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TECHNOLOGICAL CHANGE, PRODUCTIVITY AND EMPLOYMENT IN INDONESIAN AGRICULTURE:

An analysis of the Annual Agricultural Surveys of the Central Statistical Office with regard to Rice Agriculture, particularly in Java/Bali

Cooperative Project by:

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Biro Pusat Statistik (BPS)
Boston University

by: Budiono Sri Handoko
Gillian Hart
Gustav F. Papanek
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Supported by USAID Contract No. G. -1355

November, 1982

SUMMARY

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The conclusions which follow are stated unequivocally, but we recognize that they are limited by the absence of information on institutional changes and household data, and by changing questionnaires and samples, a particularly serious problem in the early years of the agricultural surveys. The analysi is therefore largely limited to 1971-1978. These years saw the spread of technology based on high yielding varieties (HYV) of rice accompanied by heavy fertilizer use and greater water control. They were also years of substantial changes in policies and institutions, whose effect is difficult to disentangle from the consequences of technological change. Given these caveats, the following conclusions appear reasonably well founded:

1. Indonesian cultivators, like those elsewhere, are able and willing to appraise the benefits of new technology, to compare them to its costs and to adopt it very readily if the inputs are available and if the technology pays.

2. Such high rates of adoption of the new technology have been achieved that, at least for Java/Bali, there is only limited scope for a further shift from local seed varieties to HYV.

3. While technological change seems to have benefitted more and sooner the operators of larger units, the difference between them and small-holders is not great and should not be a major cause of income disparities.

4. Increased yields of rice have been the result both of (i) greater use of such inputs as fertilizer and water on traditional and HYV seeds and (ii) the shift from local to HYV. Since the shift has pretty well run its course, at

least for Java/Bali, it will be more difficult to increase yields in the future.

5. The most important means for increasing yields are:

a) Control of pest damage, which has recently affected one-third of all plots and has reduced their output by about 50%. Planthopper (wereng) is the largest identified cause of damage (1/3), followed by rats and equalled by "other" causes, which need to be more clearly identified.

b) Multiple cropping, based on irrigation, already covered 40% of land in the rice areas of Java/Bali in the early 1970's and has been increasing at 2% a year. Considerable potential exists for expanding irrigation further, thus: (i) increasing output 12-13% per crop, and (ii) permitting a shift from a low value, low labor-use, dry season crop to wet rice.

c) Fertilizer, contrary to some arguments, apparently continues to pay; at world prices every $1 spent on fertilizer yields almost $5 in greater rice output. While this estimate has a considerable margin of error, the error would have to be large indeed for fertilizer to become socially unprofitable. Fertilizer use has increased recently because the ratio of fertilizer to rice prices -- which according to government policy is to be 2:1 -- has been close to 1:1. For smaller units, reducing the risk of buying fertilizer may now be an important goal of government policy.

d) Labor is already used so extensively that an additional 10% would increase output only 1% on Java/Bali.

6. Size differences seem to affect some variables, not others:

a) Fertilizer is almost as extensively used by small as by large units. Indonesia, unlike some other countries, has made fertilizer so widely available that even rice small-holders can obtain it. Since they combine it with more labor and therefore use it more productively, it would be important to help them to use even more.

b) Unexpectedly the larger units had a higher proportion of double cropped rice land. This implies that the village elite have not only more, but also better rice land, with obvious implications for income distribution.

c) Small-holders respond as effectively to changes in prices of inputs and outputs as those operating bigger units, so there is a good deal of scope for affecting their behavior through price policies.

d) Small-holders use more labor, as one might expect, and therefore appear more productive in terms of output per unit of land.

7. Workers real income seems to have stagnated and income distribution become less equal.

a) Real wages per crop (that is wages adjusted for inflation) seem to have been stagnant from 1971 to 1978, but somewhat higher in the mid-1970's.

(i) Real wages bill per ha for all workers (Rp '000)	1971-72	1973-75	1976-78
- Java/Bali	43.2	44.4	43.2
- Other Islands	40.6	35.0	34.9

(ii) Real wage rate for each worker (Rp)	1975-76	1977-78
- Java/Bali	279.5	272.5
- Other Islands	563	515

(iii) Share of workers in output	1971-74	1975-78
- Java/Bali	26.75%	22.0%

Since the wage bill, the total amount of wages paid to all workers, stagnated in rice agriculture for Java/Bali, and the output increased in real (inflation adjusted) terms the share of workers must have gone down. That indeed seems to have happened.

c) The far less reliable figures for the Other Islands suggest an even more drastic decline in wage bill and labor share for rice agriculture.

d) Income distribution as a result is likely to have become less equal in rice agriculture, at least for Java/Bali.

e) Conclusions so far have been on a per crop basis. Multiple cropping appears to have increased almost 2% a year, but the rural population has grown at least at that rate. The two may just offset each other, so stagnant wages, declining income shares for hired labor, and worsening income distribution appear to hold true for rice agriculture.

f) Wages for other crops are less than for work on rice, so probably do not compensate for declining labor shares in rice agriculture.

8. Absolute wages in rice agriculture continue to be very low. In 1978 they averaged about Rp 400 (US $1) for the country, Rp 300 for Java/Bali. On various, somewhat arbitrary, assumptions annual income for these workers was Rp 28,500 ($70) to Rp 54,000 ($135) as against a national average of $360. Wages may be as much as 50% higher for male than female occupations.

9. There is slight evidence that the harvest wage bill may be declining, providing some support for the arguments of increasing restrictions on harvest labor.

10. Labor use per crop and hectare in rice agriculture also stagnated.

a) Labor use increased with yields. A 10% increase in output raised the use of harvest labor by about 4%, but since harvesting uses about one-third of total labor, the effect on small labor use is small.

b) Land with year-round irrigation, which is double cropped, uses about 10-15% more labor for each wet rice crop than single cropped land.

c) The more family labor per hectare is available and the smaller the size of unit operated, the greater the labor use. These two variables are, of course, inversely related. An increase of one family member or a halving of the size increase labor use about 5-9%.

d) A change in the real wage changes labor use in the opposite direction by about one-third.

e) Increased fertilizer use has a positive but negligible effect on labor use.

f) A shift to HYV seems to reduce labor use about 6%.

g) An increased use of other (non-labor, non-fertilizer) inputs also seems to reduce labor use, but by a very small percentage.

h) In short, increases in labor use per crop will come from yield and irrigation expansion, since it is undesirable to reduce wages or size of holdings further, or to increase the number of low productivity family members per hectare. As use of HYV and other inputs expand labor use may decline. The two effects might balance, resulting in little change in labor use per crop.

i) Double cropping will increase labor demand. Since it is expanding about 2% per year, the growth in labor demand may be less than the 3% increase in the labor force.

j) The use of the labor displacing sickle in harvesting seemed to increase slightly in the 3 years for which data are available and to be related to the use of commercial inputs. This could help explain the decline in harvest labor. Since sickle use could expand a great deal, these facts can be ominous for the future.

11. The share of hired labor declined, of family labor increased, within the unchanged total labor use per crop and hectare in the past, at least on Java/Bali. The decline in the role of hired labor was especially pronounced for harvesting and was noted only on the small units.

12. For the largest units on Java/Bali the family provides 5-10% of labor, for the smallest units more than 50%. On the Other Islands much less hired labor is used. Even on the largest units family workers participate in all operations. On the largest units, only about half as much labor is used per hectare as on the smallest.

13. Rice agriculture provides employment for only 10% of days available to family operating land on Java/Bali, 20% on the Other Islands on average units.

14. Despite this, marginal product of labor is extremely low. On the most labor intensive plots the loss of a worker would reduce output by Rp 30 (US $0.07) per day, on the average plot below 0.5 hectares, by only Rp 58 (US $0.15). The wage is substantially above this, so employers are either not profit maximizers, losing Rp 45-190 (0.99-3.26 kg rice) for every marginal labor-day or, more likely, the marginal workers are family members.

15. A 10% change in wages is accompanied by a 3-7% change in employment in the opposite direction. Employers respond to wage changes.

16. A pessimistic picture results. At present wages, and with a marginal product approaching zero, employment in rice agriculture on Java/Bali is likely to rise only with expansion of double cropping due to irrigation. A 2% expansion would be a fast rate, in line with past experience. But the labor force is growing at 3% a year. And if real wages are to keep up with a 6% a year growth in National Income, to keep income disparities from rising, labor in agriculture would need to decline by roughly 3% per crop. With

expanded double cropping/irrigation absorbing 2%, the net decline in rice agriculture would need to be 1% of the labor force per year. With some 15 million workers in non-cash crop agriculture in Java/Bali, some 150,000 would have to be found other jobs a year, to keep wages rising. The normal increase in the labor force is about one million. So about 1.1 million jobs are needed on the Other Islands or in non-agricultural activities on Java to keep wages rising with National Income and to prevent worsening income distribution. Of course these are, at best, rough guesses, but they do indicate the formidable task Indonesia may face in creating productive jobs.

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I. TECHNOLOGICAL CHANGE AND PRODUCTIVITY

Indonesia, like other countries in Southern Asia, has experienced rapid technological change based on high yielding varieties (HYV) of seeds, heavy application of fertilizer and greater control and increased use of water. The spread of this technology, often labelled the "Green Revolution", took place in Indonesia from the late 1960's and was accompanied by fundamental changes in the political-economic system and hence in policies which substantially affected developments in agriculture. The change in government in the mid-1960's meant, for instance, a massive rehabilitation program of irrigation, a great expansion in the availability of fertilizer, a change in pricing and procurement policies, and far reaching changes in political and power relationships in the villages.

The data available from the Agricultural Surveys, which span most of the 1970's, also cover the spread of the new technology in Indonesia. The simultaneously occurring broad changes make it difficult to disentangle the effect of new technology from the effects of the broader changes taking place in society and the economy.

Disentangling casual factors is especially difficult because the Surveys were developed primarily to elicit information on production and on inputs used and do not cover many other aspects of agriculture. For instance, the Surveys lack information on most aspects of land ownership and tenancy relations, although they do provide some data on operating units. Moreover the number of interviews conducted were so large that differences in standards of interpretation were bound to occur in

different areas. Finally, the Surveys generally focussed on rice agriculture and paid much less attention to other crops, and were more extensive for Java/Bali than for the Other Islands. Consequently our analysis is also limited to rice and emphasizes Java/Bali. The inevitable limitations of data, discussed in more detail in the Appendix, need to be kept in mind in interpreting the analyses and conclusions which follow.

1) The Spread of Technology

Two crucial issues arise with respect to the diffusion of any new technology in agriculture: how quickly are cultivators willing to adopt it, and to what extent is it used disproportionately on larger holdings and therefore benefits the wealthier groups?

a) The Speed of Technology Diffusion

Form the Survey it is clear that participation increased very rapidly in the various government package programs, which provided HYV seeds, fertilizer, credit and pesticides (See Table I-1). For Java/Bali from 1971, when less than 30% of cultivators participated, participation reached 85% in five years. While participation in the package programs is not synonymous with adoption of the new technology, the two were related. The spread of these programs was at a rate comparable to those in the most highly commercialized agricultural systems in Europe or the United States.

The rate of adoption in the Other Islands is far slower, from 10% to 44% in the same period. This reflects several factors:

- the programs were pushed less actively in these areas and were not as widely available.

PARTICIPATION IN BIMAS/INMAS PROGRAM

	Percent of Crops Cultivated Under Each Program				
	Regular BIMAS	Improved BIMAS	Regular INMAS	Improved INMAS	None
Java/Bali					
1971	29.6	--	--	--	70.4
1972	12.1	10.4	10.4	4.9	58.3
1973	13.5	33.5	9.5	10.7	32.8
1974	13.5	42.8	7.7	8.1	27.8
1975	13.5	42.8	9.2	9.0	25.5
1976	15.2	46.4	11.3	12.4	14.8
1977	15.9	38.6	16.0	12.6	17.0
1978	9.4	41.6	12.6	23.6	12.0
Other Islands					
1971	10.0	--	--	--	90.0
1972	2.5	1.6	1.6	0.7	93.5
1973	4.7	11.2	3.8	3.9	76.4
1974	6.4	13.7	3.0	3.8	73.0
1975	7.7	9.4	6.1	4.4	72.4
1976	14.3	11.2	11.4	7.1	56.0
1977	11.3	9.5	10.5	6.8	61.9
1978	8.6	14.3	11.0	11.0	55.0

- they were limited to rice cultivators in rice growing areas so that those who grew rice in areas where it was not the dominant crop could not participate. Such areas are far more widespread in the Other Islands.
- most important, irrigation is far less available in the Other Islands and without an assured water supply the new technology is generally not sufficently profitable to be adopted.

For all these reasons, and especially the last one, the 44% of the cultivators participating for the Other Islands may represent as close to a maximum as the 85% for Java/Bali.

But participation in the various package programs is not an ideal indication of the adoption of the new technology. A central feature of the package is credit, so cultivators may participate essentially to obtain government subsidized credit. Moreover there is some pressure for participation in target areas and some families may sign up pro-forma.

Several more direct indexes exist on adoption of the new technology. Data not derived from the Surveys show a doubling of the use of commercial fertilizer in the three years from 1970 to 1973. Fertilizer use then essentially stagnated to 1976, but again increased by two-thirds to 1979. The series derived from the Survey for Java/Bali unfortunately begins in 1971 and shows little increase to 1975 and then also a two-thirds increase to 1978. More dramatic is the increase in insecticides, required with the HYV. Its use tripled from 1971 to 1978 (and actually quadrupled in 1977.)

Table I-2: Complementary Bimas Input Use, Indonesia, 1970-1979.

*****

YEAR	UREA ('000 Tons)	MODERN-VARIETIES ('000 Ha.)	USERS
1970	342	1,072	
1971	413	1,848	
1972	485	2,279	
1973	669	3,326	
1974	604	3,244	
1975	670	3,784	
1976	666	4,151	
1977	919	4,801	
1978	975	5,216	
1979	1,096	5,552	

*****

Source: R.H. Bernsten, B.H. Siwi and H.M. Beachell, The Development and Diffusion of Rice Varieties in Indonesia, [10].

Table I-3

USE OF NON-LABOR INPUTS

Per Hectare

	Chemical Fertilizer (Kg.)	Animal Manure (Kg.)	Green Manure (Kg.)	Insecticide (Kg./liter)	Pesticide (Kg./liter)
Java/Bali					
1971	109	331	76	7	na
1972	88	469	99	8	2
1973	116	587	122	8	1
1974	127	(749)	154	10	2
1975	127	350	40	11	3
1976	142	326	50	12	2
1977	190	553	47	29	4
1978	214	554	43	22	4
Other Islands					
1968-70	14	28	7	na	na
1971	30	101	8	3	na
1972	15	36	6	2	1
1973	30	102	5	3	1
1974	40	118	36	5	2
1975	42	147	20	4	0.5
1976	49	71	19	6	1
1977	69	149	15	9	4
1978	88	89	24	13	15

Table I-4

DISTRIBUTION OF CROPS BY SEED VARIETY

	Percent of Crops					
	Java/Bali			Other Islands		
	International	National	Local	International	National	Local
1971	22.2	0.9	76.8	15.4	1.6	83.0
1972	33.7	14.6	51.7	15.3	5.5	79.2
1973	45.0	14.0	40.5	24.0	9.1	66.9
1974	53.6	12.5	33.8	24.9	9.1	66.0
1975	48.3	19.0	32.1	29.7	13.0	57.4
1976	47.6	23.3	29.0	28.3	15.1	56.6
1977	45.0	26.2	28.8	26.7	17.1	56.1
1978	49.3	26.6	24.1	30.8	22.0	47.2

For the Other Islands fertilizer use doubled between 1968/70 and 1973 and again doubled to 1978. The increase for insecticide are equally dramatic.

But the best index of technology spread is the adoption of HYV seeds. These fell into two categories, those developed outside Indonesia ("International") and those developed in the country ("National"). Data on their spread, given in Table 1-4, can be summarised as follows.

Table I-5

The Spread of HYV Seeds

	Java/Bali	Other Islands
1971	23.1%	17.0%
1972	44.3%	20.8%
1973	59.0%	33.1%
1974	66.1%	34.0%
1975	67.3%	42.7%
1976	70.9%	43.4%
1977	71.2%	43.8%
1978	75.9%	52.8%

Here again the diffusion of the new technology is very rapid, with use doubling or more than doubling in the two years 1971 to 1973, then increasing more slowly to 1975, essentially stagnating for the next two years and then showing another, smaller spurt in 1978. There are two likely reasons for the slowdown:

(i) The "International" varieties available in the mid-1970's were not sufficiently resistant to some pests and diseases, especially the brown planthopper (wereng) and cultivators discovered that they were risky. In fact, 1976 and 1977 were years of bad infestation and cultivators wisely waited for more resistant varieties to be developed. "National HYV" varieties, more pest resistant, continued to expand their coverage between 1975 and 1977, while the area planted to International varieties was actually declining (Table I-4). When more resistant International varieties became available for the 1978 crop, acreage planted in these varieties again increased.

(ii) As any new technology nears the saturation point, the rate of adoption is bound to slow. Moreover the taste of the HYV varieties, especially the International ones, is not liked as well as that of the local varieties. As a result some cultivators may plant part of their holdings to local varieties for their own consumption, while most of their land is planted to higher yielding varieties for sale. Unless and until the HYV are as acceptable to the local consumer, coverage is unlikely to reach 100%.

b) <u>Size of holdings and adoption of the new technology</u>

It is widely argued that the new technology favors those with large holdings. By itself the technology is largely scale neutral, as usable by those with small holdings as those with larger ones. ("largely" because some irrigation works, such as wells, have some economies of scale). However, it is assumed and argued that small holders are less likely to adopt the new technology because:

(i) they can less afford the risk of cash purchases of inputs and of crop damage from less resistant varieties;

(ii) they lack access to credit, becaure of the higher cost to lenders of smaller loans, and less creditworthiness and credit rationing;

(iii) they are similarly less likely to receive information, because it is more costly per unit to provide it to small units;

(iv) they have less personal and political influence, so if any input (including information) is scarce they will be the last ones to receive it.

Table I-6 indicates that indeed small holders on Java/Bali adopted HYV more slowly than those operating larger units. The gap is 15-30% in different years. The smallest units also participate less in the package approach to modern technology (BIMAS/INMAS). However, on all sizes of holding the new varieties spread very rapidly so that by 1975, four years after our series begin, about 60% of the smallest operators was using them on Java/Bali. For participation in BIMAS/INMAS the gap between small and large actually shrank quite dramatically from more than 50%, in 1971 to about 10% in 1978. For the Other Islands the gap is never large, is reversed in some years, and shows no clear trend.

There is indeed a differential adoption rate but even the tiniest operating units, of 0.2. hectares or less, quickly adopted HYV. If one takes account of the fact that HYV and local varieties are not perfect substitutes because of differences in taste, and that small holders may want to keep a larger proportion of their land in local varieties to satisfy their taste preference, it may well be that within 4-5 years of the introduction of HYV nearly all units had reached their desired level

Table I-6

ADOPTION OF MODERN VARIETIES AND PARTICIPATION IN BIMAS/INMAS BY FARM SIZE GROUPS

	Hectares of Adjusted Farm Size*				
	.2	.2-.5	.5-1	1-2	2
Java/Bali					
1971: % MV's	17.4	20.7	21.9	22.5	24.8
% BIMAS/INMAS	14.9	25.0	30.0	29.4	34.3
1975: % MV's	63.3	61.3	67.7	71.8	73.4
% BIMAS/INMAS	64.4	66.9	74.4	78.2	83.7
1976: % MV's	59.2	67.6	71.4	73.0	77.7
% BIMAS/INMAS	66.7	81.0	86.7	88.6	92.1
1977: % MV's	55.0	61.0	69.9	75.3	84.6
% BIMAS/INMAS	68.7	75.9	82.0	86.2	91.6
1978: % MV's	60.7	65.9	74.3	78.8	84.5
% BIMAS/INMAS	80.2	82.6	85.9	87.8	90.9
Other Islands					
1971: % MV's	(22.0)	20.0	17.7	14.6	16.4
% BIMAS/INMAS	(20.5)	10.8	10.5	8.8	8.3
1975: % MV's	(20.5)	42.0	44.6	41.3	46.5
% BIMAS/INMAS	(17.9)	28.4	27.0	28.9	29.7
1976: % MV's	(13.0)	36.3	45.3	44.3	48.7
% BIMAS/INMAS	(26.1)	46.2	42.1	46.1	42.5
1977: % MV's	(34.4)	41.5	41.8	43.7	52.4
% BIMAS/INMAS	(42.4)	36.7	40.5	37.7	35.2
1978 % MV's	(50.0)	53.2	46.0	53.7	59.2
% BIMAS/INMAS	(21.9)	37.6	42.5	47.5	45.2

Parentheses indicate very few observations.

* In all tables: (i) size intervals are 0-.199; .2-.499; .5-.99; 1.0-1.99; and 2.0 and over. (ii) size is defined in terms of the unit operated, but not necessarily owned, by a family. "Adjusted" refers to the attempt to take account of land quality by giving a weight of 2 to land that is multiple cropped and 0.67 to dry land.

of the new technology. That is, all the obstacles, enumerated above, to the adoption of HYV by small holders seem, in fact, not to be serious in Indonesia.

Participation in BIMAS/INMAS is a slightly different story. Initially it was limited to better irrigated areas and gave preference to larger holdings But when these restrictions were abandoned, and the advantages became apparent, 80% of all plots on Java/Bali participated in these programs.

c) The Spread of New Technology and Multiple Cropping

One of the advantages of the new seeds is that they have a shorter growing season and therefore facilitate multiple cropping of rice. This obviously increases output and employment, and tends to reduce extreme seasonal fluctuations in labor requirements.

It should be possible therefore to trace the spread of new technology by analyzing the seasonality of the rice harvest. We expected that the percentage of the rice crop harvested in the off season would gradually increase over time, but there is no evidence for this in the Survey data (Table I-7). We have no good explanation for the fact that the three peak months show 47.5% to 50.8% of the crops harvested throughout the period, with no clear trend. (The exception is 1972 when apparently the harvest was a bit more spread out). The three peak months do move from the May-August to the March-May period and that probably reflects the shorter growing period of the new seeds. However, there is not another major peak for a second crop, which is puzzling.

Table 1-7

SEASONALITY OF RICE CULTIVATION

Percent of Rice Crops Harvested in Each Month

	1971		1972		1973		1974		1975		1976		1977		1978	
Java/Bali																
January	4.5		5.7		2.2		3.4		2.8		2.9		1.8		1.8	
February	5.6	10.1	6.1	11.8	3.6	5.8	5.6	9.0	5.2	8	4.7	7.6	4.0	5.8	4.3	6.1
March	5.8		7.3		10.6		11.8		14.9		13.8		12.4		13.1	
April	9.0		11.1		24.4	49.8	24.0	48.6	21.9	48.9	23.5	48.9	25.2	50.3	26.6	50.8
May	21.6		12.8	35.4	14.8		12.8		11.6		11.6		12.7		11.1	
June	14.3	47.5	11.5		7.9		6.4		6.5		6.6		7.5		4.7	
July	11.6		10.2		6.4		6.2		6.8		6.4		7.5		6.0	
August	13.6		15.0		7.6		8.4		7.4		7.6		9.8		10.9	
September	3.1		5.7		5.4		5.6		7.6		6.8		7.3		7.7	
October	2.9		4.5		5.8		5.7		6.4		6.4		5.0		5.8	
November	2.7	13.9	4.3	19.9	5.8	22.5	4.7	21.5	5.2	22.8	5.4	22.7	3.3	19.1	4.2	21.5
December	5.2		5.4		5.5		5.5		3.6		4.1		3.5		3.8	
	100%		100%		100%		100%		100%		100%		100%		100%	
Other Islands																
January	4.4		3.2		6.5		5.5		4.0		3.0		3.8		2.9	
February	2.0		6.1		11.4		9.1		10.5		8.7		8.0		8.0	
March	2.9		11.0		13.4	13.4	14.2	13.6	14.1	13.5	16.0	14.9	13.2	13.3	10.8	15.0
April	7.0		11.3		17.9		22.5		20.8		23.6		22.3		30.2	
May	26.7		16.7		10.8		8.7		8.4		11.1		9.6		11.1	
June	15.4	17.2	11.3	13.3	8.3		7.5		7.5		6.6		6.6		4.7	
July	12.2		10.4		6.7		4.4		5.0		4.8		6.4		5.8	
August	14.6		14.6		7.4		10.6		7.4		9.4		7.4		8.4	
September	5.1		5.6		5.5		6.3		11.4		5.6		7.5		6.7	
October	2.3		3.5		4.6		3.8		4.2		3.9		6.2		4.2	
November	3.2		2.5		3.1		4.2		4.0		3.8		5.1		3.9	
December	4.4		3.0		4.5		3.2		2.7		3.6		3.8		3.5	
	100%		100%		100%		100%		100%		100%		100%		100%	

For the Other Islands the four peak months similarly shift from May-August to February-May, and similarly show no diminution of the concentration in these months.

While we have no good explanations for the failure of a second harvest peak to appear, this is not enough in itself to overbalance the weight of evidence that there has indeed been a very rapid spread of the new technology.

d) Conclusions - The Spread of Technology

The evidence is overwhelming that Indonesian cultivators adopted the new technology at a very rapid rate. Within 3 to 5 years from the time HYVs became widely available in about 1970, two-thirds of all rice plots on Java were planted to these seeds and some 40% on the other Islands. When International varieties proved inadequately pest resistant there was a temporary increase in use of improved National varieties until the international plant breeders also came up with pest resistant varieties. By the late 1970's three-quarters of all plots on Java/Bali and half on the other Islands were planted with High Yielding Varieties. This is probably close to an upper limit, given the taste preference for Local Varieties and the lack of suitable HYV for some areas.

Participation in BIMAS/INMAS increased even more rapidly, by 1978 reaching 90% for Java/Bali and 45% in the Other Islands.

These developments were accompanied, as one would expect, by a rapid increase in the use of commercial inputs, notably fertilizer and pesticides.

The rate of technological diffusion was somewhat less, and the level reached somewhat smaller, for small holders than for those operating,

larger units. But the gap is 30% or less and small-holders too adopted the new varieties very rapidly and reached quite high levels of adoption. For the two smallest size categories HYV adoption was 61% and 66% respectively and 80% or more for participation in BIMAS/INMAS. Again, given taste preferences and the availability of irrigation, this may represent close to the maximum for now.

Three clear conclusions emerge from the data: (i) Indonesian cultivators, like those elsewhere, are apparently able and willing to appraise the benefits of new technology, to compare them to its costs and to adopt it very readily if the inputs are available and if the technology pays.

(ii) Such high rates of adoption of the new technology have been achieved that, at least for Java/Bali, there is only limited scope for a further shift from local varieties of seed to HYV.

(iii) while technological change seems to have benefitted more and sooner the operators of larger units, the difference between them and small holders is not great and should not be a major cause of income disparities.

2. Technology, Inputs, and Outputs and The Effect of Size Over Time

The technology diffused in Indonesia in the 1970's involved, as already mentioned changes in a number of inputs and practices and resulted in increased yields. In this section the different components are discussed separately. Since such components as HYV seeds, fertilizer and irrigation generally go together, examining them separately gives the impression that all increases in output are due to a particular input, which is clearly wrong. Part 3 uses cross section analysis to analyze their interaction..

a) Yields

The overall data on yields from the Surveys are of limited reliability because of sample and questionnaire changes over the years. But even if one compares years with identical questionnaires one finds substantial fluctuations in output (Table I-8), partly due to changes in weather, but substantially due to variations in crop damage. (Table I-10). Regardless of fluctuations in overall yields the Modern Varieties and the technology associated with them, generally produce yields 20-30% higher than the Local Varieties in Java/Bali. For the Other Islands, the difference is around 15% only. It is substantially higher than this in two years, but negative in one year, so the variance and risk are clearly greater on the Other Islands. The reasons for the slow adoption of Modern Varieties on the Other Island is thus clear: the benefits are less and the risk greater than for Java/Bali.

For both Modern and Local Varieties there were significant gains in yields over the decade, if one compares an average of the initial three years with one for the terminal years. Additional gains in output resulted from the shift which occurred during the same period from Local to Modern Varieties, especially for Java/Bali.

Table I-8

WET RICE YIELDS BY SEED VARIETY

	Kg/hectare						
	Modern Varieties		Local Varieties		Average		F Statistic
Java/Bali							
1968-70					3056		
1971	4011		2901		3151		590.9
1972	2718	3093	2237	2402	2437	2626	63.8
1973	2549		2069		2291		48.5
1974	3117		2249		2743		98.0
1975	3944		3058		3659		372.9
1976	4007		3229		3781		293
1977	3428	3672	2671	2958	3210	3475	257
1978	3581		2974		3435		202
Other Islands							
1968-70					2476		
1971	2934		2498		2573		15.3
1972	2280	2495	1826	2052	1907	2156	30.8
1973	2272		1833		1988		17.2
1974	2061		1850		1907		3.0
1975	3180		2751		2936		25.0
1976	3042		3210		3115		4.4
1977	3104	3118	2717	2909	2888	3066	21.3
1978	3207		2799		3014		17.1

Table I-9

Trends in Yields by Seed Varieties and From Shift in Varieties

(1971/73 compared with 1976/78)

	Modern Varieties	Local Varieties	Average*
Java/Bali	19%	23%	32%
Other Islands	25%	42%	39%

* This, of course, incorporates the effect of the shift.

Since some at this point unknown, share of the gains were due to the shift to Modern Varieties, which has largely run its course - at least in Java/Bali - it will clearly be more difficult to increase yields and output in the future.

(b) Damage.

The importance of damage to output has already been noted. Several facts are striking in Table I-10:

- the high percentage of crops damaged each year, averaging well above 30% for the Other Islands and generally 20-30% for Java/Bali.
- the sharp increase in damage for Java/Bali in 1976-78, primarily because of the growing importance of HYV, less resistant to local pests.
- the importance of rat damage for the Other Islands, where labor for pest control is more expensive and of the brown planthopper (wereng) on Java/Bali where HYV are more widespread.

The development and distribution in 1978 on Java/Bali of varieties resistant to that pest shows up in the data, but not very strongly. Puzzling are the fluctuations in reported rat damage and the residual

EXTENT AND NATURE OF CROP DAMAGE

	Percent of Crops Damaged	Cause of Damage (percent)				
		Brown Planthopper	Rats	Flood	Drought	Other
Java/Bali						
1972	21.5	na				
1973	18.6					
1974	11.4					
1975	20.3	27.3	18.2	5.9	3.8	44.8
1976	24.2	38.1	10.6	1.6	12.8	36.9
1977	34.4	39.5	12.6	1.2	9.6	37.1
1978	35.8	31.4	28.9	1.0	2.0	36.7
Other Islands						
1972	39.5	na				
1973	30.7					
1974	29.0					
1975	36.9	16.4	27.1	5.8	3.7	47.0
1976	32.6	17.1	26.5	4.1	10.8	41.5
1977	35.9	17.4	38.1	1.7	6.5	36.3
1978	37.2	26.5	27.1	5.6	6.6	34.2

*Data on damage not available for 1968-70 and 1971, and on cause of damage for all years prior to 1975

"other" category. Both may be in large part due to survey problems. The importance of damage for output is confirmed by the cross-section analysis.

(c) Marketed surplus.

The share of the rice crop marketed rather consistently increases from 1972 to 1978 (Table I-11). A larger proportion of the rice grown from Modern Variety seeds is marketed than from Local Varieties. As previously mentioned, there is a preference for the taste of Local Varieties, that is not always fully reflected in market price differential. As a result cultivators tend to take advantage of the higher yields of Modern Varieties in growing rice for sale, especially to Government and cooperative agencies, while Local Varieties are grown for home consumption or sale in the village.

Since output per capita increased in the 1970's, (see Table I-9), one would expect the marketed surplus to increase as well, as a smaller share of output satisfied the needs of the cultivator's family. Also, with higher increases as a result of greater production, the share of rice in total expenditure may decline. But the near-doubling of marketed surplus in 6 years for Java/Bali can probably not be explained adequately by these two factors. It may well be that it also reflects a shift from payment in kind to payment in cash for labor. To the extent that such a shift has taken place it would obviously involve selling more of the crop, rather than transferring it directly to workers at the time of harvest.

Table I-11

MARKETED SURPLUS BY SEED VARIETY*

	Percent of Output Sold			
	Modern Varieties	Local Varieties	Average	F Statistic
Java/Bali				
1972	21.9	15.8	18.7	100.8
1973	24.7	14.9	20.8	263.6
1974	27.6	16.1	23.7	53.7
1975	30.4	20.5	27.2	53.7
1976	36.9	35.2	36.2	0.05
1977	n.a.	n.a.	n.a.	n.a.
1978	39.4	23.9	35.7	28.0
Other Islands				
1972	16.3	10.6	11.8	41.3
1973	17.1	8.9	11.6	84.1
1974	20.3	13.8	16.0	37.0
1975	25.8	14.9	19.6	54.8
1976	25.1	16.5	20.2	18.3
1977	21.3	19.1	20.1	1.6
1978	25.5	(39.6)	(32.1)	0.5

*Data not available prior to 1972.
Parentheses indicate obvious data error.

(d) The Effect of Size of Operating Unit

The differential speed and extent of technology diffusion to small, as against large, operating units has already been discussed. There are also differences in yields and input use. Various factors have a major influence on these differences which are examined throughout this paper.

