	3.85707	10.94308	17.15 *	3.32	4 and 562

Note: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV and HYV.
* = Significantly different at one percent level.

$$\text{F-ratio} = \frac{Q_3/k}{Q_2/(m + n - 2k)}$$ [1]

where:

$Q_3 = Q_1 - Q_2$

Q_1 = sum of squared residual of m + n observation
Q_2 = sum of squared of m observation plus sum squared of n observation

[1] See J. Johnston, op.cit., pp. 136-138.

Resource Use Efficiency

In order to examine resource use efficiency, the ratio of Marginal Value Products (MVP) to Marginal Factor Costs (MFC) (i.e., the acquisition cost) was examined. A resource or input factor is said to be used most efficiently if its MVP is equal to its MFC.[1] The production functions from Table 4.1 are used as the basis of the analysis and four major inputs were considered: land, fertilizer, other current input, and labor.

The parameter estimates for NHYV's and HYV's were considered separately since the hypothesis that there is no significant difference between these coefficients has already been rejected.[2]

The Marginal Physical Products of the input factors were estimated at their geometric mean because the mean was not heavily weighted by extreme values and it gives conservative figures, as pointed out by Mason.[3]

The geometric mean of the input factors and corresponding outputs are presented in Table 4.3. The estimated Marginal Physical Products and the corresponding Marginal Value Products ($MPP_{xi} \times P_y$) are presented in Table 4.4. The average price of rice is presented in Table 4.5. The acquisition cost of inputs is indicated in Table 4.6.

Resource use efficiency can be tested by determining

[1]J.H. Duloy, "Resource Allocation and a Fitted Production Function," The Australian Journal of Agricultural Economics Vol. 3(2), (December 1959).

[2]For the test result, see Tables 4.1 and 4.2.

[3]R.D. Mason, Statistical Techniques in Business and Economics (4th ed.; Homewood, Illinois: R.D. Irwin, Inc., 1978).

Table 4.3

Geometric Mean of Selected Inputs and Corresponding Rice Output in the Study Area, Wet-Season 1977-78 and Wet-Season 1978-79

Varieties	Land (hectare)	Human Labor (man/days)	Fertilizer (000 rupiahs)	Current Inputs (000 rupiahs)	Rice Output (quintals)
NHYV	0.77	163.45	8.921	9.428	27.47
HYV	0.65	136.79	9.601	11.053	32.23

Note: NHYV = Non-High Yielding Varieties.
HYV = High Yielding Varieties.

Table 4.4

Relative Efficiency of Factor Use, Non-High Yielding Varieties (NHYV) and High Yielding Varieties (HYV), Study Area

Varieties	Land	Labor	Fertilizer	Current Input
Marginal Physical Product (in Quintals):				
NHYV	15.45	0.02	0.63	0.64
HYV	24.94	--	0.90	0.83
Marginal Value Product (in Rupiahs):*				
NHYV	140,919.45	182.42	5,746.23	5,837.44
HYV	208,373.70	--	7,519.50	6,934.65

* Example: 15.45 x 9,121 = 140,919.45. For rice prices, see Table 4.5.

Table 4.5

Average Price of Rice Paddy
(Threshed Dry Stalk Paddy) at Geometric Mean

Year	Non-High Yielding Varieties (in Rupiah/Quintal)	High Yielding Varieties (in Rupiah/Quintal)
Wet-Season 1977-78	7,067	6,276
Wet-Season 1978-79	11,175	10,433
Both Seasons Pooled	9,121*	8,355*

Note: *These figures taken as an average figure for both seasons.

Table 4.6

Acquisition Cost of Input Factors

Year	Land (Rupiah/hectare)	Human Labor (Rupiah/day)	Fertilizer (Rupiah/unit) **	Current Input (Rupiah/Unit) **
Wet-Season 1977-78	75,000	400	1,000	1,000
Wet-Season 1978-79	110,000	600	1,000	1,000
Both Seasons Pooled*	92,500	500	1,000	1,000

Notes: * These figures are taken as an average figure for both seasons.

** The acquisition cost of fertilizer and current inputs was taken at one thousand rupiah since those inputs were measured in value terms at one thousand rupiah.

if the ratio of the Marginal Value Product relative to its acquisition cost is significantly different from unity. From these ratios one can examine whether too much or too little of individual input factors are being used. If the Marginal Value Product is much lower (higher) than the Marginal Factor Cost, more (less) intensive use of the input is suggested in order to equate the marginal return with its factor cost.[1]

The results in Table 4.7 suggest a need to employ more new inputs such as fertilizer, pesticides, and new seeds as well as the utilization of more marginal land. Conversely, in the case of NHYV's, the ratio of MVP/MFC for labor is much less than unity, suggesting the excess use of labor. All of the estimated ratios are significantly different from unity at the one percent level.

In short, considerable resource inefficiency apparently persists in the region as a whole. For HYV's, the underutilization of land, fertilizer, and current inputs is very pronounced. Conversely, there is some evidence that labor is overutilized despite the MPP > 0.[2] As such, the null hypothesis that there are no major resource use inefficiencies in the region is rejected.

These apparent inefficiencies may well be due to data deficiencies, risk and uncertainty, input supply constraints, or other unidentified characteristics of the

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[1]Duloy, op.cit., p. 76.

[2]Schultz, op.cit., p. 52.

Table 4.7

The Ratio of Marginal Value Product to Marginal Factor Cost

Varieties	Land	Labor	Fertilizer	Current Input
NHYV	1.52	0.36	5.75	5.84
	(0.15)	(0.14)	(0.97)	(1.77)
	{10.13}*	{2.57}*	{5.93}*	{3.30}*
HYV	2.25	--	7.52	6.93
	(0.26)		(1.35)	(2.06)
	{8.65}*		{5.75}*	{3.36}*

Notes: Numbers in parentheses are the standard errors.
Numbers in brackets are the t-values.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
* = significantly different from unity at the one percent level.

Source: Table 4.4 and Table 4.6.

region. The contrary findings of both Anderson and Dillon[1] and Schultz[2] would also suggest that further research is desirable.

Returns to Scale

Table 4.1 presents the output elasticities of the respective inputs, *ceteris paribus*. The sum of the output elasticities in each regression indicates the return to scale.

With a Cobb-Douglas production function, the summation of these output coefficients could be less than one, equal to one, or greater than one.[3] These three features indicate decreasing, constant, or increasing returns to scale, respectively.

In the present analysis, the three possible kinds of economies of scale are tested against unity, using the t-test, as suggested by Heady and Dillon.[4] The estimated sum of the output elasticities for NHYV's, HYV's and

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[1] J.R. Anderson and J.L. Dillon, "On Estimating Allocative Efficiency in Cross-Sectional Analysis of Production," The Australian Journal of Agricultural Economics, Vol. 15(3), (December 1971), pp. 146-150.

[2] Schultz, op.cit., pp. 36-52.

[3] Heady and Dillon, op.cit., p. 230; see also D.F. Heathfield, Production Functions, Macmillan Studies in Economics (Basingstoke, England: The Macmillan Press Ltd., 1971), p. 33.

[4] Heady and Dillon, op.cit.; in this present study, however, the t-test as suggested by Bernard Ostle is used. See Bernard Ostle, op.cit., p. 45.

all production are 1.0, 1.06, and 1.03, respectively (Table 4.8), However, these results do not significantly deviate from unity as indicated by the t-test. In other words, the nature of returns to scale in Eastern Indonesian agriculture is that of constant returns to scale.

These findings imply that a one percent increase in the use of all factors of production will also cause output to increase by approximately one percent.[1] For example, if farm and all other inputs are increased by one percent, total production would increase by one percent.

In short, on the basis of the analysis, the null hypothesis of constant returns to scale cannot be rejected. This result is consistent with other studies of returns to scale in traditional agriculture, notably those by Srivastava, Nagadevara and Heady.[2]

Intraregional Analysis

Factor Use

In order to examine the nature of the shift in the rice production function for NHYV's to HYV's for each province (Bali, NTB and NTT), separate regressions for NHYV's

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[1]Heady and Dillon, op.cit., p. 69.

[2]U.K. Srivastava, V. Nagadevara, and E.O. Heady, "Resource Productivity, Returns to Scale and Farm Size in Indian Agriculture: Some Recent Evidence," The Australian Journal of Agricultural Economics, Volume 17(1), (April 1973), p. 47.

Table 4.8

Return to Scale, Study Area

Varieties	The Sum of Coefficients	Return to Scale Indicated by the t-test[1]
NHYV's	1.00	Constant
HYV's	1.06 n.s.	Constant
Pooled	1.03 n.s.	Constant

Notes: NHYV's = Non High Yielding Varieties.
HYV's = High Yielding Varieties.
Pooled = NHYV's + HYV's.
n.s. = not significantly different from unity.

Source: Basic data in Table 4.1.

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[1]The t-test follows the procedure documented by Bernard Ostle, op. cit., p. 45.

and HYV's are compared with the pooled data results for the respective provinces (Table 4.9). The F-test, as suggested by Johnston,[1] is again employed to determine if the estimated input-output relationships are significantly different from one another, as tabulated in Table 4.10.

The tests give an F-ratio of 29.04, 6.11 and 2.91 for Bali, NTB and NTT, respectively. These tests are significant at the one percent level for Bali and NTB and at the five percent level for NTT. Therefore, the results again indicate that the parameter estimates associated with the NHYV's and HYV's are significantly different from one another. Even at the provincial level, a shift from NHYV's to HYV's has resulted in a significant change in the output elasticities of the respective factors of production.

A more thorough assessment of the provincial input-output relationships for rice suggests the following:

1. For the provinces of NTB and NTT, the general magnitude and directional influence of virtually all of the variables (excluding labor) are consistent with *a priori* expectations. By and large, the role of capital inputs (including land) increases in importance with the introduction of HYV's. The shift is considerable. Moreover, the explanatory power of the variables considered (measured by the R^2) is generally better for the HYV's than it is for the NHYV's. These results are consistent with the regional results.

[1] Johnston, op.cit., pp. 136-138.

Table 4.9

Estimates of Production Function, by Varieties, and by Provinces Wet-Season 1977-78 and Wet-Season 1978-79

Provinces	Bali			Nusa Tenggara Barat			Nusa Tenggara Timur		
Rice Varieties	NHYV	HYV	Pooled	NHYV	HYV	Pooled	NHYV	HYV	Pooled
Degree of Freedom	58	162	224	125	50	179	113	35	151
Regression Number	I	II	III	IV	V	VI	VII	VIII	IX
Constant Term	2.1610	1.9751	1.6149	-0.0949	-1.1620	-1.1719	-0.2203	0.2216	-0.4305
Land	1.0812 * (0.1342) 82.44%	1.0269 * (0.0785) 79.51%	0.9218 * (0.0811) 76.97%	0.4449 * (0.0759) 59.41%	0.4954 * (0.0759) {88.55%}	0.3821 * (0.0677) {66.03%}	0.5439 * (0.0717) {87.17%}	0.7199 * (0.1266) {88.17%}	0.5244 * (0.0676) {86.65%}
Labor	0.5046 ** (0.1911) 1.66%	-0.5281 * (0.1099) 3.05%	---	---	-0.2181 ** (0.0839) {1.73%}	---	---	---	---
Bullock Labor	---	---	---	---	---	---	---	---	---
Fertilizer	---	0.2125 * (0.0638) 1.12%	0.2822 * (0.0623) 1.39%	---	0.3860 * (0.0763) {2.32%}	0.1941 * (0.0591) {1.55%}	0.2239 * (0.0386) {3.19%}	0.3193 * (0.1003) {2.66%}	0.2541 * (0.0362) {3.47%}
Capital Flow	---	---	---	---	0.2182 * (0.0781) {0.70%}	0.1604 *** (0.0860) {0.48%}	---	---	---
Current Inputs	-0.3934 * (0.1307) 2.13%	---	-0.2635 * (0.0910) 0.76%	0.4099 * (0.0826) {6.68%}	0.2553 ** (0.1256) {0.51%}	0.3565 * (0.0738) {7.38%}	0.1992 ** (0.0830) {0.47%}	---	0.2254 * (0.0743) {0.56%}
Standard Error of Estimate	0.1004	0.1115	0.1273	0.1405	0.0713	0.1316	0.1326	0.1345	0.1356
R^2	0.8622	0.8368	0.7914	0.6610	0.9382	0.7544	0.9082	0.9032	0.9087
F value	120.9695	276.8257	283.2549	131.8557	151.7308	137.4626	372.7926	173.2243	501.1356
F_s .05	2.76	2.60	2.60	3.07	2.37	2.37	2.68	3.32	2.60
F_s .01	4.13	3.78	3.78	4.79	3.34	3.32	3.95	5.39	3.78
T_s .05	2.00	1.96	1.96	1.98	2.00	1.96	1.98	2.02	1.96
T_s .01	2.60	2.57	2.57	2.61	2.66	2.57	2.61	2.70	2.57
Return to Scale	1.19	0.71	0.94	0.85	1.14	1.09	0.97	1.04	1.00

Notes: Numbers in parentheses are standard error of estimated coefficient b_i.
Percentages in square brackets are relative contribution of particular input.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV and HYV.

* = coefficients significant at 1 percent level.
** = coefficients significant at 5 percent level.
*** = coefficients significant at 10 percent level.

Table 4.10

Test of Equality of Regression Coefficients Between NHYV's and HYV's, Provinces of Bali, NTB and NTT, Wet-Season 1977-78 and Wet-Season 1978-79

Provinces	Sum of Squared Residuals			F-ratio	F-Statistic	Degree of Freedom
	NHYV	HYV	Pooled			
Bali	0.58489	2.01334	3.63058	29.04*	3.78	3 and 222
NTB	2.46889	0.25433	3.10158	6.11*	3.32	4 and 176
NTT	1.98726	0.63350	2.77452	2.91**	2.60	3 and 149

Notes:
NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieites.
Pooled = NHYV and HYV.
NTB = Nusa Tenggara Barat.
NTT = Nusa Tenggara Timur.
* = significant at 1 percent level.
** = significant at 5 percent level.

$$F \text{ ratio} = \frac{Q_3/k}{Q_2/(m+n-2k)}$$ [1]

where:

$Q_3 = Q_1 - Q_2$;
Q_1 = sum of squared residual of m + n obse
Q_2 = sum of squared of m observation plus sum squared of n observation.

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[1] See J. Johnston, op. cit., pp. 136-138.

2. Conversely, in the case of Bali, virtually all of the parameter estimates are contrary to *a priori* expectations. The output elasticity associated with land exceeds or approaches unity, the output elasticity for labor is unstable, and the impact of additional current inputs is negative. Comparing NHYV's, HYV's and pooled data results also suggests some further anomolies; the role of capital (including land) seemingly declines with the shift to HYV's. Furthermore, the R^2 for HYV's is lower than for NHYV's, again contrary to other provinces and *a priori* expectations.

To resolve these apparent "inconsistencies," more research is highly desirable. However, some tentative explanations can be advanced:

1. The conventional explanation of why the directional influence is contrary to *a priori* expectations is that the input is being used too intensively. In this case, the MPP is actually negative. The conflicting literature on the MPP of labor in traditional agriculture is well-documented.[1] The negative sign denotes a negative marginal productivity. This could be a result of the existence of an excessive labor supply in the agricultural sector due to lack of employment opportunities in other sectors of industry.

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[1] L.G. Reynolds, "Agriculture in Development Theory: An Overview," in L.G. Reynolds, Agriculture in Development Theory (New Haven: Yale University Press, 1975), pp. 11-14.

Heady and Dillon[1] point out that the negative MPP for human labor may be due to the fixity of family labor and the land tenure system, whereby farmers actually purchase a large proportion of their own product through their labor. However, it was surprising to note that in the case of NHYV's, in the wet-season 1977-79, the coefficient for human labor was positive and relatively large. The same was noted in the case of the pooled regression analysis.

2. A similar explanation can be advanced for capital inputs. Their use may be excessive. Bali may have excessively high irrigation fees. At any rate, it might be expected that the MRP of the limited irrigation infrastructure in NTB and NTT would, *ceteris paribus*, generally exceed the MPP of the much more adequate facilities on Bali. This idea was advanced by Prabowo and Sayogyo.[2]

3. In the final analysis, however, the reliability of the survey data must be re-examined. The data for Bali appears to be particularly suspect. The accurate measurement of on-farm labor requirements, for example, is obviously very difficult. Similarly, the estimation procedure employed may have generated unstable parameter estimates because of multicollinearity and/or data misspecification (see Appendices C.4.16 - C.4.26).

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[1]Heady and Dillon, op.cit., p. 27.

[2]Dibyo Prabowo and Sayogyo, "Changes in Rice Farming in Selected Areas of Asia, Case Study in Indonesia," in I.R.R.I., Changes in Rice Farming in Selected Areas of Asia (Manila: IRRI, 1975), p. 195.

4. With respect to (3) above, it is also important to note that the sample data indicate that NTT (which is the least developed province) had the highest mean input level of the three provinces considered here (Table 4.13). That is, the level of inputs (other than land) predictably tends to be proportional to farm size. This is reflected in government policy; the government's subsidized credit to rice farmers is allocated on the basis of farm size.[1]

In short, about all that is obvious is that NHYV's and HYV's respond differently to the respective inputs, and the nature of the response varies between Bali, NTB, and NTT. There are statistically and economically significant differences in the fundamental role of land, labor, and capital when using NHYV's versus HYV's in East Indonesia, and this also varies within the region. This is seen, not only through differences between parameter estimates, but also through differences in the intercept term in each regression. In general, the larger the intercept term, the less responsive output is to a change in the respective inputs.

Subsequent research should respecify the model to circumvent these and other possible biases in the sample data.

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[1]Most of the farmers are dependent on subsidized government credit in their rice farming. For the study area, about 63 percent of the rice farmers depend on this credit (about 72.37 percent in the province of Bali, 59.12 percent in the province of Nusa Tenggara Barat, and 58.71 percent in the province of Nusa Tenggara Timur).

Resource Use Efficiency

Resource use efficiency at the provincial level is evaluated by again looking at the ratio:

$$\frac{MPPx_i \cdot Py}{MFCx_i} \gtreqless 1$$

Estimates of $MPPx_i$ are calculated at their geometric mean. The provincial geometric means are tabulated in Table 4.11. The corresponding MPP's are indicated in Table 4.12.

In Bali, the MPP of land for HYV's is higher than the MPP of land for NHYV's by about 25 percent. The same result is found for human labor and fertilizer.

A zero MPP for bullock days, capital and other current input indicate the apparent insignificance of these particular inputs in the production process. In turn, this would seemingly suggest another obvious misallocation of resources in Bali. This is similarly true of current inputs for NHYV's which apparently have a negative MPP. As noted previously, however, these anomalies may prevail because of data inconsistencies, institutional constraints, or numerous other reasons.

The MVP of each input for each province is presented in Table 4.13. The MVP of each individual input is found by multiplying the MPP of the respective inputs by the average price of rice per quintal. The average price of gabah is taken at its geometric mean, as presented in Table 4.14.

The ratio of the MVP to its acquisition cost (See Table 4.16) is presented in Table 4.15. These ratios are

Table 4.11

Geometric Means of Particular Inputs and the Corresponding Output, by Provinces, Wet-Season 1977-78 and Wet-Season 1978-79

Provinces	Varieties	Land (ha)	Human Labor (Man days)	Bullock Labor (bullock days)	Fertilizer (000 Rphs)	Capital Flow (000 Rphs)	Current Input (000 Rphs)	Output (Quintals)
Bali	NHYV	0.48	104.4	14.8	6.711	2.419	9.477	18.83
	HYV	0.50	107.3	13.8	7.720	2.584	9.921	25.70
Nusa Tenggara Barat	NHYV	0.63	197.3	21.2	8.065	2.224	8.871	27.25
	HYV	0.72	194.9	23.8	10.344	2.565	13.098	41.05
Nusa Tenggara Timur	NHYV	1.20	168.7	27.2	11.584	2.721	10.051	33.85
	HYV	1.74	202.3	27.1	22.303	3.066	13.804	60.63

Note: ha = hectare.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.

Table 4.12

Marginal Physical Product (MPP)
at Geometric Mean,
Wet-Season 1977-78 and Wet-Season 1978-79

Province	Varieties	Land	Human Labor	Bullock Labor	Ferti- lizer	Capital Flow	Current Input
Bali	NHYV	42.42	0.09	---	---	---	-0.78
	HYV	52.78	0.13	---	0.46	---	---
NTB	NHYV	19.25	---	---	---	---	0.26
	HYV	28.24	0.05	---	1.53	3.45	0.68
NTT	NHYV	15.34	---	---	0.65	---	0.67
	HYV	25.08	---	---	0.87	---	---

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
NTB = Nusa Tenggara Barat.
NTT = Nusa Tenggara Timur.

Table 4.13

Marginal Value Product (MVP) of Input
By Province, Wet-Season 1977-78 and Wet-Season 1978-79

Province	Varieties	Land	Human Labor	Bullock Labor	Ferti- lizer	Capital Flow	Current Input
Bali	NHYV	306,442	650.16	---	---	---	-5,635
	HYV	372,046	916.37	---	3,243	---	---
NTB	NHYV	162,085	---	---	---	---	10,609
	HYV	215,867	382.20	---	11,695	26,346	5,198
NTT	NHYV	151,053	---	---	6,401	---	6,597
	HYV	228,679	---	---	7,933	---	---

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
NTB = Nusa Tenggara Barat.
NTT = Nusa Tenggara Timur.

Table 4.14

Average Price of Rice (Gabah) in the
Provinces of Bali, Nusa Tenggara Barat and Nusa Tenggara Timur
(in Rupiahs per Quintal)

Province	Non-High Yielding Varieties	High Yielding Varieties
Bali	7,224	7,049
Nusa Tenggara Barat	8,420	7,644
Nusa Tenggara Timur	9,847	9,118

Table 4.15

Ratios of Marginal Value Product to Marginal Factor Cost, by Provinces, Wet-Season 1977-78 and Wet-Season 1978-79

Provinces	Varieties	Land	Human Labor	Bullock Labor	Ferti-lizer	Capital Flow	Current Input
Bali	NHYV	3.06*	1.18*	---	---	---	-5.64*
		(0.80)	(0.45)				(1.88)
	HYV	3.72*	1.67*	---	3.24**	---	---
		(0.57)	(0.34)		(1.50)		
Nusa Tenggara Barat	NHYV	1.75*	---	---	---	---	10.61*
		(0.30)					(2.14)
	HYV	2.33*	0.76*	---	11.70*	10.27ns	5.20ns
		(0.83)	(0.27)		(2.59)	(9.56)	(3.01)
Nusa Tenggara Timur	NHYV	1.78*	---	---	6.40*	---	6.60**
		(0.23)			(1.11)		(2.75)
		2.69*	---	---	7.93*	---	---
		(0.47)			(2.49)		

Notes: Numbers in parentheses are the standard errors of the ratios.

* = significant difference from unity at 1 percent level.

** = significant difference from unity at 5 percent level.

ns = no significant difference from unity.

Table 4.16

Acquisition Cost of Input Factors by Province

Province	Land (Rphs/ha)	Human Labor (Rphs/day)	Bullock Labor (Rphs/day)	Fertilizer (Rphs/unit)	Capital Flow (Rphs/unit)	Current Input (Rphs/unit)
Bali	100,000	550	1,375	1,000	1,000	1,000
NTB	92,500	500	1,375	1,000	1,000	1,000
NTT	85,000	450	1,125	1,000	1,000	1,000

Notes: Rph = Rupiah, Indonesian Currency.
ha = hectare.
NTB = Nusa Tenggara Barat.
NTT = Nusa Tenggara Timur.

tested against unity, using the t-test. The results of the t-test indicate that almost all the ratios are significantly different from unity. Only a few are not significantly different from unity, such as capital flow and other current inputs for HYV's in NTB. These findings suggest that there are a relatively large number of major resource inefficiencies in each of the provinces in East Indonesia. Although labor and (to a lesser extent) land are apparently used relatively efficiently, other inputs are generally very under-utilized, with the possible exception of current inputs in Bali, which are seemingly over-utilized. These findings are generally consistent with the observation that the most "advanced" capital intensive agriculture is found in Bali whereas NTT has the most "primitive" agriculture and associated infrastructure.

In short, different levels of development are seemingly characterized by very different kinds of resource inefficiencies. These apparent inefficiencies may well be correlated with social, cultural, and institutional constraints which persist in the respective provinces.

Returns to Scale

In the first section of this chapter, the analysis indicated that constant returns to scale generally seem to characterize farms in East Indonesia. In this section, an attempt is made to examine the validity of this finding on a regional basis. Returns to scale are again indicated by the sum of regression coefficients, as presented in Table 4.9.

When the separate provincial results are examined, constant returns to scale are found in almost all cases. However, for HYV's in Bali, the summation of the respective output elasticities is less than unity, signifying decreasing returns to scale (Table 4.17).

In the Bali case, two out of three cases were found to be less than one. Only one of them is significantly different from unity at the 10 percent level, and even this is not significantly different from unity at the 5 percent level.

On NTB farms, a similar situation prevails. The t-tests indicate that they are not significantly different from unity. The same result is found in the case of NTT farms.

Thus, one can conclude that East Indonesian farms generally exhibit constant returns to scale, with the possible exception of HYV's in Bali. This unexpected finding could be the result of excluding one or more inputs from the analysis. Other current inputs, capital flow, bullock labor and management are all excluded from the input-output relationships estimated in Table 4.9. The exclusion of these inputs leads to under-estimation of returns to scale.[1]

Before concluding that decreasing returns to scale characterize HYV's in Bali, additional studies are recommended.

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[1]Heady and Dillon, <u>op.cit.</u>, p. 230.

Table 4.17

Returns to Scale, by Province,
Wet-Season 1977-78 and Wet-Season 1978-79*

Provinces	Varieties	The Sum of Coefficients	Return to Scale Indicated by the T-Test
Bali	NHYV	1.19^{ns}	Constant
	HYV	0.71^{s}	Decreasing
	Pooled	0.94^{ns}	Constant
Nusa Tenggara Barat	NHYV	0.85^{ns}	Constant
	HYV	1.14^{ns}	Constant
	Pooled	1.05^{ns}	Constant
Nusa Tenggara Timur	NHYV	0.97^{ns}	Constant
	HYV	1.04^{ns}	Constant
	Pooled	1.00	Constant

Notes: NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV plus HYV.

s = significantly different from unity at the 10 percent level.
ns = not significantly different from unity.

*Calculated from Table 4.9.