Yields are higher, the smaller unit in every year and in both areas. (Table I-12) This could be because:

- smaller units are on more fertile land;
- they are farmed more intensively, because operators need the additional income and alternative employment of their family labor is less attractive or rewarding.

The first of these is undoubtedly true and its contribution is examined further below. The second, the probability that opportunity cost of labor is less than the market wage is discussed in Part II.

Greater fertilizer use does not explain higher yields on smaller units: except for 1971 (and for units of 2-5 ha on the Other Islands) smaller units use somewhat less fertilizer than larger ones. But the differences are not great and appear insufficient to explain differences in yield (Table I-13).

That the smallest units use almost as much fertilizer as the largest in 1978, and that their use of fertilizer increased rapidly, indicates that operators of the small units had no difficulty appreciating the advantages of fertilizer and obtaining access to it. As far as all material inputs are concerned, in general smaller operating units actually use more than larger ones. (Table 1-14). Since chemical

Table I-12:

WET RICE YIELDS BY FARM SIZE GROUPS

	kg/hectare						
	Hectares						F
	.2	.2-.5	.5-1	1-2	2	All	Statistic
Java/Bali							
1968-70	(6337)	2942	2477	2397	2335	3056	5.9
1971	3916	3435	3320	2948	2694	3117	66.4
1975	4661	3920	3605	3476	3188	3642	54.1
1976	4178	3980	3807	3520	3518	3770	24.8
1977	3500	3138	3172	3015	2795	3100	12.0
1978	3925	3485	3348	3241	3271	3361	15.2
Other Islands							
1968-70	3963	2552	2249	1909	1396	2476	27.5
1971	(4487)	3059	2572	2205	2246	2542	46.3
1975	(4326)	3581	3109	2601	2475	2935	27.9
1976	(4859)	3784	3348	2909	2504	3126	34.5
1977	(4054)	3419	3145	2684	2275	2880	28.2
1978	(4693)	3149	2954	3021	2693	2983	10.3

Parentheses indicate small number of observations or large standard deviations, casting doubt on the reliability of the data.

Table I-13

CHEMICAL FERTILIZER USE BY FARM SIZE GROUPS

kg/hectare

	Hectares						F
	.2	.2-.5	.5-1	1-2	2	All	Statistic
Java/Bali							
1971	112	1[illegible]	117	108	96	109	11.9
1975	115	120	127	134	132	127	6.3
1976	120	138	142	146	156	142	11.4
1977	164	178	195	204	186	190	12.8
1978	208	204	213	222	219	215	6.0
Other Islands							
1971	40	39	35	25	22	30	4.8
1975	32	53	43	44	34	43	2.6
1976	25	58	53	48	41	50	2.3
1977							
1978	71	78	87	93	93	89	0.9

Table I-14

REAL VALUE OF NON-LABOR INPUTS PER HECTARE
BY FARM SIZE GROUPS
(per hectare)

	Hectares						F
	.2	.2-.5	.5-1	1-2	2	All	Statistic
Java/Bali							
1968-70	876	588	474	481	394	551	7.7
1971	851	701	676	629	514	635	17.1
1975	539	506	501	506	429	494	6.9
1976	457	470	460	472	452	464	0.7
1977	482	495	529	527	483	514	5.2
1978	564	533	538	524	512	530	3.6
Other Islands							
1968-70	651	375	524	283	195	434	0.8
1971	(496)	551	501	551	332	480	
1975	(597)	431	333	374	397	378	2.6
1976	(374)	323	364	328	364	343	0.8
1977	(630)	427	413	411	359	406	3.1
1978	(390)	414	377	381	410	391	0.8

*Deflated by farm gate rice price.
Parentheses indicate small number of observations.

fertilizer is the largest component, by value of these material inputs, and smaller units use less chemical fertilizer than large units, it is probable that the smaller units use more animal and green manure. There is no time trend in the real value of these material inputs. Since the quantity used of both chemical fertilizer and insecticides/pesticides increased over time, the quantity of manure and green fertilizer presumably declined (see also Table 1-3).

But the principal conclusions which one can draw on the effect of size on the use of material inputs are:

- small holders access to and/or willingness to use chemical fertilizer is only somewhat less than those for operating larger units.
- their use of chemical fertilizer has increased quite rapidly, as has their use of HYV seeds, and in 1978 was only 5% below that of the largest units on Java/Bali (but almost one-quarter below on the Other Islands).
- they appear to compensate for their smaller use of chemical fertilizer by greater use of animal and green manure, so the total value of materials inputs does not differ significantly by size of operating unit.

As one would expect, proportion of output marketed is on the whole directly related to the size of unit (Table I-15) Also it is probably not unexpected that the percent of small units may be increasing for Java/Bali, that of large units declining. However, annual fluctuations in the data make us suspicious that changes in sample or definition affect these results. The data in Table I-16 should therefore be treated with caution. But taken at face value, the two smallest categories

Table I-15

MARKETED SURPLUS BY FARM SIZE GROUPS*

	Percent of Total Output Sold						
	Hectares						F
	.2	.2-.5	.5-1	1-2	2	All	Statistic
Java/Bali							
1975	6.3	20.1	26.4	32.9	41.3	27.5	42.1
1976	8.4	23.7	41.6	45.6	44.4	36.3	2.8
1977	na	na	na	na	na	na	na
1978	9.9	21.0	34.3	44.3	50.2	35.7	17.5
Other Islands							
1975	3.2	12.8	17.8	20.3	29.6	19.7	15.9
1976	5.4	12.5	20.4	18.8	29.6	20.1	6.7
1977	2.4	8.8	15.3	22.0	34.2	20.1	
1978	10.4	12.8	14.7	24.7	(74.9)	32.0	1.3

Parentheses indicate small number of observations.

Table I-16

DISTRIBUTION OF OBSERVATIONS BY ADJUSTED FARM SIZE (CROPS)

	% of crop observations in each group					
	Hectares					
	.2	.2-.5	.5-1	1-2	2	n
Java/Bali						
1971	3.6	16.5	29.4	28.6	21.9	7800
1975	4.9	23.5	32.9	25.3	13.4	6553
1976	6.2	25.2	32.5	23.9	12.2	6713
1977	5.7	23.4	33.2	26.9	10.8	5938
1978	4.2	21.9	30.6	26.5	16.9	7702
Other Islands						
1971	5.2	14.2	24.2	29.9	26.5	1638
1975	2.6	15.9	31.6	29.2	20.7	1527
1976	1.4	15.4	29.6	34.8	18.8	1613
1977	2.1	14.9	30.8	31.3	20.9	1541
1978	2.5	13.7	28.4	31.3	24.1	1267

Parentheses indicate small number of observations.

increased from 20% of observations in 1971 to 26% in 1978, while the two largest declined from 50.5% to 43% for Java/Bali. For the Other Islands over the same period of time there is no clear trend (the smallest declined from 19% to 16%, and the largest remained essentially unchanged from 56% to 55%). Population pressure presumably led to fragmentation on Java/Bali.

The same factor could also reduce the average farm size. Indeed, if one compares 1971 with 1978 there is a sharp decline for Java/Bali in both unadjusted and adjusted (for double cropped and dry land) farm size and only a minor increase for the Other Islands (Table I-17). The picture is mixed and unclear for the more recent period with comparable questionnaires (1975-78). One might expect the size of plots to decline as well. Since the number of plots per operational unit fluctuates but remains essentially unchanged for Java/Bali and the size of holding declines, the size of plot also declined.

The same table shows that the rate of share-cropping is very low in Indonesia compared to many other Asian countries. It has not changed much over time.

(e) Fertilizer/Rice Price Ratios

Studies of other countries have concluded that the ratio between the price of fertilizer, the most expensive input, and of outputs is a crucial determinant of the spread of HYV technology. Indonesian policy has been guided by the rule that the price of a kilogram of fertilizer should be roughly twice that of rice. As is obvious from Table I-18 the ratio has been more favorable than that throughout the 1970's and has been closer to unity since 1972. A heavy subsidy for

Table I-17

LANDHOLDING CHARACTERISTICS OF WET RICE FARMS

(CROP OBSERVATIONS)

	Ave. Farm Size (Ha) Unadjusted	Ave. Farm Size (Ha) Adjusted	Ave. Plot Size (Ha)	No. Plots/ Holding	Percent Sharecropping	Total No. Rice Crops
[illegible]/Bali						
1971	0.82	1.63	0.568	1.88	7.5	8479
1972	na	na		1.88	7.5	12667
1973	na	na		1.78	8.6	7732
1974	na	na		1.79	6.7	10129
1975	0.552	1.199	0.424	1.84	6.4	6963
1976	0.594	1.151	0.379	1.79	6.9	7016
1977	0.542	1.106	0.384	1.80	6.9	6686
1978	0.582	1.310	0.440	1.88	8.2	9650
[illegible]her Islands						
1971	0.895	1.609		2.15	12.9	1774
1972	na	na		1.84	9.1	6893
1973	na	na		1.70	9.8	2536
1974	na	na		1.72	9.4	
1975	0.799	1.504	0.582	1.75	10.1	1669
1976	0.840	1.485	0.596	1.82	8.7	1738
1977	0.823	1.507	0.612	1.73	9.2	1628
1978	0.939	1.718	0.670	1.92	9.7	1341

Table 1-1a

RATIO OF FERTILIZER TO RICE PRICE

Rp/Kg

	Java/Bali			Other Islands		
	Fertilizer Price	Rice Price	1:2	Fertilizer Price	Rice Price	1:2
1968-70	30.5	19.7	1.55	36.1	19.5	1.85
1971	29.2	17.2	1.70	35.9	20.5	1.75
1972	29.5	30.8	0.96	35.8	32.5	1.10
1973	38.3	33.7	1.14	36.5	42.2	0.86
1974	51.5	39.6	1.30	53.8	50.4	1.07
1975	71.5	45.0	1.59	75.8	53.4	1.42
1976	74.0	51.9	1.43	74.1	56.3	1.32
1977	72.7	60.0	1.21	75.9	63.4	1.20
1978	71.5	61.0	1.17	74.1	66.6	1.11

fertilizer has made its use attractive and has contributed significantly both to the increase in fertilizer use and to the spread of Modern Varieties of seed, heavily dependent on more fertilizer use for their benefits. In real terms the rate of subsidy was least in 1968-71 and in the mid-1970's. Following on several years of stagnant yields, the ratio has consistently been lowered between 1975 and 1978 from 1.6 to 1.2 for Java/Bali (it has been even lower for the Other Islands).

(f) Multiple Cropping

Seeds, fertilizer and water are the principal ingredients of the new technology. As irrigation systems were rehabilitated and extended on Java/Bali multiple cropping increased, encouraging the spread of HYV seeds and the increased use of fertilizer.

Again there are year to year fluctuations in multiple cropping which may be partly due to differences in rainfall and perhaps partly to vagaries of the sample. If one ignores 1968-70 as of doubtful reliability and compares two year averages to reduce the effect of random fluctuations, then there was an increase of 12.6 percentage points in the area multiple cropped over 6 years for Java/Bali (Table 19a), a 28% increase compared to the base. That is, the multiple cropped area increased by about 2% a year.

For the Other Islands the changes from year to year are even larger and appear quite erratic. If the figures are to be believed, and again comparing two year averages, there was a decline of 7.3 percentage points, representing an almost 50% decrease in multiple cropped area. It is possible that this decline reflects improved income earning possibilities in activities other than rice agriculture, including the

Table I-19a

TREND OF PLOTS MULTIPLE CROPPED WITH RICE
(in % of plots)

Year	Java/Bali		Other Islands	
1968-1970	32.4		6.9	
1971	47.6	44.9	10.8	15.6
1972	42.1		20.4	
1973	47.1		11.9	
1974	54.4		8.3	
1975	59.1		10.3	
1976	52.5		9.5	
1977	50.7	57.5	9.6	8.3
1978	64.3		7.0	

growing of other crops.

"Multiple cropping" here means more than one crop of wet rice. Many of the areas changing from a single to more than one rice crop had grown more than one crop before: a crop of wet rice during the rainy season and such crops as dry rice or maize or cassava during the dry season. So a shift to multiple cropping in most cases did not mean a doubling of output, but a smaller increase.

On the other hand, during the same period a few areas may grow a dry season crop in addition to shifting from one to two wet rice crops or even to three rice crops in 13 months. Both factors would lead to a more than doubling of production from improved water control.
The additional output above two wet rice crops, would help offset the fact that multiple cropping does not really double output. Of course, there is no way of knowing the relative magnitude of the two factors, but it may not be unreasonable, although optimistic, to assume that a shift from single to multiple cropping doubles output.

Surprisingly, multiple cropping in rice agriculture is more prevalent on larger holdings. Our assumption had been that smaller operating units developed in areas of higher yields and that these would also be areas where multiple cropping is more prevalent. However, not only do the larger holdings have a higher percentage of multiple cropped areas, the gap has also grown over time on Java/Bali. If one ignores 1968/70 as too unreliable, one finds that the largest holdings have about twice the multiple cropped areas of the smallest for Java/Bali. For the latter the increase was 27% between 1971 and 1978 and if the first and last two years are averaged there was actually a decline in multiple

Table 1-19b

TREND OF PLOTS MULTIPLE CROPPED WITH RICE

BY ADJUSTED FARM SIZE

(in % of plots)

	<0.2	0.2 - <0.5	0.5 - <1.0	1.0 - <2.0	>2.0
1. Java/Bali					
1968-70	37.0	42.4	45.3	52.0	47.0
1971	31.2	38.6	48.2	52.4	66.4
1975	44.3	56.0	65.8	68.5	80.3
1976	31.7	48.8	59.5	66.5	78.2
1977	30.1	44.0	56.0	66.0	72.6
1978	39.6	58.0	66.0	75.6	85.2
2. Other Islands					
1968-70	(4.3)	5.6	5.4	10.8	16.7
1971	(7.1)	14.7	31.2	29.6	42.4
1975	(2.0)	24.7	25.5	30.4	53.2
1976	(0.0)	16.5	27.6	8.1	34.9
1977	(0.0)	17.0	20.9	29.0	35.2
1978	(6.3)	19.7	27.5	39.6	41.5

Numbers in parantheses indicate too few observations for reliable conclusions.

cropping. For the largest units over the same period the increase was 28%, but if averages are used it was an increase of about 10% as against a decline for the smallest units. The units of 1-2 hectares showed a more dramatic increase of nearly 50% from 1971 to 1978.

For the Other Islands the gap is even higher. We do not have enough observations for the smallest units (up to 0.2 ha), but for the next smaller units (0.2 to 0.5 ha) multiple cropping covered less than half the percent of the largest units. There is no clear time trend for the Other Islands.

If one compares multiple cropping of rice land (Table 19b) with multiple cropping on all land (Table 19c) one finds an interesting contrast. For all land, multiple cropping is more prevalent on the smallest holding, in all years for which we have data, and there is a growing gap between the smallest units and the next to largest units (data for the largest units are not reliable and are for a group which has no counterpart in Table 19b). The discrepancy between the two sets of data reflects in part regional differences. Many or most of the largest operating units involve dry land farming and grow no wet rice. They therefore appear in Table 19c and are recorded as large units that do not multiple crop. What Table 19b shows then is that if the comparison is limited to comparable areas, growing wet rice, the larger operators also tend to have the better, more reliably irrigated, land which is capable of producing two crops of wet rice.

According to these data then, multiple cropping, which almost invariably requires access to irrigation, differs from other aspects of the new technology While there is no evidence of a great or widening

Table I-19c

MULTIPLE CROPPING OF ALL CROPS

(percent)

	Farm Size Groups (ha)					
	≤ 0.3	0.3 - 0.5	0.5 - 1.0	1.0 - 5.0	≥ 5.0	All
371	44.0	32.2	29.3	17.3	5.8*	27.1
375	44.8	26.4	32.1	35.7	11.3	34.8
376	61.4	41.9	31.1	20.2	23.9	41.0
377	64.9	44.2	32.0	22.5	35.0	42.9

Observations are less than 10

ote: Derived from data available earlier, before the 1978 sample was processed and before careful cleaning.

disparity between small and large units with respect to the spread of MV, participation in the package programs (BIMAS/INMAS), fertilizer use and the use of other material inputs - and the gap seems in fact to be shrinking for at least some of these inputs - the gap with respect to multiple cropping is very large for both areas and there is some evidence that it is growing, at least for Java/Bali. This, of course, implies the existence of substantial income disparities and the possibility that they are widening.

g) Conclusions on Trends

The shift to new rice technology has clearly increased yields when compared to traditional methods of farming. In addition there appear to have been increases in yields for both those using modern and those using traditional technology. Since the shift from traditional to modern technology has largely run its course, at least for Java/Bali, gains from that shift will not be available in the future. Yield increases will therefore be more difficult to achieve and depend on better management, the development of still higher yielding seeds and the use of additional inputs whose benefits exceed their cost.

One of the most effective means for increasing output would be to limit damage to the crops, which recently has affected about a third of all plots. The most important identified element in damange is the brown planthopper (wereng) so the development of resistant strains is clearly important. But rat damage has also become significant and it would be desirable to explore further the large category of "Other damage".

Smaller units consistenly produce higher yields, although they use less chemical fertilizers. However, the differences in fertilizer use are not great, indicating that unlike some other countries, Indonesia has been successful in distributing fertilizer even to the smallest units and probably in providing the credit needed to purchase the fertilizer. Chemical fertilizer use increased rapidly for all size groups and small units appear to compensate for somewhat lower application by using more animal and green manure. The behavior of smaller units will become increasingly salient, since their importance appears to be growing.

One of the principal reasons for the increase in fertilizer use by all size groups is its favorable price. Government aimed at a 2:1 fertilizer/rice price ratio, assuming that this would stimulate fertilizer use. In 1968/71 the actual ratio was close to this "farmers formula", but since then the ratio has generally been closer to 1:1.

Another reason for the widespread adoption of the new technology, especially on Java/Bali, has been the wide availability of irrigation, crucial for its success. Multiple cropping of rice, generally pre-supposing irrigation, covered about 40% of rice land before the spread of new technology, a high proportion by world standards Since 1971 it has increased about 2% a year. The level of coverage is significantly higher for the larger units and the gap has been increasing, the latter perhaps only on Java/Bali. The Survey provides no information on the reasons, but it is of concern since it implies wide and widening disparities between smaller and larger holdings, with implications for income distribution.

3) Technology and Productivity in Cross Section Analysis

For the last three years (1976-78) the Surveys produced particularly reliable data from essentially identical questionaires. Pooling these data one can analyse more specifically and carefully factors in productivity. This analysis is limited to rice and Java/Bali, because data are most reliable for this sample and less affected by great differences in agro-climatic, economic and social circumstances (It is therefore not unreasonable to assume that we are dealing with a single production function). The work underlying this analysis was largely carried out by Budiono Sri Handoko. The methodologies used, the precautions to be observed and the detailed results are reported by him separately. ("Productivity, Farm Size and Employment in Rice Production in Java and Bali", Ph.D. dissertation, Boston University, 1983). This report deals essentially with the major results and their implications.

a) Factors in Rice Output

Standard production function analysis can provide an indication of the factors which affect output of rice. Table 1-20 permits the following interpretation:

(i) HYV seeds show no significant independent effect on output. This appears a surprising result, but is at least in part due to the fact that such seeds are always part of a package of more fertilizer and some other inputs and better water control (problem of multicollinearity). By themselves the seeds would probably not have much effect, as indicated in the regression.

(ii) The better control of water supply implied by multiple cropping by itself increases output 12-13% per crop, other factors

Table I-20

TABLE I-20: Simple COBB-DOUGLAS Production Function Coefficients, JAVA-BALI.

Coefficient	With Non-normalized K inputs	With Normalized K inputs
1. Intercept	4.41 (15.31)	5.47 (27.13)
2. Dummy Variables		
a. Seed Var.	0.02 (0.43)	-0.006(-0.17)
b. Mult.Crop.	0.12 (4.01)	0.13 (4.20)
c. Damage	-0.51(-15.91)	-0.52(-16.26
d. Year 1977	-0.27 (-6.92)	-0.22 (-5.89
e. Year 1978	-0.19 (-5.23)	-0.14 (-3.99)
3. Log. Land (L)	0.49 (12.37)	0.45 (11.61)
4. Log. Labor (N)	0.11 (3.30)	0.12 (3.58)
5. Log. K input	0.31 (11.92)	0.34 (13.79)
Sum of input coefficients	0.916	0.920
R^2	0.6656	0.6768
F-ratio	361.28	381.45
Degrees of freedom	1233	1233

Note : t-statistics between brackets.
Estimated on the Sample Set I.

"Normalized K inputs" is the real value of all material inputs, that is their value divided by the farmgate rice price.

remaining unchanged. In addition it, of course, permits double or triple cropping, so the spread of irrigation procuduces very sizeable benefits.

(iii) Output on damaged plots is only half of the output on undamaged plots. This emphasizes again the importance of reducing damage.

(iv) 1977 and 1978 were less good years than 1976, presumably largely due to weather.

(v) Increasing the area under cultivation by 10%, with inputs held constant, increases output about 5%, but increasing labor by 10% increases output only about 1%. This is a clear indication of how intensively labor is already being used in rice agriculture on Java/Bali (Discussed extensively in Section II)

(iv) An increase in the combination of all material inputs of 10% will increase output by a bit over 3%. The principal factor here presumably is greater use of chemical fertilizer.

Unfortunately, as is usual in this type of analysis these results are not unambiguous. First for the reason already mentioned: the fundamental assumption always is that other factors do not change. But HYV seeds, for instance, are rarely, if ever, used without assured water supply ("multiple cropping") and substantial amounts of fertilizer. It has been said that HYV seeds are more productive only because they can effectively use more of such other inputs. If HYV is highly correlated with multiple cropping and fertilizers it is difficult and really not very useful to distinguish their separate effects.

Second, we can not adequately correct for differences in quality of land. In general, river valley land is more fertile, has a higher

higher proportion of irrigated area which is multiple cropped and is operated in smaller units than some upland areas. The multiple cropping variable is particularly subject to ambiguity as a result. Some part of the increased output on multiple cropped land is due to the better control over water implied, but some is due to inherently more fertile land and we can not distinguish between the two.

Third, there is "management bias." The better managers can use more inputs with higher productivity than those who are less good. But we can not identify management quality. So we identify greater output with greater use of inputs whem, in fact, both may be due to the omitted variable of better management.

These problems are inherent in the technique and plague all production function analysis. They limit the reliability of the conclusions that can be drawn from the analysis and need to be kept in mind throughout.

b) <u>The Effect of Farm Size</u>

The effect of land quality particularly bedevils the analysis of farm size, that is whether larger or smaller units are more productive. The analysis of size in this section distinguishes three categories: less than 0.5 ha, 0.5 to 1 ha, and above 1 ha. A multiple cropping variable is used as a rough index or proxy for land quality.

Holding other variables constant the medium sized units do not differ significantly from the small units in any respect (Table I-21). However the large size units, above one hectare, differ from the smaller units in several respects:

Table I-21

TABLE I-21: Cobb-Douglas Parameter With Farm Size Dummy Interaction.

*****

Coefficient of:	Sample Set I	Sample Set II
1. Intercept	5.83 (19.85)	5.79 (19.18)
2. Dummy Variables:		
Mult. Cropping	0.16 (4.90)	0.13 (3 76)
Seed Variety	0.002(0.07)	0.11 (3.04)
Damage	-0.55 (-17.46)	-0.53 (-16.0)
Medium Size Farms	0.27 (0.55)	-0.54 (-1.13)
Large Size Farms	-1.77 (-3.37)	-0.78 (-1.39)
3. Log Land:		
For Small Size	0.56 (8.96)	0.62 (9.87)
interacted with		
Medium Size	0.07 (0.62)	-0.12 (-1.07)
Large Size	-0.19 (-1.62)	-0.19 (-1.67)
4. Log Labor:		
For Small Size	0.10 (2.01)	0.16 (3.39)
interacted with		
Medium Size	-0.07 (-0.94)	0.03(0.36)
Large Size	0.17 (1.97)	-0.16 (-1.88)
5. Log Real K:		
For Small Size	0.29 (8.62)	0.24 (7.17)
interacted with		
Medium Size	-0.01 (-0.05)	0.05 (0.88)
Large Size	0.14 (2.17)	0.24 (3.28)
R^2	0.6760	0.6900
F-ratio	216.21	217.60
Degrees of Freedom	1227	1150

*****

Note: t-statistics between brackets.

An initial sample was used to search for an appropriate model to test. Once a reasonable set of variables and specifications had been determined on this sample, it was tested on the remaining observations to see if it adequately described the relationships. Where the results for the two samples differ significantly, no conclusions, or as at least no firm conclusions, can be drawn.

- the larger units are less productive. A 10% increse in land size for small and medium units will increase output 6%, while for large units the increase is only 4%. But it needs to be stressed again that we do not know to what extent, if any, this difference in productivity is due to remaining differences in land quality.
- the largest units also use significantly more material inputs.
- the results with respect to labor are ambiguous, with different results for the two samples.

The same issue, of land size, was analysed with a different production function that appears to be a better specification (translog rather than Cobb-Douglas, see Table I-22). It is also more complex. This suggests that the smaller farms have higher labor intensity (see also Section II below), and as a result have higher yields.

One other issue is worth addressing with respect to size of unit: its effect on responsiveness to economic factors. It is sometimes argued that small-holders are tradition-bound and not as responsive to economic forces as those who operate larger units. Some evidence that this is false has already been mentioned and more is provided in Section II below. Table I-23 shows that, in fact, they are as responsive or more responsive to differences in wages than larger operators, and about as responsive to changes in fertilizer and rice prices. Throughout the size range, Indonesian cultivators respond to market forces.

Table I-22

TABLE I-22: Estimated Coefficients of Land Productivity Models.

*****

Coefficient of Right Hand Variable	Dependent Variable: Yield per Hectare	Dependent Variable: Value Added per Hectare
1. Intercept	3.67 (1.65)	6.27 (2.56)
2. Dummy Variables:		
Mult. Cropping	0.09 (2.69)	0.11 (2.97)
Seed Variety	0.03 (0.74)	-0.008(-0.19)
Damage	-0.55(-15.54)	-0.61(-15.57)
Year 1977	-0.22(-4.92)	-0.08 (1.57)
Year 1978	-0.16(-3.72)	0.04 (0.91)
3. Log Land (=L)	-0.38(-1.23)	-0.47(-1.37)
5. Log Labor (=N)	0.89 (1.37)	1.47 (2.04)
5. Log K input (=K_1)	0.06 (0.22)	0.16 (0.52)
6. Log Fertilizer (=F)	0.21 (0.55)	0.04 (0.09)
7. (L^2)/2	0.05 (1.14)	0.11 (2.29)
8. (N^2)/2	-0.12(-0.91)	-0.27(-1.88)
9. (K_1^2)/2	0.11 (4.71)	0.10 (4.21)
10. (F^2)/2	0.09 (2.31)	0.08 (1.79)
11. L * N	0.02 (0.29)	0.005(0.08)
12 L * K_1	0.07 (2.98)	0.08 (3.00)
13. L * F	-0.02(-0.41)	0.02 (0.46)
15. N * K_1	-0.004(-0.10)	-0.02(-0.36)
15. N * F	-0.03(-0.49)	0.03 (0.41)
16. K_1 * F	-0.06(-2.02)	-0.07(-2.10)
R^2	0.314	0.288
F ratio	26.66	23.32
Degrees of freedom	1112	1112
F-value from test against Cobb-Douglas form	4.71	4.48
significant level	1%	1%

*****

Note: t-statistics between brackets.

Table I-23

TABLE I-23 Distribution of Rice Supply Elasticities by Seed Variety and Adjusted Farm Size.

*****

Description:	Farm Size (Ha). ≤ 0.5	0.5 - ≤ 1.0	> 1.0	All Farms.
Local Varieties:				
W.r.t. wage rate	-0.28	-0.21	-0.17	-0.24
W.r.t. fertilizer rpice	0.04	0.05	0.05	0.04
W.r.t. rice price	0.30	0.22	0.16	0.24
Modern Varieties:				
W.r.t wage rate	-0.22	-0.24	-0.21	-0.22
W.r.t. fertilizer price	0.04	-0.001	-0.02	0.04
W.r.t. rice price	0.22	0.29	0.28	0.26

*****

Note: W.r.t. = with respect to.

e.g.: for Local varieties and the smallest units, a 10% rise in wages results in a 2.8% decline in labor use.

c) Fertilizer Use

(i) Effect on Yield. There is a great deal of variance in fertilizer use. A large group is shown as using no chemical fertilizer at all, but this is not a homogeneous group. Some may be traditionalists who do not believe in its usefulness, or who use seed varieties that do not respond well to fertilizer, or who are unwilling to take the risk involved in purchasing fertilizer. But another group are not otherwise distinguishable from their fellows, they have just temporarily decided not use fertilizer, perhaps only for one crop. They may be delinquent on their BIMAS loan and waiting to be re-instated into the program. Or their fertilizer may have arrived too late for a particular cropping season. If they have previously applied substantial quantities of fertilizer, its residual effect may be so large that one can not find a significantly lower yield as a result of failure to use fertilizer. That may explain why the effect on yield of fertilizer use in the simple presentation of Table T-24 is not at all clear-cut.

While Sample Set II shows the expected clear increase in yield with increased fertilizer use, for Sample Set I there is little difference between those who use no fertilizer and those who are below the mean.

Using the same Sample Sets for more sophisticated production function analysis also produces ambiguous results for Set I and more reasonable ones for Set II. For the latter increased fertilizer use increases output and increases the productivity of land, while reducing the productivity of labor. But since the results of Set I are generally inderminate (and sometimes the opposite of Set II), little can be concluded on the basis of this exercise.

Table I-24

TABLE I-24: The Main Variables By Farm Type and Fertilizer Class.

*****

Classes	Yield/ha (kg)		Labor Use per Ha.		Normalized K per Ha.	
	SS I	SS II	SS I	SS II	SS I	SS II
Single cropping:						
1. Zero User	2866.8	2641.5	181.4	193.7	215.8	247.6
2. Below Mean	2903.5	2790.8	170.4	162.6	304.6	290.9
3. Above Mean	3603.0	3637.5	186.2	187.5	548.9	543.7
Multiple cropping:						
1. Zero User	3225.9	2334.1	150.1	177.6	213.6	159.2
2. Below Mean	3226.5	3187.6	178.2	181.7	304.2	301.9
3. Above Mean	3901.1	3812.8	185.5	187.2	545.5	531.6

*****

Note: SS= Sample Set. Labor Use in mandays.

Note: Mean is 193 kg/ha

(ii) Marginal Product. The next step is again to use another (translog) production function, which requires excluding those using no fertilizer. The issue examined here is whether there is much scope for increasing fertilizer use in rice agriculture. The argument has been made that productivity of fertilizer (its marginal product) is by now so low that it should be used primarily for crops other than rice. Table I -25 is the basic production function from which were derived calculations of the marginal product (ie: the increase in kg. of rice produced by one additional kg of fertilizer).

The (average) marginal product for fertilizer is calculated to be 3.98 using Sample Set I and 4.74 for Sample Set II. Since one kg of fertilizer on the average can be bought for 1.28 kg of rice, and yields 3.98 kg of rice when applied, it obviously pays to apply more fertilizer at the prices for fertilizer and rice which prevailed in 1976-78.

A more detailed breakdown of marginal product is provided in Table I-26. It indicates that one more kilogram of fertilizer in 1976 on units of less than 0.5 hectares increased production by 5.87 kilograms of rice. This was the highest estimated marginal product, but even the lowest, which is for units above one hectare in 1977, is for 1 kg of additional fertilizer to yield 3.13 kg of additional rice. Since fertilizer could be "bought" for the equivalent of 1.16 to 1.59 kg of rice in different years by different size units, it appears to be highly profitable in all years and for all size groups to use more fertilizer at the current market price of fertilizer and of rice. The size of the "gap" - the difference between the benefit and the cost of fertilizer in kilogram of rice - indicates the extent to which it makes sense for a profit maximizing operation to buy more fertilizer.

Table I-25

TABLE I-25: Translog Production Function Coefficients, Fertilizer is Treated as A Separate Input.

*****

Dependent Variable: Log of Quantity Produced.

Right Hand Variables	Coefficient	t-stat.
1. Intercept	3.55	1.58
2. Dummy Variables:		
a. Mult. Cropping	0.10	2.88
b. Seed Variety	0.04	0.94
c. Damage	-0.57	-16.23
3. Log Land (=L)	-0.61	-0.70
5. Log Labor (=N)	0.79	1.21
5. Log Real K (=K)	0.08	0.28(@)
6. Log Fertilizer (=F)	0.30	0.79
7. $(1/2*L)^2$	-0.23	-1.27
8. $(1/2*N)^2$	-0.10	-0.79
9. $(1/2*K)^2$	0.10	4.39
(10. $1/2*F)^2$	0.07	1.79
11. L * N	0.16	1.26
12. L * K	0.04	0.75
13. L * F	0.007	0.10
15. N * K	0.004	0.08
15. N * F	-0.03	-0.47
16. K * F	-0.07	-2.18

Degree of freedom 1112
F ratio 121.53
Degrees of freedom 1227
R^2 0.6511
F value for a test against Cobb-Douglas specification = 4.21, significant at the 1%.
F value for a test against Kmenta's CES approximation =2.71, significant at the 5% level.

*****

Note: (@) Expenditure on chemical fertilizer is taken out from this variable.