Production Variability Over Time

In the preceding two sections of this chapter, the nature of the production function estimates for different varieties (NHYV's and HYV's) were presented on a regional and intraregional basis. This section examines how the production function may be changed over time, i.e. wet-season 1977-78 versus wet-season 1978-79. Table 4.18 presents the estimated production function for both seasons for the study area as a whole.

In order to examine the shift of production function from NHYV's to HYV's in the wet-season 1977-78, regressions I and II were compared with pooled regression III. For the wet-season 1978-79, regression coefficients IV and V were compared to pooled regression VI. The equality of the regression coefficients between NHYV's and HYV's in each year has been tested using an F-test. The results give F-ratios of 9.31 and 21.83 for 1977-78 and 1978-79 respectively. The two F-ratios are both significantly different from zero at the one percent level (Table 4.19).

These results imply that the hypothesized equality of the regression coefficients between NHYV's and HYV's should be rejected in either year. The results also differences in the slope coefficients between NHYV's and HYV's production functions for both seasons.

Table 4.18

The Estimates of Production Function, Study Area Wet-Season 1977-78 and Wet-Season 1978-79

Year	Wet-Season 1977-78			Wet-Season 1978-79		
Rice Varieties	NHYV	HYV	Pooled	NHYV	HYV	Pooled
Degree of Freedom	212	152	369	86	100	189
Regression Number	I	II	III	IV	V	VI
Constant Term	-0.7421	-0.2449	-0.6500	0.0813	-0.8855	-1.3049
Land	0.4188 * (0.0532) [75.76%]	0.6222 * (0.0665) [85.43%]	0.4709 * (0.0384) [77.02%]	0.4965 * (0.0551) [86.26%]	0.3657 * (0.1097) [32.39%]	0.2441* (0.0823) [76.93%]
Labor	0.0966 *** (0.0553) [0.26%]	---	---	0.2313 * (0.0326) [0.92%]	---	0.1678** (0.0809) [3.56%]
Bullock Labor	---	---	---	---	---	---
Fertilizer	0.1721 * (0.0435) [1.43%]	0.2536 * (0.0520) [1.96%]	0.2130 * (0.0334) [1.87%]	0.2310 * (0.0516) [2.73%]	0.2744 * (0.1040) [1.03%]	0.3265* (0.0480) [3.56%]
Capital Flow	---	---	---	---	---	---
Current Expenses	0.3404 * (0.0675) [4.88%]	0.2084 * (0.0677) [0.74%]	0.3341 * (0.0465) [4.63%]	---	0.3451 * (0.1385) [1.75%]	0.2892* (0.1013) [0.89%]
Standard Error of Estimate	0.1515	0.1186	0.1429	0.0963	0.1192	0.1310
R^2	0.8232	0.8813	0.8351	0.8991	0.8517	0.8179
F value	246.7803	376.2254	623.0009	255.3313	191.4551	212.2565
F_s .05	2.37	2.60	2.60	2.68	2.69	2.37
F_s .01	3.32	3.78	3.78	3.95	3.95	3.32
T_s .05	1.96	1.96	1.96	2.00	1.98	1.96
T_s .01	2.58	2.58	2.57	2.66	2.62	2.58
Return to Scale	1.03	1.08	1.02	0.96	0.99	1.03

Notes: Numbers in parentheses are the standard errors of the estimated coefficients b_i; Percentages in square brackets are the relative contribution of particular inputs to rice output.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV plus HYV.
* = coefficients significant at 1 percent level.
** = coefficients significant at 5 percent level.
*** = coefficients significant at 10 percent level.

Table 4.19

Test of Equality of Regression Coefficients, Study Area, 1977-78 and 1978-79

Year	Sum of Squared Residual			F-ratio	F-Statistics	Degree of Freedom
	NHYV	HYV	Pooled			
1977-78	4.86571	2.13614	7.53628	9.31*	3.73	3 and 367
1978-79	0.79706	1.42019	3.24369	21.83*	3.32	4 and 186

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties
Pooled = NHYV plus HYV
* = significant at the 1 percent level.

$$\text{F-ratio} = \frac{Q_3/k}{Q_2/(m + n - 2k)}$$ [1]

where:
$Q_3 = Q_1 - Q_2$
Q_1 = sum of squared residual of m + n observation
Q_2 = sum of squared of m observation plus sum of squared of n observation

[1] See J. Johnston, op.cit., pp. 136-138.

Looking at relative factor contributions, the land output elasticity is significant at the one percent level in all cases in both periods. Land is consistently the greatest contributor to rice output compared with the other inputs. In the production function for 1977-78, land contributes 75.76 percent for NHYV's and 85.43 percent for HYV's. The land contribution ranges from about 82 percent to 86 percent in the wet-season 1978-79.

The output elasticities of other current inputs are only significant at the one percent level for HYV's. For NHYV's in the wet-season 1978-79, the output elasticity for current inputs is not significantly different from zero, even at the 20 percent probability level.

The human labor coefficient is significant only for the NHYV's and, surprisingly, not significant for HYV's. In other words, once again it seemingly made a zero contribution to the rice output of HYV's. Nor are the output elasticities for bullock labor and capital flow significantly different from zero in either year, even at the 20 percent level. Consequently, these two inputs are not included in the subsequent analysis of resource use efficiency.

It must be recognized, however, that a non-significant input may not really have a zero Marginal Physical Product; it may just be very low.[1] This may be especially true in the traditional agriculture characteristic of East Indonesia.

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[1] See Schultz, op.cit., p. 52.

An increase in the constant term indicates a neutral technological change. A neutral technological change is also indicated by a shift in the summation of the output elasticities. Conversely, a non-neutral technological change is depicted by a variation of the ratio of those output elasticities in the regression.[1]

In this inter-temporal comparison, very little additional information regarding the nature of the technological change which is taking place is in evidence. As pointed out previously, non-neutral technological change is occurring as farmers shift from NHYV's to HYV's. This is illustrated by the intra-year differences in both the constant term and the respective output elasticities. However, the inter-year comparisons do not consistently illustrate the dynamics of this change. To capture this temporal shift, it is suggested that future research: (a) employ sample data for a longer time frame; and, (b) introduce climate and other environmental factors into the analysis.

The short time-frame also limits our analysis of resource efficiency over time. Nevertheless, a number of observations can be made:

1. The Marginal Value Products of the various inputs appear to fluctuate considerably from one season to the next.

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[1]Murray Brown, <u>On the Theory and Measurement of Technological Change</u> (Cambridge: University Press, 1966), p. 39.

2. Irrespective of (1), the ratio of Marginal Value Products to Factor Cost (MVP/FC) generally appears to be greater than unity, except for labor. Once again, this suggests that resource inefficiencies persist.
3. There is some evidence that, *expost*, farmers react rationally. For example, in the wet-season 1977-78 in the NHYV's case, the MVP/FC ratio for labor was less than unity. Thus, farmers acted rationally by reducing human labor inputs from 169.7 man-days in the wet-season 1977-78 to 149.3 man-days in the wet-season 1978-79. This rationing brought the Marginal Value Product of labor nearer to its acquisition cost in 1978-79. Further details are provided in Appendices C.4.1 to C.4.4.

With respect to returns to scale over time (see Appendix C.4.7), the variations in the sum of the coefficients from year to year are also provided. However, the t-test again indicates variations are not significantly different from unity.

This finding is consistent with the preceding analysis on returns to scale on a regional basis as well as on an intraregional basis. There is little doubt that constant returns to scale generally characterize traditional agriculture in East Indonesia.

Summary

Summary estimates of the production functions for both NHYV's and HYV's in each province over time are provided in Tables 4.20, 4.21, and 4.22. The respective F-tests are tabulated in Table 4.23.

Final Comments

Although the evidence is not overwhelming, the analysis generally supports the following very tentative conclusions:

1. Land, fertilizer, and other current expenses are principal inputs in the production of both HYV's and NHYV's. Labor, animal power, and capital flows are not generally very significant.
2. There is a distinct shift in the input-output relationship as farmers shift from NHYV's to HYV's. Most inputs are used more intensively and there is a modest shift towards land and other capital goods. That is, the HYV's technology is modestly biased against labor but this non-neutral shift in favor of capital is being neutralized by the more intensive use of all factors of production.
3. Resources are used relatively inefficiently. Generally, capital inputs (including land) are under-utilized; labor inputs (including bullock labor) are over-utilized.

Table 4.20

The Estimate of Production Function, Bali, by Varieties Wet-Season 1977-78 and Wet-Season 1978-79

Year	Wet-Season 1977-78			Wet-Season 1978-79		
Rice Varieties	NHYV	HYV	Pooled	NHYV	HYV	Pooled
Degree of Freedom	35	106	145	21	50	76
Regression Number	I	II	III	IV	V	VI
Constant Term	3.1503	2.1415	1.7919	0.4190	7.5789	3.3702
Land	1.2422 * (0.1660) [83.51%]	1.0954 * (0.1209) [81.15%]	1.0065 * (0.0893) [80.97%]	0.6939 * (0.0917) [84.24%]	1.7256 * (0.1400) [81.09%]	1.1344 * (0.1585) [68.83%]
Labor	---	-0.3241 ** (0.1339) [0.73%]	---	0.5252 *** (0.0264) [2.49%]	-0.8165 * (0.1450) [4.75%]	---
Bullock Labor	---	---	---	---	---	---
Fertilizer	---	0.2878 * (0.0677) [2.74%]	0.2677 * (0.0604) [1.64%]	---	-0.5080 * (0.1430) [2.17%]	---
Capital Flow	---	---	---	---	0.5668 * (0.1291) [2.77%]	---
Current Inputs	-0.3699 ** (0.1708) [1.95%]	-0.2193 *** (0.1138) [0.52%]	-0.2906 * (0.0999) [0.9%]	---	---	-0.4027 *** (0.2021) [1.55%]
Standard Error of Estimate	0.1135	0.1098	0.1168	0.0847	0.0756	0.1406
R^2	0.8546	0.8515	0.8357	0.8674	0.9140	0.7037
F value	102.8734	151.8860	245.8763	68.6728	132.7705	90.2608
F_s .05	3.23	2.45	2.60	3.47	2.53	3.15
F_s .01	5.18	3.48	3.78	5.78	3.65	4.98
t_s .05	2.02	1.98	1.96	2.08	2.00	2.00
t_s .01	2.70	2.62	2.58	2.83	2.66	2.66
Return to Scale	0.87	0.84	0.98	1.22	0.97	0.73

Notes: - Numbers in parentheses are standard error of estimated coefficients b_i; Percentages in square brackets are relative contribution of particular input.

NHYV = Non High Yielding Varieties.
HYV = High Yielding Varieties.
Pooled = NHYV plus HYV.

* = coefficients significant at 1 percent level;
** = coefficients significant at 5 percent level;
*** = coefficients significant at 10 percent level.

Table 4.21

The Estimates of Production Function, Nusa Tenggara Barat, by Varieties
Wet-Season 1977-78 and Wet-Season 1978-79

Year	Wet-Season 1977-78			Wet-Season 1978-79		
Rice Varieties	NHYV	HYV	Pooled	NHYV	HYV	Pooled
Degree of Freedom	91	22	116	30	23	60
Regression Number	I	II	III	IV	V	VI
Constant Term	-0.1240	0.3039	-0.7746	0.0735	1.6280	-2.2048
Land	0.4226 * (0.1079) {4.09%}	0.7807 * (0.1062) {87.70%}	0.3626 * (0.0889) {5.68%}	0.5133 * (0.1387) {73.44%}	0.9322 * (0.0427) {96.08%}	0.3409 ** (0.1326) {3.16%}
Labor	-0.1819 *** (0.0929) {1.33%}	---	---	---	---	---
Bullock Labor	---	---	---	---	0.1068 *** (0.0558) {0.45%}	---
Fertilizer	---	0.3402 * (0.0904) {4.82%}	0.2075 * (0.0694) {2.07%}	---	---	---
Capital Flow	---	---	---	---	---	0.2960 *** (0.1605) {1.00%}
Current Inputs	0.5296 * (0.1006) {63.04%}	---	0.3796 * (0.1010) {65.48%}	0.3584 *** (0.1934) {2.73%}	---	0.6795 * (0.1561) {78.19%}
Standard Error of Estimate	0.1463	0.0914	0.1457	0.0916	0.0453	0.1004
R^2	0.6837	0.9252	0.7322	0.7617	0.9653	0.8234
F value	65.5794	136.0631	105.7038	47.9341	389.8870	93.2684
F_s .05	2.76	3.44	2.68	3.32	3.34	2.76
F_s .01	4.13	5.72	3.95	5.39	5.45	4.13
T_s .05	1.98	2.07	1.98	2.04	2.05	2.00
T_s .01	2.62	2.82	2.62	2.75	2.76	2.66
Return to Scale	0.77	1.12	0.95	0.98	1.04	1.32

Notes: Numbers in parentheses are standard error of estimated coefficients b_i;
Percentages in square brackets are relative contribution of particular input;

NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties
Pooled = NHYV plus HYV

* = coefficients significant at 1 percent level;
** = coefficients significant at 5 percent level;
*** = coefficients significant at 10 percent level.