Table I-26

TABLE I-26: Distribution of Marginal Product of Fertilizer, Relative Price and The Gap By Years and Farmsize.

*****

Farm Size and Parameter	YEAR 1976	1977	1978
1. Fertilizer (kg/Ha.):			
< 0.5	148.9	204.6	214.2
0.5 - < 1.0	156.5	216.9	212.3
> 1.0	157.3	193.9	213.1
2. Marginal Product:			
< 0.5 Ha.	5.87	3.71	3.98
0.5 - < 1.0	4.61	3.33	3.85
> 1.0	4.51	3.13	3.26
3. Relative Price:			
< 0.5 Ha.	1.43	1.27	1.20
0.5 - < 1.0	1.59	1.23	1.22
> 1.0	1.52	1.30	1.16
4. Gap: between 3 - 2			
< 0.5 Ha.	-4.44	-2.44	-2.79
0.5 - < 1.0	-3.02	-2.10	-2.63
> 1.0	-2.98	-1.83	-2.11

*****

Note: Although not printed, coefficient of variation indicate high stability in these parameters, except for the gap for 1978's in < 0.5 Ha farm.

---

2 = kg of rice produced for 1 kg of fertilizer used
3 = cost of 1 kg of fertilizer in terms of kg of rice

(iii) Why do cultivators not use more fertilizer On the face of it these results indicate that cultivators are not profit maximizers, that is they do not behave with economic rationality. They simple do not apply enough fertilizer to their land. Quite consistently the gap is largest, that is the deviation from the economic optimum is greatest, for the smallest units.

That fact suggests at least a partial explanation: the smallest operators are also the most risk averse, the ones who have the most to lose from vagaries of weather and price. The gap we observe is, of course, after the fact. There is the risk of less output per unit of fertilizer, because the rains or the irrigation system fail, damage from pests or disease is great, and there is the risk of a drop in the rice price. The magnitude of the risk can be seen from the fact that the gap in 1977 in each category is one-third to nearly one-half below that of 1976. So fluctuation and risk are considerable. But over this three year period it still clearly paid, even in the worst year, to use more fertilizer.

Several other factors can explain the failure to use the amounts of fertilizer which economic rationality would dictate:

(i) distribution and credit problems. Fertilizer may arrive late, cultivators may be dropped from the BIMAS program or may not be able to obtain fertilizer at the subsidized rate.

(ii) lags in adjusting to more favorable price ratios. As noted earlier, the ratio between the price of rice and fertilizer has improved steadily since 1975 (Table I-18) and fertilizer consumption has increased since then. As cultivators gradually adjust to the better ratio,

Government improves it further and they again adjust with some lag. Ignorance and the slow spread of information may be a major reason for the lag.

(iii) some failure to maximize profits, to behave with full economic rationality, perhaps because the cost of a wrong decision is so great. 1976 and 1977 were years of substantial damage to the rice crop. On the average it still paid to apply fertilizer, but if your plot was severely affected and you had to sell land to meet your debts, you might not be much comforted by the fact that on the average, over several years or over several hundred cultivators, the purchase of fertilizer was profitable.

(iv) How much more fertilizer to apply. A rough estimate is that for every additional kilogram of fertilizer above the current mean of 193 kg. the additional rice produced will decline by 0.011 kg*. Since each kilogram of fertilizer costs about 1.28 kg of rice on the average and the lower average marginal product of fertilizer is 3.98, one could increase fertilizer use by 245 kg. on the average before it no longer pays (3.98-1.28=2.70; the gap of 2.70 divided by 0.011 = 245).

The resulting application of 438 kg. would be far above current recommendations of 250 kg of fertilizer. But of course the higher amount leaves no margin for risk, assumes that the calculation of marginal product is quite accurate and reliable (which it may not be) and

---

* A linear approximation of a complex marginal product curve was derived by using a simple linear regression, relating marginal product to fertilizer intensity. It yields a coefficient of -0.011, (t-statistic of -9.22). If the relationship is expressed in logarithmic form, the elasticity parameter is -0.45, (t - statistic of -11.29) Both are significant at 99%.

is an average, which would mean that about half of all cultivators would actually lose money on fertilizer use, which is not something a government extension service could readily propose.

Still these figures:

- suggest that it is worth exploring whether a recommendation higher than 250 kg would be warranted for the typical cultivator on Java/Bali,
- provide no support for the argument that rice intensification has reached its limits and that little more can be gained from increasing fertilizer use on rice, especially since the calculations have been based on the lower estimate of marginal product. If the estimate derived from Sample Set II had been used then an additional application of 315 kg or a total recommended 408 kg would be warranted. But this comparison also suggests the uncertainty surrounding these estimates and the caution that needs to be observed in using them.

(v) Fertilizer productivity at shadow prices All calculations so far have used actual or market prices. Since fertilizer and rice are subsidized, market prices are really not appropriate for such calculations if one takes into account society's interest, not just that of the individual cultivator. Both fertilizer and rice have been imported (at the margin) so the relevant price from the point of view of society is the international price.

Table I-27

TABLE I-27: The c.i.f. Import Prices of Fertilizer and Rice.

*****

Year	Fertilizer-Price		Rice-Price		Ratio	
	(US$/ton)	(Rp./kg)	(US$/ton)	(Rp./kg)	(2):(3)	
(1)	(2)		(3)		(4)	
					A	B
1972	72.77	30.20	148.54	61.62	0.49	0.48
1973	93.96	38.99	204.86	85.02	0.46	0.57
1974	197.21	81.84	330.54	137.17	0.60	0.65
1975	335.17	139.10	471.41	196.64	0.71	0.79
1976	182.71	75.82	345.91	143.55	0.53	0.72
1977	138.76	57.59	343.57	142.58	0.40	0.60

*****

Source: C.B.S.' STATISTICAL YEARBOOK OF INDONESIA, 1977.

Note: US$ prices are computed by dividing import value by volume. Exchange rate of US$ 1=Rp.415, is used to convert into Rupiah figures. Ratio A is computed from this import data, while B is from the sample.

Table 1-27 gives these prices. The farmgate rice price used earlier was of unhusked rice (gabah), while the world price is for milled rice. It takes roughly 1.67 kg of the former to produce 1 kg of the latter.

As noted earlier, a kilogram of fertilizer increases yields by about 4 kg of unhusked rice or 2.4 kg of milled rice. Reducing inports by 2.4 kg of milled rice saved enough foreign exchange, during most of this period, to buy nearly 5 kg of fertilizer on the world market. Or to put it differently, by importing fertilizer Indonesia could produce almost 5 times as much rice as it could have imported. Clearly at international prices as well it is highly desirable to use more fertilizer on rice*

(vi) Size of holding, fertilizer use and marginal product. Table I-26 provides information on who uses and benefits from fertilizer by size group. It was previously indicated that smaller units use almost as much fertilizer as larger ones when there were five size categories. With these amalgamated into three categories there no longer are any noticable differences in fertilizer use, nor are there any consistent differences in the increase in fertilizer used over the three years. So small-holder rice growers seem to have as good access to fertilizer as those operating larger units. Nor does the real price vary significantly among size categories.

*One could refine some of these calculations further, to take account of distribution costs for instance, but this is really not worthwhile, first because the gap is so large that no minor changes will have any effect and second, because if rice is imported instead of fertilizer it will also involve distribution costs.

But what does differ is the productivity (marginal product) of the fertilizer they use. In every year the smaller the unit, the higher the productivity of the fertilizer. Since the cost of fertilizer does not vary by much, the gap between cost and benefit is particularly great for the smallest units. Therefore, while it is desirable for Government to encourage fertilizer use in general, it is especially desirable to encourage use by the smallest units.

They are also the ones who are, for good reason, most risk averse and most in need of credit. The results in Table I-26 provide a clear rationale for Government to reduce the risk faced by small holders in using more fertilizer and to increase their ability to obtain credit.

The principal reason why the productivity of fertilizer is particularly high on small units is that all material inputs are combined with particularly large amounts of labor. The unusually labor intensive nature ofthe small farm, particularly in Java/Bali and the reasons for it are a central theme of the next section.

d) Conclusions on Factors in Productivity

The analysis of factors affecting productivity in this section, based primarily on production functions (and profit functions) suffers from all the limitations common to the breed. Conclusions need to be used with particular caution.

Improved seeds by themselves add little to output, they need to be part of a package which includes other inputs. Among these water control is crucial. Irrigation increases output by 12-13% per crop, as well as generally permitting double cropping. Perhaps the most significant influence on output is damage to the crop from pests, disease and

drought, damage which on the average reduces production by 50%. Resistant varieties, greater water control, control of rats and of disease therefore can add very significantly to output. Labor is already used so intensely that a 10% increase in input raises output only 1%. More on this in Section II.

Comparing operational units of different size, the larger units appear less productive, in part because of lesser labor intensity. What is most striking however, is that operators of smaller units respond to changes in prices to the same extent as those of larger units. Throughout the size range Indonesian cultivators respond to market forces.

Contrary to the argument sometimes made that the potential for rice intensification is largely exhausted we find that the productivity of additional fertilizer remains quite high. In fact, cultivators on Java/Bali apply too little fertilizer. If the figures are to be believed and one must emphasize again the substantial uncertainty surrounding them at present prices it would pay to increase fertilizer use from the current average of less then 200 kg per hectare to more than twice as much. At world prices every dollar spent on importing fertilizer would save about five dollars in rice imports, as the result of using the fertilizer to produce rice in Indonesia. It is particularly desirable to increase fertilizer used by smaller units whose productivity is particularly high. Since they are especially risk averse - one reason why less fertilizer is used than desirable or apparantly rational - steps to reduce the risk smallholders face and to increase their access to credit are especially desirable.

II. WAGES AND EMPLOYMENT

One of the most important sets of questions about agricultural development is its impact on employment and wages. The interviews always included some questions on these issues, but the usefulness of the results is limited by the fact that the questions changed over time and were ambiguous in some years. For some years particular questions are so ambiguous that no useful data could be extracted. (See Appendix for details.)

Moreover, the Surveys contain no information on the nature of contractual arrangements. Intensive studies have shown that labor relations in Javanese agriculture are often tied in with land and/or credit relations in various complex ways (Soentoro et al., 1981; Kikuchi et al., 1980; Husken, 1979; Hart and Sisler, 1978). Further important changes in labor organization appear to have taken place during the 1970's. That which has attracted the greatest attention is the shift from the "traditional" open harvest to the tebasan system in which the standing crop is sold to an intermediary who brings in his or her own harvesting crew (Collier et al., 1974). More recent evidence suggests that restricted harvesting opportunities and sickle use are taking place independently of the tebasan system. In fact, a large scale survey in West Java found tebasan to be declining (Wiradi, 1979). However the same survey documented the increasing importance of an institution known variously as kedokan, ceblokan and ngepak-ngedok, in which workers who perform particular preharvest tasks are only paid at harvest time. The

effect of a shift to kedokan could be to lower the number of workers and the employer's wages bill, while the wage income of workers included in these arrangements could increase. Although large-scale evidence is extremely limited, there is reason to suppose that these and other relatively complex forms of labor arrangements tended to increase during he 1970's. In considering the trends in wages outlines below, it is important to bear in mind the probability that major structural changes were taking place over this period.

1. Wage Trends

Elsewhere (Papanek, 1980) it has been argued that real wages of unskilled workers rose quite rapidly between the mid-1960s and about 1970, but changed very little from then until the late 1970s in the labor surplus areas of Java. There was a slight rise in Sumatra. The data on which these conclusions were based included little or no information on agriculture outside the plantations. The conclusions were therefore subject to doubt, since they were based on little direct evidence from the sector which is the largest user of unskilled labor. Agricultural wage data from the Surveys do not provide evidence for the thesis that recovery and stabilization in the late 1960s provided great benefits to most groups in the population, since the Surveys began only in 1968. However they tend to support the conclusion that the development strategy followed in the 1970s resulted in labor income that rose more slowly than the income of wealthier groups.

a) Java/Bali - The Real Wages Bill and Observed Real Wages

The longest series derived from the Surveys with information on labor incomes shows the total real wages bill (Table II-1). For Java/Bali the

Table II- 1a

REAL WAGES BILL PER HECTARE BY ACTIVITY: JAVA/BALI
(per crop)

	Plowing	Hoeing	Planting	Weeding	Total Preharvest	Harvest	Total	Other Work
Deflated by Implicit Rice Price (in kg. of rice)								
1968-70	--	(168.1)	(138.8)	(110.1)	(416.8)	(270.4)	(687.9)	(27.0)
1971	--	303.8	120.5	142.4	566.7	254.4	821.1	39.7
1972	82.6	203.3	94.4	118.5	499.3	218.1	717.4	27.6
1973	97.9	200.2	99.4	138.7	536.2	281.9	818.1	33.4
1974	104.6	189.8	102.0	143.1	539.5	268.6	808.1	30.8
1975	146.8	179.2	109.1	132.3	567.4	268.2	835.6	(93.1)
1976	106.5	188.9	120.7	146.8	562.9	242.8	805.7	(27.6)
1977	82.3	223.3	113.3	155.2	574.1	259.7	833.2	(34.1)
1978	116.7	257.8	128.7	179.8	683.0	285.3	968.3	(39.3)
Deflated by Urban Food Price Index (in thousand of 1978 Rupiah)								Harvest as a % of Total
1968-70	--	(6.60)	(5.48)	(3.69)	(15.77)	(9.00)	(24.79)	36.3%
1971	--	15.17	5.81	6.92	27.89	12.58	40.78	30.8%
1972	5.32	12.48	5.94	7.28	31.02	14.56	45.59	32.0%
1973	5.68	12.07	5.72	8.12	31.58	16.68	48.26	34.5%
1974	5.51	9.94	5.28	7.45	28.18	13.99	42.17	33.2%
1975	7.42	9.16	5.53	6.71	28.81	13.82	42.63	32.4%
1976	5.36	9.82	6.09	7.45	28.72	12.55	41.27	30.5%
1977	4.08	11.52	5.62	7.70	28.92	12.92	41.84	30.9%
1978	5.58	12.55	6.18	8.67	32.98	13.70	46.69	29.3%

Parentheses indicate very high standard deviations and few observations.

Note: 1968-70 data are especially suspect (see Appendix) and are therefore not used in the analysis.

Table II-1b

REAL WAGES BILL PER HECTARE BY ACTIVITY: OTHER ISLANDS

(per crop)

	Plowing	Hoeing	Planting	Weeding	Total Preharvest	Harvest	Total	Other Work
Deflated by Implicit Rice Price (kg. of rice)								
1968-70	---	(38.6)	(58.5)	(21.8)	(119.2)	(67.7)	(186.9)	(8.7)
1971	---	271.1	135.7	144.0	550.8	164.9	715.7	21.3
1972	27.4	80.4	110.9	103.3	322.0	158.2	480.2	19.5
1973	63.9	70.3	97.9	98.4	330.5	186.1	516.6	19.4
1974	54.1	61.7	95.1	94.8	305.7	161.8	467.5	16.3
1975	(159.7)	133.5	104.1	120.2	517.5	180.5	698.0	(89.2)
1976	62.8	85.9	112.8	95.5	357.0	170.5	527.5	(15.8)
1977	41.0	131.3	119.8	114.4	406.5	183.9	590.4	(14.1)
1978	83.4	120.9	117.2	118.2	439.7	232.5	672.2	(20.6)
Deflated by Urban Food Price Index (000 of 1978 Rp.)								
1968-70	---	(1.34)	(2.1)	(0.8)	(4.3)	(2.5)	(6.8)	
1971	---	16.97	8.4	8.9	34.27	9.76	44.03	
1972	2.15	5.47	8.8	8.25	24.67	12.49	37.17	
1973	3.68	4.87	6.33	7.05	21.92	11.61	33.53	
1974	3.24	3.81	5.8	5.97	18.83	9.73	28.56	
1975	(9.86)	8.43	6.48	7.6	(32.38)	10.61	42.98	
1976	3.72	5.54	7.8	5.89	22.95	10.49	33.44	
1977	2.49	8.09	7.29	7.14	25.01	10.77	35.78	
1978	4.41	6.53	6.13	6.4	23.47	12.00	35.47	

Parentheses indicate very high standard deviations and few observations.

Table II-1c

PRICE INDEXES

	Java		Other Islands		Indonesia
Year	Urban Food	Rice	Urban Food	Rice	Urban Food
1967	8.0		8.2		8.0
1968	20.2	19.7	23.1		20.8
1969	22.0		24.4		22.5
1970	24.8		26.6		24.1
1971	27.1	17.2	26.5	20.5	24.8
1972	29.9	30.8	28.8	32.5	26.0
1973	44.7	33.7	46.4	42.2	44.6
1974	58.2	39.6	61.8	50.4	59.2
1975	67.7	45.0	62.9	53.4	66.4
1976	79.6	51.9	72.5	56.3	77.8
1977	92.9	60.0	82.8	63.4	90.3
1978	100.0	61.0	100.0	66.55	100.0

Sources and definitions:

Urban food: a weighted index of major foods in all major urban areas, from Papanek/Dowsett (1974)

Rice: implicit farm gate price per kilogram reported by Survey respondents for unhusked rice, unweighted, i.e., value of rice divided by quantity.

total wages paid per hectare in the sample show no trend between 1971 and 1978 when deflated by the urban food price index, probably the best index for longer-term price changes (see Papanek and Dowsett, 1974). 1978 was a good year in this series, with the wages bill 10% above 1977 and 14% over 1971, but it still did not differ significantly from 1972 or 1973.

If the wages bill is deflated by the rice price calculated from Survey data the picture is somewhat different. The increase in 1978 is 16% over 1977 and nearly 18% over 1971. However, a rice price deflator, ignoring the cost of other foods and other goods, covers only about one third (BPS, 1969/70) of the cost of living of workers, and is therefore less appropriate than a food price index, which covers 78% of expenditures for all groups and 81% for the lower income groups. Even if it is taken at face value, however, the increase over the 7 years for which we have data averages only slightly better than 2% a year, far below the rise of 5-6% in average per capita income during this period.

Moreover, with either deflator, any change is in the total wage bill, and during this period the rural population increased about 2% a year, so the wage bill presumably had to be spread over a larger group. We lack clear evidence on the trends in the number of hired workers per hectare but it may not have changed (see below). If the number remained essentially unchanged and the total wage bill stagnated if deflated by the more reliable index, it seems highly likely that the wage bill per worker and crop stagnated as well.

Data for 1975-78 for the "observed" wage rate confirm this inference. (Tables II-2). While the wage bill deflated by the rice price rose nearly 16% over these four years, the "observed" wage rate

REAL WAGE RATES BY ACTIVITY FOR RICE-FARMERS IN KGS OF UNHUSKED RICE

	Java/Bali				Other				Indonesia			
	75	76	77	78	75	76	77	78	75	76	77	78
Plowing												
Computed	---	11.8	7.3	11.1	---	12.3	8.3	10.3				
Observed	6.6	6.3	6.0	7.4	7.4	7.7	7.0	8.4	6.6	6.6	6.2	7.5
Hoeing												
Computed	---		5.2	5.8	---	6.9	7.5	6.85				
Observed	5.1	5.3	5.0	5.7	7.5	7.8	7.3	7.5	5.5	5.7	5.4	5.9
Planting												
Computed	---	3.4	3.2	3.7	---	6.0	5.75	5.4				
Observed	3.2	3.3	3.0	3.6	6.1	6.6	5.9	6.1	3.8	3.9	3.6	3.9
Weeding												
Computed	---	3.4	3.4	3.7	---	5.6	5.65	5.2				
Observed	3.3	3.4	3.2	3.7	6.1	6.4	6.0	6.0	3.8	3.9	3.7	4.0
Ave. Preharvest*												
Computed	---	4.7	4.3	5.0	---	6.8	7.0	6.3				
Observed	4.1	4.2	4.0	4.6	6.7	7.0	6.5	6.7	4.6	4.7	4.4	4.9
Harvest												
Computed	---	5.2	5.1	5.9	---	6.9	7.2	7.2				
Observed	4.5	4.6	4.2	4.9	6.8	7.3	6.3	6.6	5.0	5.1	4.7	5.1
Ave. Total*												
Computed	---	4.8	4.5	5.3	---	6.85	7.0	6.6				
Observed	4.2	4.3	4.0	4.7	6.7	7.1	6.4	6.7	4.7	4.8	4.5	4.95
Other Work												
Computed	---	5.9	6.45	6.35	---	11.8	8.3	10.3				
Ave. Farm Gate Rice Price (Rp/Kg)	45.0	51.9	60.0	61.0	53.4	56.3	63.4	66.55				

REAL WAGE RATES. BY ACTIVITY FOR RICE FARMS DEFLATED
BY URBAN FOOD PRICE INDEX

(1978 = 100)

	Java/Bali				Other Islands			
	75	76	77	78	75	76	77	78
Plowing								
Computed	---	746	446	669	---	918	605	664
Observed	439	408	387	449	491	505	449	510
Hoeing								
Computed	---	328	330	353	---	546.5	575	453
Observed	340	343	320	345	497	510	471	460
Planting								
Computed	---	216	202	221	---	453	437	348
Observed	213	214	195	220	408	427	383	371
Weeding								
Computed	---	216	209	225	---	431	438.5	347
Observed	217	219	204	223	605	418	390	365
Ave. Preharvest								
Computed	---	275	263.5	295	---	514	497	408
Observed	275	274	255	281	603	622	571	560
Harvest								
Computed	---	326.5	315	355	---	516	522	466
Observed	297	288	270	297	455	475	409	403
Ave. Total								
Computed	---	275	273	300	---	515	504	424.5
Observed	281	278	259	286	550	576	520	510

deflated by the more reliable food price index rose less than 2%. Stagnation or decline between 1975 and 1978 is consistent with data from other wage series (Papanek, 1980). It therefore provides confirmation that real wages move together throughout the economy. It also lends support to the contention that real wages in Java/Bali stagnated throughout the 1970s, despite the rapid growth in the economy as a whole and in average per capita income.

b) Other Islands - The Real Wages Bill and Observed Real Wage Rates

What is surprising, however, is that the picture is not radically different for the Other Islands. While very spotty data indicate that other wages continued to rise in Sumatra (Papanek, 1980) the "Other Islands" real wages bill in the Surveys, deflated by the urban food price index shows 1978 as substantially below 1971, 1972 (19%) and 1975 (17%), with the exception of harvest labor in 1971. The picture is somewhat different if the less reliable rice price deflator is used: an incredible 40% rise is indicated between 1972 and 1978, but 1978 is below 1971 in this series as well, except for harvesting. Moreover, the 1978 wage bill is generally below 1975. If one discounts some of the figures for individual operations and years which are out of line, then the most reasonable conclusion is that there is no clear trend in the real wage bill in the Other Islands in the 1970s.

Observed real wage rates for the Other Islands, available for 1975 to 1978 show a considerable decline if deflated by the food price index. Deflated by the rice price, they are essentially stagnant. This provides some support for the wage bill series.

Stagnant wages in the Other Islands are puzzling since one might expect a clear upward trend, given that other series show such a trend -- albeit a modest one -- and that there are well known labor shortages in some areas of these islands. The principal reason for our failure to find a trend may be due to the concentration of the Survey on the rice growing areas which have not been areas of labor shortage in general.

c) The Effect of Multiple Cropping

The discussion so far, however, has been based on wages paid for each rice crop. But if the number of crops grown per year increased, then annual income of workers would also go up. From the earlier discussion (Section I) it is clear that multiple cropping of rice has increased, although the magnitude of the increase is not clear because multiple cropping fluctuates from year to year.

For Java/Bali if one ignores 1970 because of data problems, and compares an average of the two initial and two terminal years to reduce random fluctuations, one observes an increase of 12.6% in multiple cropped area. (44.9% double cropped in 1971 and 1972 and 57.5% in 1977 and 1978, see Table I-19). That is roughly a 2% increase per year in multiple cropped area. The effect of expanded multiple cropping on workers income is not clear. To calculate it one would need to know (i) whether the additional rice crop(s) was grown on land previously fallow or, more likely, replaced a dry season crop, and the labor income from that dry season crop, and (ii) whether the change was from one to two crops or to three crops. The shift from dry season crop to wet rice increased labor income, but the increase may be modest if the dry season crop was also rice. So it would be an overestimate to assume that a shift

from single to multiple cropping of rice doubled labor income. On the other hand we do not know the extent to which land shifted from one rice crop to more than two rice crops. On some land labor compensation may therefore have more than doubled. If one arbitrarily assumes that the two unknowns are equal then one can assume that a shift from single to multiple crops of rice doubles labor compensation. Then a 2% per year increase in double cropping would result in an equal 2% per year rise in labor compensation over this 6 year period. This is probably an optimistic assumption, since the area triple cropped is small and the gain in employment may not be very great from moving from dry season crops to wet rice.

Alternative assumptions are, of course, possible. If one compares the good year 1971 (47.6% double cropped) with the good year 1978 (64.3%), one obtains a yearly increase closer to 2.5%. One could obtain a much greater increase by comparing a bad initial year, when double cropping was low (1972) with a good terminal year (1978) when it was high and obtain a large annual increase (3.7%), but that would clearly be wrong. So would the opposite approach of comparing a good initial year (1971) and a bad terminal year (1977), yielding an annual increase of only 0.5%.

A reasonable estimate then is of a 2% per year increase in multiple cropping. One can speculate that this will also increase total days worked a year by 2%. Since the wage bill per crop seems to have remained stagnant, total annual labor compensation would also have increased by 2%, as a result of multiple cropping. But since rural population also increased 2%, per capita or per worker income of workers in rice

agriculture on Java/Bali may well have stagnated.

For the Other Islands the annual fluctuations recorded are great and erratic (Table I-19) but, if anything, multiple cropping has substantially declined over the years. If one compares 1971/72 with 1977/78, the area multiple-cropped appears to have declined by about half. On top of a declining, or at least stagnant, wage bill this suggests a decline in total labor compensation in rice agriculture. At the same time plantation wages rose (Papanek, 1980) and so did job opportunities in some areas. A plausible explanation of that discrepancy is that there were two conflicting trends. In the rapidly developing areas, such as the oil and timber producing regions of Sumatra and Kalimantan, hired labor declined, or perhaps even disappeared, in rice agriculture. In these areas double cropping of rice may have become less attractive, as the labor required became less available and more costly. Other areas, such as Lampung, where development was slower and migrants from Java arrived in large numbers, more labor intensive rice agriculture continued. In the sample as a whole the latter, with low wages, would receive greater weight, resulting in an apparent decline in real wages due to a shift in composition of the hired labor force in the sample. At the same time multiple cropping would decline. Yet in many areas workers income would actually improve, but this is not picked up in these data, limited to rice agriculture. While plausible, it must be emphasized that this scenario is speculation, but worth further research.

d) "Computed" Wage Rates: a Digression

For the three years 1976-78 wage rates were also computed by dividing the total wage bill by the number of person-days worked (Tables II-2).

This brief series is somewhat less accurate than the so-called "observed" wages. "Observed" wages derive from a specific question on "what are the wages paid per day in this area for (hoeing, planting, etc.)." The response is a single number with relatively little margin for error.[1]

"Computed" wages are based on three pieces of information, each subject to error: the wage bill for a plot of land divided by the number of hired worker-days for that plot of land, the latter the result of multiplying number of workers by average days worked. Since the wage bill is supposed to include both payments in cash and in kind and since reporting it requires recollection of payments over a whole cropping season, there is considerable margin for error in reports on the wage bill. But the room for error is even greater for the number of worker-days. First, a "day" can vary from 4 hours to 12 hours. Second, estimation and recollection are difficult for such data as the average number of workers employed and particularly the average number of days they worked. So the wage rates, computed by dividing the wage bill by worker-days, are likely to be less accurate than "observed" wage rates. Moreover, computed wage rate are available only for three years, observed wage rates for four. For both reasons, much of the analysis has been used "observed" wages.

[1]The only uncertainty arises from the fact that the observed wages are not crop specific. That is, they represent answers to questions on the wages for different activities, without specifying on what crop the work was done. It is, of course, not only possible but even likely that wages vary as between crops. However, Table II-3 shows the observed wage responses separately for rice cultivators and those cultivating other crops. The observed wage rates used for analysis are for rice cultivators only and therefore represent overwhelmingly the wages paid for work on the rice crop.

Table II-3

REAL OBSERVED WAGE RATES BY ACTIVITY DEFLATED BY URBAN FOOD PRICE INDEX

(1978 = 100)

	Java/Bali				Other Islands				Indonesia			
	75	76	77	78	75	76	77	78	75	76	77	78
Plowing	429	392	378	444	507	509	652	513	442	414	390	451
Rice	439	408	387	449	491	505	449	510	449	427	398	456
Non-rice	396	349	348	423	581	522	466	538	420	378	363	431
Hoeing	328	325	308	333	488	514	471	466	355	359	339	348
Rice	340	343	320	345	497	510	471	460	365	372	349	358
Non-rice	293	278	274	288	467	520	471	485	330	327	315	312
Planting	214	210	196	217	417	421	391	377	254	251	235	238
Rice	213	214	195	220	408	427	383	371	250	255	233	240
Non-rice	217	201	196	204	437	406	410	600	266	242	240	230
Weeding	219	215	204	220	412	414	395	376	257	254	243	241
Rice	217	219	204	223	605	418	390	365	250	255	240	241
Non-rice	220	201	203	210	426	404	406	410	276	250	253	241
Prellarvest	271	265	251	275	604	622	575	569	422	419	396	409
Rice	275	274	255	281	603	622	571	560	425	430	402	416
Non-rice	258	239	237	252	607	620	585	601	412	391	383	382
Harvest	287	273	263	285	458	465	412	410	327	319	296	303
Rice	297	288	270	297	455	475	409	403	333	330	300	312
Non-rice	256	237	240	242	466	446	422	443	313	291	285	271
Aver. Total	276	267	254	278	558	573	524	519	392	388	365	375
Rice	281	278	259	286	550	576	520	510	396	399	370	383
Non-rice	257	238	238	249	562	566	533	548	380	360	352	350

A few brief comments on the computed wage data are warranted, however. Using either the farmgate rice price or urban food price as deflators, calculated real wages in Java/Bali for most operations rose between 1976 and 1978. Weighted average pre-harvest real wages increased 7% and the weighted average for all wages, including harvest wages rose by 9%. Even the latter figure is still less than the increase in average per capita income, but is rather close. Over the same three years the more accurate "observed" wage rate shows a 5% increase using the food price index. The increase shown in the computed wage rate therefore confirms that 1978 was a good year for wage earners when compared to the two previous years, but of course does not shed light on the longer term changes, and particularly does not contradict the slight decline between 1975 and 1978 indicated in the observed wage series.

A comparison of observed and computed wages for the three years of overlap is encouraging (Table II-4). Plowing data differ, probably because the "computed" figure sometimes includes payments for the bullocks or the boy who leads them. Harvest wages also tend to differ by more than 10%, understandable since the number of harvesters on which the computed wage rates is based is, at best, an approximation. But for all other activities the two figures, derived from quite different sets of data are, in general, within 2% of each other. This is reassuring, not only for the accuracy of the wage data but also for other data, since the computed wage suffers from serious problems of recall and estimation (see above).

Table II-4

NOMINAL WAGE RATES BY ACTIVITY--RICE FARMERS

	Java/Bali				Other Islands			
	75	76	77	78	75	76	77	78
Plowing:								
Computed	---	594	415	669	---	665	501	664
Observed	297	325	360	449	332	402	417	510
Hoeing:								
Computed	---	261	307	353	---	396	476	453
Observed	230	273	297	345	339	406	438	460
Planting:								
Computed	---	172	188	221	---	328	362	348
Observed	144	170	181	220	276	340	356	371
Weeding								
Computed	---	172	194	225	---	312	363	346
Observed	147	174	190	223	279	333	362	365
Ave. Preharvest								
Computed	---	219	245	295	---	312	397	407
Observed	186	218	235	306	299	364	388	410
Harvesting								
Computed	---	260	293	355	---	374	432	466
Observed	201	229	251	297	308	378	380	403
Ave. Total								
Computed	---	219	254	300	---	310	399	448
Observed	190	221	241	304	302	368	386	408
Other Work								
Computed	---	295	365	385	---	565	509	655

e) Rice/Non-Rice Cultivators

The observed wage is available for all households, whether cultivating rice or not. As is obvious from Table II-3, the observed wages paid by cultivators growing rice on Java/Bali is consistently higher than for those growing other crops, but there is no consistent pattern for the Other Islands. For the Other Islands both groups report a drop in real wages between 1975 and 1978, more pronounced for the rice farmers. In contrast, for Java/Bali 1978 is shown as a good year for both groups, with real observed wages above those of the previous two years. However, compared to 1975, wages paid by rice growers show a 2% increase, while wages paid by those growing other crops show a 3% decline.

The non-rice crop figures are especially subject to error. Since not all crops are weeded and they are in general not transplanted, the definition of "planting" and "weeding" are ambiguous. Also "non-rice" includes a wide variety of crops. Finally it is possible that these crops are grown under less satisfactory agro-climatic conditions than rice; that is we are comparing not just different crops but probably also different seasons and regions. Given the margin of error, the year-to-year fluctuations and the ambiguous nature of some of the series, it is probably reasonable to conclude only that:

- for Java/Bali wages probably remained stagnant, for workers employed by both rice and non-rice growers
- for the Other Islands they probably declined for both groups,

for Java/Bali workers on rice received somewhat higher wages (generally 10-15% more) than those working on other crops.

f) Male-Female Wage Differentials

One can distinguish activities generally carried out by women, notably planting, and those by men, notably hoeing. Using either deflator for Java/Bali there is some difference in the trend of the real wages bill.(Table II-1a) For hoeing, by men, the wages bill was clearly higher early and late in the decade (1971-73 and 1977-78) compared to the mid-1970's (1974-76). In contrast, while planting wages, for women, fluctuate a good deal, it is difficult to distinguish any trend or periods where the wages bill is higher or lower. Weeding, carried out by both genders, is in between. The "observed" data on wage rates (Tables II-2) for 1975-78 show roughly a 20% decline for planting, hoeing and weeding wage rates on Java/Bali. There is no significant difference among these activities, or between genders, over this four year period.

The only significant difference between men's and women's wages then is the decline in real wages bill for men engaged in hoeing in the middle of the decade. No good explanation for this phenomenon suggests itself. If there were a steady decline one could speculate on the possible effect of increased use of tractors on this activity, but the rise in wage bill in 1977 and 1978 contradicts this and so do data on labor use. In fact the number of hired workers used in hoeing steadily increases from 1972 to 1978 (see below). Between 1976 and 1978 the number of hired man days for hoeing remains unchanged as does the number of women days for planting. So the reasons for the discrepancy remain unclear. It would be worth examining later data to see whether 1977-78 were a fluke and

male wages have declined, or 1974-76 were unusually low and wage rates have remained unchanged. In any case the survey data so far do not support the notion that male wage rates are declining more or rising less than females because men do work that is increasingly being taken over by machines or family members.

g) Conclusions

In short, no conclusion is possible on differential movements of male and female agricultural wages. For both genders there appear to have been three periods of relatively higher wages in the 1970's, in this as in other wage series: at the begining of the decade, around the middle and at the end. These were years of lower rates of inflation. The years are not the same in all series, so even this conclusion is not firm.

However, as far as one can tell from the sketchy data there is no clear, significant trend in real wages per crop over the period 1971 to 1978. To reduce the effect of yearly fluctuations, particularly in the rice price, summary Table II-4a shows three year averages for the wages bill series and two year averages for the observed wage rates. These data confirm the absence of any clear trend in real wages over the 1970's: deflated by the more appropriate urban food price index the real wage bill per crop was the same in 1976/8 as in 1971/2 for Java/Bali, and almost 15% lower for the Other Islands.

Summary Table II-4a

TRENDS IN REAL WAGES -- TOTAL LABOR PER CROP

	1971 to 1972	1973 to 1975	1976 to 1978
1) Real Wages Bill			
Java/Bali			
--Implicit Rice Price	769	821	869
--Urban Food Price	43.2	44.4	43.2
Other Islands			
--Implicit Rice Price	598	557	597
--Urban Food Price	40.6	35.0	34.9
		1975-76	1977-78
2) Wage Rates-Observed-Rice Cultivators			
Java/Bali			
--Implicit Rice Price		4.3	4.4
--Urban Food Price		279.5	272.5
Other Islands			
--Implicit Rice Price		6.9	6.6
--Urban Food Price		563	515

Multiple cropping of rice probably increased about 2% annually and with it total labor compensation per year. But since rural population increased at about the same rate, labor compensation per worker seems to have stagnated. Per capita income in Indonesia increased by well over 50% during this period. Since the pay of workers in rice agriculture seems not to have risen, then income disparities almost certainly increased in rural areas.

2) Hired Labor's Share in Output

Over the 1970s the value added in food crop agriculture increased by about 3.5% a year in real terms for all of Indonesia. For Java the increase in output, and presumably in value added, was less pronounced.

Table II-5

Shares of Hired Labor, Other Inputs and Land/Family Labor in Value of Production

	-- Percent --				Means in constant 1978) rupiah* (rounded)	
	Multiple Sample**		Single Sample**			
	1971-74	1975-78	1971-74	1975-78	1971	1978
Non-labor inputs	16.0	15.0	13.5	14.0	5,200	3,500
Wages	26.75	22.0	22.0	20.75	7,000	5,600
Residual	57.0	63.0	64.75	65.25	14,500	13,400
Value of production	99.75	100.0	100.25	100.0	26,700	22,500

*Deflated by urban food prices; multiple sample data.

** The "multiple" sample uses different numbers of observations for each variable; the "simple" sample has the same number of observations because it uses only those cases where data exist for all three variables. See Note A for details.

(In our sample the value of production is shown as declining per plot - see Table II-5 - but this probably reflects just the decline in plot size.) Since there appears to have been no clear trend in the real wage bill or the wage rate in the 1970's, one would expect that the share of hired labor in agriculture declined. The sketchy evidence available supports this hypotheis.

The more useful of the two indices, for reasons discussed in Note A, is the one for the multiple sample. For that sample the share of hired labor in the value of output declined by about a fifth in the second half

of the 1970s compared to the first half. The share of the residual, which represents the return to land and to family labor principally, increased by more than 10% in the same period. This is consistent with evidence from the wage bill and employment data, discussed earlier, that income distribution probably became less equal in agriculture over the 1970s.

There are too few observations for a meaningful statistical test of hypotheses on what caused the sharp annual fluctuations in the share of hired labor and landowners/family labor. Presumably wages tend to adjust only partly to sharp fluctuations in output due to weather and adjust to price changes only with a lag. So when total agricultural income rises sharply over the previous year, because yields or prices increase, the residual will increase more than wages, and vice versa when income falls. Yields declined sharply in 1972 and 1977, and rose sharply in 1974 and 1975. (Table I-9) Price increases accelerated in 1973 and 1976 decelerated in 1974, 1975 and 1978. The rise in labor shares in 1972 and 1977 and decline in 1975 could therefore be explained by yield changes. Similarly the decline in 1973 and 1976, and the rise in 1978 could be due to the acceleration or deceleration of inflation. The drop in labor shares in 1976 is, however, a bit extreme for the small rise in yield and acceleration of inflation. With that partial exception, the two variables pretty well explain most of the annual changes in labor shares. But the series is too brief for any conclusive view of factors influencing the labor share.

Table II-6

Time Series for Labor Shares, Yields and Prices

(Java/Bali, rice -- all in percent)

	1) Wages as % value of production	2) Yield annual changes	3) Price
1971	26	-3	9
1972	29	-23	11
1973	26	-6	50
1974	26	+20	30
1975	24	+33	16
1976	16	+3	18
1977	23	-15	17
1978	25	+7	8

Source: 1) and 2) farm survey; 3) Papanek (1980).

t is interesting that the share of non-labor inputs does not seem to have changed significantly over the decade. The value of production ofcourse rose substantially,[1] partially because prices increased and to a lesser extent with higher yields. While the average nominal Rupiah value of non-labor inputs more than doubled, so did the value of output (Table II-8). The quantity of some inputs, notably chemical fertiliser and insecticides, probably reflects declining plot size increased significantly over the decade, but other inputs changed little or even declined, notably animal

1 Not withstanding the decline shown in Table II-5, which shows the decline in output per plot and probably reflects declining plot size.

PERCENT SHARES IN INCOME FROM RICE AGRICULTURE

JAVA/BALI

	1968-70		1971		1972		1973		1974	
	M*	S**	M	S	M	S	M	S	M	S
Value of Production	100	100	100	100	100	100	100	100	100	100
Non-Labor Inputs	(17)	(17)	20	17	16	13	14	11	15	13
Wages	(21)	(21)	27	25	29	22	26	20	26	21
Residual	(62)	(62)	53	59	55	65	60	69	59	66

	1975		1976		1977		1978	
	M	S	M	S	M	S	M	S
Value of Production	100	100	100	100	100	100	100	100
Non-Labor Inputs	15	13	13	12	16	16	16	15
Wages	24	18	16	17	23	23	25	25
Residual	61	69	71	71	61	61	59	60

* multiple sample; ie: the number of observations differed for different variables

** single sample; ie: the same observations for all three variables

SHARES IN INCOME FROM RICE [illegible]

JAVA/BALI

(Mean per plot)

	1968-70 M*	1968-70 S**	1971 M	1971 S	1972 M	1972 S	1973 M	1973 S	1974 M	1974 S
Value of Production	19,675	19,940	25,665	29,746	22,133	32,917	37,711	48,969	46,224	56,437
Non-Labor Inputs	(3,408)	(3,332)	5,165	5,007	3,680	4,314	5,081	5,463	6,758	7,420
Wages	(4,159)	(4,147)	7,001	7,324	6,330	7,089	9,938	9,797	11,920	11,686
Residual	(12,108)	(12,461)	13,499	17,415	12,123	21,514	22,692	33,709	27,546	37,331
N	2,715	2,289	7,614	3,822	11,686	3,546	7,584	2,041	9,615	2,273

	1975 M	1975 S	1976 M	1976 S	1977 M	1977 S	1978 M	1978 S
Value of Production	57,043	83,917	66,591	70,440	64,312	66,430	83,005	84,620
Non-Labor Inputs	8,388	10,665	8,742	8,297	10,638	10,715	13,081	13,091
Wages	13,467	15,000	10,683	11,843	14,541	15,073	20,585	21,100
Residual	35.188	58,252	47,166	50,300	39,133	40,642	49,339	50,429
N	6,613	1,030	7,013	2,227	6,677	4,067	8,647	5,970

* multiple sample
** single sample
N = number of valid observations; in case of multiple sample it is for the observations for Value of Production.

manure and green manure (Section I), which explains the unchanged proportion of all non-labor inputs.

For four years it is possible to break down the shares by size of adjusted operating unit. The pattern for 1975, when a somewhat different questionnaire was used, and the sample is smaller, differs from the other three years (Tables II-9 and II-10), which are quite consistent with each other. For the latter years, as one would have expected, the residual is larger for the smaller units, where family labor -- included in the residual -- is more important. On the other hand, the share of wages, that is of hired labor, increases with size. On the larger operating units (above 1 ha) the wage share is one-third to one half greater than on the smallest units (below 0.2 ha). The share of non-labor inputs also increases with size, but to a lesser degree. For 1975 the same pattern holds for non-labor inputs, but the share of wages declines with size and that of the residual rises. This makes little sense, unless by mistake some notional payments to family labor were included in the wage bill. If one ignores 1975, a quite consistent pattern emerges, with the share of wages increasing from 1976 to 1978 in all size categories and also increasing with size of operating unit. The principal conclusion from these data is that the share of hired labor in value of agricultural output would decline rather drastically if population pressure leads to the breakup of larger units into smaller ones, using primarily family labor.

For the Other Islands, the number of valid observations is often quite small. It may also be that the valid observations are drawn from different areas of the Other Islands in different years. It is difficult

to explain sharp changes in shares and even more in absolute numbers which take place from year to year. For instance, it is just unbelievable that the mean wage per plot should rise by 60% from 1974 to 1975 and then drop by two thirds in the next year, while the mean value of production changed by much less or even moved in the opposite direction. (Tables II-11 and II-12). Therefore only the most tentative conclusions can be drawn, and the single sample needs to be ignored altogether because of the extremely low number of observations. Within these limits there is some indication that the share of both labor and non-labor inputs has declined, while the residual share, for family labor and returns to land has increased. These, highly tentative, conclusions for the Other Islands are the same as those for the more reliable Java/Bali data.

In short, the data on the share of wages for hired labor confirm the data on the real wage bill: from 1971 to 1978 the income of hired labor was a declining share of the value of production. Income distribution in rice agriculture therefore almost certainly became less equal.

Table II-9

PERCENT SHARES IN INCOME FROM RICE AGRICULTURE BY ADJUSTED SIZE OF OPERATION

JAVA/BALI

	<.2	.2 to <.5	.5 to <1	1 to <2	2 +	All
Value of Production						
1978	100	100	100	100	100	100
1977	100	100	100	100	100	100
1976	100	100	100	100	100	100
1975	100	100	100	100	100	100
Non-Labor Inputs						
1978	14.8	15.3	16.0	16.0	14.9	15.8
1977	14.1	15.9	15.8	17.0	16.9	16.8
1976	10.1	11.9	12.0	13.4	12.4	13.2
1975	10.8	13.1	13.6	14.1	13.8	14.7
Wages						
1978	19.5	23.7	25.1	26.1	24.9	24.9
1977	17.5	21.9	21.9	23.5	25.2	23.0
1976	10.6	15.4	16.2	17.3	17.3	16.2
1975	26.8	23.7	21.4	20.9	20.1	23.5
Residual						
1978	65.7	61.0	57.9	58.0	60.2	59.2
1977	68.5	62.4	62.3	59.5	57.9	60.2
1976	79.3	72.7	71.8	69.3	70.3	70.6
1975	62.4	63.2	65.0	65.1	66.1	59.5

Table II-10

SHARES IN INCOME FROM RICE AGRICULTURE BY ADJUSTED SIZE OF OPERATION

Java/Bali (Multiple sample)

	<.2	.2 to <.5	.5 to <1	1 to <2	2+	All	N	F
Value of Prod.[a]								
1978	14,183	28,387	51,912	90,789	213,821	82,683	7,694	1,440
1977	13,878	26,117	48,744	80,901	171,976	63,419	5,931	694
1976	14,437	29,115	50,202	82,787	178,526	65,971	6,710	1,160
1975	13,095	22,706	39,924	70,877	153,467	57,322	6,432	882
Non-labor Inputs								
1978	2,096	4,346	8,324	14,556	31,922	13,086	6,460	1,492
1977	1,953	4,164	7,713	13,759	29,048	10,655	4,462	832
1976	1,463	3,478	6,024	11,083	22,065	8,715	3,209	678
1975	1,412	2,965	5,420	9,980	21,222	8,427	2,937	443
Wages								
1978	2,765	6,730	13,026	23,700	53,210	20,622	6,990	1,240
1977	2,424	5,717	10,662	19,017	43,323	14,589	5,347	823
1976	1,531	4,483	8,146	14,299	30,964	10,662	4,467	695
1975	3,507	5,386	8,541	14,778	30,855	13,497	2,011	255
Residual								
1978	9,322	17,311	30,562	52,523	128,639	48,975		
1977	9,501	16,296	30,369	48,125	99,605	38,175		
1976	11,443	21,154	36,032	57,405	125,497	46,594		
1975	8,176	14,355	25,963	46,119	101,390	34,130		

Table II-11

Percent Share in Income from Rice Agriculture

Other Islands

	1968-70		1971		1972		1973		1974	
	M	S	M	S	M	S	M	S	M	S
Value of Product[n]	100		100	100	100	100	100	100	100	100
Non-labor Inputs			19	13	24	10	12	8	12	10
Wages	6		28	23	29	15	19	16	20	14
Residual			53	64	47	74	69	76	68	76

	1975		1976		1977		1978	
	M	S	M	S	M	S	M	S
Value of Product[n]	100	100	100	100	100	100	100	100
Non-labor Inputs	13	12	11	10	14	12	13	11
Wages	25	18	8	8	10	11	14	16
Residual	62	70	81	82	78	77	73	73

Table II-12

SHARES IN INCOME FROM RICE AGRICULTURE

Other Islands

	1968-70	1971		1972		1973		1975	
	M	M	S	M	S	M	S	M	S
Value of Prod.[n]	21,143	24,174	29,063	28,598	64,335	49,362	70,577	56,663	75,501
Non-labor Inputs		4,566	3,695	6,736	6,717	5,892	5,659	6,964	7,757
Wages	1,312	6,807	6,698	8,420	9,965	9,192	11,256	11,294	10,620
Residual		12,801	18,670	13,442	47,653	34,278	53,662	38,405	57,124
N	1,311	1,603	280	5,845	137.	2,487	91	2,133	92

	1975		1976		1977		1978	
	M	S	M	S	M	S	M	S
Value of Prod.[n]	71,799	101,121	87,204	93,748	91,445	100,560	106,907	114,591
Non-labor Inputs	9,178	12,108	9,300	9,444	13,014	12,041	13,886	13,204
Wages	18,210	18,257	6,610	7,288	9,483	11,200	14,741	17,962
Residual	44,411	70,758	71,294	77,016	68,949	77,319	78,280	83,425
N	1,565	110	1,738	295	1,599	466	1,337	560

Note A
Data on Shares in Value of Output

Whenever several variables are combined in an analysis the problem of missing values is compounded. In the analysis of income shares it turns out that there is a high proportion of missing values for data on both wages and non-labor inputs, apparently often for the same plots. There are fewer missing observations for the third variable, value of production. If plots are included in the sample only if there is a valid observation for all three variables -- here called a single sample -- the size of the sample is greatly reduced (see Table II-30).

Apparently the single sample is also biased. In comparing it with a multiple sample, one where the mean is calculated for all valid observations of each variable (so that the number of observations differs for the three variables) one finds that the mean for wages and non-labor inputs changes very little, but the mean for value of production differs a great deal (Table II-30). Apparently the missing observations for wages and non-labor inputs occurred primarily on the smaller plots. That is not surprising: when cultivators are asked for the output from a small plot, they usually can provide a reply. The price for which that output is sold does not differ from the price for the output of a larger plot, so price presents no special problem. Multiplying output and price gives the value of production and that seems to be usually available for small, as well as for large, plots. But on very small plots (which can be 0.2 ha or less) it may be difficult to estimate the cost of non-labor inputs and wages paid.

So the single sample appears to exclude most of the small plots for which labor costs and non-labor inputs are not separately given. The average value of production per plot for this single sample, which covers mostly larger plots, is therefore far higher than for all plots. As a result the mean for the value of production is overstated in this sample and with it the residual. If the overstatement were consistent from year to year it would not matter for our analysis of changes over time. But unfortunately in some years the bias towards the larger plots is far greater than in other years. For instance in 1978 the multiple sample is less than 50% greater than the single sample (see N in Table II-18) and the mean value of production for the single sample is only 2% greater than for the multiple sample. At the other extreme is 1975, where the multiple sample is 6.4 times as large as the single sample, and the value of production for the latter is 47% higher than the former. Therefore if it is correct that the single sample is biased to the larger plots for value of production, using such a sample will introduce error into year-to-year comparisons.

A comparison of the two samples (Table II-A-1) shows that in the multiple sample 40% of the observations for value of production are in the smallest size category (plots up to .2 ha), while in the single sample only 25% are in this category. For the smaller size plots, where the number of observations is fairly large, the means do not differ all that much in each category between multiple and single sample. The overall mean differs primarily because the single sample drops so many observations in the smallest size category. For the other variables the

differences in proportion of observations in different size categories between multiple and single sample is much less and therefore the difference in overall means is also much less. For the crucial wage variable, and for the smaller size groups the proportion of observations is 28% for the multiple sample and 25% for the single sample, the same proportion as in the case of value of production. The single sample in 1975 thus greatly overstates the residual. Analyses in the paper are therefore largely based on the multiple sample.

Table II-A-1

A Comparison of Single and Multiple Samples -- Java/Bali, 1975

	Value of Production				Non-labor Inputs			Wages		
	Multiple		Single		Multiple		Single*	Multiple		Single*
	Mean	N	Mean	N	Mean	N	Mean	Mean	N	Mean
up to 2 ha	22,238	2,583	28,548	250	1,813	1,072	1,704	2,918	564	5,695
.2-.5 ha	46,222	2,698	53,239	378	3.234	958	3,011	5,012	749	9,842
.5-1 ha	82,019	1,080	93,699	232	5,858	535	5,275	9,813	430	17,593
1-2 ha	128,787	489	171,531	93	8,933	231	8,030	15,082	170	27,015
2+ ha	194,842	242	250,972	55	15,050	128	14,290	23,950	97	43,112
All	54,688	6,537	83,547	1,013	8,668	2,949	9,652	12,872	2,016	14,167

*Of course, the N for non-labor inputs and wages for the single sample are the same as the N for value of production.

3) The structure of wage rates

On the whole the structure of wage rates is what one would expect: higher for work done by males than females, and for Other Islands than for Java. But there are some interesting aspects in the relationships.

Plowing wages have a wide dispersion and may be subject to particularly great error. Apparently some respondents correctly gave only the wage paid to the adult male involved in the operation. In other cases it may be the wage of the boy guiding hte animals or even the rental charge for the animals was included. Because of the ambiguity, plowing is left out of further analysis.

a) Wage levels

It is striking that even in 1978 wages for rice farming for the country averaged only about Rp 400 (or US $1) per day and averaged Rp 300 for Java/Bali (Table II-13) If one accepts very spotty data from other studies that employment was available for perhaps half of 365 days and that half of all household members were non-earners (primarily small children) one can estimate yearly per capita agricultural income at Rp 15,000 to 36,000 or US $37.50 to $90.[1] Returns to labor in the types of non-agricultural activities to which landless households have access

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[1]Employment for 125-200 days, for 2 to 3 out of 5 family members, then minimum income is Rp 300 x 125 x 2 = 75,000/5 = Rp 15,000 and maximum income is Rp 300 x 200 x 3 = 180,000/5 = Rp 36,000.

Table II-13a

NOMINAL OBSERVED WAGE RATES FOR RICE AND NON-RICE CULTIVATORS

JAVA/BALI

	75	76	77	78
Plowing	290	312	351	444
Rice	297	325	360	449
Non-rice	268	278	323	423
Hoeing	222	259	286	333
Rice	230	273	297	345
Non-rice	198	221	255	288
Planting	145	167	182	217
Rice	144	170	181	220
Non-rice	147	160	182	204
Weeding	148	171	190	220
Rice	147	174	190	223
Non-rice	149	160	189	210
Harvest	194	217	244	285
Rice	201	229	251	297
Non-rice	173	189	223	242
Preharvest Average	183	211	233	297
Rice	186	218	235	306
Non-Rice	174	190	220	261
All Operations - Average	186	212	238	294
Rice	190	221	241	304
Non-Rice	174	183	221	256

Table II- 13b

NOMINAL OBSERVED WAGE RATES FOR RICE AND NON-RICE CULTIVATORS

OTHER ISLANDS

	75	76	77	78
Plowing				
Rice	343	405	420	513
Non-rice	332	402	417	510
	393	416	433	538
Seeding				
Rice	330	409	438	466
Non-rice	336	406	438	460
	316	416	438	485
Planting				
Rice	282	335	363	377
Non-rice	276	340	356	371
	296	323	381	400
Weeding				
Rice	279	330	367	376
Non-rice	274	333	362	365
	287	322	377	410
Harvest				
Rice	310	370	383	410
Non-rice	308	378	380	403
	315	355	392	434
Preharvest Average				
Rice	301	362	392	417
Non-Rice	299	364	388	410
	305	359	402	443
All Operations - Average				
Rice	304	365	389	415
Non-Rice	302	368	386	408
	311	358	399	410

Table II-13c

NOMINAL OBSERVED WAGE RATES FOR RICE AND NON-RICE CULTIVATORS

INDONESIA

	75	76	77	78
Plowing	299	330	362	451
Rice	304	340	370	456
Non-rice	284	301	337	431
Hoeing	240	286	315	348
Rice	247	296	324	358
Non-rice	223	260	293	312
Planting	172	200	218	238
Rice	169	203	217	240
Non-rice	180	193	223	230
Weeding	174	202	226	241
Rice	169	203	223	241
Non-rice	187	199	235	241
Harvest	221	254	275	303
Rice	225	263	279	312
Non-rice	212	232	265	271

are often lower than rice wages (see White, 1979, Husken, 1979, Hart, 1978 and Table II-3). So if the landless work at Rp 150-200 on the days they can not obtain work in rice agriculture their total annual income would be of the order of Rp 28,500 ($70) to Rp 54,000 ($135)[1]. This compares to a 1978 per capita income of $360, which is three to five times as large. Unskilled construction workers in Java, excluding Jakarta, had daily wages of nearly Rp 800 in 1978 and monthly wages for plantation workers in Java were Rps 13,200 for permanent and Rp 8,300 for temporary workers (Papanek, 1980). Temporary workers would receive Rp 300 a day if they work a 26 day month, quite comparable to the pay in rice agriculture. Permanent plantation workers, on the same basis, received Rp 500 a day. These comparisons confirm that workers in rice agriculture, paid Rp 300 a day on Java, are among the poor, with incomes substantially below average and less well paid than permanent workers on plantations or in urban jobs. They also confirm the absolute poverty of this group.

In general, those who work on non-rice crops have even lower wages, especially on Java/Bali. In short, even in 1978 agricultural workers remained very poor.

b) Wage rates for different activities and for men and women

Comparing hoeing (male) and planting (female) one finds that the former is consistently paid at a 55% to 65% higher rate. There is no trend in this ratio, but then we have data for only four years, so one would not expect much. The male/female comparison may not be accurate, since it is possible that a "day" does not have the same number of hours in hoeing and planting, or for men and women.

Weeding, which is done by both women and men, is paid at a rate which is barely above that for planting. But wage rates reflect not only gender but also season, and it is not clear whether the similarity indicates that weeding is largely performed by women or that it is done in the off season, and the wage is therefore lower.

Wage rates for harvesting are surprisingly consistent over the years and quite high. We had assumed that data on labor use and wages paid for harvesting would be quite unreliable since it is difficult to know how many people participate in the harvest in some parts of Java, given the number involved, and even more difficult to define what a "day" of work involves. In some cases there could be enough harvest work only for an hour or two, in others for the whole day. But in fact data for the harvest wage were quite consistent from year to year and with other wage data.

The harvesting wage rate is consistently higher than the pre-harvest average. For some parts of Java, and perhaps elsewhere, payment at harvest time includes compensation for work done earlier (the kedokan system mentioned above); this perhaps explains a relatively high harvest wage despite the extensive participation of lower paid women and children.

There is another interesting question about the harvest wage. Various studies claim that there has been a distinct shift in harvest procedures in Java from an "open" harvest in which large numbers each receive a small share of the harvest they bring in and thus a small total wage, to a system where only a few persons participate, each receiving higher pay. In the old system the hand knife (ani-ani) is used and the wage bill is between one seventh and one twelfth of the harvest. In the

new system the sickle is used more often and the total real harvest wage bill is much smaller, although each participant receives a higher wage. They may receive a smaller share of the larger amount they harvest, or payment in cash.

The evidence from the Surveys is quite limited on this hotly contested issue. The average observed harvest wage rate exceeded the average pre-harvest wage rate in Java/Bali by 32% in 1975 and drops in the three succeeding years to an excess of 10%, 11% and 12% respectively. If a shift from traditional to commercial harvesting is taking place one would expect that the harvest wage rate per day would rise, compared to other activities where no change in technology is taking place, as fewer harvesters each receive a higher wage. But the data indicate instead a significant drop between 1975 and 1976, and no significant change since. The decline from 1975 to 1976 is some evidence of reduced labor compensation for harvesting, since a reduced wage rate appears to accompany reduced employment.

The evidence provided by the wage bill does tend to support the argument that the "open harvest" is being reduced, or at least that total harvest compensation is declining, but the evidence is not strong. The harvest wage bill as a percent of the total wage bill has declined since a high point in 1973, though it was also lower in 1971-72.

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[1]Employment for 150 to 225 days outside rice agriculture means Rp 200 x 150 x 3 = 90,000/5 = Rp 18,000 or Rp 150 x 225 x 2 = 67,500/5 = Rp 13,500. Those working the minimum number of days in rice agriculture would, on the assumption that they can not afford to remain idle for many days, work the maximum number of days outside rice agriculture.

Table II-14

HARVEST WAGE BILL AS PERCENT OF TOTAL WAGE BILL

1968-70	36.8%
1971	30.8%
1972	32.0%
1973	34.5%
1974	33.2%
1975	32.4%
1976	30.5%
1977	30.9%
1978	29.3%

If one compares the first three years (32.4%) in the series with the last three (30.2%), one finds a 7% decline in the share of the harvest wage bill, not very large given the vagaries of these data. The absolute total real harvest wage bill also seems to have declined by over 10%, comparing 1971-3 to 1976-8. Both trends are consistent with some decrease in compensation to harvest labor as a result of institutional changes. Unfortunately the Agricultural Survey provides no direct and little indirect evidence on underlying institutional changes. As discussed in the introduction to Part II a number of different developments could be taking place simultaneously, which affect wages in general and the harvest wage in particular. Constant real wages could mask changes such as:

the spread of ceblokan, under which access to work is more limited than in the past, pre-harvest work is required and rewarded with a share in the harvest, and fewer workers each receive a higher wage rate and higher incomes, while the total wage bill remains unchanged or declines.

a switch from snare to piece-rate cash payments, which could increase or decrease wage rates and could decrease the wage bill.

Some of these issues are discussed further below, but no definitive conclusions are possible.

The trend in relative wage bill between Java/Bali and the Other Islands has already been commented on. The absolute differences in nominal wages are also of some interest. Wages for the Other Islands are about 60% higher than on Java in 1976-77, a tremendous gap, but one which declined sharply to 1/3 for 1978. Since prices rose more rapidly in the Other Islands in 1978, the gap declined even more in real terms. No obvious explanation presents itself for this difference in trends. The consistently higher level is, of course, expected, given the more favorable resource/population ratio in the Other Islands.

c) Conclusion

Nominal wages reflect the great absolute poverty of agricultural labor, especially on Java. Even in better paid rice agriculture, workers' income appears to be only one-third or less of the national average. As expected, wages are higher for male than for female

occupations and by as much as 50%. They are similarly higher for the Other Islands than for Java/Bali. There is some evidence that the harvest wage bill is declining, which provides support for the argument of increasing restrictions on access to the harvest as the result of institutional changes.

4) Employment and Employment Trends

As noted in "A Guide to the Data" there is some ambiguity about labor use data for the early years which makes comparisons dubious. For these years information is available only on the number of workers, with little usable data on the number of days worked. Since unambiguous data are available for only three years, most of the analysis is limited to these years and the following analysis of trends is largely speculative. The importance of extending the data to the next crop years, 1979 and 1980, is apparent.

a) Employment Trends

While the questions used are not identical, and conclusions therefore must remain tentative, it appears that the total number of family and hired workers employed per plot remained essentially unchanged from 1972-74 to 1976-77 in Java/Bali (Table II-15a)[1]. It could be argued by pessimists that there is no evidence here that a dynamic, expanding agricultural sector was able to absorb additions to the labor force in high productivity jobs. Conversely, optimists could interpret the data to indicate that jobs were created in other sectors at a rate which made it unnecessary for redundant workers to crowd into low-productivity agricultural jobs. Stagnant wages (see above) are more consistent with the first explanation.

As in the earlier discussion of wages, it must be stressed that these data are on a per crop basis. Multiple cropping of rice has increased, at an estimated rate of 2% per year, and rice uses more labor

[1]The data for employment by all units for 1971 are dubious and are ignored here. See below for discussion.

Table II-15a

LABOR USE IN ALL ACTIVITIES*: JAVA/BALI
1971-1978

	Hectares						F
	< .2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						(4.9)	
1973			na			(4.6)	
1974						(4.6)	
1976	5.85	5.40	5.68	5.63	6.21	5.7	4.5
1977	5.34	5.74	5.83	5.99	6.10	5.9	1.7
1978	5.54	5.40	5.28	5.45	5.09	5.3	1.5
Ave. No. Hired Workers							
1968-70						(59.9)	
1971	(17.98)	(25.82)	(34.73)	(46.15)	(63.15)	(42.6)	522.7
1972						(30.9)	
1973			na			(35.9)	
1974						(36.7)	
1976	6.99	18.57	29.63	43.05	61.62	33.0	553.1
1977	8.07	17.31	28.18	41.83	63.74	31.8	452.1
1978	7.99	17.70	29.64	43.81	73.54	37.3	834.2
Ave. No. Days/Worker							
1971	(6.4)	(9.2)	(12.2)	(15.9)	(27.8)	(15.1)	395.7
1972						(15.2)	
1973			na			(15.0)	
1974						(16.3)	
1976: Family	7.1	8.8	10.7	12.7	15.3	11.0	78.8
Hired	3.2	6.6	9.4	13.4	18.9	10.4	423.9
Total	10.3	15.4	20.1	26.1	34.2	21.4	
1977: Family	7.0	8.1	10.4	11.7	15.6	10.5	77.1
Hired	3.9	6.4	9.6	12.6	17.5	10.1	273.1
Total	10.9	14.5	20.0	24.3	33.1	20.6	
1978: Family	6.4	7.8	9.2	10.8	12.3	9.7	55.9
Hired	3.8	6.4	9.2	12.4	18.1	10.7	425.3
Total	11.2	14.2	18.4	23.2	30.4	20.4	
No. of Unpaid Workers							
1968-70	1.36	2.81	3.70	3.70	4.12	3.51	6.6
1971	2.25	2.22	2.24	2.53	3.20	2.55	8.79

*Includes plowing, hoeing, planting, weeding, and harvesting, but excludes "other work"

na = not available. Note that plowing data are not available for 1968-70, 1971.
Parentheses indicate data ambiguity.