Table 4.22

Estimates of Production Function, Nusa Tenggara Timur, Wet-Season 1977-78 and Wet-Season 1978-79

Year	Wet-Season 1977-78			Wet-Season 1978-79		
Rice Varieties	NHYV	HYV	Pooled	NHYV	HYV	Pooled
Degree of Freedom	79	16	100	30	14	47
Regression Number	I	II	III	IV	V	VI
Constant Term	0.6547	-0.0242	-0.6908	0.4465	-2.7374	-0.4249
Land	0.5028 * (0.0908) {87.41%}	0.4184 *** (0.3088) {92.24%}	0.5126 * (0.0870) {87.82%}	0.6109 * (0.0654) {78.22%}	---	0.4143 * (0.1083) {3.52%}
Labor	---	---	---	---	0.3623 *** (0.2295) {0.09%}	0.3328 ** (0.1525) {78.02%}
Bullock Labor	---	-0.5622 ** (0.2386) {17.84%}	---	---	---	---
Fertilizer	0.1726 * (0.0518) {2.38%}	---	0.1890 * (0.047[illegible]) {2.39%}	0.2620 * (0.0564) {9.12%}	0.4104 * (0.1205) {5.90%}	0.3025 * (0.0591) {7.18%}
Capital Flow	---	---	---	---	---	---
Current Inputs	0.3642 * (0.1303) {0.91%}	0.9011 ** (0.3665) {0.06%}	0.3612 * (0.1178) {0.62%}	---	0.4446 *** (0.2454) {87.94%}	---
Standard Error of Estimate	0.1415	0.1137	0.1422	0.0996	0.1044	0.1135
R^2	0.9071	0.9471	0.9103	0.8734	0.9478	0.8871
F value	260.2185	95.4720	338.3044	103.4432	84.6408	123.0680
F_s .05	2.76	[illegible].24	2.68	3.32	3.34	2.84
F_s .01	4.13	5.29	3.95	5.39	5.56	4.31
T_s .05	2.00	2.12	1.98	2.04	2.15	2.02
T_s .01	2.66	2.92	2.61	2.75	2.98	2.70
Return to Scale	1.04	0.76	1.06	0.87	1.22	1.05

Notes: Numbers in parentheses are standard error of estimated coefficients b_i;
Percentages in square brackets are relative contribution of particular input.

NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties
Pooled = NHYV plus HYV
* = coefficients significant at 1 percent level;
** = coefficients significant at 5 percent level;
*** = coefficients significant at 10 percent level;

Table 4.23

Test of Equality of Regression Coefficients
Provinces of Bali, NTB and NTT, 1977-78 and 1978-79

Province	Wet Season	Sum of Squared Residual			F-ratio	F-statistics	Degree of Freedom
		NHYV	HYV	Pooled			
Bali	1977-78	0.45090	1.27742	1.97784	6.85*	3.78	3 and 143
	1978-79	0.15047	0.28598	1.50171	91.53*	4.98	2 and 75
Nusa Tenggara Barat	1977-78	1.94739	0.18376	2.46272	5.91*	3.78	3 and 114
	1978-79	0.25157	0.05735	0.60490	18.84*	4.13	3 and 58
Nusa Tenggara Timur	1977-78	1.60090	0.20688	2.02212	3.87**	2.68	3 and 98
	1978-79	0.29737	0.15270	0.60490	5.16*	4.31	3 and 45

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties
Pooled = NHYV plus HYV
* = significant at 1 percent level
** = significant at 5 percent level

$$F \text{ ratio} = \frac{Q_3/k}{Q_2/(m+n-2k)}$$ [1]

where:
$Q_3 = Q_1 - Q_2$
Q_1 = sum of squared residual of m + n observation
Q_2 = sum of squared of m observation plus sum squared of n observation

[1] See J. Johnston, op.cit., pp. 136-138.

4. Constant returns to scale generally characterize agriculture in East Indonsia, irrespective of the location or technology employed.
5. The input-output relationships for irrigated rice in East Indonesia are unique to each variety and province in the region. Each season is also characterized by a unique input-output relationship.

Despite these findings (which are consistent with *a priori* expectations), two principal anomalies persist:

1. The most perplexing is the empirical evidence that suggests a complementary factor of production has a zero or even negative Marginal Physical Product. The research on this topic is already extensive, particularly with respect to labor.[1] For example, Heady and Dillon point out that the negative sign of human labor coefficient may be due to the fixity of family labor and land tenure. In this situation, farmers actually purchase a large proportion of their own product through their labor. The negative human labor coefficients may also be the result of over-estimating labor use (at least at the time when the interviews were conducted). A negative coefficient for human labor has also been reported in other studies.[2]

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[1] Heady and Dillon, op.cit., p. 27.

[2] See Ibid.; and see also E.O. Heady, "Production Functions from a Random Sample of Farms," Journal of Farm Economics, Vol. 28(4), (November 1946), p. 994.

2. The apparent inefficiencies in existing resource use (which, in some cases, are relatively large) are also questionable. Are farmers in East Indonesia really as inefficient as this analysis might suggest? Probably not, because capital costs (including land) are likely under-estimated, whereas labor costs are likely over-estimated. Actual financial prices (rather than indirect shadow prices) were employed. In addition, factor supply variability, infrastructure constraints (including irrigation facilities), and institutional constraints (legal-social-cultural) all serve to indirectly alter the real cost of production. These variables, for the most part, are ignored. Finally, risk and uncertainty are not explicitly considered in the analysis. If this factor is ignored, the ratio MVP/MFC would logically exceed unity. The apparent output variability in two consecutive years (due to climate, etc.) illustrates the need to explicitly consider risk and uncertainty in the analysis, even in a static framework.[1]

At the same time, it is readily apparent that the sample data constraints, as well as a number of methodological limitations, may have impinged on the usefulness of the empirical analysis conducted in the preceding:

1. The sample data have a number of limitations;

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[1] A similar argument was made by Kazuo Saito, "On the Green Revolution," Developing Economics, Volume 9(1), (March 1971), pp. 16-30.

a) In all likelihood, it was impossible to completely avoid some errors or biases, particularly those due to the respondents as well as the enumerators.

b) There is a dearth of secondary data on traditional small-holder farms, which persists for several reasons. Small scale holders are not well organized and most small farm operators do not keep any records.

c) The sample villages were purposely chosen to represent the irrigated rice areas in the region.

d) Only two periods of wet-season data were collected due to the limited time and budget available.

The data for Bali are particularly suspect due to the result contrary to *a priori* expectations.

2. Aside from (1), there are also a number of methodological issues concerning the specification of variables, the functional form, and the estimation technique employed which deserve the attention of subsequent researchers.

One issue surrounds the proper qualifications of some of the variables already alluded to: risk and uncertainty, climate, public infrastructure (irrigation facilities, extension, etc.), asset level (stock versus flow), and others.

Another problem is how to circumvent multi-collinearity amongst the independent variables, particularly when, by definition, the independent variables represent a "package" of complementary inputs. This is exacerbated by official government policy which ties subsidized farm credit and other inputs to farm size. The extent of this complementarity is indicated by the simple correlation coefficients calculated in Appendix C (Tables C.4.15-C.4.26). Simple correlation coefficients in excess of 0.8 (e.g., land and other current inputs) may generate unstable (although unbiased and efficient) parameter estimates.[1] At the same time, it has been suggested that multicollinearity is not really a serious problem unless it is highly relative to the overall multiple correlation for all variables.[2] Using this criterion, with multiple correlation coefficients ranging from .85 to .97, the study estimates can at least be accepted as being efficient. These comments should help to put the empirical results in perspective.

[1] Heady and Dillon, op.cit., pp. 115-136.

[2] Lawrence R. Klein, An Introduction to Econometrics, (Englewood Cliffs, New Jersey: Prentice Hall, 1962), p. 101.

CHAPTER V

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

Summary

This study focuses on the small farm production relationships for rice in East Indonesia. The production function for both NHYV's and HYV's is examined. Sample data for three provinces were collected during the wet-season 1977-78 and the wet-season 1978-79. The three provinces are: Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT). In total, some 567 farmers were interviewed.

The principal objectives of the study were:

1. To describe and analyse the pertinent interrelationships which exist between rice production (output) and the various factors of production (inputs) for both Non-High Yielding Varieties (NHYV's) and High Yielding Varieties (HYV's).
2. To analyse the nature of the shift in the production function from Non-High Yielding Varieties (NHYV's) to High Yielding Varieties (HYV's).
3. To investigate resource use efficiency at the farm level for both Non-High Yielding Varieties (NHYV's) and High Yielding Varieties (HYV's).

4. To investigate the return to scale in rice farming with both Non-High Yielding Varieties (NHYV's) and High Yielding Varieties (HYV's).

Thus, the hypotheses to be tested were the following:

1. That there are statistically and economically significant differences in the fundamental role of land, labor, fertilizer, other current inputs, and capital when using Non-High Yielding Varieties (NHYV's) versus High Yielding Varieties (HYV's) in East Indonesia, and that these also vary within the region.
2. That the technological change is a non-neutral type and is biased toward modern input usage and less labor-intensive production techniques.
3. That there are existing resource use inefficiencies in both High Yielding Varieties (HYV's) and Non-High Yielding Varieties (NHYV's).
4. That rice farms in East Indonesia exhibit constant returns to scale irrespective of the technology employed.

The choice of variables in the hypothesized production relationships is based on the theory of production and *a priori* knowledge of the factors which appear to affect rice production in the study area. The basic model is:

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} \exp. U$$

The variables X_1 to X_6 in the equation are land, human labor, bullock labor, fertilizer, other current inputs, and capital flow, respectively.

A Cobb-Douglas production model is employed and the analysis is conducted at three levels.

1) Regional,

2) Provincial,

3) Temporal.

Consistent with the hypotheses, the analysis at each level focused on factor use, resource use efficiency, and returns to scale.

The resulting empirical estimates indicate that land, fertilizer, and other current inputs (seed, pesticides, and irrigation fees) are statistically significant in almost every regression. In constrast, human labor, bullock labor and capital flow are significant in only a few regressions. The impact of these inputs varies between provinces and varieties. The variables included in the equations accounted for .80 to .91 of total explained variation in the estimated production relationships.

The nature of the recent technological change in rice production is examined by looking at the relative output elasticities for the respective sample farms (HYV's versus NHYV's). The results indicate that the HYV's coefficients are significantly higher than NHYV's coefficients. From this result, it was also possible to conclude that non-neutral technological change is in progress. With the shift from NHYV's to HYV's, there is an apparent shift toward a relatively more capital intensive technology; a shift which encourages the use of fertilizers, land and other current inputs and discourages the use of labor. The adoption of the HYV's has shifted the production function non-neutrally upward.

The analysis of resource use efficiency shows varying tendencies for different groups of growers. NHYV's growers, for example, appear efficient in allocating labor resources but less efficient with other resources. However, all growers have apparently failed to allocate land, fertilizer, and other current inputs efficiently. The use of some inputs appears to be in excess of the optimum level in a few instances, particularly Bali. In most cases, however, capital inputs are seemingly under-estimated.

HYV's growers spend more for modern inputs per hectare than the NHYV's growers. The employment of labor varies among groups of growers among provinces. Less human labor employment relative to output is indicated on HYV's in Bali and Nusa Tenggara Timur, and less bullock labor on HYV's in Nusa Tenggara Barat.

The analysis of farm scale indicates that eastern Indonesian farmers generally exhibit constant returns to scale.

Conclusions

The study data enable the following conclusions to be drawn:

1. The statistically and economically significant differences in the fundamental role of land, fertilizer, other current inputs, capital flow, and labor (including bullock labor) between NHYV's versus HYV's satisfy *a priori* expectations in Nusa Tenggara Barat and Nusa Tenggara Timur. By and large, the role of capital inputs (including land) increases in importance with the introduction of HYV's. The shift is considerable. Moreover, the explanatory power of the variables considered is generally better for the HYV's than it is for the NHYV's.
2. In the case of Bali, several parameter estimates are contrary to *a priori* expectations. The output elasticity of land approaches (or exceeds) unity, the output elasticity of labor is unstable, and the impact of additional current inputs is negative. The role of capital appears to decline with the shift to HYV's.
3. Land, fertilizer, and other current expenses are principal inputs in the production of both HYV's and NHYV's. Labor, animal power, and capital flows are not generally as important.
4. There is a distinct shift in the input-output relationship as farmers shift from NYYV's to HYV's. Most inputs are used more intensively and there is a modest shift

towards land and other capital inputs. That is, the HYV's technology is modestly biased against labor but this non-neutral shift in favor of capital is being neutralized by the more intensive use of all factors of production.

5. The inter-temporal comparison provides little additional information regarding the nature of the technological change which is taking place. As indicated above, non-neutral technological change is occuring as farmers shift from NHYV's to HYV's. This shift is suggested by the intra-year differences in both the constant term and the respective output elasticities, rather than by year-to-year differences over the two year time span.

6. The input-output relationships for irrigated rice in East Indonesia are unique to each variety and province in the region. Each season is also characterized by a unique input-output relationship.

7. Resources are used relatively inefficiently. Generally, capital inputs (including land) are under-utilized; labor inputs (including bullock labor) are over-utilized. These apparent differences may well be due to: data defficiencies; risk and uncertainty; input supply constraints; social, cultural, and institutional constraints; or other unidentified characteristics of the region.

8. Constant returns to scale generally characterize agriculture in East Indonesia, irrespective of the location or technology employed.

Policy Implications

Knowledge of the parameters of the technical relationships which determine resource allocation in agriculture would be extremely useful in designing a national strategy to achieve increases in agricultural output. However, it is possible to summarize the many factors which contribute to changes in rice production in terms of the changes in the effective area planted, and changes in yield.

Some implications for policy which can be derived from the results of the study are:

1. The significant upward shift in the production function by using HYV's instead of NHYV's suggests that higher production and productivity are attainable by enhancing the rate of expansion of the HYV's. This can be facilitated by augmenting the "package" of modern inputs, such as fertilizer, pesticides, etc., with more intensive extension services and improvement of irrigation facilities.
2. The empirical evidence suggests that constant returns to scale prevail in East Indonesian agriculture. This finding implies that a one percent increase in the use of all factors of production will also cause output to increase by approximately one percent.
3. The analysis of resource use efficiency indicates a number of inefficiencies in the use of factor inputs for rice production in East Indonesia. This implies that a reallocation of resources could have a significant

impact on production. However, the improvement of the quality of factors of production, specifically the wider use of HYV's, seems to be a more appropriate strategy for increasing rice production in East Indonesia.

4. The increase in expenditures for the new rice technology shows an increasing awareness of East Indonesian farmers of the importance of adopting modern inputs. The increase in the mean expenditures for modern inputs seem to be the result of a "package" of modern inputs available to farmers. Making available low-cost inputs at the farm level encourages adoption of new rice technology. However, the extent to which production gains have been due to good programs or good weather is not resolved by data presented here.

5. The new rice technology is responsive to reliable water supplies. Thus, a development of irrigation systems is a prerequisite to the introduction and application of modern rice technology and to increased land productivity. The further improvement in irrigation may also create the potential for an additional crop.

6. The existence of an excess labor supply is indicated by its negative or low marginal productivity. The negative marginal productivity of human labor may be due to the fixity of family labor and land tenure. In this situation, farmers actually purchase a large proportion of their own product through their labor. Possible means to resolve this problem include opening up new land for

agriculture, and the accompanying development of more irrigation facilities.

The negative human labor coefficients may also be the result of over-estimating labor use. This and related data-based explanations suggest care is needed in policy prescription and that significant pay-offs may exist to further refinements of data concerning input usage and costs of inputs.

Need for Future Research

Considerable empirical work has been done on production function estimates for developing countries. Most of these studies focus on the analysis of factor use, technological change, resource use efficiencies, and return to scale. The studies are mostly local in nature, thus cannot be used as representative of the country as a whole.

In a country like Indonesia, which is predominantly agricultural with rice as a staple food, frequent assessments of factor use both at the farm level and on experimental stations are recommended. Such exercises require reliable empirical knowledge about the degree of responsiveness of particular input factors. Such information can also assist in assessing the extent to which production gains are due to weather or to the effectiveness of a variety of production-oriented public programs.

In short, a need for further research along the lines of this study is suggested. To capture the temporal shift of production relationships it is suggested that future research: (a) employ sample data for a longer time frame; and (b) introduce climate and other environmental factors into the analysis. However, a clearly defined framework is needed to minimize the effect of sample data errors and biases, due to the response of sample farmers or to enumerators.

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APPENDIX A

RICE AND RECENT DEVELOPMENT IN AGRICULTURE

Appendix A.2.1

Balance of Trade in Indonesia, 1950-1975
(U.S. $1 million)

Year	Including Oil			Exclusing Oil		
	Export	Import	Balance	Export	Import	Balance
1950	799.7	439.0	+ 360.7	652.6	407.4	+ 245.2
1951	1290.9	870.8	+ 420.1	1106.5	835.1	+ 271.4
1952	934.3	947.8	- 13.5	743.0	898.1	- 155.1
1953	840.2	764.7	+ 75.5	635.6	712.2	- 76.6
1954	866.5	629.3	+ 237.2	639.4	583.4	+ 56.0
1955	945.5	631.1	+ 314.4	729.7	571.0	+ 158.7
1956	926.2	860.1	+ 66.1	670.9	799.7	- 128.8
1957	954.4	803.3	+ 151.1	651.6	720.2	- 68.6
1958	790.7	544.1	+ 246.6	475.5	484.3	- 8.8
1959	931.0	451.9	+ 449.1	645.3	436.6	+ 208.7
1960	840.8	577.7	+ 263.1	620.0	551.9	+ 68.1
1961	788.2	796.2	- 8.0	527.3	746.6	- 219.3
1962	663.7	647.0	+ 16.7	447.9	608.0	- 160.1
1963	697.8	521.4	+ 176.4	429.1	489.8	- 60.7
1964	724.2	679.9	+ 44.3	457.7	671.6	- 213.9
1965	707.7	694.7	+ 13.0	435.7	682.1	- 246.4
1966	678.7	526.7	+ 152.0	475.3	519.2	- 43.9
1967	665.4	649.2	+ 16.2	425.8	636.6	- 210.8
1968	730.7	715.8	+ 14.9	433.2	709.7	- 276.5
1969	853.7	700.7	+ 73.0	470.8	769.8	- 299.0
1970	1108.1	1001.5	- 106.6	661.8	986.8	- 325.0
1971	1233.6	1102.8	+ 130.8	755.7	1082.4	- 326.7
1972	1777.7	1561.7	+ 216.0	864.6	1531.4	- 666.8
1973	3210.0	2729.1	+ 481.7	1602.1	2685.3	-1083.2
1974	7426.3	3841.9	+3584.4	2214.9	3658.9	-1444.0
1975	7102.5	4769.8	+2332.7	1791.7	4516.3	-2724.6

Source: Biro Pusat Statistik, <u>Statistical Pocket Book of Indonesia</u>, Jakarta, 1976, p. 175.

Appendix A.2.2

Petroleum Exports, Indonesia
1965 - 1974

Year	Quantity (000 ton)	Value (million U.S. $)
1965	13,100.3	175.2
1966	11,197.8	144.6
[illegible]	14,900.9	192.4
[illegible]	19,704.5	258.6
[illegible]	25,504.6	333.0
1970	31,038.4	408.5
1971	34,022.4	441.4
1972	40,706.6	833.6
1973	49,438.1	1,382.5
1974	54,634.8	4,680.3

Source: Government of Indonesia, Statistical Year Book, 1975, Jakarta 1976, Table XI.1.21, p. 729.

Appendix A.2.3

Area, Production, and Yield of Rice in Indonesia, 1968 - 1975

Year	Harvested Area (000 ha)	Yield (ton/ha)	Production (000 tons)
1968	8,021	1.45	11,666
1969	8,014	1.54	12,353
1970	8,135	1.62	13,451
1971	8,324	1.65	13,723
1972	7,897	1.67	13,182
1973	8,403	1.74	14,607
1974	8,537	1.81	15,452
1975	8,620	1.80	15,519
Average Annual Increase	1.2%	3.3%	4.8%

Source: Adopted from Biro Pusat Statistik, Statistical Pocket Book, Indonesia, Jakarta, various years.

Appendix A.2.4

Availability of Rice, Population and Price of Rice in Indonesia, 1968 - 1975

Year	Production and Imports (000 tons)	Population (000)	Per Capita Availability (kgs)	Price (Rps/ kg)
1968	12,152	112,348	108.2	12.40
1969	12,591	114,880	109.6	36.90
1970	13,775	117,469	117.3	42.60
1971	13,843	120,149	115.2	40.80
1972	13,517	123,115	110.0	49.90
1973	16,470	126,088	131.1	76.50
1974	16,584	129,083	128.5	81.70
1975	16,211	132,104	122.7	98.30

Source: Biro Pusat Statistik, Statistical Pocket Book, Jakarta, various years.

Appendix A.2.5

Recommended Bimas Credit Package
Indonesia, Selected Years

Input	HYV		NHYV	
	Quantity	Value	Quantity	Value
Wet Season 1971-72[1]		(Rph)	in kind	(Rph)
urea fertilizer	200 kgs.	5,320	100 kgs.	2,660
TSP fertilizer	45 kgs.	1,200	35 kgs.	990
insecticide	2 liters	2,350	2 liters	2,350
zinc phosphide	100 kgs.	50	100 kgs.	50
total	--	8,920	--	6,050
			in cash	
sprayer rent	--	600	--	600
seeds	--	1,000	--	0
intensification cost	--	3,500	--	3,500
total	--	5,100	--	4,100
total credit	--	14,020	--	10,150
Wet Season 1974-75[2]				
seed	25 kgs.	1,000	--	--
urea fertilizer	200 kgs.	16,000	150 kgs.	12,000
TSP fertilizer	100 kgs.	8,000	75 kgs.	6,000
insecticides	2 liters	1,800	2 liters	1,800
spraying		2,000		2,000
cost of living		3,000		3,000
total credit		31,000		25,800

[1] I.R.R.I., Change in Rice Farming in Selected Areas of Asia, The I.R.R.I., 1975, p. 190.

[2] Department of Agriculture of Indonesia, Unpublished paper, 1975.

Appendix A.2.6

Agricultural Production in Indonesia, 1973 - 1975
(000 tons)

Commodity	1973	1974[a]	1975	Percentage Change 1973-4	Percentage Change 1974-5
Main Foods					
Rice	14,607	15,276	15,342	4.6	0.4
Maize	3,690	3,011	2,638	-18.4	-12.4
Cassava	11,186	13,031	12,323	16.5	-5.4
Sweet Potatoes	2,387	2,469	2,478	3.4	0.4
Soybeans	541	589	563	8.9	-4.4
Peanuts	290	307	330	5.9	7.5
Other Foods					
Fish - sea	886	949	994	7.1	4.7
- inland	393	395	403	0.5	2.0
Meat	379	403	433	6.3	7.6
Eggs	81	98	126	21.0	28.4
Milk[b]	35	57	51	63.0	-10.9
Vegetables	2,259	2,579	2,015	12.4	-21.9
Fruit	4,249	5,179	5,169	21.9	-0.2
Other Crops					
Rubber	845	818	823	-3.2	0.6
Palm Oil	289	347	374	20.1	7.8
Copra	1,237	1,422	1,461	15.0	2.7
Coffee	150	158	159	5.3	0.6
Tea	67	65	74.5	-3.0	14.6
Cloves	22	15	16.1	-31.8	7.3
Pepper	29	27	27	-6.9	0
Tobacco	80	n.a.	n.a.	n.a.	n.a.
Sugar	1,009	1,210	1,257	19.9	3.9
Cotton	2.7	6.7	5.2	14.8	-22.4
Teakwood[c]	276	620	660	-8.3	6.5
Jungle wood[c]	25,124	22,660	18,330	-9.8	-19.1

[a] Revised

[b] Thousand Litres

[c] Thousand m^3

Source: Calculated from Statistical Pocket Book of Indonesia, Jakarta, 1976.

Appendix A.2.7

Size Distribution of Farms, Indonesia, 1973

Region	Percentage of Farms by Size (hectare) Less than 0.5	0.5 to 1.0	1.0 to 5.0	5.0 and over	Total
Java	57.42	24.82	17.30	0.46	100.00
Sumatra	28.80	26.04	41.88	3.27	100.00
Kalimantan	22.07	20.70	43.33	13.80	100.00
Sulawesi	25.44	24.45	46.70	3.42	100.00
Other Islands	31.10	23.33	41.70	3.87	100.00
Average	45.64	24.73	27.49	2.14	100.00

Source: Anne Booth and R.M. Sundrum, "The 1973 Agricultural Census," BIES, Vol. III (July 1976): p. 94.

APPENDIX B

LITERATURE REVIEW

APPENDIX B

LITERATURE REVIEW

Introduction

Considerable research has already been devoted to a socio-economic evaluation of the new rice technology in Asia. The general impact of the "green revolution" in the third world is well documented by Sen.[1] Yet, despite its apparent success, a number of questions are still unresolved. For example, a whole host of questions relate to the farm production characteristics of the new HYV's in outlying regions. Are they more susceptible to diseases and pests? Or, with less potential factor substitution, is the farmer subject to more risk with HYV's? More risk could also reduce resource efficiency levels.

Nor is it readily apparent how this new technology has altered relative factor use. Has it been biased towards either capital or labor? Or, in other words, have the HYV's actually contributed to the out-migration from agriculture?

In addition, unique demand characteristics for HYV's may also affect farm viability. For example, if grain

[1] S. Sen, Reaping the Green Revolution, (New Delhi: Tata McGraw-Hill Publishing Co., 1975).

quality is inferior, how does this ultimately affect producers of HYV's? And finally, one major concern has been the possibility that HYV's benefit larger farmers relatively more than smaller farmers. Because larger farmers generally have greater access to capital, their capacity to exploit the benefits of HYV's would seemingly be somewhat greater. Furthermore, if the technology is more applicable to larger units, larger farm-units would become more prevalent, adversely affecting traditional land tenure patterns.

In fact, social tension has increased in some parts of the third world because of widening income disparities between regions and between groups within regions. Has the spread of HYV's actually contributed to this undesirable social phenomena?[1]

In short, a number of specific issues are of particular relevance with respect to the present study:

1. How has the new technology affected aggregate production in traditional agriculture?[2]
2. Has real farm income increased and has the income distribution become more or less equal as a consequence of adopting the new technology?
3. What is the nature and magnitude of the shifts in the production function? Has technological change at the

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[1]Sen, op.cit., p. 3.

[2]Traditional agriculture is farming based wholly upon the kinds of factors of production that have been used by farmers for generations. See T.W. Schultz, Transforming Traditional Agriculture, (New Haven: Yale University Press, 1964), p. 3.

farm level been neutral, or has it been biased towards either labor or capital?