Note that here and subsequently the categories really are .201-.499, .5-.999, etc

Table II-15b

LABOR USE IN ALL ACTIVITIES*: OTHER ISLANDS
1971-78

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						7.92	
1973			na			7.13	
1974						7.69	
1976	7.09	7.75	8.49	10.37	12.06	9.64	17.4
1977	7.48	8.37	9.30	10.13	11.02	9.71	5.6
1978	7.24	7.55	8.14	8.26	8.00	8.04	0.6
Ave. No. Hired Workers							
1971	(19.5)	(22.9)	(25.3)	(27.0)	(35.2)	(27.8)	30.9
1972						(6.25)	
1973			na			(9.17)	
1974						(7.58)	
1976	3.14	6.95	8.09	10.34	17.78	10.34	16.5
1977	3.55	4.38	8.91	11.33	17.62	10.48	27.3
1978	2.84	8.06	12.42	19.48	33.50	18.33	38.4
Ave. No. Days/Worker							
1971	(8.6)	(14.9)	(20.7)	(25.1)	(35.2)	(24.3)	31.1
1972						(31.9)	
1973			na			(33.8)	
1974						(32.8)	
1976: Family	10.7	18.3	25.4	32.6	43.3	29.7	38.1
Hired	1.3	3.2	5.4	7.2	11.7	6.8	22.1
Total	12.0	21.5	30.8	39.8	55.0	36.5	
1977: Family	9.2	18.6	24.8	32.1	33.9	27.5	18.9
Hired	1.5	3.7	5.4	8.5	10.8	7.0	22.1
Total	10.7	22.3	30.2	40.7	44.7	34.5	
1978: Family	9.6	14.2	21.7	24.8	28.2	22.8	11.3
Hired	1.4	3.3	5.3	8.6	13.5	7.9	38.9
Total	11.0	17.5	27.0	33.4	41.7	30.5	
No. of Unpaid Family Workers							
1968-70	3.12	3.42	4.61	4.74	5.59	4.10	6.6
1971	1.71	2.21	3.33	3.17	4.88	3.45	5.01

*i.e., plowing, hoeing, planting, weeding, and harvesting, but excluding "other work"

na = not available

Parentheses indicate data ambiguity.

Note that plowing data are not available for 1968-70 and 1971.

than dry season crops. So total labor use has probably also increased, perhaps at a rate approaching that for population in the rural areas. Apparently the new seed varieties and the accompanying increased use of commercial inputs and of greater water control have increased demand for labor. The new technology does not seem to demand more labor per crop, but it is accompanied by multiple cropping. However, the increase in total labor use has at best been as rapid as rural labor force growth, and below the rate of increase in the total (rural and urban) labor force.

There is clear difference in the trend with respect to family and hired workers. Family labor increased from an average of 4.7 persons in 1972-74 to 5.6 persons in 1976-78, while the number of hired workers remained essentially unchanged.

Disaggregating the data by operation can provide further information. For family labor the increase in number of workers for 1976-78 over 1972-74 is consistently present in all activities. For hired labor for all activities except harvesting and plowing, 1978 is a year with unexplained high labor use. But in comparing 1972-74 with 1976-77 only in hoeing (and plowing) did the number of hired workers increase. For planting and weeding, and especially for harvesting, the number of hired workers declined. For harvesting the average number of hired workers declined from an average of 15.5 to 14.8 (Table II-16).

The tentative conclusion one can draw from this is that with increasing population pressure the number of family workers was increasing somewhat in the late 1970s. The total effort on plowing and hoeing -- substitutes to a substantial extent -- was increased, presumably in order to satisfy the requirements of high yielding

Table II-16

SUMMARY -- NUMBER OF FAMILY AND HIRED WORKERS BY ACTIVITIES

JAVA/BALI 1971 - 1978

	Plowing			Hoeing			Planting			Weeding			Harvesting			All		
	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T
1971	---	---	---	---	6.4	---	---	11.0	---	---	7.5	---	---	17.8	---	---	42.6	---
1972	.3	.9	1.2	1.1	2.6	3.7	1.1	8.1	9.2	1.1	5.7	6.8	1.3	13.5	14.8	4.9	30.9	35.8
1973	.3	1.1	1.4	1.0	3.6	3.6	1.0	9.2	10.2	1.1	5.6	6.7	1.3	16.4	17.7	4.6	35.9	40.5
1974	.2	1.3	1.5	1.0	3.4	3.4	1.0	9.6	10.6	1.2	5.9	7.1	1.3	16.5	17.8	4.6	36.7	41.3
1976	.2	1.6	1.8	1.3	3.9	4.2	1.2	8.8	10.0	1.4	5.6	7.0	1.6	13.1	14.1	5.9	33.0	38.7
1977	.2	1.3	1.5	1.3	3.8	4.2	1.3	8.5	9.8	1.5	5.5	7.0	1.6	12.5	14.1	5.9	31.8	37.7
1978	.2	1.4	1.6	1.1	4.5	5.6	1.1	10.2	11.3	1.3	7.1	8.4	1.6	14.0	15.6	5.3	37.3	42.6

F = family; H = hired; T = total number of workers
Note: these are simple averages of the number of workers per plot.

varieties. Their shorter growing period, which facilitates multiple cropping, also requires that land preparation be compressed to the shortest possible time, hence increased use of hired labor. Both plowing and hoeing are male occupations. On the other hand planting (female) and weeding (both genders) probably saw some substitution of family for hired labor within a slightly increased total. The number of hired workers decreased for reasons already discussed. Only 1978 showed a higher total number of workers in most activities, due to an increase in hired labor, for reasons which are not clear. Disaggregation by activity and source does not provide strong evidence for either optimistic or pessimistic conclusions on labor use. However, the rise in family labor at the cost of hired workers, except for the arduous task of land preparation, is somewhat more consistent with the notion of increasing pressure for employment and crowding out the landless. The drop in hired harvest labor is most significant in that respect.

Data on the number of days worked are broken down by family and hired only in the last three years. Earlier the figure is ambiguous and appears to be mixed, probably including all hired labor-days, and some family labor-days, since the 1971-74 figures tend to be less than the total number of days reported for family and hired workers combined and more than the number of hired days reported for 1976-78. The break-down by activity again suggests some slight decline in number of days in women's tasks (planting, most weeding) and some rise in men's, especially for hired workers, but the differences are so slight and the time periods so short that no strong conclusion is warranted.

For the Other Islands the data for 1971 are particularly suspect, but indicate a decline for numbers of hired labor in all size categories between 1971 and 1978. There is also a 20% increase in the number of

family members working between 1972-74 and 1976-78. 1978 also shows an extraordinary increase (80%) in hired labor over 1976 and 1977, which is as difficult to explain as the smaller increase seen for Java/Bali. Finally there is a decline of some 20% in the average number of days worked between 1976 and 1978, all due to fewer days worked by family members, especially for the larger units, that partly balances the increase in the number of family workers.

One possible explanation of these changes is that they are largely statistical artifacts, especially in comparing years with different questionnaires and samples (1971 with 1972-74, with 1976-78). But this is not too likely except for 1971, since the questionnaires were not all that different in other years and the samples are quite large. More likely is that there was indeed a trend to increased labor use -- perhaps exaggerated in the data -- in part as a result of expanding use of high yielding varieties, fertilizer, pesticides and irrigation water (see below). For Java/Bali the effect on labor of greater input use was muted because labor intensity was already great. But in the Other Islands where the number of family plus hired labor was about 15 in 1972-74, compared to 35-40 for Java/Bali, labor productivity and labor use could be increased as a result of greater input use. Since family members were already heavily engaged in rice agriculture (averaging nearly 8 persons in 1972-74 compared to less than 5 for Java/Bali) the increase took primarily the form of additional hired workers.

The decline in average days worked by family members between 1976 and 1978 parallels the same phenomenon for Java/Bali, but is far more pronounced. In both cases it may reflect the increased participation of family members who have other work, either off-farm or in the home or

Table II-17a

LABOR USE IN PLOWING*: JAVA/BALI
1972-78

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						.28	
1973			na			.29	
1974						.24	
1976	.12	.17	.22	.27	.34	.23	21.4
1977	.06	.17	.22	.30	.32	.23	18.8
1978	.18	.20	.22	.26	.26	.23	4.4
Ave. No. Hired Workers							
1972						0.89	
1973			na			1.10	
1974						1.27	
1976	.12	.71	.22	.27	.34	.23	21.4
1977	.06	.17	.22	.30	.32	.23	18.8
1978	.18	.20	.22	.26	.26	.23	4.4
Ave. No. Days/Worker							
1968-70							
1971							
1972						(2.9)	
1973			na			(3.3)	
1974						(3.7)	
1976: Family	0 2	.4	.7	1.3	2.1	.9	57.7
Hired	0.6	1.2	2.1	3.1	4.3	2.3	203.8
Total	0.8	1.6	2.8	4.4	6.4	3.2	
1977: Family	0.1	0.4	0.7	1.3	2.5	0.9	61.7
Hired	0.7	1.1	2.1	3.0	4.5	2.3	152.5
Total	0.8	1.5	2.8	4.3	7.0	3.2	
1978: Family	0.2	0.4	0.6	1.0	1.5	0.8	34.0
Hired	0.7	1.3	2.1	2.9	4.1	2.4	209.7
Total	0.9	1.7	2.7	3.9	5.6	3.2	

na = not available
*No data on plowing for 1968-70 and 1971.
Parentheses indicate data ambiguity.

Table II-17b

LABOR USE IN HOEING: JAVA/BALI

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						1.06	
1973			na			.99	
1974						1.02	
1976	1.30	1.18	1.27	1.30	1.28	1.26	3.2
1977	1.11	1.22	1.29	1.40	1.31	1.29	7.6
1978	1.17	1.09	1.18	1.16	1.06	1.13	4.2
Ave. No. Hired Workers							
1968-70						(10.29)	
1971	(4.27)	(4.30)	(5.26)	(6.52)	(9.86)	(6.43)	189.4
1972						2.58	
1973			na			3.61	
1974						3.41	
1976	.93	2.53	3.34	5.10	7.23	3.90	186.1
1977	1.09	2.32	3.32	4.96	7.25	3.81	159.7
1978	1.21	2.32	3.58	5.29	8.63	4.52	267.4
Ave. No. Days/Worker							
1971	(2.1)	(3.7)	(5.0)	(6.4)	(9.5)	(6.1)	223.3
1972						(5.1)	
1973			na			(4.7)	
1974						(5.2)	
1976: Family	2.7	3.5	4.4	5.2	5.8	4.5	44.8
Hired	0.8	1.8	2.6	3.7	5.2	2.9	203.8
Total	3.5	5.3	7.0	8.9	11.0	7.4	
1977: Family	2.8	3.2	4.2	4.4	5.9	4.1	46.0
Hired	0.9	1.8	2.6	3.4	4.8	2.9	133.9
Total	3.7	5.0	6.8	7.8	10.7	7.0	
1978: Family	2.3	2.9	3.8	4.8	5.0	3.9	40.9
Hired	0.9	1.6	2.4	3.3	5.4	2.9	251.5
Total	3.2	4.5	6.2	8.1	10.4	6.8	

na = not available

Parentheses indicate data ambiguity.

Table II-17c

LABOR USE IN PLANTING: JAVA/BALI

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						1.14	
1973			na			.95	
1974						.97	
1976	1.36	1.18	1.19	1.13	1.25	1.19	3.0
1977	1.27	1.30	1.24	1.25	1.18	1.25	0.8
1978	1.21	1.20	1.10	1.13	1.08	1.13	2.2
Ave. No. Hired Workers							
1968-70						(14.31)	
1971	(4.73)	(6.47)	(8.68)	(11.86)	(17.51)	(10.97)	452.9
1972						8.12	
1973			na			9.17	
1974						9.57	
1976	1.17	4.67	7.82	11.62	17.67	8.78	525.2
1977	1.99	4.30	7.67	11.35	17.13	8.54	418.4
1978	2.21	4.78	7.98	12.03	20.49	10.23	647.1
Ave. No. Days/Worker							
1971	(1.2)	(1.4)	(1.7)	(2.4)	(3.8)	(2.3)	252.5
1972						(1.7)	
1973			na			(1.5)	
1974						(1.6)	
1976: Family	1.0	1.0	1.1	1.3	1.8	1.2	22.5
Hired	0.6	1.1	1.3	1.8	2.7	1.5	142.8
Total	1.6	2.1	2.5	3.1	4.5	2.7	
1977: Family	1.0	0.9	1.1	1.2	1.3	1.1	8.2
Hired	0.8	1.1	1.4	1.7	2.5	1.5	66.8
Total	1.8	2.0	2.5	2.9	3.8	2.6	
1978: Family	0.9	0.9	1.0	1.1	1.3	1.0	9.8
Hired	0.7	1.1	1.4	1.7	2.4	1.5	76.1
Total	1.6	2.0	2.4	2.8	3.7	2.5	

na = not available

Parentheses indicate data ambiguity.

Table II-17d

LABOR USE IN WEEDING: JAVA/BALI

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						1.06	
1973			na			1.14	
1974						1.16	
1976	1.47	1.36	1.46	1.40	1.52	1.43	2.7
1977	1.37	1.46	1.48	1.48	1.60	1.48	1.9
1978	1.38	1.31	1.30	1.35	1.22	1.30	2.3
Ave. No. Hired Workers							
1968-70						(10.91)	
1971	(3.93)	(4.65)	(5.68)	(7.87)	(12.12)	(7.48)	297.2
1972						5.74	
1973			na			5.59	
1974						5.92	
1976	.97	2.86	4.74	7.62	12.12	5.63	329.8
1977	1.30	2.87	4.52	7.32	12.46	5.53	329.8
1978	1.25	3.13	5.48	8.51	14.47	7.11	445.3
Ave. No. Days/Worker							
1971	(1.8)	(2.7)	(3.7)	(4.8)	(7.0)	(4.5)	219.7
1972						(3.6)	
1973			na			(3.7)	
1974						(4.0)	
1976: Family	1.8	2.5	3.1	3.4	3.9	3.1	28.5
Hired	0.6	1.3	2.0	2.9	4.2	2.2	265.5
Total	2.4	3.8	5.1	6.3	8.1	5.3	
1977: Family	2.1	2.3	3.1	3.4	4.1	3.0	33.2
Hired	0.7	1.4	1.9	2.8	3.9	2.2	175.7
Total	2.8	3.7	5.1	6.2	8.0	5.2	
1978: Family	1.9	2.3	2.7	3.0	3.2	2.7	17.6
Hired	0.7	1.3	1.9	2.7	4.0	2.3	266.6
Total	2.6	3.6	4.6	5.7	7.2	5.0	

na = not applicable
Parentheses indicate data ambiguity.

Table II-17e

LABOR USE IN HARVESTING: JAVA/BALI

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						1.34	
1973			na			1.25	
1974						1.27	
1976	1.61	1.53	1.57	1.53	1.75	1.57	2.2
1977	1.61	1.67	1.60	1.57	1.75	1.62	1.1
1978	1.70	1.69	1.54	1.56	1.60	1.60	1.0
Ave. No. Hired Workers							
1968-70						(24.05)	
1971	(3.44)	(10.89)	(15.25)	(20.23)	(25.81)	(17.75)	255.0
1972						13.52	
1973			na			16.38	
1974						16.51	
1976	2.91	7.84	12.64	17.05	23.27	13.12	263.9
1977	3.45	6.97	11.48	16.38	22.82	12.49	236.2
1978	3.01	6.50	11.50	16.37	27.10	13.95	
Ave. No. Days/Worker							
1971	(1.3)	(1.6)	(1.9)	(2.4)	(3.5)	(2.3)	125.3
1972						(2.0)	
1973			na			(1.7)	
1974						(2.0)	
1976: Family	1.8	2.5	3.1	3.4	3.9	3.1	28.5
Hired	0.6	1.3	2.0	2.9	4.2	2.2	265.5
Total	2.4	3.8	5.1	6.3	8.1	5.3	
1977: Family	2.1	2.3	3.1	3.4	4.1	3.0	33.2
Hired	0.7	1.4	1.9	2.8	3.9	2.2	175.7
Total	2.8	3.7	5.1	6.2	8.0	5.2	
1978: Family	1.9	2.3	2.7	3.0	3.2	2.7	17.6
Hired	0.7	1.3	1.9	2.7	4.0	2.3	266.6
Total	2.6	3.6	4.6	5.7	7.2	5.0	

na = not available
Parentheses indicate data ambiguity.

Table II-17f

LABOR USE IN "OTHER WORK": JAVA/BALI

	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Ave. No. Family Workers							
1972						0.66	
1973			na			0.79	
1974						.76	
1976	.41	.51	.58	.63	.71	.58	11.6
1977	.42	.54	.62	.71	.80	.63	16.4
1978	.46	.55	.61	.71	.73	.64	13.2
Ave. No. Hired Workers							
1968-70						(1.65)	
1971	(.53)	(.84)	(1.04)	(1.49)	(2.54)	(1.45)	8.2
1972						.66	
1973			na			.71	
1974						.75	
1976	.12	.43	.77	1.01	1.76	.82	46.4
1977	.23	.39	.63	1.19	1.95	.84	62.8
1978	.16	.49	.75	1.31	2.45	1.1	106.1
Ave. No. Days/Worker							
1971	(1.2)	(2.3)	(2.6)	(3.7)	(5.0)	(3.3)	31.6
1972						(2.5)	
1973			na			(3.9)	
1974						(3.8)	
1976: Family	1.6	2.2	3.2	3.8	3.3	3.0	8.8
Hired	0.1	0.4	0.6	1.2	1.9	0.8	47.7
Total	1.7	2.6	3.8	5.0	4.2	3.8	
1977: Family	1.4	2.0	2.8	3.0	3.4	2.6	6.2
Hired	0.2	0.3	0.7	1.1	1.9	0.8	56.5
Total	1.6	2.3	3.5	4.1	5.3	3.4	
1978: Family	1.6	2.2	2.7	4.3	4.3	3.2	22.3
Hired	0.2	0.5	0.7	1.1	1.8	0.9	57.5
Total	1.8	2.7	3.4	5.4	6.1	4.1	

na = not available
Parentheses indicate data ambiguity.

with livestock, who therefore have fewer days available for rice agriculture.

b) Size of holding and employment: over time

The effect of size of holding on labor use is important in its own right and also for the light it may shed on time trends. By disaggregating the number of workers by adjusted size of operating units one can immediately see that the 1971 data for hired labor use on Java/Bali are quite consistent with those for 1976-78 for operating units of 1 hectare or above, but diverge strongly for smaller units (Table II-15a). Disaggregating further by activity one finds that the discrepancy is quite consistent for all activities (Tables II-17.) (Note that plowing was not separately recorded in 1971 and is probably included either under "hoeing" or "other" in that year.) A possible explanation is that between 1971 and 1976 families with small operating units relied increasingly on family labor for all operations because the alternative opportunities for family labor were becoming less attractive. Those with larger holdings were already using all the family labor they had available or had more attractive alternatives and therefore kept hiring labor. The change in these five years was quite remarkable if one takes the data at face value: for the smallest units (less than 0.2 hectares) the number of hired workers dropped from 18 in 1971 to 7-8 in 1976-78, for slightly larger units from 26 to 18, or one-third. For middle-sized units the decline is 17%; for large units there is no change. This explanation is consistent with a pessimistic interpretation of developments in rural Java: as alternative opportunities declined, small holders increased the family labor they applied to their plots and reduced their use of hired labor.

Table II-18a

FAMILY AND HIRED LABOR USE PER HECTARE IN PREHARVEST AND HARVEST ACTIVITIES: JAVA/BALI
BY SIZE OF OPERATING UNIT, 1976-78

	Person-days						
	Hectares						F
	<.2	.2-.5	.5-1	1-2	>2	All	Statistic
Preharvest							
1976: Family	152	90	65	43	29	67	294.3
Hired	81	126	126	131	120	123	28.9
Total	233	216	191	174	149	190	
1977: Family	142	83	64	43	27	63	223.0
Hired	97	118	119	119	112	117	6.1
Total	239	201	183	161	139	180	
1978: Family	139	82	53	38	20	53	364.1
Hired	110	127	126	126	123	125	3.0
Total	249	209	179	164	143	178	
Harvest							
1976: Family	49	22	13	7	9	16	85.1
Hired	46	67	64	54	47	59	
Total	95	89	77	61	56	75	
1977: Family	48	24	14	8	5	15	86.7
Hired	60	57	58	51	43	54	
Total	108	81	72	59	48	69	
1978: Family	47	21	11	7	4	12	269.6
Hired	64	58	58	53	51	56	
Total	111	79	69	60	55	68	
Total							
1976: Family	201	112	78	50	38	83	
Hired	127	193	190	185	167	182	
Total	328	305	268	235	205	265	
1977: Family	190	107	78	51	32	78	
Hired	157	175	177	170	155	171	
Total	347	282	255	221	187	249	
1978: Family	186	103	64	45	24	65	
Hired	174	185	184	179	174	181	
Total	360	288	248	224	198	246	

Table II-18b

FAMILY AND HIRED LABOR USE PER HECTARE IN PREHARVEST AND HARVEST ACTIVITIES: OTHER ISLANDS, BY SIZE OF OPERATING UNIT, 1976-78

Person-days

	Hectares						
	<.2	.2-.5	.5-1	1-2	>2	All	F Statistic
Preharvest							
1976: Family	195	145	121	105	74	112	22.9
Hired	29	44	35	29	28	33	3.9
Total	224	189	156	134	101	145	
1977: Family	184	160	116	99	69	109	
Hired	28	36	39	34	31	35	
Total	212	196	155	123	100	144	
1978: Family	200	122	105	76	49	89	
Hired	23	39	39	34	31	35	
Total	223	161	153	123	97	135	
Harvest							
1976: Family	75	58	53	43	30	46	5.0
Hired	22	19	30	18	18	22	10.9
Total	97	77	30	18	18	22	
1977: Family	77	68	46	43	21	44	
Hired	19	14	16	17	19	17	
Total	96	82	62	60	40	61	
1978: Family	(118)	47	48	29	23	38	7.3
Hired	35	21	31	29	25	27	
Total	(153)	68	65	47	46	55	
Total							
1976: Family	(270)	203	174	148	104	158	
Hired	51	63	65	47	46	55	
Total	(321)	263	239	195	150	213	
1977: Family	(261)	228	162	142	90	153	
Hired	47	50	55	51	50	52	
Total	(308)	278	217	193	140	205	
1978: Family	(318)	169	153	105	72	127	
Hired	58	60	79	76	73	73	
Total	(376)	229	232	181	145	206	

This interpretation is consistent with the stagnation or possible decline in the per worker wage bill (see above), but inconsistent with other fragmentary evidence from the labor use tables. In the more accurate data for 1976 to 1978 there is no continuation of any trend for the smaller units to increase the use of family labor. On the contrary the number of family-days worked declined almost 10% between 1976 and 1978 for the smallest units, while the number of hired-days worked increased or remained unchanged. The alternative explanation is that the change between 1971 and 1976 is a statistical artifact, due to the change in sample or in the wording of the question.

But this latter explanation is difficult to reconcile with the rise in the number of hired workers between 1971 and 1976 on larger units (Table II-15a). For the smallest operating units the recorded drop in hired labor is more than 50%, and as one moves up the scale, the decline in hired labor becomes less and less, until it becomes an increase for the largest units. Therefore one can conclude that the data lend some support to the pessimistic view that those who operated small units in Javanese rice agriculture found declining alternative off-farm opportunities between the early and late 1970's.

c) Size of holding and employment: cross section data

As previously noted the data for the recent years are more reliable than for earlier ones. For Java/Bali one finds a clear cut and expected relationship between family and hired labor in these data: the proportion of hired labor increases sharply with the size of operating unit. For the smallest operating units the number of family members working is almost as great as the number of hired workers (Table II-15a). But since the number of family members barely increases as the

size of operating unit increases, the number of hired workers must necessarily increase steeply with the size of unit. So for the larger units the number of hired workers is ten times or more the number of family workers.

However, the number of days worked by family members roughly doubles from the smallest to the largest units (Table II-18a). The number of days worked by hired labor increases five-fold. And while family members work about twice as many days as hired workers on the smaller units, they work only 2/3 the number of days on the larger units. As a result, the number of worker-days is somewhat larger for family workers (less than 40) than for hired workers (less than 30) on the smaller units, but it is far smaller on the larger units (family 60 to 100, hired 900 to 1300). That is as one would expect. Presumably families operating more land participate in the work primarily to supervise and at peak seasons. They probably also have greater alternative opportunities for off-farm labor. But even if neither of these statements applies, family labor would be shown as working fewer days per hectare on the larger units since they need to spread their work over more hectares.

If one disaggregates by activity (Table II-17) one finds that plowing is somewhat different: the smallest units hire a good deal of plowing labor, presumably because they do not own bullocks and one cannot rent bullocks without the labor that accompanies it. For other operations the family usually supplies slightly more than one person for single sex operations (hoeing, planting) and more than 1-1/2 persons for the operations performed by both genders (weeding and harvesting), both regardless of size of operating unit. The number of days worked by family members does increase with size of unit, not quite doubling from the

smallest to the largest units. Actually the increase in number of days worked is greatest for hoeing, the most back-breaking of the tasks. It is small for harvesting, often carried out in one day. In other words, even for the larger units on Java/Bali family workers participate in all the work. Hired labor appears to be a residual in all cases, employed after the family has provided all the people it can of appropriate age and gender. Hired labor is especially significant for operations that have to be carried out quickly. Those with larger units may have slightly larger families, so provide more family labor, and they operate more plots, so they can spread their work over more days, but their labor supply function seems not to differ in other respects from those operating smaller units. Larger units hire more workers and have them work more days, to cover the work for which there is inadequate family labor.

On the Other Islands, the number of family workers is significantly greater than for Java/Bali, especially for larger units (Table II-15b). With land more readily available there appears to be a closer relationship between the number of family members available for work and the size of unit operated. The scarcity of hired labor compared to Java is another factor in the greater use of family labor. On the smaller units in the Other Islands only half as many hired workers are used as on Java, while for the units above one hectare, it is only one quarter. The number of days worked by hired workers ranges from one-half for the smaller units to two thirds for the larger in the Other Islands compared to Java. The shortage and cost of labor in most of the Other Islands makes for a larger ratio of family to hired labor and for a close

correlation between availability of family labor and larger operating units absent in Java.

The effect of size of agricultural unit on labor use can be seen more clearly in Tables II-18 on a person-days per hectare. These data are available only for three years so changes over time are difficult to discern, but for these years there is more detail available and the data are relatively unambiguous. Labor use is consistently inversely related to size of operating unit. This is wholly due to the decline in family labor-days. Hired labor days actually are slightly higher for units of 0.2 to 0.5 hectares than for smaller units and remain almost unchanged for larger units until one reaches the very largest (more than 2 ha), when they decline a bit. But family labor use for Java/Bali goes from nearly 200 worker-days to less than 40 per hectare as one moves to larger units. The pattern is the same for the Other Islands, although the absolute numbers are somewhat different.

The pattern of declining labor use with increasing size is what one would expect from the experience of other countries. Often the inverse correlation is due to the exclusion of land quality from the analysis. In India, for instance, the size of units, either owned or operated, is obviously larger in the Rajasthan desert than in the Ganges plain or the delta and more labor is used per hectare in the latter than in the former. Any correlation between size and labor intensity is meaningless in this comparison. The same problem of land quality, or fertility or productivity arises in all comparisons. We have attempted to compensate for it so some degree by using an "adjusted land size" variable which uses multiple cropping as an index of irrigation and land quality.

Moreover, our analysis deals with relatively homogeneous areas, especially on Java. The range of land quality is far narrower than in a country like India, especially since the analysis is limited to wet rice growers. Differences in rainfall are therefore of much less significance than in countries where labor use can vary greatly between areas with little assured rain and those with assured irrigation. Nevertheless an unknown proportion of the difference in labor use among units of different size is due to the inverse correlation between size of unit and quality of land.

Other factors in the greater use of labor by smaller units include:

(i) the difference in opportunity cost between family and hired labor. Family members can save on transport costs and inconvenience by working on family-owned land. Women can combine agricultural work with house work more readily. Also hiring labor requires cash, not needed to employ family members.

(ii) In addition to these reasons, which are "rational" in any strictly economic calculus, it is sometimes argued that additional family labor may be used "irrationally" if there is no careful attempt to compare returns of labor on the family farm with possible income if the same family members hired out. Most observers, however, think that poor cultivators rarely behave this way, because they really can not afford it.

(iii) Work on the family land also tends to be preferred to hiring out for reasons of prestige or status. These can be, at least in part, perfectly "rational," even if a family is concerned only with income, since status can affect ability to obtain credit and other economic arrangements. And, of course, most families desire status independent of income.

(iv) Job opportunities may be quite limited and uncertain off the family farm. That factor is closely related to opportunity cost. If some jobs for hired workers are, in effect, rationed and allocated as a joint product with other relationships then family members will have access to a limited amount of off-farm work at good pay and any additional work will be at much lower pay. The recorded wage is an average of the two, so the opportunity cost of working on the family farm may be far lower than the recorded wage.

(v) The quality of family labor is likely to be higher or its cost per unit of work lower than that of hired labor. Hired labor needs to be supervised, adding an unrecorded cost, and even so it may work less hard and conscientiously than most family labor.

(vi) Those operating smaller units have greater need of income and therefore a different attitude on the trade-off between leisure and income than wealthier households. Family members in families that operate little land may be willing to put in additional days even if the return is very low.

For all these reasons, and possibly others, the labor applied per hectare on the largest operating units (over 2 hectares or about 4-5 acres) is consistently almost half that of the smallest units (less than .2 ha or .45 acres) for Java/Bali and the Other Islands (Tables II-18). This inverse relationship between size and labor use is quite consistent throughout the size range and for pre-harvest as well as harvest labor.

The ratio is, in fact, greater for the Other Islands than for Java/Bali. That is because for the Other Islands the smallest units presumably located in the most densely populated areas, use almost as

much labor as in Java/Bali. The bigger units are generally in areas where labor is more expensive. They are probably also larger on the average in the open-ended ("above 2 ha") group. As a result they use almost 50% less labor than do the largest units on Java/Bali.

As previously noted, data for harvest labor are less reliable, but even for pre-harvest labor the the largest units on Java/Bali used 56% to 74% more labor in 1976-78 than did the smallest units. The increase in labor use holds true for all operations (Tables II-9).

Even discounting for unknown differences in land quality, it is clear that a very substantial increase in labor use accompanies declining size of operating units in agriculture. Therefore the increasing population pressure and resulting fragmentation of units is accompanied by an increasing ability of agriculture to absorb additional labor, although at declining productivity.

d) Total Employment: Surplus Labor

Unfortunately the Surveys provide no data on labor use by months. But the data do permit the inference that rice agriculture leaves a great deal of unemployed labor at most, or perhaps all, seasons of the year.

The average adjusted size of sample operating units is a bit over one hectare (ha) for Java/Bali and around 1.5 ha for the Other Islands. In that size range 224 person-days are used per hectare on Java/Bali and 181 on the Other Islands (Tables II-18), or around 250 person-days for both areas for the average operating unit. Units of this size report more than one family member each engaged in hoeing (male) and planting (female) (Tables II-17), so one can assume that they have about 2.5 family members available for work. Since the poorer families in rural areas work 7 days a week practically all year round (Hart, 1978), it is not unreasonable to assume that each person has 350 days a year available, or 875 person-days for the typical family of 2.5 members. With rice agriculture providing only 250 person-days of work, they would need to look for other work for more than two thirds of their time even if the family provided all labor for rice agriculture.

But in fact for Java/Bali the family provides only a bit over a fifth of the total labor, while for the Other Islands it is 75% or less (Tables II-18) in this size class. Especially for Java/Bali a small fraction of the "hired" labor may be provided on an exchange basis within the village, with a particular family working for a neighbor during a busy period and in turn employing the neighboring family during its busy time. If one assumes there is little exchange work in the Other Islands, then rice agriculture provides work for about 20% of available

Table II-19

LABOR DAYS PER HECTARE BY ACTIVITY AND FAMILY/HIRED LABOR

		Plowing	Hoeing	Planting	Weeding	Total Preharvest	Harvest	Total	Other Work
Java/Bali									
1976:	Family	3.3	28.2	9.6	25.4	66.6	15.7	82.3	17.4
	Hired	11.0	37.1	36.8	38.9	123.7	59.1	182.8	5.4
	Total	14.3	65.3	46.4	64.3	190.3	74.8	265.1	22.8
1977:	Family	3.1	25.9	9.6	24.5	63.1	15.5	78.6	15.0
	Hired	11.7	33.8	34.3	37.5	117.2	54.4	171.6	5.3
	Total	14.8	59.7	43.9	62.0	180.3	69.9	250.2	20.3
1978:	Family	2.3	21.7	7.9	20.7	52.6	12.3	64.9	16.5
	Hired	11.6	35.2	36.7	41.8	125.3	55.5	255.3	2.6
	Total	13.9	56.9	44.6	62.5	177.9	67.8	245.7	22.5
Other Islands									
1976:	Family	10.9	32.1	29.9	38.5	111.5	47.0	158.5	0.7
	Hired	5.1	8.1	11.1	9.1	33.4	21.8	55.2	0.4
	Total	16.0	40.2	41.0	47.6	144.9	68.8	213.7	1.1
1977:	Family	10.9	32.1	29.9	38.5	111.5	47.0	158.5	0.7
	Hired	5.1	8.1	11.1	9.1	33.4	21.8	55.2	0.4
	Total	16.0	40.2	41.0	47.6	144.9	68.8	213.7	1.1
1978:	Family	8.7	29.5	20.3	30.6	89.1	37.4	126.5	0.7
	Hired	7.0	9.6	15.7	12.9	45.3	27.7	73.0	0.6
	Total	15.7	39.1	36.0	43.5	134.4	65.1	199.5	1.1

family-days on the typical operating unit there. For Java/Bali, if work exchange doubles the number of days of work available in rice agriculture, it still provides only a bit more than 10% of available family labor-days. Since work exchange is not extensive, rice agriculture probably provides employment for closer to 5% of time.