4. Are the adoptions of the new technology more efficient in allocating their scarce resources than the non-adopters?

5. What are the consequences of the new technology with respect to farm scale, and does farm size change as a consequence of the new technology?

The primary purpose of the following discussion is to identify some of the principal studies conducted in Less Developed Countries which have addressed one or more of these issues.

Production Characteristics

There does not seem to be much doubt that production levels are much higher with HYV's than they are with traditional varieties. For example, Parthsarathy and Prasad[1] found in a study of rice production in Andhara Pradesh, India, that during the wet-season 1971-72 and the dry-season 1972, the productivity of HYV's was substantially higher than local varieties. The yield of HYV's averaged about 32.5 percent more during the wet-season and 82 percent more during the dry-season.

[1]B. Parthsarathy and D.S. Prasad, "Response to and Impact of H.Y.V. Rice According to Land Size and Tenure in a Delta Village Andhara Pradesh, India," Developing Economics, Volume 12(1), (1974): 182-198.

Five years after the IRRI (International Rice Research Institute) was established, Barker and Quintana[1] conducted a survey on IR8-rice varieties in Laguna, Philippines. At the farm level, they concluded that the yield of IR8 varieties averaged 4.8 tonnes, while local varieties averaged only 2.4 tonnes per hectare.

Those results have also been supported by Evenson's[2] cross-sectional study of 12 Asian and Middle-Eastern countries during 1948-71. This study reaffirms that the HYV's have contributed significantly to increased production and productivity in the Less Developed Countries during the last two decades. Yet the author is also careful to point out that most of the studies are local in nature and, thus, cannot be used to assess the relative advantages of HYV's for entire regions or countries.

Income Changes

A number of regional studies have also been conducted to ascertain the real impact of the HYV's on farmers' net incomes and its distribution among factors of production. For example, Barker and Quintana,[3] in a Philippine study, concluded that the net value of HYV's to the farmer ranged from 895 to 1,109 pesos for the respective varieties.

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[1] Randolf Barker and E.U. Quintana, "Studies of Returns and Costs for Local and High Yielding Rice Varieties," The Philippines Economic Journal, Vol. 7(2), 1968: 155.

[2] R. Evenson, "The Green Revolution in Recent Development Experience," American Journal of Agricultural Economics, Vol. 56(2), (May 1974): 387-394.

[3] Barker and Quintana, op.cit., p. 156.

This, of course, suggests that the net Value Marginal Product of the new technology is higher than that of the old technology. The study by Tjatera[1] for the period 1970-72 for Indonesia, for example, indicated that HYV's of rice gave a gross return of Rp. 2,955 for every Rp. 1,000 spent on production compared to Rp. 2,590 for NHYV's.

Similar results were obtained by Bhati[2] with respect to high yielding rice varieties in Malaysia. The study is devoted to a comparison of "continuous" and "discontinuous" plantings of HYV's (IR.5). Bhati found that continuous use of HYV's yielded M$ 1,244 per hectare whereas discontinuous use yielded only M$ 647 per hectare.

Sujono[3] used data from sample farmers in eight villages in central Java during 1968-69 and 1973-74, and concluded that due to the increasing adoption of the new paddy production technology, average farm income increased, income inequalities were reduced and a number of employment opportunities were generated.

Similarly, a study by Chourasia and Singh[4] in India,

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[1] I. Wayan Tjatera, "Impact of New Rice Varieties on Farmers' Incomes in Indonesia," Term Paper, In L. Bauer (Instructor), Advanced Farm and Ranch Management, (January - April 1979): 183.

[2] U.N. Bhati, "Use of High-Yielding Rice Varieties in Malaysia," Developing Economics, Volume 13(2), (Tokyo, 1975): 187-207.

[3] Irlan Sojono, "Growth and Distributional Changes of Income in Paddy Farms in Central Java, 1968-74," Bulletin of Indonesian Economic Studies, Vol. 12(2), (July 1976): 80-89.

[4] R.R. Chourasia and V.N. Singh, "Economics of Local and High Yielding Varieties of Paddy and Wheat in Panagar

in 1968-69, showed that net returns for HYV's were about 225 percent higher than for local varieties. At the same time, it is evident that a specific technology can only be successfully applied in a specific environment. The HYV's, for example, cannot be introduced successfully where irrigation facilities are poor or water supply is not adequately controlled. This, of course, implies that the new technology gives great advantages to particular regions or farmers who, in some cases, are already relatively favored. in this case, one should realize that the unequal access to technology improvement is not primarily due to the technology adoption process but rather to the technology development process.

Market imperfections also restrict access of small peasants to many factor markets, notably credit.[1] Landlords, on the other hand, can easily obtain capital in the organized credit market and have ready access to Commercial Banks outside the farming locality. However, small farmers turn to money-lenders who charge high interest rates because of the risks of default and lack of collateral. With some exceptions, government credit institutions, as well as international financial institutions, have generally been regarded as less sympathetic to small farmers. For example, in a descriptive analysis of the economic and social effects of

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Village of Malay Pradesh," Indian Journal of Agricultural Economics, Volume 27(1), (January-March 1972): 93-98.

[1]IRRI, Change in Rice Farming in Selected Areas of Asia, (Los Banos, Philippines, 1975).

the new technology in a delta village, Andhra Pradesh, India, Parthasarathy and Prasad,[1] reported that: (a) there was no evidence of reduced concentration of land during the period 1964-1965 and 1971-1972; and, (b) although there was very little evidence that the level of living of smaller farmers had deteriorated, the relative income distribution appeared to have worsened.

Katar Singh[2] analysed the Aligargh farming district of Uttar Pradesh, India, however, and concluded that: (a) in the period of 1963-64 to 1968-69, there was a decline in farm income inequality in the district; (b) the new agricultural technology had a significant impact on year-to-year differences in farm income inequality; and, (c) the average farm income was negatively correlated with farm income disparities in the district.

Similarly, Johl[3] examined changes in agricultural employment in Pubjab State, India, between 1956-66 (representing the pre-green revolution conditions) and 1970-71 and concluded that "...the proportion of farmers

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[1]Parthsarathy and Prasad, op.cit., pp. 182-198.

[2]K. Singh, "The Impact of New Agricultural Technology on Farm Income Distribution in the Aligarph District of Uttar Pradesh," Indian Journal of Agricultural Economics, Volume 28(2), (April-June 1973): 1-11.

[3]S.S. Johl, "Gains of the Green Revolution: How They Have been Shared in Punjab," The Journal of Development Studies, Volume 11(3), (April 1975): 178-189.

in low in[illegible]ups has declined and a large percentage of them [illegible]ave [illegible] up the ladder. The green revolution, under the [illegible]esent socio-economic structure of Punjab, has thus yielde[illegible]espread benefits to all sections of the rural societ[illegible] most of the concern expressed about income disparitie[illegible]on a theoretical basis is not validated by the actual [illegible]cts."

[illegible]enson[1] also reported that the total income of all agricult[illegible]al households moved slightly towards a more equal distribution between 1965-66 and 1970-71 in Tanjavur District, South India. However, the change was marginal and could [illegible] be considered a major shift.

An entirely different view was expressed by Smith[2] regarding the impact of the new seeds in Bangladesh. Employing a linear programming technique, he predicted that "inevitable imbalances in class and regional access to scarce inputs will accelerate on-going processes of land agglomeration and add to the vast pool of the landless proletariat."

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[1]C.G. Swenson, "The Distribution of Benefits from Increased Rice Production in Tanjavur District, South India," Indian Journal of Agricultural Economics, Volume 3(1), (January-March 1976): 1-22.

[2]D.V. Smith, "New Seeds and Income Distribution in Bangladesh," The Journal of Development Studies, Volume 11 (2), (January 1975): 162-185.

Technological Change

How has the green revolution affected labor use? One study dealing with the evaluation of the nature and magnitude of shifts in the production function from the old to HYV's was conducted by Sidhu.[1] He made a separate estimate of the Cobb-Douglas production function for old and new wheat varieties in Indian Punjab. After testing the equality of the coefficients of the two regressions using covariance analysis, he concluded that the technical change had been neutral in character. The output elasticities with respect to various inputs were the same in separate regressions for both old and new wheat. However, he found that the intercept term for new wheat was higher by some 22.85 percent. This apparent shift implied that these new wheat varieties simply gave relatively more output per unit of input.[2] Accordingly, Sidhu points out that the "green revolution" has been able to absorb labor because of aggregate production increases, despite its increased use of capital. The accurate assessment of technological change, however, is generally dependent on both the form of the production function employed and the sensitivity of the estimating techniques used.[3]

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[1] S.S. Sidhu, "Economics of Technical Change in Wheat Production in Indian Punjab," American Journal of Agricultural Economics, Volume 56(2), (May 1974): 217-228.

[2] See also Murray Brown, On the Theory and Measurement on Technological Change, (Cambridge: Cambridge University Press, 1966), p. 39.

[3] Jack H. te Kloot and Jock R. Anderson, "Estimation

Resource Efficiency

At the same time, a great number of studies have been conducted which focus on resource efficiency in agriculture in Less Developed Countries, most of which indicate that only small inefficiencies are apparent. For example, Saini,[1] in his study of the Uttar Pradesh and Punjab area of India, argues that the inefficient use of fertilizer is caused by unpredictable factors such as excessive rainfall. He also notes that the MVP of land tends to decrease as farm size increases. However, with respect to the MVP of labor, it generally tended to approximate the existing wage rate.

In the mid-fifties, Hopper[2] also conducted a study on allocative efficiency in an eastern Uttar Pradesh village. This earlier study also concluded that farmers economized on their scarce resources; that is to say, they were relatively efficient.

A recent study by Singh[3] in Eastern Uttar Pradesh, India, for the period of 1967-68, also investigated

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of Technological Change in the Pastoral Zone," Review of Marketing and Agricultural Economics, Volume 45(4), (December 1977): 159-165.

[1]G.S. Saini, "Resource Use Efficiency in Agriculture," Indian Journal of Agricultural Economics, Volume 24(2), (April-June 1969): 1-18.

[2]W.D. Hopper, "Allocation Efficiency in a Traditional Indian Agriculture," Journal of Farm Economics, Volume 7(3), (August 1965): 611-623.

[3]J.P. Singh, "Resource Use, Farm Size and Return to Scale in a Backward Agriculture," Indian Journal of Agricultural Economics, Volume 20(2), (April-June 1975): 32-46.

resource efficiency and, again, this report indicates that farmers have been allocating their resources relatively efficiently, except for land which was underutilized. He argues, however, that this may be due to economic and technical uncertainty regarding the weather, prices and inaccurate knowledge of production relationships. Similarly, Mellor[1] has argued that "...the variation among farmers in resource use may simply reflect substantial variation in the costs and returns to resources and perhaps inefficiency in the working of factor markets rather than inefficiency in the internal organization of farms." He also points out that the study of efficiency in resource allocation is based upon assumptions concerning factor costs, output prices and productivity, which are highly variable and difficult to determine. This is particularly true of the cost of labor in traditional agriculture, which is largely determined by the subjective judgement of peasant farmers.

Return to Scale

Information on returns to scale for HYV versus HHYV is somewhat more limited. Srivastava, Nagadevara and Heady[1] used cross-sectional data for Punjab in 1967-68 and Uttar

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[1]J.W. Mellor, "Production Economics and the Modernization of Traditional Agricultures," The Australian Journal of Agricultural Economics, Volume 13(1), (June 1969): 27.

[2]U.K. Srivastava, V. Nagadevara and E.O. Heady, "Resource Productivity, Returns to Scale and Farm Size in Indian Agriculture: Some Recent Evidence," The Australian Journal of Agricultural Economics, Volume 17(1), (April 1973): 43-53.

Pradesh in 1966-67 to test the hypotheses that constant returns to scale prevail and that farm size is inversely related to both output and farm income per hectare.[a] The results indicated, however, decreasing returns to scale although total inputs per hectare did vary inversely with farm size. At the same time, farm income per hectare was directly related to farm size in Uttar Pradesh but inversely related in Tamil-Nadu.

Final Comments

From this brief review, the following features should be observed:

1. The green revolution does have an affect on farm size. Larger farms are encouraged. However, some studies argue that traditional agriculture reflects constant returns to scale, even after HYV's have been adopted.
2. In general, HYV's have a positive effect on farm income, although this may or may not improve the regional farm income distribution.
3. There has been a shift in the production function with the introduction of the new technology in traditional agriculture. This shift has been fairly neutral, implying an increase in the use of both capital and labor as production is expanded.
4. Most of the earlier studies indicate that farmers have used their scarce resources relatively efficiently. Gross inefficiencies are generally traced to factors

external to the farm organization, e.g. weather, price variability, factor supplies, etc.

5. The Cobb-Douglas production function has been used in most of the agricultural production function studies in LDC's because it fairly accurately reflects actual input-output relationships and because it is easy to both estimate and interpret.