Whatever the assumption, it is clear that rice agriculture, by far the predominant agricultural activity, provides employment to families operating the mean-sized unit for only a small fraction of the days they have available.

Of course, those operating smaller units have even fewer days of available work, although they use more labor per hectare and especially more family labor. For the smallest units on Java/Bali, total labor used is about 50% greater than for the average sized units and half to two thirds is provided by the family (Table II-17a). If one assumes that practically all "hired" labor is really provided on an exchange basis, one gets 300 plus person-days used per hectare, but since these units are only 0.2 ha or smaller they provide only about 50 days of labor or about 6% of the time available. Since only 10-15% of operating units exceed 2 ha on Java/Bali, and 20-25% on the Other Islands, most families operating rice land need to find other work for 90% or more of their time on Java/Bali and 80% on the Other Islands.

A small fraction of that work comes from other crops and from livestock. But these data confirm micro-studies which show rural families, especially in Java, continually searching for non-agricultural work, even though such activities as mat weaving, palm sugar production or fuel gathering produce very little income per hour worked.

d) Employment by Activity - Java vs. Other Islands

There are some interesting differences between Java/Bali and the Other Islands in the labor effort devoted to different activities. There is actually slightly more labor applied to plowing on the Other Islands, generally because plowing and hoeing are substitutes to a degree, and on the Other Islands with more costly labor the more capital intensive plowing is substituted for more labor intensive hoeing (Table II-19). In large part, as a result of this substitution, in part because land is less well prepared, about 30% less labor is devoted to hoeing on the Other Islands.

There appears to be only limited scope for reducing labor inputs in planting and harvesting, since the number of labor days for the Other Islands is generally only 10% less than for Java/Bali. This is particularly surprising for harvesting, since a shift from the hand-knife (ani-ani) to the sickle can sharply reduce labor needs. However, this technological change still seemed to have been adopted for only about one third of the plots, even in the Other Islands rice growing areas (see below). Weeding on the other hand can be done more or less frequently and carefully. Other Islands use about 30% less labor for this activity.

As previously noted there is a great difference in the relative importance of family and hired labor: almost three quarters of total labor is provided by the family for the Other Islands as against less than one third for Java/Bali. Hired labor is simply less readily available and more costly for the Other Islands.

Within Java/Bali there are some striking differences in the role of family labor in different activities. For the strenuous male activity of hoeing, family labor provides about 60% of the total while for planting,

carried out by women, the family provides less than a quarter of labor. For harvesting too the family's share is around one quarter of the total labor. Since harvesting provides more than a quarter of total labor, it provides nearly a third of all employment to hired workers, with the remainder shared about equally among hoeing, planting and weeding. So any reduction in hired labor used for harvesting could be quite serious.

f) Commercialization, Sickle Use and Employment

There has been a reference earlier to the contention that indeed labor use in harvesting is declining sharply as landlords shift from a traditional "open" harvest, with many workers each receiving a share of the amount harvested, to the employment of a few workers paid on a cash basis. Supposedly the shift is the result of the increased commercialization of rice agriculture, and of reduced social and political pressure to provide employment and is accompanied by a decreased use of the hand knife (ani-ani) and an increased use of the sickle. There is also evidence of a shift to the "kedokan" system, discussed earlier, which would tend to reduce the number of workers participating in the harvest. Some data have been provided earlier which tend to support, albeit to a slight degree, this contention: the small decline in the wage bill for harvesting (Table II-6) and in the number of workers hired for harvesting (Table II-16a).

The best evidence on the existence and importance of such a trend could be data on the use of the sickle as against the ani-ani. Unfortunately the Survey collected data on harvest method for only three years, early in the 1970s: 1972 to 1974. It is obviously risky to attempt to discern trends over such a short period, but one can analyze

what factors seem to affect sickle use and whether they are consistent with the hypothesis that this technology will have increased use.

Not only is the time series very short, it is also confused by the existence of a category labelled "other," which is ambiguous. Some harvesting may be done by machines, but surely not 3-4% of all plots on Java/Bali. But if both problems are ignored there is a distinct increase, of almost 40%, in the area harvested by sickle for Java/Bali from 1972 to 1974. However, even in 1974 the area so harvested remained a small proportion (16%) of the total (Table II-20).

As expected the sickle is used more widely on larger, more commercialized operating units and more in the Other Islands than Java. The use of the sickle and of "other" harvesting methods, primarily machinery, is twice as widespread on the Other Islands and covers more than one third of all plots. For Java/Bali, the sickle is used two to three times as often on high yielding varieties as on traditional ones; twice as frequently on the largest as on the smallest operating units; and is used about twice as frequently by those using more chemical fertilizer than average as by those using below average amounts of fertilizer. For the Other Islands the differences are similar with respect to fertilizer use and use of high yielding varieties: plots using the modern technology are about twice as likely to be harvested using the sickle, as those with more traditional technology. But for unexplained reasons, the larger the area operated (harvested) by a household, the less likely it is to use the sickle. Perhaps changes in labor organization are a factor.

(percent)

Categories	Java/Bali Sickle 72	73	74	Ani-ani 72	73	74	Other 72	73	74	Other Islands Sickle 72	73	74	Ani-ani 72	73	74	Other 72	73	74
All	11.7	14.9	16.3	83.3	82.9	80.7	5.0	2.2	3.0	24.1	37.8	32.4	65.3	58.1	62.4	10.6	4.0	5.2
Seed varieties																		
High yield	16	20	21	81	78	77	2	2	2	48	53	48	49	44	49	3	3	4
Traditional	7	7	8	84	92	89	8	2	3	17	31	26	68	65	69	15	4	6
Area harvested per household																		
-.2 ha	8	12	12	89	85	84	4	3	3	25	42	34	65	67	60	10	4	6
.2-.5 ha	12	12	16	83	86	81	5	2	3	31	45	38	61	54	56	8	4	5
.5-1.0 ha	12	17	15	83	81	82	5	2	3	25	37	31	66	52	65	10	4	4
1.0-2.0 ha	13	19	19	81	80	78	6	2	3	16	31	26	70	60	70	14	6	3
2 + ha	19	25	22	76	73	74	6	2	4	18	16	19	68	64	68	14	3	13
Quantity of fertilizer/ha																		
zero	9	7	11	79	90	83	12	3	6	16	27	21	72	69	73	12	5	7
0 to < mean	9	10	12	87	87	85	4	3	3	51	54	43	47	43	56	(2)	(3)	(1)
Mean to +1 SD	15	19	20	83	79	77	2	2	3	71	75	58	27	24	38	(1)	(1)	(4)
> mean +1 SD	13	22	21	86	76	77	2	2	3	93	70	74	(7)	28	22	0	(1)	(4)
				Actual Quantity of Fertilizer Used Per Plot														
	141	153	154	123	110	122	46	106	107	66	58	80	8	14	23	2	14	28

Table II-21

THE EFFECT OF HARVEST METHOD ON EMPLOYMENT AND THE WAGE BILL

(percent)

Number of family members harvesting/ha	Java/Bali									Other Islands								
	Sickle			Ani-ani			Others			Sickle			Ani-ani			Others		
	72	73	74	72	73	74	72	73	74	72	73	74	72	73	74	72	73	74
zero	19	27	32	77	70	65	4	2	3	25	41	35	65	53	53	10	6	7
0.01-4	10	14	13	84	84	84	6	2	3	31	36	28	61	61	68	8	3	4
4-6	10	10	10	85	89	88	5	2	3	25	42	33	66	54	61	10	5	6
6-12	10	11	11	85	87	87	6	3	3	16	39	36	70	57	60	14	4	5
12+	6	8	9	88	90	89	6	2	3	18	35	37	68	60	57	14	6	6

Number of hired workers harvesting/ha	Java/Bali									Other Islands								
	Sickle			Ani-ani			Others			Sickle			Ani-ani			Others		
	72	73	74	72	73	74	72	73	74	72	73	74	72	73	74	72	73	74
zero	7	9	11	76	85	85	17	6	5	20	37	33	65	59	60	16	4	6
0.1-12	20	24	27	68	72	68	12	4	5	28	43	32	65	54	64	7	3	4
12-40	15	19	20	82	78	77	4	3	4	28	41	38	66	54	56	6	5	6
40-80	15	16	16	85	83	82	3	1	2	25	17	18	71	76	79	(5)	(7)	(4)
80+	6	8	9	93	91	88	2	1	2	23	23	15	71	75	82	(6)	(2)	(4)

Note: parentheses indicate few observations.

It is therefore likely that as high yielding varieties spread and as more fertilizer is used, that is as commercialization of agriculture becomes more widespread, use of the sickle will continue to increase. If the size of operating unit decreased with population pressure that would, at least on Java/Bali, exert pressure in the opposite direction: to greater use of the ani-ani. But since fragmentation of land is a slow process and commercialization can move rather rapidly, one would expect the latter to dominate, and the shift from ani-ani to sickle to continue beyond 1974.

This could have serious consequences if it substantially reduces the work and income available to workers from participation in the harvest. Unfortunately the information on this issue is largely indirect and fragmentary. For Java/Bali it is reasonably clear cut that fewer harvest workers and the use of the sickle go together (Table II-21). The sickle is used on only 6-9% of the plots where a maximum of family members (12 or more) is available, but on three times as many plots where no family labor is used. Similarly, as the number of hired workers rises, the sickle is far less likely to be found.[1]

The number of days worked on the harvest and the use of the sickle are inversely related. The use of the sickle is three times as great when 2 or fewer days are used for harvesting than where there is work for 20 or more days. Similarly, the wage bill for harvesting and use of the sickle are inversely correlated.[2] For the Other Islands the relationships tend to be similar, but are often less clear cut.

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[1] The category of zero hired labor shows a relatively low use of the sickle, but that is because these are the plots where a great deal of family labor is employed.

[2] Again with the exception of those who hire no labor.

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Table II-22

THE EFFECT OF HARVEST METHOD ON LABOR USE: MEANS FOR JAVA/BALI

	1972	1973	1974	1972	1973	1974	1972	1973	1974
	Sickle			Ani-Ani			Other		
Number of family workers	1.1	1.2	1.1	1.9	1.9	1.9	1.6	1.8	1.6
Number of hired workers	2.3	2.4	2.3	2.6	2.7	2.6	2.2	1.9	2.2
Number of days worked	7.2	6.4	7.2	9.5	9.0	9.5	10.0	11.2	10.0

Table II-23

WAGE BILL AND HARVEST METHOD
(mean bill per plot in Rp)

	Java/Bali			Other Islands		
	Sickle	Ani-ani	Other	Sickle	Ani-ani	Other
1972	6,007	6,394	2,894	3,265	2,817	1,085
1973	8,772	8,835	4,473	4,801	3,729	4,124
1974	9,648	9,764	7,270	4,835	4,530	2,874

Note: For Other Islands Standard Deviations are high and reliability is low.

Table II-22 summarises the relationship between the use of the sickle and of labor. Quite consistently there is less labor, and especially family labor, used with the sickle than the handknife.

The best indication of the consequence for labor income of a shift from ani-ani to sickle is the difference in the wages paid harvesters. This turns out to be as expected: greater for the ani-ani, but the differences are generally not at all significant: about 1% in two of the three years. This is difficult to explain, since the whole purpose of shifting to the sickle is presumed to be a substantial increase in landowner income at the cost of harvest labor income. This strange result could be due to bias, if informants report the same labor share for harvesting done by sickle and ani-ani, regardless of the true situation. The sample is very large, however, so one would have to assume widespread and consistent error. Another possible explanation could be that as use of the sickle was increased, landlords did not reduce the wage paid in line with reduced harvest work, but instead increased other unpaid work expected from the same persons. That is, the harvest wage remained nominally unchanged but now compensated workers for additional work done in planting or weeding. Third, it could be that landlords reduced the traditional harvest share only slowly and in fact continued to pay as much as before to harvest labor. Fourth, it appears (Table II-22)that the reduction was principally in family labor, which would have no effect on the hired labor wage bill. Fifth, the units using more fertilizer and high yielding varieties presumably had higher yields. Therefore a lower share of a greater total harvest could give harvest workers the same absolute wage bill as a greater share of a

Table 11-24

LABOR DAYS PER HECTARE BY ACTIVITY AND SEED VARIETY

	Plowing	Hoeing	Planting	Weeding	Total Preharvest	Harvest	Total	Other
Java/Bali								
1976: Modern	15.0	63.3	47.2	66.0	191.5	76.4	267.9	26.6
Local	12.6	69.9	44.3	60.2	187.0	73.8	260.8	20.5
Average	14.3	65.3	46.4	64.3	190.3	75.6	265.9	24.8
F	(28.5)	(22.4)	(14.1)	(24.6)		(1.7)		(5.7)
1977: Modern	15.3	56.3	45.0	62.2	178.8	69.4	248.2	20.0
Local	13.4	68.0	41.4	61.5	184.3	74.8	259.1	24.1
Average	14.8	59.7	43.9	62.0	180.4	71.0	251.4	21.2
F	(14.9)	(84.5)	(20.9)	(0.3)		(5.5)		(3.8)
1978: Modern	14.5	54.5	45.0	62.2	176.2	67.4	243.6	24.2
Local	14.0	63.8	43.0	63.3	184.1	71.2	255.3	20.6
Average	114.4	56.8	44.6	62.5	178.3	68.4	246.7	23.5
F	(1.3)	(60.3)	(8.0)	(0.8)		(3.9)		
Other Islands								
1976: Modern	16.9	47.6	35.5	41.7	135.7	33.3	189.0	7.4
Local	15.6	39.3	45.1	51.9	151.9	83.3	235.2	15.5
Average	15.1	40.2	41.1	47.6	145.0	70.6	215.6	12.0
F	(0.6)	(1.0)	24.9	(19.7)		(18.3)		(4.1)
1977: Modern	13.1	38.0	32.0	39.3	122.50	46..0	168.5	9.0
Local	14.9	47.5	45.7	54.6	162.70	73.5	236.2	19.5
Average	14.2	43.3	37.7	47.8	145.00	61.2	206.2	14.9
F	(4.2)	(11.8)	(61.3)	(48.7)		(29.3)		(4.1)
1978: Modern	15.9	39.3	32.7	43.4	131.3	57.8	189.1	8.3
Local	15.8	38.9	39.5	43.8	138.0	74.0	212.0	14.1
Average	15.8	39.1	36.0	43.8	134.5	64.5	199.0	11.1
F	0	(0)	(13.1)	(0)		(3.8)		(3.8)

smaller harvest. Finally, changes in labor organization, under which workers are compensated at harvest time for work done previously, could be a major factor.

More likely some combination of all six explanations describes what happened. As a result there may be less of an impact than feared on labor income from the shift which seems to be taking place from harvesting with the ani-ani to harvesting with a sickle. Nevertheless with commercialization there appears to be a shift to a technology which requires less labor and which, with some lag, is likely to reduce labor income.

There is a far closer relationship between the use of er" methods of harvesting and labor use/labor compensation. Presumably "other" methods involve primarily or exclusively the use of machinery. Total labor compensation for these methods is substantially less than for either sickle or ani-ani (Table II-23) as one would expect. There is also a sharp inverse relationship between the number of hired workers and the use of "other" harvest methods, but this is a less clear cut indication of low labor use than the relationship to the total wage bills. Machines are used for harvesting, primarily on large (above 2 ha) units on the Other Islands (Tables II-21 and 22) as one would expect. As a result labor use and the wage bill are far less per hectare than on smaller units in Java.

g) Seed Varieties and Labor Use

It would obviously be very valuable if data were available beyond 1974 for the relative role of sickle and ani-ani in harvesting. For the more recent years one can relate labor use to a variety of other factors and it would have been useful if it were possible to analyze as well this

important aspect of employment. But data on harvest methods were not collected after 1974.

Another important factor in labor use, it has been widely assumed, was the shift to modern seed varieties. Surprisingly it apparently did not affect labor use in Java/Bali. One might expect that modern seed varieties would, on the one hand, involve more labor because they yield greater returns to better land preparation, more fertilizers and pesticides, and more careful planting and weeding. In addition the higher yields should also require more labor. On the other hand they might be accompanied by greater commercialization and a shift to a less labor intensive technology, especially in harvesting. The net effect of these two tendencies might cancel. Indeed over the three years for which data on labor-days are available it is difficult to discern any clear difference in a simple comparison of seed varieties. Modern varieties seem to involve more days in plowing, but fewer in hoeing, perhaps more in weeding and "other," and fewer in harvesting. But the differences are neither large nor consistent for all three years.

For the Other Islands, however, the local varieties clearly and consistently involve more labor, in one year by as much as 40%. Except for land preparation the difference is quite consistent for all years and activities. It is not clear why this should be so, but it may have to do with the size of unit using the different varieties.

All of these data are on a per crop basis. Modern varieties, with a shorter growing season, can permit increased multiple cropping of rice, with a consequent increase in labor use. This issue was addressed earlier.

In order to analyze interrelated variables in employment, it is obviously better to move beyond simple cross-tabulation to multiple regression. That is the subject of the next section.

g) Factors in labor use -- regression analysis

A variety of factors that might be expected to affect labor use can now be summarized and their relationship explored in a set of regressions for the different labor operations. Despite the noise in the data, the results are very largely what one would expect.

The basic regressions, shown in Tables 17, are the primary source for the following discussion. The R^2 in these regressions are quite low, ranging from 0.13 to 0.36 for different operations and regressions. Clearly they explain only a fraction of the variance. The principal omitted variables or variables which are inadequately represented, in rough order of importance, are probably:

(a) quality of land: the double cropping variable is primarily a proxy for irrigation, but is far from fully capturing the inherent productivity of land. Presumably the more fertile the land the more labor it can efficiently use.

(b) other elements in total factor productivity or efficiency: differences in management, in labor quality and in cost of capital all affect the (marginal) productivity of labor and therefore the magnitude of profitable labor use. We have no direct information on these variables. We are not even able to distinguish male from female labor and adult from child labor.

(c) the number of family members available per hectare operated: if the opportunity cost of family labor is less than the cost of hired labor, as discussed earlier, then the more family members are available the more labor will be used. We have an estimate of the family members actually employed on different operations. This is unadjusted for age and sex. More important, we do not know how many family members are

available for agricultural work. A family member who is available full time to work on the family farm shows up as one person, but so does another family member who can work only day a week.

Of course, these omitted variables do not affect the predictive and analytical value of the included variables if the two sets are not correlated. That is, we can draw conclusions about the effect on employment of wage changes over time, or of increased fertilizer use, or of other changes in analysed variables if variations among farms with respect to excluded factors cancel out.

(i) The real wage is inversely related to the number of worker days for every operation. In all cases the relationship is highly significant. This is as one would expect. With a coefficient averaging around 0.3 every percent difference in the wage results in a roughly one-third of a percent decline in total labor used, quite a powerful effect.

The implied elasticity would mean that the total real wage bill rises with the wage rate, if the proportion of family labor does not change. That is, workers as a group would be better off with a rise in real wages, because employment in rice agriculture declines by only 3% for every 10% increase in wages. But if a rising wage leads to the substitution of family labor for hired workers, as it well might, the wage bill could decline when the wage rate rises.

On Java/Bali about half the labor is provided by family members (see Table 15a) and for the Other Islands it is more than three quarters

Table II-25a

LABOR USE REGRESSIONS - JAVA/BALI

(Dependent variable: number of person-days per hectare*)

Indep't. Vars.	Inter.	Real Wage*	No. Fam. Wkrs.	Size of Oper.*	Quant. Chem. Fert.	Other Non-lab. Inputs *	Seed Var.+	Dbl. Crop.+	Damage+	Yield*	1977+	1978+	R^2
PLOWING													
Coeff.	3.18	-0.45	0.24	-0.14	0.00059	0.026	0.02	0.10	---	---	-0.20	-0.09	0.23
t-stat.	(23.4)	(-33.7)	(15.9)	(-9.7)	(5.5)	(1.9)	(0.9)	(5.6)	---	---	(-7.6)	(-3.6)	
HOEING													
Coeff.	4.6	-0.23	0.15	-0.038	0.00089	-0.088	-0.17	0.21	---	---	0.029	0.027	0.16
t-stat.	(40.6)	(-15.1)	(20.8)	(-2.7)	(9.3)	(-7.4)	(-8.7)	(12.3)	---	---	(1.3)	(1.2)	
PLANTING													
Coeff.	3.80	-0.36	0.053	-0.063	0.00076	-0.012	0.095	0.026	---	---	0.0044	0.045	0.20
t-stat.	(48.0)	(-34.6)	(12.4)	(-6.6)	(11.2)	(-1.5)	(6.7)	(2.2)	---	---	(0.3)	(2.9)	
WEEDING													
Coeff.	4.03	-0.26	0.087	-0.039	0.00084	-0.034	0.052	0.15	0.00032	---	0.071	0.11	0.13
t-stat.	(39.2)	(-19.9)	(16.2)	(-3.2)	(9.7)	(-3.2)	(2.9)	(10.0)	(0.0)	---	(3.4)	(5.7)	
HARVESTING (a)													
Coeff.	4.31	-0.13	0.023	-0.14	0.00089	-0.052	-0.032	0.17	0.11	---	-0.001	-0.029	0.06
t-stat.	(33.5)	(-6.2)	(5.3)	(-9.7)	(8.3)	(-3.9)	(-1.4)	(8.8)	(5.9)	---	(0.0)	(-1.2)	
HARVESTING (b)													
Coeff.	1.64	-0.20	0.026	-0.091	0.0004	-0.082	-0.079	0.12	-0.11	0.41	0.11	0.051	0.15
t-stat.	(10.3)	(-10.2)	(6.4)	(-6.5)	(3.8)	(-6.5)	(-3.7)	(6.5)	(-5.8)	(26.4)	(4.3)	(2.2)	

* In log form

\+ Dummy variable

Table II-25b

LABOR USE REGRESSIONS - OTHER ISLANDS

(Dependent variable: number of person-days per hectare*)

Indep't Vars.	Inter.	Real Wage*	No. Fam. Wkrs.	Size of Oper.*	Quant. Chem. Fert.	Other Non-lab. Inputs*	Seed Var.+	Dbl. Crop.+	Damage	Yield*	1977+	1978+	R^2
PLOWING													
Coeff.	3.61	-0.33	0.11	-0.18	-0.00015	-0.01	-0.14	0.083	---	---	0.32	0.26	0.24
t-stat.	(5.5)	(-5.6)	(1.5)	(-3.0)	(-0.3)	(0.1)	(-1.5)	(0.9)	---	---	(2.5)	(2.3)	
HOEING													
Coeff.	4.43	-0.21	0.13	-0.059	0.0018	-0.11	-0.045	0.15	---	---	0.092	-0.14	0.18
t-stat.	(7.2)	(-2.8)	(4.9)	(-0.9)	(3.4)	(-1.6)	(-0.5)	(1.8)	---	---	(0.8)	(-1.2)	
PLANTING													
Coeff.	3.70	-0.29	0.13	-0.03	0.0014	-0.055	0.074	0.0097	---	---	0.12	0.084	0.27
t-stat.	(10.9)	(-6.1)	(7.2)	(-0.8)	(4.7)	(-1.5)	(1.4)	(0.2)	---	---	(1.6)	(1.2)	
WEEDING													
Coeff.	4.80	-0·47	0·16	0·0076	0.0022	-0.095	-0.047	0.071	-0.29	---	-0.11	-0.081	0.36
t-stat.	(11.4)	(-8.3)	(6·4)	(0.2)	(6.0)	(-2.1)	(-0.68)	(1.1)	(-5.0)	---	(-1.3)	(-1.0)	
HARVESTING (a)													
Coeff.	3.72	-0·22	0·066	-0·12	0·00055	0.022	-0.12	-0.10	-0.083	---	-0.093	0.065	0.12
t-stat.	(7.6)	(-3·1)	(3.3)	(-2·2)	(1·3)	(0.4)	(-1.5)	(-1.5)	(-1.3)	---	(-0.9)	(0.7)	
HARVESTING (b)													
Coeff.	1.58	-0·29	0·07	-0·13	-0·00023	0.0087	-0.14	-0.12	-0.21	0.32	0.0002	0.19	0.19
t-stat.	(2.6)	(-4.0)	(3.6)	(-2·4)	(-0·5)	(0.2)	(-1.8)	(-1.7)	(-3.1)	(5.4)	(0.0)	(2.0)	

* In log form

\+ Dummy variable

(Table 15b). Since hired labor is treated largely as the residual, the effect of wage changes on employment of hired labor would be more dramatic than on total labor. Stagnant agricultural wages in the 1970's have therefore played a major role in facilitating the continued absorption of labor in agriculture. The opposite is presumably also true: the need to absorb large numbers of the new entrants into the labor force in agriculture has resulted in stagnating wages.

The consistently negative, and statistically significant, relationship between real wages and employment also suggests that even for Java economic factors play a major role in employment decisions. The Javanese cultivator, like his conterparts elsewhere, does pay attention to labor costs, not just to traditional obligations to hire labor.

(ii) Family labor and size of operating unit are related and greatly affect total labor use, as discussed earlier. The number of family members, normalized for size of operating unit, participating in each operation is consistently and significantly positively related to total labor use. Earlier we discussed reasons why a larger number of family members available per hectare is likely to lead to greater labor use: primarily the lower opportunity cost of family, as against hired, labor. There is no need to repeat these arguments. The relationship between the number of family members and total labor is strongly in evidence in multiple regressions for both Java/Bali and Other Islands.

The smaller the (adjusted) size of operating unit, the larger the number of family members likely to be available per plot and the more working days they will be able to devote to each plot. The number of

family members working on each operation (normalized for size of unit) is a separate variable, but we have no data on the number of days they have available. As indicated earlier (Tables 17) the number of family members per hectare varies less with size of operating unit than the number of days worked. That is as one might expect: even if a family operates 3 hectares, some male family member is likely to participate in hoeing and some female member in planting, but they are likely to spend fewer days than in a family that operates only a half-hectare unit. Since size of operating units and family-labor-days are inversely related, size of operating unit serves as a proxy for family- labor-days. For that reason and because larger units may have somewhat less productive land despite our attempt to adjust for this, and possibly because there are genuine economies of scale, an inverse relationship exists between size of operating unit and labor use. This relationship remains in the regression even when it includes as other explanatory variables both the number of family members and double cropping, the latter as a proxy for land quality and the presence of irrigation. However, while it is statistically significant for Java, for the Other Islands it is significant only for plowing and harvesting. Since the number of family members and farm size are strongly inversely related (the correlation coefficients range between -0.37 and -0.52) one would expect that the inclusion of a separate variable for number of family members would reduce the significance of the relationship between size of operating unit and the labor used. That it remains generally significant suggests that factors other than the availability of family labor play a role in greater labor use by smaller units.

LABOR USE REGRESSIONS - JAVA/BALI

(Dependent variable: number of person-days per hectare*)

Indept. Vars.	Inter.	Real Wage*	No. Fam. Wkrs.	Size of Oper.*	Quant. Chem. Fert.	Other Non-lab. Inputs	Seed Var.+	Dbl. Crop.+	Damage+	Yield*	Plot* Area	1977+	1978+	R^2
PLOWING														
Coeff.	2.70	-0.44	0.24	0.18	0.00053	0.0045	0.033	-0.015	---	---	-0.35	-0.20	-0.085	0.24
t-stat.	(18.3)	(-32.9)	(16.1)	(4.4)	(4.9)	(3.2)	(1.9)	(-0.6)	---	---	(-8.3)	(-7.7)	(-3.5)	
HOEING														
Coeff.	4.41	-0.23	0.15	0.086	0.00086	-0.080	-0.17	0.16	---	---	-0.14	0.028	0.028	0.16
t-stat.	(35.7)	(-14.8)	(20.8)	(2.4)	(9.0)	(-6.7)	(-8.5)	(7.6)	---	---	(-3.8)	(1.2)	(1.3)	
PLANTING														
Coeff.	3.68	-0.36	0.053	0.021	0.00074	-0.0077	0.098	-0.006	---	---	-0.093	0.0036	0.046	0.02
t-stat.	(42.6)	(-34.3)	(12.3)	(0.8)	(10.9)	(-0.9)	(6.9)	(-0.4)	---	---	(-3.5)	(0.2)	(3.0)	
WEEDING														
Coeff.	3.92	-0.26	0.087	0.036	0.00083	-0.03	0.055	0.12	-0.0001	---	-0.083	0.071	0.11	0.13
t-stat.	(35.1)	(-19.8)	(16.1)	(1.1)	(9.5)	(-2.8)	(3.0)	(6.4)	(-0.07)	---	(-2.4)	(3.4)	(5.7)	
HARVESTING (a)														
Coeff.	4.21	-0.12	0.023	-0.077	0.00087	-0.048	-0.30	0.14	0.11	---	-0.073	-0.0013	-0.027	0.07
t-stat.	(30.1)	(-6.1)	(5.2)	(-1.9)	(8.2)	(-3.6)	(-1.3)	(6.0)	(5.8)	---	(-1.8)	(-0.1)	(-1.1)	
HARVESTING (b)														
Coeff.	1.54	-0.20	0.026	-0.027	0.00038	-0.079	-0.077	0.091	-0.11	0.41	-0.072	0.11	0.052	0.15
t-stat.	(9.2)	(-10.0)	(6.4)	(-0.7)	(3.7)	(-6.1)	(-3.6)	(4.1)	(-5.8)	(26.4)	(1.8)	(4.2)	(2.2)	

*In log form.

+Dummy variable.

However, when plot size is introduced as a separate variable (Tables 26), the variable for size of operating unit changes sign and becomes positively correlated with labor use, for all operations on Java/Bali except for harvesting, although is is statistically significant only for plowing and hoeing. For the Other Islands the size of operating unit is positively correlated with labor use only for hoeing and planting, but the relationship is not statistically significant. However, the correlation between size of operating unit and size of plot is generally 0.9 or higher. Of course, as a result plot size is also strongly and negatively correlated with labor use and seems to pick up most of the negative relationship between both size of operating unit and plot size with labor use. But analytically it is more likely that the size of operating unit, rather than the size of plot, affects labor use. Plot size could reduce labor use because there may be some economies of scale. But it seems implausible that these economies, primarily turn-around time at the plot boundaries, are great enough to reduce labor use by 7% to 35% when plot size doubles, as the coefficients for Java/Bali indicate. What is more plausible is that three factors are most significant in the negative correlation of both size of operating unit and plot size with labor use:

(i) the larger size of both operating unit and plot in areas of inherently lower land productivity or fertility, with fertility inadequately captured by the double cropping variable.

(ii) the greater availability and lower perceived and actual opportunity cost of family labor days on smaller units, imperfectly captured by the variable for the number of family members.

(iii) economies of scale which may exist for either operating units or plots or both.

Given the information available there is no good basis for distinguishing the importance of these effects, nor to determine whether they are related primarily to plot or operating unit size.

But it is clear that for one or more reasons the smaller units with more family members available provide more total employment. Therefore if population pressure increases in the rural areas, more labor can be and will be absorbed as operating units shrink and more family members become available for work.

Conversely, if there is any tendency for the formation of larger units, as some small holders lose their land, employment will decline. More serious is another conclusion stressed before: hired labor is apparantly treated very much as a residual; the more family members are available the fewer workers are hired. If the rapidly increasing population cannot find better paid employment outside agriculture, an increasing number of family members will indeed become available for work on many agricultural holdings. Hired workers will then find even fewer days of work than now. They would compete even more fiercely for the remaining work in agriculture and will inexorably be pushed into non-agricultural work with low pay and productivity: gathering wood, paper and cigarette butts, petty trade, bicycle rickshaw driving and so on.

(iii) <u>The effect of increased use of inputs -- fertilizer, seeds, irrigation, machinery, etc.</u> -- might be to increase or to reduce the need for labor. On the one hand fertilizer, high yielding seeds and

irrigation water can require additional work to use and can justify additional labor for more careful land preparation, planting and weeding, since the marginal product will rise. On the other hand, their use implies increased commercialization of agriculture and with it a decreased willingness to use any labor whose cost exceed its marginal product. In "traditional" agriculture excess labor may be used for other, "traditional," reasons. And, of course, some inputs are not complementary to labor but are substitutes, notably machinery and bullocks. Finally areas with less fertile land which tend to use less of such inputs as fertilizer also are areas with less opportunity for off-farm employment. Therefore they may use more family labor in rice agriculture. The result would be a, non-causal, inverse relationship between labor use and commercial inputs. Given these offsetting tendencies, the regression analysis shows the expected mixed effects.

The increased use of chemical fertilizers is consistently accompanied by increased use of labor (except for harvest labor in the Other Islands, when, and only when, yield is introduced as a separate variable). Whatever the relationship of chemical fertilizer use to commercialisation and of commercialisation to lower employment -- if any -- the positive effects of greater fertilizer use outweigh them. But the effect on employment is, unfortunately, not likely to be great. First, on Java/Bali average fertiliser use is already close to 200 kg/ha, against a recommended 250 kg/ha. So there is limited scope for increased fertiliser use. Second, a coefficient averaging 0.0008 implies a negligible increase in labor use even if the average application of

fertiliser increases by 50 kg/ha*, so the effect on employment of greater fertiliser use is likely to be negligible.

Other non-labor inputs include primarily other fertilizer (animal and green manure) pesticides, and bullock use. Their effect might be expected to differ for different operations. Indeed for plowing the relationship for Java/Bali is (significantly) positive, for hoeing it is negative. For plowing the more bullock power is used, the more labor is required. Greater use of non-chemical fertilizers could also increase the task of land preparation. For both reasons a positive corelation between inputs (other than labor and chemical fertilizer) and employment in plowing is logical and is found for Java/Bali (for the Other Islands the relationship is statistically not significant). On the other hand hoeing, since these are to a degree substitutes. In fact, the relationship between other non-labor inputs and hoeing is, as expected, negative and significant for Java/Bali (negative but not significant for the Other Islands).

For other operations the variable also generally has a negative coefficient and tends to be significant. Here again, increasing use of machinery, and herbicides raises ominous prospects for future labor demand.

Modern, high yielding seeds are like chemical fertilizer in their potential for raising labor use because it pays to have more careful land preparation, planting and weeding, but they may also be accompanied by increased commercialization. In fact, the relationship differs for

*Labor days, the dependent variable, is in log form, while fertiliser use is in kg, not logged.

different operations. For planting, weeding (both statistically significant) and plowing on Java/Bali and planting on the Other Islands there is greater labor use with the high yielding varieties. These operations appear to be carried out with greater care. Hoeing and harvesting, on the other hand, involve fewer person-days with high yielding, than with traditional, varieties. The negative relationship is statistically significant (for Java/Bali and approaches significance for harvesting for the Other Islands) when yield is included in the harvesting regression.

The most reasonable explanation for these relationships is probably as follows. For Java/Bali where labor is inexpensive, especially when the relevant cost is the opportunity cost of family labor, it pays to devote more labor to land preparation, careful planting and weeding for the more productive High Yielding Varieties (HYV). However, with more effort on plowing, there is less need for hoeing later. As for harvesting, there may already be labor employed than needed to bring in the crop. So the return to the land owner, does not necessarily increase if more labor is used on plots with HYV. However, the more commercially oriented land owners who have adopted HYV also use less labor intensive methods (e.g., sickles, see Table II-20). So for harvesting, HYV and labor use are negatively correlated per unit of output. But since HYV give higher output, this negative relationship is muted when yields are not taken into account. When yield is introduced as a separate variable, the coefficient of labor use more than doubles and so does the measure of significance.

For the Other Islands labor is more expensive, particularly when account is taken of the likelihood that most additional labor will be hired, since family labor is probably fully utilised. (Table 18b) Therefore it apparently does not pay for most operations to add labor when high yielding varieties are employed. The only exception is planting, probably because more careful planting yields enough of a return to warrant additional labor cost. For most operations there is no statistically significant relationship between seed varieties and labor use. For harvesting the negative relationship comes closest to significance, probably for reasons similar to those discussed above with respect to Java/Bali.

Table 27 shows the significance for employment of increasing use of HYV on Java/Bali. The number of labor days used for different operations (Table II-23) is multiplied by the coefficient for that operation (percent) in all cases where reasonable statistical significance is indicated by a t-statistic of at least 1.4. For harvesting we used the regression which does not include yields since we are concerned with the effect of HYV on labor use including the effect of the increase in yields which results from HYV.

Table II-27

The Effect on Labor Use of a Shift to HYV Seeds

	No. of Days	Coefficient	Change in Labor Use
Plowing	14.3	Not significant	----
Hoeing	65.3	-0.17	-11.1
Planting	46.4	0.095	4.4
Weeding	64.3	0.052	-3.3
Harvesting	75.6	-0.032	-2.4
Total/Net Effect	(265.9)		-5.8

The implication for the future is that as commercialisation proceeds, accompanied by the near universal adoption of high yielding varieties, labor use on Java/Bali is likely to decline. For every hectare shifting from traditional to HYV seeds, labor use is estimated to decline by nearly 6 person-days or 2.2%. However, since about three quarters of plots have already shifted to these seeds, further shifts are likely to have only a limited impact.

The double-cropping dummy is used in part as a proxy for irrigation. One would expect that double cropped land, generally irrigated and more fertile, uses more labor. The coefficient is indeed positive and significant for all operations on Java/Bali. It is also positive, although not significant, for the Other Islands except for harvesting. We have no very good explanation for the aberrations for harvesting for the Other Islands.

However, the negative correlation is not statistically significant and may be due in part to the correlation of double cropping with other variables that reduce harvest labor use. (correlation coefficients of 0.35 with HYV seeds). But the main conclusion stands: with the spread of irrigation labor use is likely to increase, perhaps by about 10%, given the typical coefficient.

For all non-labor inputs combined one can conclude that the spread of fertilizer and irrigation tends to increase labor use, that of machinery and high yielding varieties to decrease it slightly. In one sense these are not very startling results, to be sure. However, they provide some basis for speculating on the total impact of inputs on labor use. Taking account of the compensating effects of different non-labor inputs and of the relatively low coefficients for these variables one can conclude that increased commercialisation and development may not have much of an effect on labor

use. There remains limited scope for increasing the use of high yielding varieties and of fertiliser on Java/Bali, if one takes account of the extent to which they have already been adopted. On the other hand irrigation still has a good deal of scope on these islands. The speed and scope of mechanisation, and especially of hand tractors, is unknown. One can therefore speculate that as the use of modern inputs spreads the impact on employment will not be very great.

(iv) Crop damage and yields could affect labor use, at least in harvesting. In some years and in some areas the rice crop has suffered severe damage from the brown plant hopper (wereng). A dummy variable distinguishes damaged plots from those not damaged. One would expect this variable to have most of its effect on labor used in the harvest and, to a lesser extent, on operations late in the crop cycle, such as weeding. After all, at the time of

Table II-28

Means of Selected Variables in Labor Use Regressions:

Rice Plots Only

	Java/Bali	Other Islands
% with high yielding varieties	73%	46%
% double cropping	38%	73%
Kilograms of fertiliser	186	67

plowing there usually is no way of knowing whether there will be any damage to the crop and, if so, how much. So there should be little effect on the early operations: plowing, hoeing, and planting. Early

operations could be affected only if cultivators respond to damage or lack of damage to the fields of neighbors who planted earlier.

Harvest labor would be reduced by any decline in yields, not just the decline due to crop damage. For this operation therefore yield has been introduced as a separate variable. The introduction of yield as a separate variable should reduce or eliminate the significance of the damage variable and might affect other variables.

Since damage takes a value of zero and no damage takes 1 in the regression, one would expect a positive correlation if damage reduces labor use. In the basic regressions (Tables 25) the expected correlation exists for harvest labor on Java/Bali when yield is not a separate variable. But when yield is added the coefficient changes sign. (Both results statistically significant.) These results are not unreasonable. They suggest that when yields drop as a result of crop damage, less labor is used. But the reduction in labor use is less than the reduction in yields. Presumably some cultivators devote extra labor to get all the rice harvested to compensate in part for lower yields. Others can not fully adjust their labor to the lower yields because there is little flexibility in family labor and even for some hired labor flexibility is limited by traditional arrangements or arrangements made before the extent of damage is known. So for Java/Bali the effect of damage on harvesting is quite reasonable. For weeding, there is no significant relationship. That too can be readily explained: at the time of weeding damage could not be foreseen.

For the Other Islands the comparable regressions show damaged plots to use more labor in weeding and in harvesting than undamaged plots. The relationship is significant for weeding and for harvesting with yields

included in the regression and not quite significant if yields are excluded. For harvesting with yields as a separate variable this result is consistent with those for Java/Bali and presumably has the same explanation. But for weeding and harvesting with yields excluded, it is difficult to explain why damaged plots would use more labor. One could provide a rationale for these results: when damage is threatened or has occurred, cultivators attempt to counteract it and to salvage what they can by greater labor effort. But this effect does not exist on Java/Bali, where labor is cheaper and family labor more readily available, so why should it exist for the higher cost labor of the Other Islands? Better to admit that we have no good explanation for the effect of damage on the Other Islands.

The effect of yield is quite unequivocal. In all harvest regressions as yield increases so does labor. In the basic regression (Tables 25) coefficients are 0.4 for Java/.Bali and 0.3 for the Other Islands. They indicate that as yields rise over time, demand for hired labor, which is about one third of total labor, will rise quite substantially, especially in labor abundant Java/Bali.

(vi) Differences among the three years exist. While they are not consistent for the different operations, labor use seems to have been generally higher in the later years. Note that yields were high in 1976, the base year for the comparison, lower in 1977 and in between in 1978 (see Table I-8).

Only plowing used significantly less labor in Java/Bali in 1977 and 1978 than in 1976. It is possible that lower rainfall -- one possible reason for lower yields -- in the later years discouraged some landholders from incurring the cost of hiring bullocks for plowing.

Labor used in other operations on Java/Bali is generally higher in the later years, when yields were less, and the difference is generally statis- tically significant. It may be that this extra effort, particularly in weeding, represented an attempt to compensate for less favorable circumstances. For harvesting when yield is included as a variable, the partial adjustment for lower yields, discussed earlier, would explain the higher labor use. The contrast is striking with lower labor use when yield is ignored.

For the Other Islands yields declined much less in 1977 and 1978 compared to 1976. The dummy variables for the later years tend not to be statistically significant. The only significant variables for the Other Islands are for plowing and harvest labor in 1978, when yields are introduced as a variable. The Other Islands do not have much labor with a low opportunity cost as does Java/Bali. Most cultivators there are also less desperate to make up for bad weather or pests by increased labor effort. This is speculation, but it does provide a logical, even if not necessarily correct, explanation for extra work during bad years on Java/Bali and no extra work during less bad years for the Other Islands.

(vii) Summarising the regression results one needs to stress that much of the variance in employment remains unexplained. Moreover, there undoubtedly is a lot of noise in the regression analysis, there are some discrepancies in the results and the coefficients are not firm. But several quite firm conclusions are warranted, although the numbers

associated with them are not firm at all. First, several factors tend to increase labor use:[1]

-- rising yields. A 10% increase of yields apparantly raises harvest labor by 4%

-- expanding irrigation or multiple cropping. Multiple cropped land (has a coefficient which suggests it) uses about 15% more labor per crop than single cropped

-- increasing availability of family labor. An increase of one family member per hectare apparently increases labor use by about 5%

-- a reduction in average size of operating unit or plot results in increased labor use of about 7%.

-- a declining real wage would have the greatest consequence, raising employment by nearly 30% of the decline.

It is not desirable to further reduce the size of already small operating units (or plots), nor to increase the number of family members per hectare, since their productivity is already low. And it certainly is not desirable to decrease the real wage. So the only desirable means for increasing labor in rice agriculture are to expand irrigration and to raise yields. But their effect is rather limited. It is unlikely that yields can be raised by more than 4% a year, which should increase harvest labor by 1.6%. Since harvest labor is roughly one third of all labor, total labor would rise only 0.5%. If double cropping, now above 50% on Java/Bali were to increase by 2% a year, the past trend, total labor used would rise 0.3% (2% of the land x 15% increase in labor.

[1]Figures are for Java/Bali only, and are roughly weighted averages of coefficients for different operations weighted by labor days for each operation.

labor use then might increase less than 1% a year per crop as a result of rapid increases in yield and double cropping.

However, there are other factors which tend to lower labor use:

-- adoption of new seed varieties is associated with lower labor use per crop by about 6% (Table II-27).

-- increasing use of other inputs (other than labor and chemical fertilizers) lowers labor use for all operations except plowing by about 0.5% for every 10% increase in money spent.

The coverage of high yielding varieties is likely to expand slowly (it is already 73% for Java/Bali). An increase of 3% a year would produce complete coverage in 9 more years and would reduce labor use by 0.2% a year per crop. Since expenditure on "other" inputs are likely to rise less than 10% a year, the two factors combined are unlikely to result in a decline in labor greater than 1% a year.

There are also factors whose impact on labor use is ambiguous or negligible:

-- fertiliser use definitely increases labor use, but by an amount which is not significant

-- damage to the crop reduces labor used in harvesting but is already captured by the yield variable, so it does not need to be taken into account separately.

While the regression analysis suggests that more labor was used in 1977 and 1978, other factors equal, than in 1976, it would be unrealistic to project a trend on the basis of three years. On the other hand, earlier discussion has shown a sharp drop in harvest labor as a result of a shift to sickles from the hand knife, and that factor is likely to lead to reduced labor use.

The discussion so far has been on a per crop basis. But double cropping not only increases labor per crop because of a more assured water supply, it also increases labor demand for the additional crop, even if that involves shifting from a dry season crop to wet rice. If double cropping increases at 2% a year, a reasonably optimistic assumption, labor demand will grow by less than 2%. The labor force is at the same time increasing at a rate above 2%.

Taking all these factors into account it is reasonable to conclude that agricultural development will not be able to absorb its share of the increasing labor force as real wages remain constant. Rising labor needs per crop due to rising yields and multiple-cropping (and fertiliser use), may not quite balance declining labor use due to the adoption of HYV seeds and increasing use of other (commercial) inputs. So on a per crop basis labor use may decline, even at constant wages. The shift from dry season crops to wet rice will increase labor demand at a rate below 2% a year. But real wages in rice agriculture must rise as the economy continues to grow rapidly if the large number of landless workers and smallholders are to benefit from development. Rising real wages presuppose a rather large decline in employment in rice agriculture. With population and the labor force increasing steadily, rising real wages then require a very rapid increase in job opportunities outside rice agriculture.

The next section approaches some of the same issues with different techniques, followed by a section which summarises the conclusions with respect to employment.

5) Labor productivity, employment and wages -- production functions and profit functions

By using production function and profit function analysis one can shed some light on the relationship among labor productivity, employment and wages. There is, of course, a vast literature on the usefulness of these analytical tests and on their weaknesses. The problem of "management bias" has already been discussed: our inability to distinguish farms whose greater technical efficiency leads to greater use of inputs, including labor, from farms that are less well managed. A difficulty which is probably more serious is the assumption of profit maximization in well functioning markets. Farmers, in fact, are almost certainly risk averse, and their objectives include not only profit, but also reduction in risk. Moreover the markets they face are far from perfect . Most notably, for many enterprises the opportunity cost of family labor differs from the cost of hired labor. Despite these and other problems, useful conclusions can be drawn from this analysis, as long as its weaknesses are recognized.

In general this work was done with pre-harvest labor only. As noted earlier, it is difficult to know how many workers actually participated in the harvest. Moreover the number of hours worked per day can vary widely. For both reasons the data on harvest labor were considered too unreliable for use in the more rigorous analysis.

a) Family vs. hired labor

Using a non-linear Cobb-Douglas production function it was found that the productivity of hired labor was 30% higher than for family labor.* Since the

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*Quantity of rice produced per plot was, naturally, the dependent variable. The explanatory variables were plot size, non-labor inputs (in monetary terms) and the two forms of labor.

percentage of hired labor is greater on larger operating units, larger units have greater labor productivity. There are, of course, two alternative explanations for these differences in labor productivity:

(i) Hired labor can indeed be more productive because it includes more adults, or stronger workers, or is more skilled, or more highly motivated, or better managed, or works longer hours and so on. That is, the production function for hired and family labor differ.

(ii) If the opportunity cost of family labor is less, more of it will be used per unit of other factors and its productivity will be lower. That is, the production function for hired and family labor is the same, but the cut-off point for family labor is further to the right.

We have no basis for distinguishing between these two causal variables and it is likely that both hold true simultaneously. Some evidence has been presented that the opportunity cost for family labor is indeed lower, so this is almost certainly part of the reason for the lower productivity of family labor.

b) Labor productivity -- a marginal product below the wage

Labor has a relatively low coefficient in all the estimated production functions and its marginal product is consistently below its cost. The degree of probable error is considerable in marginal product calculations and the calculated numbers can vary considerably, depending on the method used. But regardless of method used, and for two different samples the results consistently show a marginal product that is less than the wage. On the marginal labor-day the average employer loses between 0.77 and 3.26 kilograms of rice equivalent. Why then is labor hired?

It might be argued that the marginal product really applies to family labor and that the comparison with the wage for hired labor is not very relevant. There is some truth in this argument, but not in its simple form, since 99.5% of the sample use hired labor. It might appear then that practically all cultivators can reduce the amount of labor they hire, if the additional output is less than cost of the marginal labor day. However, since labor is usually hired for specific tasks and/or for the peak season this is not wholly true. Still, at the margin many cultivators should be able to reduce the labor they hire.

The most likely explanations for a marginal product below the wage include:

a) There may be non-economic reasons for hiring some workers. Patron-client relations, the social pressures for an "open" harvest where every worker can participate and more general social obligations to provide work for neighbors and fellow-villagers could influence the hiring behavior of at least some cultivators.

b) The real cost of some hired labor may be lower than the wage, because of "tie-in" sales of labor. Workers may be paid for one operation, but then do other work at no compensation. That is the pay for, say, harvesting, covers as well some "other" work.

c) The most important reason, however, most probably is that marginal labor in fact is family labor and family labor has a lower opportunity cost. Labor exchange agreements can lead to a situation where labor is apparently hired, but is in fact supplied by the family. The cultivator "hires" a neighbor at a time of land preparation or harvesting and the neighbor in turn hires the original employer when the neighbor does his land preparation or harvesting. Both receive cash, but on a net basis neither is paying out

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money, both are simply supplying family labor to each other and somewhat spreading their risk..

More generally, labor may genuinely be hired but for only a few days at the time of peak labor need. On other days the same work is carried out by family labor. On days and for operations when only family labor is involved so much labor is applied that the marginal product is lower than the wage paid on the peak days to hired labor. We can not determine whether, in fact, hired labor is employed only at times when its marginal product equals its wage, with family labor used at times when the marginal product is lower, since we can calculate only the average marginal product for a particular operation or for all pre-harvest labor, not for particular time periods.

It is possible, that a large part of the difference between marginal product and wage is due to our inability to correctly measure marginal product on the one hand and the opportunity cost of family labor on the other.

Some further light is shed on the issue by disaggregation. Plots on which relatively little labor is used have a marginal product for labor which actually exceeds the wage (Table II-30). These are, as shown earlier, the larger operating units which employ primarily hired labor. They apparently operate as profit maximisers. As one moves to the smaller plots, with more family labor, very little hired labor is used, and presumably labor is applied until its marginal product equals the opportunity cost of family labor. Note that the marginal product of labor on the most labor intensive plots approaches zero. It equals about half a kilogram of rice a day. Since the average farmgate rice price was Rp 58.5/kg at that time, the marginal workers produced less than Rp 30 a day or U.S. $0.07 for a day's work. (Rp 400 per U.S. $).

Table II-.30

[illegible] Distribution of Labor Marginal Product across Seed Varieties and Labor Use per hectare.

Labor Use Class	Marginal Product	Real Wage	Gap
Modern Varieties:			
1. < 100 mandays	6.51(0.73)	5.65(0.44)	-0.85(-5.98)
2. 100-<130	4.19(0.59)	5.09(0.48)	0.90(3.70)
3. 130-<160	2.56(0.66)	4.52(0.44)	1.95(1.35)
5. 160-<190	2.02(0.78)	4.02(0.43)	1.99(1.19)
5. 190-<220	1.62(0.62)	4.10(0.37)	2.48(0.83)
6. 220-<250	1.20(0.66)	3.93(0.48)	2.73(0.85)
7. >250	0.45(1.59)	3.67(0.48)	3.22(0.60)
Local Varieties:			
1. < 100 mandays	6.23(0.89)	4.73(0.33)	-1.51(-3.90)
2. 100-<130	3.36(0.62)	4.88(0.68)	1.42(2.53)
3. 130-<160	2.46(0.61)	4.32(0.44)	1.86(1.14)
5. 160-<190	1.73(0.80)	4.63(0.52)	2.90(0.85)
5. 190-<220	1.49(0.56)	3.64(0.56)	2.15(1.00)
6. 220-<250	0.99(0.96)	3.54(0.74)	2.56(1.27)
7. >250	0.60(1.76)	4.14(0.70)	3.55(0.69)

*****

Note: Coefficient of Variation between brackets.

There is relatively little difference in marginal product of labor between those using modern seed varieties and those using traditional ones. If the reasons for excessive labor use were primarily non-economic, one would expect the more traditional cultivators, using local varieties, to have a far greater gap between marginal product and wage than the more commercially oriented farmers using modern varieties. In fact, the gap is consistently greater at all levels of labor use, except for the highest, for those using local varieties, but the difference is not great. This is quite limited, indirect evidence that we are not dealing here primarily with economic irrationality, labor use that is "excess" in profit maximisation terms, but probably with differences in opportunity costs.

Slight further confirmation comes from a comparison that adds extent of chemical fertilizer use to differences in seeds used to distinguish commercial from traditional cultivators. One would expect that cultivators using above average doses of fertilizer and modern varieties of seed would operate on profit maximising principles, but the gap between marginal product and wage is greater for them than for those using less fertilizer. So the use of "modern" inputs is not significantly related to apparently uneconomic use of labor.

However, there is a clear relationship between size of holding and labor use. On operational holdings above one hectare the marginal product essentially equals the and at times exceeds wage. On those holdings hired labor provides the marginal labor, and the marginal product and the wage are essentially equal. It is on the smaller holdings, where family labor dominates the labor force that the marginal product is low, and substantially below the wage for hired labor. What seems to be happening is that those who operate small holdings can earn the minimum income they need only by applying

a good deal of fertilizer and labor to their small plots. They probably also have more fertile land that partly justifies greater labor and fertiliser use. But above all they have a great deal of family labor per hectare available, with a low opportunity cost, and they keep applying labor even when the returns from doing so are minimal.

It is worth emphasizing how low the apparent marginal product is for labor on a large proportion of holdings. The average marginal product on multiple cropped holdings below 0.5 hectares, is about 1 kg. of rice, worth Rp 58 or about U.S. $0.15 for a days work. But the coefficient of variation, the presumption that the marginal product is less on holdings below 0.2 hectares than on those between 0.2 and 0.5 ha, and the data in Table II-31 all suggest that rice smallholders have an opportunity cost of labor that is even lower. Java/Bali appears to remain close to a classical labor surplus area where the pressure of population on land results in a marginal product of labor that is quite close to zero, in at least some labor markets.

c) The Demand for Labor

Profit function calculations yield labor demand elasticities which provide further information on factors in employment and also some indication of the degree of economic rationality of different groups of cultivators. The results are quite consistent with those for the simple regression analysis reported in section 3 above. That is, changes in the wage rate have considerable effect on labor use.The elasticity with respect to the wage rate is quite high, so that workers as a whole benefit to only a limited extent from a rise in wages: the resulting decline in employment means that the total wage bill rises only 25-35% of the increase in the wage rate. On the other hand, the elasticity of labor demand with respect to the fertiliser price is

Table II-31

Labor Marginal Product and Its Deviation from Real Wage across Seed Variety and Fertilizer Use.

*****

	Marginal-Product	Real-Wage	Gap(*)
1. Modern Variety:			
Zero Fertilizer	3.35	4.39	1.04
	(1.21)	(0.50)	(3.66)
< Mean	2.84	4.47	1.62
	(1.13)	(0.51)	(2.11)
> Mean	2.60	4.45	1.66
	(1.06)	(0.46)	(1.68)
2. Local Variety:			
Zero Fertilizer	2.45	4.79	2.35
	(1.14)	(0.64)	(2.13)
< Mean	2.70	4.15	1.45
	(1.25)	(0.51)	(2.52)
> Mean	2.04	4.40	2.36
	(1.11)	(0.57)	(1.31)

*****

Note: Coefficient of Variation between brackets.
(*) Shown at their absolute values.

Table II-32

Distribution of Labor Marginal Product, Real Wage and Gap between them, Across Multiple Cropping and Adjusted Farm Size.

*****

	Marginal Product	Real Wage	Gap(*)
Singe Cropping:			
1. < 0.5 Ha.	1.87 (1.05)	4.46 (0.51)	2.59 (1.04)
2. 0.5 - 1.0	3.40 (0.86)	4.42 (0.54)	1.02 (2.92)
3. > 1.0	4.60 (0.98)	4.55 (0.58)	-0.05(-95.15)
Multiple Cropping:			
1. < 0.5 Ha	1.16 (1.33)	4.38 (0.47)	3.22 (0.75)
2. 0.5 - < 1.0	2.94 (1.02)	4.34 (0.46)	1.39 (2.26)
3. > 1.0	4.64 (0.78)	4.49 (0.41)	-0.15(-26.58)

*****

Note: Coefficient of Variation between brackets.
(*) Gap = Real Wage - Marginal Product.

Table II-33

Labor Demand Elasticities by Seed Varieties and Adjusted Farm Size.

*****

Description:	Farm Size (ha). ≤ 0.5	0.5 - ≤ 1.0	≥ 1.0	all sizes
Local Varieties:				
w.r.t. wage rate	-0.69	-0.69	-0.51	-0.75
w.r.t. fertilizer price	-0.06	-0.06	-0.06	-0.07
w.r.t. rice price	0.96	0.75	0.67	0.32
Modern Varieties:				
w.r.t. wage rate	-0.67	-0.66	-0.56	-0.65
w.r.t. fertilizer price	-0.07	-0.11	-0.12	-0.10
w.r.t. rice price	0.74	0.60	0.71	0.75

*****

Note: w.r.t = with respect to.

low. This too is consistent with earlier results. Presumably the fertiliser price affects labor demand via changes in fertiliser use and earlier results also indicated that while fertiliser use and labor use were positively correlated, the effect was small.

The elasticity of demand for labor with respect to the rice price is, in a sense, the reciprocal of the effect of the wage rate. As the price of rice rises, the real cost of a given wage rate falls and it pays to employ more labor. Indeed the coefficients are similar, but with the opposite sign.

One other interesting fact emerges from these data: the elasticity of demand for labor with respect to the wage is actually greater on smaller than on larger holdings. That is, the operators of smaller holdings respond even more to the economic signals provided by the wage. They are, if anything, even more concerned than those who operate large holdings with economising on labor if its cost increases. These are clearly not cultivators who determine labor use on traditional, non-economic grounds. Earlier it was shown that these smallholders employed more labor than was apparently "rational" on economic grounds; the wage they paid hired labor was a multiple of the marginal product they received. Two principal alternative explanations were offered: employment decisions could be dominated by non-economic considerations or the wage rate for hired labor was not a correct index of labor cost. The first explanation seems less plausible in view of the high price elasticity of demand for labor. Rather it is persuasive, if indirect, evidence that smallholders respond substantially to economic circumstances even in their employment policies, and use a great deal of labor with a low marginal product because the utility of a small increase in income is high and the opportunity cost of family labor is low.

6. Employment -- Summing Up

Drawing on the previous analysis one can sum up the major conclusions from tabular analysis, regression results and production function analysis. All of these conclusions are, of course, subject to considerable uncertainty, because of weaknesses in data.

a) The Facts

i) The total number of workers per crop and hectare engaged in rice agriculture appears to have remained unchanged over the 1970s despite the increase in output and in commercial inputs which took place.

ii) This was the result of the offsetting effects of rising yields and increased multiple cropping, which raised labor use, while adoption of high yielding varieties and of inputs other than chemical fertilizer reduced labor use. Increasing use of chemical fertilizer also had a positive, but negligible, effect on labor use.

iii) Within this unchanged total, the share of family labor increased, that of hired labor diminished, at least on Java/Bali. The decline in the role of hired labor was especially pronounced in harvesting.

iv) This shift to family labor resulted from a sharp decline of hired labor on the smallest operating units, while there was no change on the larger units in this respect. This conclusion is particularly subject to doubt, because 1978, the last year in the series, shows a sharp increase in total and hired labor.

v) The above conclusions are per crop. Multiple cropping may have increased labor use by up to 2% a year. This is less than the 3% increase in the total labor force.

vi) As expected, larger units rely more heavily on hired labor, less on family workers. Comparing the largest with the smallest unit on Java/Bali the number of family days worked doubled, of hired workers increased 30 to 40 fold. As a result, on the former the family provides only 5-10% of total labor, for the smallest unit more than half. On the Other Islands much less hired labor is used.

vii) On all units, even the largest, family workers participate significantly in all operations.

viii) The larger the unit, the less the total labor used per hectare, so that on the largest units it is down by almost half compared to the smallest. The decline is almost entirely due to fewer person-days of family labor; hired labor days remain almost unchanged.

ix) Data on the use of a sickle, instead of the hand-knife (ani-ani), in harvesting are available only for the early 1970s. While the extent of sickle use was still small on Java/Bali, it appeared to be increasing. Sickle use was related to commercialisation and may lead to a decline in labor use. The use of the sickle was quite widespread (about one third) on the Other Islands.

x) On various assumptions, rice agriculture provides employment for only 10% of the days available to the family operating the land on Java/Bali and 20% on the Other Islands, for units of average size. Smaller units provide even less work, of course.

xi) Nearly a third of total labor used is for harvesting.

xii) Labor use is substantially affected by the real wage paid. Each 10% change in wages results in a 3% to 7% change in employment in the opposite direction.

xiii) The marginal product of labor is extremely low. On the most labor intensive plots it is less than Rp 30 (U.S. $0.07) for a day's work, and on plots below 0.5 hectare it is Rp 58 (U.S. $0.15)

xiv) On the typical plot the marginal product is substantially below the wage, so that apparently employers lose between 0.77 and 3.26 Kg of rice on each marginal labor day, equal to Rp 45 to Rp 190 lost (U.S. $0.11 to $0.46).

xv) Plots which use little labor, that is those part of large operating units, have a marginal product which equals, or slightly exceeds, the wage. It is on the great majority of smaller units, which are labor intensive, that the wage substantially exceeds the marginal product.

xvi) The elasticity of demand for labor is greater on smaller than on larger holdings.

b) Interpretation and Conclusions

These data lead to rather pessimistic conclusions about the potential for employment in rice agriculture. With the labor force increasing at about 3% a year, and alternative jobs outside agriculture and on the Other Islands growing slowly (Dapice, 1980) it would be desirable for agriculture, and especially rice agriculture to absorb more labor. But past trends make that unlikely.

That employment was stagnant in the 1970s is indicated not only by the, quite unreliable, time series, but also by the cross section data. They imply that factors making for greater and lesser labor use on each crop probably offset each other and are likely in the future to continue to do so.

But within this unchanged total, hired labor declined. With population essure, size of holdings may well decline in the future. Since family labor pears to have a very low opportunity cost, as more family members are ailable per hectare of land, hired labor will continue to be replaced. So the future, as in the past decade, hired labor will bear the brunt of the mbined effects of population pressure and unchanged total employment. It is ired labor, and especially the landless, who will particularly suffer from ntinued shift to the less labor intensive sickle in harvesting. There is vidence that this shift accompanies institutional changes and mmercialization.

Compounding the problem is that rice agriculture already provides mployment on few days and at low productivity. With a marginal product lready close to zero and employment for perhaps 10% of the time available, ven the existing labor resources are already underemployed. If additional orkers are added to the labor force producing rice, for lack of alternatives, hey will not add much to output and may further reduce the number of days orked.

With the existing information we can not be sure why the marginal product s a fraction of the wage. To some extent non-economic factors, or at least bjectives other than profit maximisation, may be involved. However, there is evidence that the impact of non-economic considerations is limited. Smallholders and more traditional cultivators respond at least as much to changes in wage rates as more commercially oriented operators of larger units. At the same time, there is a wealth of indirect evidence that a major factor is the low opportunity cost of family labor. That suggests that there already are few alternative opportunities for employment with a significantly higher income.

Finally, even a stagnant labor force could find employment only at a real that did not increase. If wages are to rise then not only would all of additions to the labor force have to be absorbed outside rice agriculture, ge numbers of additional workers would have to be found alternative loyment. If one accepts the relatively favorable coefficient from the ession analysis, a 6% per year rise in real wages -- to keep pace with ing per capita income -- would require a 2% decline in employment. The s favorable ratio derived from the production/profit function analysis ld require a 4% decline in employment. There are perhaps 15 million kers in non-cash crop agriculture in Java.*

To reduce employment in that sector by 3% - the average of our alternative imates of 2% to 4% - to put pressure on wages, some 450,000 workers a year ld need to be found jobs.** If the expansion of irrigation absorbs 2% of labor force which is in non-cash crop agriculture, that would leave ,000 workers who need to be found work to keep wages rising. The natural ease in the labor force in Java is over a million workers, nearly 1.2 ion jobs a year would need to be created for Javanese workers, by nsmigration or in non-agricultural activities in Java.*** Of course, these very rough approximates, but they do give some idea of the magnitude of

*In 1976 the Java-Madura labor force was 33.2 million, with 59% in iculture and a relatively small proportion of them producing cash crops pice, 1980).

**We have made the arbitrary assumption that other non-cash crop iculture (cassava, maize, etc.) has a pattern of labor demand on Java/Bali ch is similar to that for rice.

***On the assumption that cash-crop agriculture cannot absorb more labor rising wages, but also does not need to shed labor.

ployment problem. The alternative to creating these jobs would be wages
-cash crop) agriculture that increase more slowly than average income
consequent worsening of income distribution.

APPENDIX

A GUIDE TO THE DATA

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INTRODUCTION

Between 1969 and 1979 the Indonesian Central Bureau of Statistics (Biro Pusat Statistik) conducted comprehensive annual farm management surveys in all provinces of Indonesia with the exception of Maluku and Irian Jaya. The objectives of the survey were (a) to obtain information for estimating agricultural GDP, (b) to assist other departments in agricultural sector planning and (c) to estimate income per hectare of foodcrops.

These data form a valuable source of information on changes in agricultural practices and employment during the past decade. While the questionnaires have varied somewhat over the years, the data basically consist of a detailed enumeration of inputs and outputs of each crop cultivated by farm households during the preceding year. A small proportion of these data was processed manually and is available in publications of the Bureau of Statistics.[1] However, much of the information -- particularly that pertaining to labor use -- was not processed. By 1978 a huge number of questionnaires had accumulated, and it appeared likely that they would be destroyed.