APPENDIX C

EMPIRICAL ANALYSIS OF RICE PRODUCTION CHARACTERISTICS

Appendix C.4.1

Geometric Means of Particular Inputs and the Corresponding Rice Output, Study Area

Year	Variety	Geometric Means				
		Land (hectare)	Human Labor (man/days)	Fertilizer (000 Rupiahs)	Current Expenses (000 Rupiahs)	Rice Output (Quintals)
Wet-Season 1977-78	NHYV	.72	169.72	8.107	8.059	26.04
	HYV	.62	137.17	9.064	9.975	28.92
Wet-Season 1978-79	NHYV	.89	149.26	11.237	13.765	31.23
	HYV	.70	136.22	10.466	12.894	37.91

Appendix C.4.2

Marginal Physical Product of Resources at Geometric Mean, Study Area

Year	Variety	Land	Human Labor	Fertilizer	Current Inputs
		(in quintal of rice paddy)			
Wet-Season 1977-78	NHYV	15.15	0.01	0.55	1.10
	HYV	29.02	—	0.81	0.60
Wet-Season 1978-79	NHYV	17.42	0.05	0.64	—
	HYV	19.81	--	0.99	0.01

Appendix C.4.3

Marginal Value Product of Inputs at Geometric Mean, Study Area

Year	Variety	Land (Rupiahs)	Human Labor (Rupiahs)	Fertilizer (Rupiahs)	Current Inputs (Rupiahs)
Wet-Season 1977-78	NHYV	107,065.05	70.67	3,891.80	7,773.70
	HYV	182,129.52	---	5,083.56	3,765.60
Wet-Season 1978-79	NHYV	194,668.50	558.75	7,152.00	---
	HYV	200,104.94	---	10,328.67	10,537.33

Appendix C.4.4

Ratio of Marginal Value Products to Factor Cost, Study Area

Year	Variety	Land	Human Labor	Fertilizer	Current Inputs
Wet-Season 1977-78	NHYV	1.43	0.18	3.89	7.77
		(0.17)	(0.14)	(0.99)	(1.54)
		{8.41}*	{1.29}ns	{3.93}*	{5.05}*
	HYV	2.43	--	5.08	3.77
		(0.07)		(1.09)	(1.52)
		{34.71}*		{4.66}*	{2.48}**
Wet-Season 1978-79	NHYV	1.77	0.93	7.15	--
		(0.20)	(0.32)	(2.57)	
		{8.85}*	{2.91}*	{2.78}*	
	HYV	1.82	--	10.33	10.54
		(0.57)		(3.93)	(3.94)
		{3.19}*		{2.63}*	{2.68}**

Notes: Numbers in parentheses are the standard errors;
Numbers in brackets are the t-value
* = significant at one percent level
** = significant at five percent level
ns = not significant

Appendix C.4.5

Acquisition Cost of Inputs

Year	Land (Rupiah/hectare)	Human Labor (Rupiah/day)	Fertilizer (Rupiah/unit)	Current Input (Rupiah/unit)
Wet-Season 1977-78	75,000	400	1,000	1,000
Wet-Season 1978-79	110,000	600	1,000	1,000

Acquisition Cost of fertilizer and current input was taken at one thousand rupiah since those inputs were measured in value terms at one thousand rupiah.

Appendix C.4.6

Average Price of Rice Paddy (Threshed Dry Stalk Paddy) at Geometric Mean

Year	Non High Yielding Varieties (in Rupiah/Quintal)	High Yielding Varieties (in Rupiah/Quintal)
Wet-Season 1977-78	7,067	6,276
Wet-Season 1978-79	11,175	10,433

Appendix C.4.7

Return to Scale, Study Area, 1977-78 and 1978-79

Year	Variety	The Sum of Coefficients	Return to Scale Indicated by t-test
Wet-Season 1977-78	NHYV	1.03^{ns}	Constant
	HYV	1.08^{ns}	Constant
	Pooled	1.02^{ns}	Constant
Wet-Season 1978-79	NHYV	0.96^{ns}	Constant
	HYV	0.99^{ns}	Constant
	Pooled	1.03^{ns}	Constant

ns = not significantly different from unity

Source: Basic data from Table 4.17.

Appendix C.4.8

Geometric Means of Selected Inputs and the Corresponding Output Provinces of Bali, Nusa Tenggara Barat, Nusa Tenggara Timur 1977-78 and 1978-79

Region/Province	Wet Season /Year	Variety	Land (ha)	Human Labor man/days	Bullock Labor bullock/day	Fertilizer (000 Rphs)	Capital Flow (000 Rphs)	Current Input (000 Rphs)	Output (Quintals)
Bali	1977-78	NHYV	0.45	107.4	15.1	6.021	2.398	8.295	18.43
		HYV	0.49	114.7	14.2	7.319	2.482	9.439	23.71
	1978-79	NHYV	0.55	99.9	14.3	7.970	2.453	11.702	19.48
		HYV	0.51	103.9	12.9	8.597	2.804	10.969	30.25
Nusa Tenggara Barat	1977-78	NHYV	0.65	216.1	21.6	7.946	2.158	8.312	28.13
		HYV	0.81	250.3	22.8	11.924	2.429	12.697	41.73
	1978-79	NHYV	0.58	151.9	19.9	8.417	2.426	10.697	24.88
		HYV	0.66	159.3	25.5	9.223	2.680	13.431	40.51
Nusa Tenggara Timur	1977-78	NHYV	0.99	158.9	24.5	9.487	2.507	7.680	27.92
		HYV	1.56	174.8	24.3	21.082	2.608	10.084	55.15
	1978-79	NHYV	1.92	196.5	35.3	19.258	3.353	19.935	55.27
		HYV	1.95	237.9	30.5	23.741	3.670	19.698	67.37

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties

Appendix C.4.9

Marginal Physical Products at Geometric Mean, by Province
1977-78 and 1978-79

Province	Wet-Season	Variety	Land	Human Labor	Bullock Labor	Fertili-zer	Capital Flow	Current Input
			(in quintal of rice)					
Bali	1977-78	NHYV	50.87					-0.82
		HYV	53.00	-0.07		0.93		-0.55
	1978-79	NHYV	24.58	0.10				
		HYV	102.35	-0.24		-1.79	0.61	
Nusa Tenggara Barat	1977-78	NHYV	18.29	-0.02				1.79
		HYV	40.22			1.19		
	1978-79	NHYV	22.24					0.83
		HYV	57.22		0.18			
Nusa Tenggara Timur	1977-78	NHYV	14.18			0.51		1.32
		HYV	23.31		-1.27			4.93
	1978-79	NHYV	17.58			0.75		
		HYV		0.10		1.16		1.52

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties

Appendix C.4.10

Marginal Value Products at Geometric Mean

Province	Wet-Season	Variety	Land	Human Labor	Bullock Labor	Fertili-zer	Capital Flow	Current Input
			(in Rupiahs)					
Bali	1977-78	NHYV	301,506					-4,860
		HYV	311,799	-411.81		5,471		-3,236
	1978-79	NHYV	245,800	1000.00				
		HYV	978,977	-2295.60		-17,121	5,835	
Nusa Tenggara Barat	1977-78	NHYV	127,353	-139.26				12,464
		HYV	272,973			8,077		
	1978-79	NHYV	225,047					8,399
		HYV	572,200		1,800			
Nusa Tenggara Timur	1977-78	NHYV	111,795			4,020		10,407
		HYV	182,121		-9,923			38,578
	1978-79	NHYV	238,033			10,155		
		HYV	---	1273.60		14,774		19,359

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties

Appendix C.4.11

Ratios of Marginal Value Product to Acquisition Cost

Province	Year	Variety	Land	Human Labor	Bullock Labor	Fertilizer	Capital Flow	Current Input
[illegible]	1977-78	NHYV	4.02*					-4.86**
			(1.19)					(2.25)
		HYV	4.16*	-0.82**		5.47*		-3.24 ns
			(0.94)	(0.33)		(1.29)		(1.68)
	1978-79	NHYV	1.97*	1.67 ns				
			(0.47)	(0.86)				
		HYV	7.83*	-3.83*		-17.12*	5.84 ns	
			(1.25)	(0.67)		(4.81)	(13.32)	
Nusa Tenggara Barat	1977-78	NHYV	1.82*	-0.31*				12.46*
			(0.46)	(0.15)				(1.27)
		HYV	3.90*			8.08*		
			(0.53)			(2.15)		
	1978-79	NHYV	1.96*					8.40 ns
			(0.52)					(4.55)
		HYV	4.98*		1.20ns			
			(0.23)		(0.59)			
Nusa Tenggara Timur	1977-78	NHYV	1.72*			4.02*		10.41*
			(0.31)			(1.20)		(3.74)
		HYV	2.80**		-9.92**			38.52 ns
			(1.31)		(4.20)			(20.55)
	1978-79	NHYV	2.27*			10.16*		
			(0.15)			(1.40)		
		HYV		2.55 ns		14.77*		19.36 ns
				(1.65)		(14.36)		(10.69)

Notes: * = significantly different from unity at the one percent level.
** = significantly different from unity at the five percent level.
ns = not significantly different from unity.

Appendix C.4.12

Average Price of Rice in the Provinces of Bali, Nusa Tenggara Barat and Nusa Tenggara Timur (in Rupiahs per Quintal)

Province	Variety	Year 1977-78	Year 1978-79	Year Pooled
Bali	NHYV	5927	10000	7224
	HYV	5883	9565	7049
Nusa Tenggara Barat	NHYV	6963	10119	8420
	HYV	6787	10000	7644
Nusa Tenggara Timur	NHYV	7884	13540	9847
	HYV	7813	12736	9118

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties

Appendix C.4.13

Acquisition Cost of Inputs

Province	Year	Land	Human Labor (Rphs)	Bullock Labor (Rphs)	Fertili-zer (Rphs)	Capital Flow (Rphs)	Current Input (Rphs)
Bali	1977-78	75,000	500	1250	1000	1000	1000
	1978-79	125,000	600	1500	1000	1000	1000
Nusa Tenggara Barat	1977-78	70,000	450	1250	1000	1000	1000
	1978-79	115,000	550	1500	1000	1000	1000
Nusa Tenggara Timur	1977-78	65,000	400	1000	1000	1000	1000
	1978-79	105,000	500	1250	1000	1000	1000

Note: The value of fertilizer, capital flow, current input was taken as one thousand rupiahs, since those input factors were measured in thousand rupiahs.

Appendix C.4.14

Return to Scale, by Varieties, Provinces of Bali, NTB and NTT 1977-78 and 1978-79

Province	Year	Varieties	The Sum of Coefficients	the t-test result	Calculated from Table
Bali	Wet-Season 1977-78	NHYV	0.87^{ns}	Constant	4.20
		HYV	0.84^{ns}	Constant	4.20
		Pooled	0.98^{ns}	Constant	4.20
	Wet-Season 1978-79	NHYV	1.22^{ns}	Constant	4.20
		HYV	0.97^{ns}	Constant	4.20
		Pooled	0.73^{ns}	Constant	4.20
Nusa Tenggara Barat	Wet-Season 1977-78	NHYV	0.77^{ns}	Constant	4.21
		HYV	1.12^{ns}	Constant	4.21
		Pooled	0.95^{ns}	Constant	4.21
	Wet-Season 1978-79	NHYV	0.88^{ns}	Constant	4.21
		HYV	1.04^{ns}	Constant	4.21
		Pooled	1.32^{ns}	Constant	4.21
Nusa Tenggara Timur	Wet-Season 1977-78	NHYV	1.04^{ns}	Constant	4.22
		HYV	0.76^{ns}	Constant	4.22
		Pooled	1.06^{ns}	Constant	4.22
	Wet-Season 1978-79	NHYV	0.87^{ns}	Constant	4.22
		HYV	1.22^{ns}	Constant	4.22
		Pooled	1.05^{ns}	Constant	4.22

Notes: NHYV = Non High Yielding Varieties
HYV = High Yielding Varieties
Pooled = NHYV plus HYV
ns = not significantly different from unity.