In an effort to retrieve the data, a joint project was initiated among the Central Bureau of Statistics, Gadjah Mada University and Boston University. The purpose of the project, financed by the Agency for International Development, has been to transfer the data to computer tapes, to edit the data, and to conduct a series of

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[1] Survey Pertanian (Jakarta: Biro Pusat Statistik), 1971 to 1978.

analyses of some of the major agricultural policy issues confronting Indonesia, focussing particularly on trends in rice production and employment.

This document is designed to serve two major purposes. First, it forms the background to the analysis presented in the main report. Second, it is intended as a guide to future users of the data. The first and second sections discuss sampling methods and data coverage, and the third section explains how the data were processed. The procedures used to clean the data are discussed in Section IV, which also shows how the means and standard deviations of key variables are affected by cleaning. More detailed information about the data -- including code-books, location of files and values of discrete variables -- are contained in the appendices.

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I. SAMPLING DESIGN

The farm household survey is one of four rounds[1] of agricultural data collected annually by FPS since the inception of the First Five Year Development Plan (Repelita I) in 1969. The survey is conducted between January and April, and covers production during the preceding calendar year. Unless otherwise specified, data are presented in terms of crop years rather than survey years. Between 1971 and 1972 the sampling design changed as follows:

(a) Sampling Design I (1970 and 1971 crop years[3])

In these two years the sample was selected so as to include only rice producing areas. The first sampling stage was the kabupaten (regency). Villages in each kabupaten were listed sequentially according to rice area cultivated during 1964-8.[4] Of the total 257 kabupatens, 98 produced no rice and were excluded. Stage two

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[1]The others consist of two rounds of surveys on livestock and poultry, and a crop cutting survey which is used to estimate annual yield figures.

[2]Note that the earlier paper (The Indonesian Agricultural Surveys: A Preliminary Review of the Data, May 1980) presented data in terms of survey years.

[3]Information on the sampling design used in the 1969 and 1970 survey years is not available.

[4]These statistics are collected annually by the provincial office of the Department of Agriculture.

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consisted of a systematic selection of villages from the 159 rice producing kabupatens; the number of villages selected per kabupaten ranged from one to 20. The sampling frame for stage three was the Census Block list prepared for the 1971 Population Census, and one census block was selected randomly from each census block. In the final stage, households were randomly selected from each census block. In the 1970 crop year 12 households per census block were selected, and this was reduced to 6 in the 1971 crop year.

(b) Sampling Design II (1972-1978 crop years)

According to BPS publications, the sampling method employed from 1972 onwards is as follows: the first stage selection was lowered to the kecamatan (sub-district) level. Villages within each kacamatan were arranged according to total staple foodcrop area (rice, maize, cassava, sweet potato, soybeans and mung beans), and a stratified sample of food-producing kacamatans was selected.[1] In the second stage, four census blocks were selected systematically from each kecamatan in Java-Madura, and two from each kecamatan in the other islands. Finally, four households were selected randomly from each census block.

The information provided by BPS publications indicates that the size of the sample and its distribution across provinces was as follows:[2]

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[1]The number of kecamatans selected each year was determined by budget size.

[2]This information is not available prior to 1972 or after 1977.

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	Crop Years		
	1972-75	1976	1977
Java	65.4	70.1	78.9
Bali	1.2	1.4	78.9
Sumatara	14.5	14.3	8.5
Kalimantan	7.5	3.2	1.9
Sulawesi	7.8	7.6	4.4
Nusatenggara	3.6	3.4	4.7
	100.0%	100.0%	100.0%
	34504	19136	31768

The total number of observations after processing and editing is shown in Table 1. With the exception of 1972, 1973 and 1974, all the questionnaires available at BPS were processed. It appears therefore that a number of questionnaires were either not returned to BPS or were lost there. For the 1972, 1973 and 1974 crop years the number of questionnaires available at BPS were 25970, 23318, and 14318 respectively. A sub-sample of these questionnaires was selected at random such that the absolute number of observations for each province was roughly the same across years. From Table 1 it may be seen that the distribution of available observations across provinces used in our study is broadly consistent with the original sample, although in some years there are divergences.

It has not been possible to establish sample design and size

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Table 1

DISTRIBUTION OF THE SAMPLE BY PROVINCE

Crop Year / Survey Year	68 / 1969	69 / 1970	70 / 1971	71 / 1972	72 / 1973	73 / 1974	74 / 1975	75 / 1976	76 / 1977	77 / 1978
JAVA										
Jakarta	--	--	--	--	0.1	--	0.9	0.1	--	0.0
West Java	11.4	1.7	100	18.8	15.5	16.0	16.0	18.2	20.5	20.8
Central Java	11.5	17.6	--	33.5	20.6	24.4	28.8	27.6	27.2	28.2
Yogyakarta	2.2	1.3	--	4.5	3.9	2.7	4.0	3.0	3.0	2.2
East Java	42.2	0.3	--	21.5	18.4	20.3	24.3	23.0	22.2	21.5
TOTAL JAVA	67.3	20.9	100	78.3	58.5	63.4	74.0	71.9	72.9	72.7
BALI	2.0	5.5	--	1.7	1.6	2.7	1.6	1.5	1.4	1.4
SUMATRA										
Aceh	--	17.0	--	--	3.8	4.6	1.7	1.4	1.5	1.5
North Sumatra	4.8	9.2	--	--	2.7	2.8	3.0	3.3	3.2	3.6
Riau	--	0.8	--	--	1.8	0.7	0.6	0.7	0.5	0.4
Jambi	1.3	0.6	--	--	0.9	0.3	--	0.5	0.6	0.4
West Sumatra	--	--	--	4.4	1.7	2.3	2.1	1.9	1.8	1.9
South Sumatra	4.4	1.1	--	2.2	1.6	1.8	1.3	1.5	1.1	2.0
Bengkulu	0.3	0.7	--	--	0.1	0.3	0.5	0.5	0.5	0.3
Lampung	4.1	0.4	--	2.6	1.8	0.7	2.1	2.0	1.7	2.0
TOTAL SUMATRA	14.9	29.8	--	9.2	14.4	13.5	10.3	11.8	10.9	12.1
KALIMANTAN										
West Kalimantan	2.9	--	--	--	1.5	1.2	0.8	0.7	0.9	0.8
Central Kalimantan	--	7.0	--	--	3.4	2.6	1.3	2.5	2.2	0.9
South Kalimantan	--	--	--	--	4.1	0.2	3.4	1.8	1.5	1.2
East Kalimantan	--	3.3	--	--	0.0	0.4	--	0.1	0.0	0.1
TOTAL KALIMANTAN	2.9	10.3	--	--	9.0	4.4	5.5	5.1	4.6	3.0
SULAWESI										
North Sulawesi	0.0	6.4	--	1.7	1.6	2.5	1.2	1.2	1.4	1.5
Central Sulawesi	2.1	2.1	--	--	2.2	1.7	--	0.6	0.4	0.3
South Sulawesi	5.2	4.4	--	7.1	3.2	4.1	3.0	3.3	4.7	4.5
Southeast Sulawesi	0.2	0.8	--	--	1.2	0.5	--	0.6	0.6	1.0
TOTAL SULAWESI	7.5	13.7	--	8.8	8.2	8.8	4.2	5.7	7.1	7.3
West Nusantenggara	2.7	7.5	--	2.1	3.7	3.7	1.7	2.0	2.1	1.9
East Nusantenggara	2.8	12.4	--	--	3.5	3.6	1.8	2.0	0.9	1.6
	100	100	100	100	100	100	100	100	100	100
TOTAL SAMPLE SIZE	2219	1433	93	8333	11356	10918	11949	8710	9101	8836

*Rice producing areas

Note: The system of province codes for the 1979 survey year are different; see Appendix B.

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or 1968 to 1970, and there is some confusion as to what years are actually covered by these questionnaires. Analysis of the data from these years has produced results which are inconsistent with those of other years, and it appears that this is due to sampling peculiarities.

As far as the representativeness of the sample in the other years is concerned, there are two reasons as to why the sample is probably skewed towards small farmers. First, the sampling procedure is such that the sample is not representative of the farming population. The reason for this is that households were selected from census blocks, which include landless households. Given the high rate of landlessness, particularly in Java, a large proportion of the households selected was likely not to have operated any land. The procedure followed by BPS was to interview a nearby household which did operate land. If, as is the case in some villages, landless and small landowning households tend to live in the same vicinity, this would result in the sample covering a disproportionately large number of small landowning households.

A second consideration which should be borne in mind is that the sample was drawn from the major food producing areas in 1972-78, and rice-producing areas in 1971. Particularly in the areas outside Java a large proportion of farmers in the sample cultivated wet rice even in the years after 1971. To the extent that (a) wet rice cultivation tends to be concentrated in relatively well-endowed regions, and (b) farm size in these areas tends to be relatively small, this would tend to bias average farm size downwards.

II. DATA COVERAGE AND QUALITY

As was mentioned earlier, interviews took place between January and April and cover the preceding year. Particularly in the case of farmers who cultivate a number of crops, the length of the recall period is likely to pose problems of data quality.

It is also possible that there are differences between Java and other islands in terms of the quality of the data. In Java interviewing is conducted by an interviewer (mantri statistik) from the kabupaten whereas data in the other islands is collected primarily by local staff (mantri tani) of the Department of Agriculture who have had considerably less experience and training in data collection.

The coverage of the data is laid out in full in the codebooks which are contained in Appendix A. The questionnaires underwent five changes as follows:

Crop Years	Survey Years
1. 1968, 1969, 1970	1969, 1970, 1971
2. 1971	1972
3. 1972, 1973, 1974	1973, 1974, 1975
4. 1975	1976
5. 1976, 1977, 1978	1977, 1978, 1979

The major changes in the questionnaires concern the definitions of land and labor, and it is indeed these two variables which impose the greatest limitations on data analysis. The main points which should be kept in mind concerning data coverage are as follows:

(a) Landholding Size:

Information on landholding size is notoriously difficult to gather, particularly in Java where extremely intricate tenurial arrangements are the norm. Until 1971, fairly detailed data were collected on landholding size which took account of renting and sharecropping. While there are undoubtedly a number of problems with the accuracy of these data, the coverage is far more comprehensive than in subsequent years. Between 1972 and 1974 no questions at all were asked about landholding size, the only evidence being the area cultivated for each crop. After 1975 a rather ambiguous question was asked on the number of plots of wet land (sawah) and dry land and the total area of each. As is explained more fully elsewhere, an effort has been made to construct a measure of adjusted farm size which takes account of variations in land quality as far as possible.

(b) Labor Use

In addition to problems of recall (particularly with respect to family labor), the labor data suffer from major discrepancies in coverage and the way in which questions were asked across years:

1971: Number of days spent in hoeing, planting, weeding, harvesting, and "other work";
Average number of hired workers per day in each of the above activities;
Total number of unpaid workers (not by activity).

1972-74 Total number of days spent in each activity (with hoeing and plowing asked separately)

Average number of family and hired workers per day in each activity

1975 No data on labor input (only labor costs by activity)

1976-78 Only in these questionnaires are the questions on labor asked in an unambiguous way. The questionnaire is constructed in such a way that the distinction between family and hired workers and the number of days worked is clear. In contrast, the 1972-74 data fail to indicate whether or not family and hired laborers worked for the same number of days, and the family labor data in 1971 is unusable. A further limitation of the labor data is that no distinction is drawn between male and female workers in any of the years.

In general, great caution should be exercised in interpreting the labor use data. In addition to the problems outlined above, the category of "other work" is not at all clear. It could refer to either preharvest operations (seedbed preparation, fertilizer application, water control, etc.) which are not specified in the preharvest labor activities, or to post-harvest activities. Underlying all of this is the point made at the beginning of this paper -- namely that the major purpose of the survey was to gather data on production and farm income rather than on employment.

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(c) Other Data Coverage Limitations:

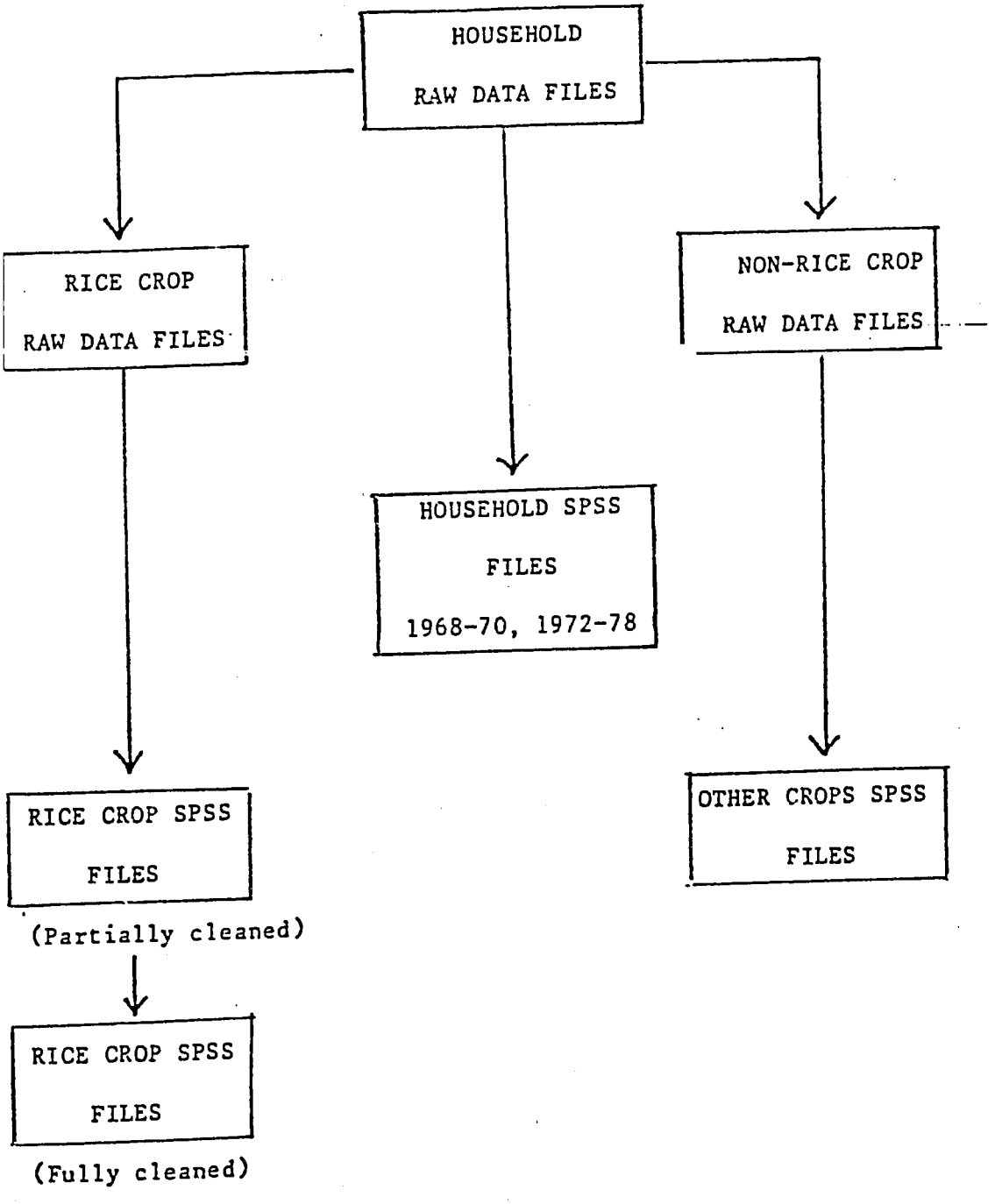
A third major shortcoming of the data is inadequate information on irrigation. After 1971 the only data on irrigation is a variable on cost, which in no way reflects access to or use of irrigation water. An attempt has been made to construct an index of multiple cropping, which appears to be the only way of obtaining some indication of whether or not a farmer has access to irrigation, but it is obviously not unambiguous.

As may be seen from the codebooks, there are a number of other inconsistencies across years in data coverage. For instance, the question as to whether harvesting was done with a finger knife (ani-ani) or sickle -- an issue which has assumed major importance in the debate over labor use in agriculture -- was only asked in 1972-74. Also, as may be seen from the codebooks, the amount of information on sharecropping is very limited in later years.

III. DATA PROCESSING AND CONSTRUCTION OF FILES

The coding and punching of the data were done at the Central Bureau of Statistics in Jakarta. The magnitude of the data is such that it was not feasible to transfer the data to coding sheets. Each questionnaire was checked and some transformations were made, and the data were then punched onto cards directly from the questionnaires. The punched cards were sent to the computer center at Gadjah Mada University in Yogyakarta where they were transferred to tapes. The records were then sorted according to province, kabupaten (regency), kecamatan (sub-district), village and household. Checks were then made for completeness of identification columns, non-numerics and missing cards. The final cleaning of the data has been done at Boston University, and is explained in detail in Section IV below.

The original household raw data files have been transformed into five separate files:


HOUSEHOLD
RAW DATA FILES
RICE CROP
RAW DATA FILES
NON-RICE CROP
RAW DATA FILES
HOUSEHOLD SPSS
FILES
1968-70, 1972-78
RICE CROP SPSS
FILES
(Partially cleaned)
OTHER CROPS SPSS
FILES
RICE CROP SPSS
FILES
(Fully cleaned)

1. Household Raw Data Files, 1968-78

The storage location of the data for each of the years is as follows:

Name of Tape	Position	Survey Year	Crop Year
		1979	1978
INDONC	1	1978	1977
INDONB	1	1977	1976
INDOND	1	1976	1975
INDONA	1	1975	1974
BIOC	1	1974	1973
BIOB	1	1973	1972
BIOC	2	1972	1971
BIOB	4	1971	1970
BIOB	3	1970	1969
BIOB	2	1969	1968

The Job Control Language (JCL) needed to work with these tapes can be copied from the file.

2. Household SPSS Files

All data in the household raw data files were transferred to household SPSS files. Further information on these files can be found in the following appendices:

(a) Code Books for each of the years containing variable descriptions, SPSS names, format and missing values are in Appendix A, and codes for discrete variables are listed in Appendix B.

(b) Position of the files and tape descriptions are in Appendix C.

The household SPSS files have been used for editing purposes. The consistency checks are discussed in Section IV, together with a description of the assignation of missing values.

The Household Data Files consist of two sets of variables:

(a) A set of household-level variables on farm size, capital accumulation, etc.

(b) A set of crop-specific variables, for up to six crops.

The number of variables is large (in the vicinity of 500) and the files are therefore extremely expensive to use. Further, it is difficult to conduct crop-specific analyses. The reason for this is that each of the six sets of crop variables can refer to any of 17 possible crops. Thus, for example, in order to carry out any analysis of rice production one has to insert a set of SELECT IF statements which cover all possible combinations. This is not only cumbersome, but extremely expensive.

3. Crop Files

For these reasons, two sets of crops files were created;

(a) Wet Rice Crop Files

(b) Other Crop Files (including dry rice)

There are separate files for each year with the exception of the 1968-70 data which have been amalgamated into one file because of the relatively small number of observations; however, there is a variable (YEAR) which allows for identification of the survey years. These files contain considerably fewer variables and are therefore cheaper and more convenient to use for most types of analysis.

In addition to crop-specific information, the crop files contain a set of household-level variables which are listed in Appendix A. Also included are 15 variables pertaining to other crops cultivated by the household. They are:

Type of crop
Area harvested } for each of five other possible crops
Harvest month

The wet rice crop files also include a new variable CROPX; this is an index of multiple cropping and is described in the report.

The positioning, name of tapes and JCL language necessary to access the crop raw data files can be found in Appendix C.

IV. EDITING PROCEDURES

It is inevitable that a data set of this size and complexity contains a large number of errors, some of which could seriously distort the results. A great deal of effort has been devoted to eliminating as many of the errors as possible, and it is important that users of the data be aware of the exact procedures used.

The editing has been performed in three stages:

1. Initial Checks

As explained in the preceding section, a series of data checks were conducted in the initial stages of processing. In addition to scrutiny of the questionnaires prior to coding, these involved checking for completeness of cards and identification columns, and identifying obvious punching errors such as non-numerics. At this

stage, an effort was made to return all incorrect data to the Bureau of Statistics in Jakarta in order to correct the data from the original questionnaires. Some errors were corrected in this way, but it proved too complex and expensive to retrieve every questionnaire and a number of observations had to be deleted.

2. Consistency checks

The second round of editing was conducted at Boston University once the Household SPSS files had been set up. This involved running a large number of consistency checks on both continuous and discrete variables and assigning missing values to those observations which failed the tests. The program for the consistency checks is available from Boston University.

3. Imposing cut-off points to eliminate inadmissible values

The final stage of editing has involved eliminating values of key variables which fall outside an admissible range. The best procedure is to specify the underlying distribution (generally log-normal) and then to eliminate those values which are greater or less than three or four standard deviations from the mean. (The choice of cut-off point was generally the point at which the sample distribution deviated substantially from the log-normal.) Where possible, this method was used. In many cases, however, it proved unfeasible because of extremely large variances. In these cases cut-off points were defined on the basis of prior knowledge. The methods and results of imposing limits on each of the key variables are as follows:

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(a) Yield per Hectare

The upper cut-off point for this variable, defined as total output of rice divided by area harvested, is 10,000 kg or 10 metric tons per hectare. The rationale for this is that yields of 10 tons per hectare represent more or less the maximum possible under highly controlled conditions; it is most unlikely that yields greater than this would be realized in peasant agriculture. Two lower cut-off points have been used, depending on whether or not the crop was subject to damage such as drought, flooding and/or pests; as maybe seen from the code-books, there are variables (DAMAGE and DAMCAUS) which convey this information. The lower limits are 20 kg per hectare and 100 kg per hectare respectively for crops which have and have not been damaged. Missing values were assigned to both total quantity of production (QPROD) and area harvested (AHAR) for observations which fell outside these limits. While one would expect yields to be more or less normally distributed, it was not possible to impose limits on the basis of standard deviations because the variance of the uncleaned data was so large. The effects of imposing cut-off points on the mean, standard deviations and number of observations is shown in Table 2. It should be noted that the reduction in number of observations is not only the result of eliminating inadmissible values of yield, but also of other variables constructed with either quantity of production or area harvested (e.g. labor input per hectare and imputed rice price -- see below.) The second set of values thus represents the yield figures and number of observations in the third set of rice crop files (see Section III above.) Similarly the first set of values is

Table 2
RICE YIELDS PER HECTARE: THE EFFECTS OF IMPOSING LIMITS

Tons/Hectare

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	3213	16847	4132	2867	9930	4023
1971	49979	*	10244	3050	1768	9618
1972	338794	*	19269	2557	1916	17109
1973	338894	270448	10220	3272	1724	9942
1974	5101	75592	12269	3317	1719	11322
1975	10798	440913	8516	3506	1809	8334
1976	4466	25674	8736	3646	1749	8637
1977	3764	8542	8224	3146	1740	8048
1978	3589	4609	19688	3376	1716	9785

*Too large to be printed by computer.

derived from the second set of rice crop files which have already been subject to consistency checks.

(b) Labor Input per Hectare

Labor input refers to the sum of family and hired labor days per hectare in preharvest operations. The minimum and maximum values which have been used are 30 and 500 days respectively. Other studies of labor use in Javanese rice production suggest average values in the vicinity of 180 days; the range which we have allowed for is thus fairly generous, and some users may consider it necessary to impose more stringent limits. There are several reasons why we have not attempted to impose limits on the data for harvesting labor. In the first place, particularly when harvests are open it is often virtually impossible to count the number of harvesters on a relatively large field; for example, one of the participants in this project observed a harvest of a one hectare field in which the owner estimated that there were over 1000 harvesters -- in practice, it was impossible to tell. The second difficulty with data on harvesting labor is that the duration of the harvest can vary considerably;the harvest described above was completed in less than an hour, whereas a harvest in the same village on a similar sized plot which was limited to six or seven workers took a number of eight-hour days to complete. As will be discussed in the section on wages, there are also variations in the length of the working day in pre-harvest operations; however,the degree of variations is probably considerably less than in the case of harvesting.

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Two other points should be noted. First, the measure of preharvest labor input excludes the variable "OTHER WORK". As mentioned above, this variable could refer to either pre- or post-harvest operations, and its meaning is not clear. The value of "other work" on a per hectare basis exhibits extremely wide variation. Given the problematic nature of this variable, it has been left in its original form.

The second point to note is that the method of labor data collection varied across years (see Section III), thus necessitating different calculations of labor input. The actual measures of total preharvest labor input for the different surveys are as follows:

1976/77/78 crop years (1977/78/79 survey years):

(FAMHOE1 x FAHODAY1) + (HIRHOE1 x HIHODAY1) +

(FAMPLO1 x FAPODAY1) + (HIRPLO1 x HORPDAY1) +

(FAMPLA1 x FAPADAY1) + (HIRPLA1 x HIRPADY1) +

(FAMWEE1 x FAWEDAY1) + (HIRWEE1 x HIRWEDY1)

1975 crop year (1976 survey year): No data on labor input.

1972/3/4 crop years (1973/4/5 survey years): The problem with this set of data is that the number of days worked was not specified separately for family and hired workers. We have therefore had to assume that the number of labor days was the same for family and hired labor:

(FAMHOE1 x HOEDAY1) + (HIRHOE1 x HOEDAY1)

(FAMPLO1 x PLODAY1) + (HIRPLO1 x PLODAY1)

(FAMPLA1 x PLADAY1) + (HIRPLA1 x PLADAY1)

(FAMWEE1 x WEEDAY1) + (HIRWEE1 x WEEDAY1)

1971 crop year (1972 survey year): The data for this year are even more problematic. First, there are no data on plowing. An even more serious problem is that the number of family workers is not specified by operation. There is a variable "unpaid workers"; however, one cannot assume that this number of workers participated in each operation, one of the reasons being the division of labor by sex among operations in Indonesian agriculture. The labor input variable has thus been calculated as:

(HOEDAY1 x WORHOE1)+

(PLADAY1 x WORPLA1)+

(WEEDAY1 x WORWEE1)

The effect of imposing cut-off points on the labor input data is shown in Table 3.

Table 3

LABOR INPUT PER HECTARE IN PRE-HARVEST OPERATIONS:

THE EFFECT OF IMPOSING LIMITS

	Labor Days/Hectare					
	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	- - - - - - - - - - - - not available - - - - - - - - - - - - - - - - - -					
1971	226	571	9154	169	95	7892
1972	286	3301	18631	170	105	15239
1973	244	360	10021	190	99	9187
1974	359	3525	11962	197	101	10696
1976	221	1745	8400	182	93	8012
1977	206	402	7931	177	88	7442
1978	194	200	18739	175	87	8992

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(c) Wages

As may be seen from the code-books, there are two sets of data on wages. From 1975 (crop year) onwards, respondents were asked the wage rates for particular activities, regardless of whether or not they hired labor. In addition, there is a consistent variable across years which represents the total wages bill by activity. This is the variable which has been edited. Because of the problems with the labor input data in the earlier survey years discussed above, the variable selected for cleaning was not the imputed wage rate (i.e. total wage bill divided by hired labor days) but rather the total wages bill by activity per hectare. In general, one would expect wages (and wage income) to be log-normally distributed. Proceeding on this assumption, we calculated the logarithmic mean and standard deviation of wages bill per hectare (by activity), and eliminated observations which were greater or less than three standard deviations from the logarithmic mean. The result of this procedure are shown in Tables 4 to

Table 4

WAGE BILL FOR PLOWING: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year*	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1972	408	1234	19532	562	1220	12830
1973	816	1683	10171	1077	1824	7502
1974	1159	2529	12082	1431	2698	9203
1975	1444	2866	7906	2619	3297	4134
1976	1568	3034	8386	1877	3108	6739
1977	1440	2946	8264	1623	2848	6332
1978	2450	4743	19738	2735	4789	7909**

*No data for 1968-70 and 1971.

**Reflects a 50% sample.

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Table 5

WAGE BILL FOR HOEING: THE EFFECT OF IMPOSING LIMITS

(Rp)

Year	Before Cutting			After Cutting		
	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	774	2138	4155	1296	2520	2416
1971	2210	3853	10016	2456	3852	8328
1972	723	2006	19449	1251	2396	10335
1973	1355	2747	10066	1947	2971	6846
1974	1671	3599	11632	2342	4002	7831
1975	1906	3237	7294	2642	3544	5055
1976	2189	4461	7628	3309	4865	4783
1977	3161	5875	8252	4472	6112	5150
1978	4385	7457	19724	6034	8518	6706*

*Reflects 50% sample.

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Table 6

WAGE BILL FOR PLANTING: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	678	2200	4136	797	1321	3005
1971	986	2164	10081	1055	1988	8481
1972	545	1285	19447	871	1430	11251
1973	1024	1871	9769	1171	1467	8146
1974	1252	2222	11665	1431	2208	9572
1975	1444	2866	7906	1792	2213	6212
1976	1831	2884	8456	2281	2895	6497
1977	2042	3131	8273	2543	3267	5893
1978	2842	4098	19729	3371	4423	7724*

*Reflects 50% sample.

Table 7

WAGE BILL FOR WEEDING: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	522	1655	4148	947	7904	2113
1971	1114	2152	10037	1232	2128	8221
1972	563	1490	19503	871	1430	11251
1973	1131	2137	9947	1580	2275	6946
1974	1428	2891	11780	1937	3022	8160
1975	1559	2515	7739	2128	2750	5461
1976	1864	3675	8212	2805	4009	5236
1977	2394	4397	8295	3417	4586	5055
1978	3423	5525	19733	4638	6116	6698*

*Reflects 50% sample.

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Table 8

WAGE BILL FOR HARVESTING: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	1279	3414	4103	1811	3486	2733
1971	2030	3828	9912	2008	3306	8984
1972	1221	2690	19369	1822	3220	12064
1973	2747	4576	9638	3199	4725	8105
1974	3068	5120	11458	3493	5098	9545
1975	3281	5369	7432	4210	5806	5590
1976	3363	5331	7531	4301	5465	5672
1977	4388	6885	8122	5426	7161	5894
1978	6323	9580	19593	7327	10084	7774*

*Reflects 50% sample.

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(c) Fertilizer Use Per Hectare

Fertilizer use is a problematic variable to clean, as zero observations are quite possible and checks for the consistency of zero observations are difficult; for instance, farmers who cultivate modern varieties are more likely to use fertilizer, but this is not necessarily the case. We have therefore defined only an upper limit on fertilizer use per hectare of 450 kg of chemical fertilizer. The results of this are shown in Table 9.

Table 9

CHEMICAL FERTILIZER PER HECTARE: THE EFFECT OF IMPOSING LIMITS

Kg/Hectare

Year	Before Cutting			After Cutting		
	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	64	256	4161	49	80	4105
1971	123	331	10213	95	100	9406
1972	90	430	19455	62	96	17882
1973	103	192	8566	91	94	8468
1974	273	5013	10246	108	100	9869
1975	170	2556	7716	109	92	7585
1976	142	294	7584	121	93	7456
1977	213	534	8172	164	129	7487
1978	242	506	19598	197	125	8982*

*Reflects 50% sample.

(d) Rice Prices and Fertilizer Prices

Rice prices and chemical fertilizer prices have been calculated from the data on quantity and value. Both of these variables have been cleaned using the same procedure as that for the wage bill -- namely, observations which are greater or less than three standard deviations from the logarithmic mean have been eliminated. The results are reported in Table 10.

Table 10

RICE PRICE: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	21	28	4131	20	17	4026
1971	22	31	10230	32	30	
1972	53	299	18595	31	26	17652
1973	40	104	10233	36	12	10075
1974	64	261	12228	42	13	11767
1975	52	134	8509	47	16	8273
1976	56	98	8745	53	11	8592
1977	71	200	8227	61	14	8008
1978	71	501	19588	62	9	9749*

*Reflects 50% sample.

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Table 11

CHEMICAL FERTILIZER PRICE: THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	34	45	1699	31	8	1659
1971	39	146	6829	30	6	6544
1972	38	132	7881	30	7	17652
1973	40	58	5268	39	11	10075
1974	64	236	6944	52	15	11762
1975	77	175	5537	72	16	8273
1976	80	178	5649	74	10	8592
1977	81	194	6452	73	11	8008
1978	76	167	16997	72	7	9749*

*Reflects 50% sample.

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(f) Value of Non-Labor Inputs

This represents the sum of expenditures on chemical fertilizers, animal manure, green compost, pesticides, insecticides, animal hire and irrigation fees. Observations greater or less than three standard deviations from logarithmic means have been discarded, and the results are shown in Table 12.

Table 12

VALUE OF NON-LABOR INPUTS PER HECTARE:

THE EFFECT OF IMPOSING LIMITS

(Rp)

	Before Cutting			After Cutting		
Year	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	Number of Observations
1968-70	7870	23387	3616	9506	8259	1415
1971	16820	161497	8276	10368	8338	4789
1972	12415	18928	6475	13724	8642	4049
1973	9608	70025	19082	11711	9912	7050
1974	34219	578294	7779	18248	12959	4993
1975	31043	449505	5109	20863	11172	3447
1976	30305	245746	5060	22717	11017	3678
1977	34717	110124	7431	28898	14196	5096
1978	33130	52458	18563	31402	14191	7120*

*Reflects 50% sample.

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