Appendix C.4.15

Simple Correlation Coefficients Between Independent Variables, Study Area, Wet-Season 1977-78

Variety	Variable	Land	Capital Flow	Ferti- lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.57487	0.79826	0.65111	0.60835	0.80779
	Capital Flow		1.00000	0.59034	0.38246	0.36561	0.55670
	Fertilizer			1.00000	0.58007	0.55682	0.79144
	Bullock Labor				1.00000	0.64495	0.56018
	Human Labor					1.00000	0.56472
	Current Input						1.00000
HYV	Land	1.00000	0.39686	0.84141	0.72394	0.78142	0.80909
	Capital Flow		1.00000	0.31792	0.34867	0.30568	0.38226
	Fertilizer			1.00000	0.66872	0.68651	0.69395
	Bullock Labor				1.00000	0.75930	0.55711
	Human Labor					1.00000	0.70092
	Current Input						1.00000
Pooled	Land	1.00000	0.50396	0.80088	0.67305	0.67639	0.77748
	Capital Flow		1.00000	0.51156	0.33307	0.31751	0.50804
	Fertilizer			1.00000	0.56986	0.57529	0.75781
	Bullock Labor				1.00000	0.69757	0.48815
	Human Labor					1.00000	0.56031
	Current Input						1.00000

Appendix C.4.16

Simple Correlation Coefficients Between Independent Variables, Study Area, Wet-Season 1978-79

Variety	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.77144	0.79350	0.81505	0.77580	0.92407
	Capital Flow		1.00000	0.67204	0.66180	0.63882	0.71197
	Fertilizer			1.00000	0.72184	0.65894	0.70338
	Bullock Labor				1.00000	0.79744	0.69029
	Human Labor					1.00000	0.69710
	Current Input						1.00000
HYV	Land	1.00000	0.65706	0.92915	0.70444	0.86985	0.91196
	Capital Flow		1.00000	0.70520	0.40923	0.59943	0.65838
	Fertilizer			1.00000	0.62334	0.80979	0.88425
	Bullock Labor				1.00000	0.82971	0.67915
	Human Labor					1.00000	0.83965
	Current Input						1.00000
Pooled	Land	1.00000	0.68309	0.85896	0.76324	0.82520	0.81471
	Capital Flow		1.00000	0.68116	0.48884	0.60250	0.67171
	Fertilizer			1.00000	0.66483	0.74075	0.79832
	Bullock Labor				1.00000	0.81354	0.68132
	Human Labor					1.00000	0.77588
	Current Input						1.00000

Appendix C.4.17

Simple Correlation Coefficients Between Independent Variables, Study Area, Wet-Season 1977-78 and Wet-Season 1978-79

Varieties	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.62713	0.79557	0.69681	0.62776	0.81281
	Capital Flow		1.00000	0.61837	0.44942	0.39120	0.61140
	Fertilizer			1.00000	0.60869	0.54895	0.76854
	Bullock Labor				1.00000	0.67066	0.56704
	Human Labor					1.00000	0.50895
	Current Input						1.00000
HYV	Land	1.00000	0.51636	0.87520	0.71546	0.81326	0.84269
	Capital Flow		1.00000	0.48486	0.39262	0.41736	0.52494
	Fertilizer			1.00000	0.64778	0.72865	0.76252
	Bullock Labor				1.00000	0.77917	0.61294
	Human Labor					1.00000	0.73266
	Current Input						1.00000
Pooled	Land	1.00000	0.56524	0.81535	0.70501	0.70817	0.80011
	Capital Flow		1.00000	0.56892	0.38618	0.37400	0.58450
	Fertilizer			1.00000	0.59528	0.60123	0.76480
	Bullock Labor				1.00000	0.72537	0.53428
	Human Labor					1.00000	0.56286
	Current Input						1.00000

Appendix C.4.18

Simple Correlation Coefficients Between Independent Variables, Bali, Wet-Season 1977-78

Varieties	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.33051	0.83300	0.80598	0.84395	0.92207
	Capital Flow		1.00000	0.31831	0.41884	0.24992	0.26299
	Fertilizer			1.00000	0.63723	0.71726	0.85358
	Bullock Labor				1.00000	0.78111	0.73763
	Human Labor					1.00000	0.80699
	Current Input						1.00000
HYV	Land	1.00000	0.34690	0.75265	0.53578	0.79099	0.89457
	Capital Flow		1.00000	0.23570	0.27870	0.26564	0.29295
	Fertilizer			1.00000	0.49338	0.53281	0.71983
	Bullock Labor				1.00000	0.48212	0.47627
	Human Labor					1.00000	0.68187
	Current Input						1.00000
Pooled	Land	1.00000	0.34401	0.77856	0.60651	0.79574	0.90176
	Capital Flow		1.00000	0.26335	0.30389	0.26724	0.28521
	Fertilizer			1.00000	0.51625	0.57502	0.77238
	Bullock Labor				1.00000	0.53112	0.54535
	Human Labor					1.00000	0.70145
	Current Input						1.00000

Appendix C.4.19

Simple Correlation Coefficients Between Independent Variables, Bali, 1978-79

Varieties	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.50899	0.98570	0.57689	0.64284	0.96409
	Capital Flow		1.00000	0.50798	0.38233	0.11631	0.46982
	Fertilizer			1.00000	0.57749	0.67101	0.96048
	Bullock Labor				1.00000	0.64590	0.52155
	Human Labor					1.00000	0.67097
	Current Input						1.00000
HYV	Land	1.00000	0.55159	0.93833	0.67666	0.80814	0.89484
	Capital Flow		1.00000	0.48585	0.41708	0.42048	0.46165
	Fertilizer			1.00000	0.56950	0.74917	0.89032
	Bullock Labor				1.00000	0.72198	0.58878
	Human Labor					1.00000	0.74750
	Current Input						1.00000
Pooled	Land	1.00000	0.50251	0.94345	0.63477	0.75490	0.91592
	Capital Flow		1.00000	0.48933	0.32005	0.35459	0.42575
	Fertilizer			1.00000	0.54364	0.71200	0.90722
	Bullock Labor				1.00000	0.64795	0.56289
	Human Labor					1.00000	0.70472
	Current Input						1.00000

Appendix C.4.20

Simple Correlation Coefficients Between Independent Variables, Bali, Wet-Season 1977-78 and Wet-Season 1978-79

Varieties	Variables	Land	Capital Flow	Ferti- lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.39655	0.88152	0.69171	0.73721	0.92960
	Capital Flow		1.00000	0.38288	0.39549	0.19019	0.33033
	Fertilizer			1.00000	0.57532	0.64911	0.88700
	Bullock Labor				1.00000	0.73405	0.60276
	Human Labor					1.00000	0.68708
	Current Input						1.00000
HYV	Land	1.00000	0.41203	0.80369	0.55703	0.77892	0.88865
	Capital Flow		1.00000	0.33452	0.24897	0.25984	0.36865
	Fertilizer			1.00000	0.46702	0.55840	0.77219
	Bullock Labor				1.00000	0.56804	0.45885
	Human Labor					1.00000	0.66039
	Current Input						1.00000
Pooled	Land	1.00000	0.40516	0.82589	0.59185	0.75819	0.90012
	Capital Flow		1.00000	0.35416	0.26503	0.25469	0.35380
	Fertilizer			1.00000	0.48248	0.57383	0.81454
	Bullock Labor				1.00000	0.57960	0.49887
	Human Labor					1.00000	0.65040
	Current Input						1.00000

Appendix C.4.21

Simple Correlation Coefficients Between Independent Variables, Nusa Tenggara Barat (NTB), Wet-Season 1977-78

Varieties	Variety	Land	Capital Flow	Ferti- lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.33681	0.68766	0.60101	0.62808	0.79536
	Capital Flow		1.00000	0.37588	0.14812	0.21815	0.41609
	Fertilizer			1.00000	0.45884	0.30773	0.78434
	Bullock Labor				1.00000	0.55001	0.54236
	Human Labor					1.00000	0.45671
	Current Input						1.00000
HYV	Land	1.00000	0.64832	0.77004	0.66761	0.76208	0.91821
	Capital Flow		1.00000	0.36726	0.57612	0.60844	0.46599
	Fertilizer			1.00000	0.44722	0.54206	0.60275
	Bullock Labor				1.00000	0.79420	0.57019
	Human Labor					1.00000	0.65383
	Current Input						1.00000
Pooled	Land	1.00000	0.43575	0.71297	0.61207	0.65692	0.81708
	Capital Flow		1.00000	0.38439	0.26445	0.32250	0.43376
	Fertilizer			1.00000	0.45139	0.36837	0.53459
	Bullock Labor				1.00000	0.58981	0.53459
	Human Labor					1.00000	0.50160
	Current Input						1.00000

Appendix C.4.22

Simple Correlation Coefficients Between Independent Variables,
Nusa Tenggara Barat (NTB), Wet-Season 1978-79

Varieties	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.61509	0.88806	0.57701	0.65710	0.83538
	Capital Flow		1.00000	0.65455	0.27759	0.40235	0.45786
	Fertilizer			1.00000	0.46097	0.55826	0.76363
	Bullock Labor				1.00000	0.61261	0.40072
	Human Labor					1.00000	0.55099
	Current Input						1.00000
HYV	Land	1.00000	0.55024	0.96499	0.56891	0.81722	0.95785
	Capital Flow		1.00000	0.49779	0.24133	0.41076	0.52628
	Fertilizer			1.00000	0.54662	0.75429	0.90842
	Bullock Labor				1.00000	0.75230	0.68234
	Human Labor					1.00000	0.87422
	Current Input						1.00000
Pooled	Land	1.00000	0.58640	0.92964	0.57301	0.74500	0.89424
	Capital Flow		1.00000	0.56526	0.30817	0.41265	0.52823
	Fertilizer			1.00000	0.51593	0.67248	0.84279
	Bullock Labor				1.00000	0.67755	0.64698
	Human Labor					1.00000	0.72644
	Current Input						1.00000

Appendix C.4.23

Simple Correlation Coefficients Between Independent Variables, Nusa Tenggara Barat (NTB), Wet-Season 1977-78 and Wet-Season 1978-79

Varieties	Variable	Land	Capital Flow	Ferti- lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.35741	0.70581	0.59603	0.62056	0.75916
	Capital Flow		1.00000	0.41183	0.14536	0.15760	0.44484
	Fertilizer			1.00000	0.45436	0.30300	0.77291
	Bullock Labor				1.00000	0.54764	0.50970
	Human Labor					1.00000	0.36275
	Current Input						1.00000
HYV	Land	1.00000	0.55465	0.85740	0.58375	0.75404	0.90922
	Capital Flow		1.00000	0.36338	0.45730	0.37307	0.47457
	Fertilizer			1.00000	0.45097	0.63045	0.70572
	Bullock Labor				1.00000	0.58892	0.62409
	Human Labor					1.00000	0.61043
	Current Input						1.00000
Pooled	Land	1.00000	0.43712	0.75564	0.59697	0.65356	0.78653
	Capital Flow		1.00000	0.41242	0.27212	0.22217	0.48241
	Fertilizer			1.00000	0.46448	0.38999	0.75784
	Bullock Labor				1.00000	0.55241	0.54806
	Human Labor					1.00000	0.40123
	Current Input						1.00000

Appendix C.4.24

Simple Correlation Coefficients Between Independent Variables, Nusa Tenggara Timur (NTT), Wet-Season 1977-78

Varieties	Variable	Land	Capital Flow	Ferti- lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.70667	0.83682	0.66471	0.71257	0.92220
	Capital Flow		1.00000	0.69212	0.60879	0.65396	0.72597
	Fertilizer			1.00000	0.69765	0.75578	0.84256
	Bullock Labor				1.00000	0.77614	0.69246
	Human Labor					1.00000	0.75603
	Current Input						1.00000
HYV	Land	1.00000	0.51230	0.89024	0.85004	0.94622	0.97135
	Capital Flow		1.00000	0.53621	0.36694	0.42690	0.61075
	Fertilizer			1.00000	0.77172	0.88459	0.88831
	Bullock Labor				1.00000	0.81163	0.78185
	Human Labor					1.00000	0.89642
	Current Input						1.00000
Pooled	Land	1.00000	0.67717	0.84896	0.68156	0.74304	0.92767
	Capital Flow		1.00000	0.65938	0.55457	0.58452	0.69633
	Fertilizer			1.00000	0.68361	0.75766	0.84817
	Bullock Labor				1.00000	0.78250	0.70506
	Human Labor					1.00000	0.78671
	Current Input						1.00000

Appendix C.4.25

Simple Correlation Coefficients Between Independent Variables, Nusa Tenggara Timur (NTT), Wet-Season 1978-79

Varieties	Variable	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.77823	0.51010	0.76791	0.87541	0.94323
	Capital Flow		1.00000	0.53836	0.71948	0.73869	0.74205
	Fertilizer			1.00000	0.67297	0.59480	0.37183
	Bullock Labor				1.00000	0.76641	0.71319
	Human Labor					1.00000	0.81748
	Current Input						1.00000
HYV	Land	1.00000	0.81728	0.88465	0.86081	0.93651	0.96085
	Capital Flow		1.00000	0.84713	0.74257	0.80239	0.87485
	Fertilizer			1.00000	0.83066	0.85538	0.87326
	Bullock Labor				1.00000	0.78168	0.85247
	Human Labor					1.00000	0.92110
	Current Input						1.00000
Pooled	Land	1.00000	0.77928	0.66802	0.79146	0.89056	0.94959
	Capital Flow		1.00000	0.69582	0.68246	0.76910	0.79936
	Fertilizer			1.00000	0.70388	0.72022	0.59478
	Bullock Labor				1.00000	0.72146	0.76108
	Human Labor					1.00000	0.85344
	Current Input						1.00000

Appendix C.4.26

Simple Correlation Coefficients Between Independent Variables, Nusa Tenggara Timur (NTT), Wet-Season 1977-78 and Wet-Season 1978-79

Varieties	Variables	Land	Capital Flow	Ferti-lizer	Bullock Labor	Human Labor	Current Input
NHYV	Land	1.00000	0.73923	0.80565	0.71129	0.74643	0.90600
	Capital Flow		1.00000	0.69210	0.65851	0.67896	0.73691
	Fertilizer			1.00000	0.71425	0.73086	0.77006
	Bullock Labor				1.00000	0.77593	0.73144
	Human Labor					1.00000	0.73047
	Current Input						1.00000
HYV	Land	1.00000	0.65916	0.88585	0.84938	0.93960	0.92561
	Capital Flow		1.00000	0.65551	0.54204	0.61142	0.74372
	Fertilizer			1.00000	0.78164	0.86437	0.82378
	Bullock Labor				1.00000	0.80874	0.80258
	Human Labor					1.00000	0.89018
	Current Input						1.00000
Pooled	Land	1.00000	0.72191	0.82569	0.72832	0.78453	0.91047
	Capital Flow		1.00000	0.68362	0.62320	0.65656	0.74143
	Fertilizer			1.00000	0.70668	0.75481	0.78714
	Bullock Labor				1.00000	0.77545	0.73846
	Human Labor					1.00000	0.89065
	Current Input						1.00000