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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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**IMPROVED CROPPING PATTERNS, LABOR ABSORPTION AND
SMALL FARM MECHANIZATION IN INDONESIA**

By

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INTRODUCTION

Since 1978 there appear to have been dramatic changes in the rural areas of Java. Rice production has obviously increased during this period, especially since overcoming the brown planthopper problem. Intensity of cropping patterns has increased with some regions achieving three rice crops per year. Water management has improved due to the major rehabilitation of irrigation systems and more favorable weather conditions. Fertilizer use has substantially increased because of a low and subsidized price and improved distribution. Farmer incomes have increased because of these improved cropping patterns and yield increases, though the farmers on marginal holdings have not advanced as rapidly. Real wages to landless laborers and marginal farmers for hired labor in agriculture have at least stabilized, halting the decline observed from the early 70's. Work opportunities for hired laborers both in agriculture and non-agricultural activities appear to have improved due partly to the economic advance in the major cities perhaps fueled by the foreign exchange surplus from oil exports.

Although these developments are indicators that the rural situation has improved since the widespread devastation of the brown planthoppers, it is still counterbalanced by other trends that suggest a widening gap between the rich and poor in the lowland, rural areas in Java. Land concentration by wealthy villages and urban investors has occurred and is accelerating because of a very active land market that transfers control by sales of land from small, marginal farmers to those who have capital, by renting land from small farmers to large farmers, and sharecropping of land from the large farmers to marginal farmers and landless villagers. Incomes of villagers who have few assets having perhaps increased but at a much slower rate than those villages who have sufficient assets. Women laborers being displaced in the labor markets by institutional changes that favor the employment of a few men formed into contracting groups rather than many women working individually. Rationalization of rice cultivation by employing fewer workers and thus lowering the costs of production.

The main purposes of this paper are to examine: (1) the different periods in the historical process of change in rural Java; (2) the present situation for rice production; (3) the improved cropping patterns in the lowland, rice producing regions; (4) the increased demand for non-farm employment of rural villagers; (5) labor use in rice cultivation by operations; (6) the effect of mechanizing these operations on labor absorption; and then (7) to determine the potential impact of mechanization on labor absorption in the lowland areas of Java. Although the economics of mechanization are important for understanding the use of this machinery, the really important question for rural development and stability in Java is what has happened in the labor markets for landless laborers and marginal farmers. Only if these hired laborers are able to find sufficient employment in non-farm or off-farm activities can the economics of

mechanization be encouraged to influence the increased use of machines in rice cultivation. This paper will try to achieve these purposes and to give some information on the issue of increased non-farm employment.

II. Historical Process of Change in Rural Java.

During this century rural Java has experienced prosperity (1900's - 1920's), depression (1930's), war (1941-1945), revolution (1945-1948), political instability (1948-1966), and relative economic stability (1966-1981). These forces which have come from outside of the villages have influenced rural development and the land and labor markets in the rural areas of Java. To examine the cropping patterns, labor absorption and mechanization in the lowland areas of Java, it is necessary to recognize these various periods and to further subdivide the periods after the war in order to understand what has occurred between 1948 and 1981. At the risk of over simplifying the historical process of change in rural Java, it appears that since independence the forces that have influenced the land and labor markets, rice cultivation, and rural development can be best understood if studied separately for the following periods:

1. 1948-1965 - A period of relative economic and political instability when people who owned and farmed rice land needed the support of a large number of villagers, could not appear to have much wealth, and absorbed as many workers as possible in rice cultivation. Land and labor markets were characterized by the dominance of the landless laborers' and marginal farmers' demand for access to employment and land.
2. 1965-1968 - A change in political leadership that was able to stabilize the economy, achieve reasonable political stability, and lay the foundation for improvements in the situation in rural Java, though rice cultivation remained traditional in methods and varieties.
3. 1968-1973 - Having achieved political stability, the new high yielding rice varieties were introduced and spread throughout Java. Bimas credit was available to the farmers, irrigation systems were rehabilitated, yields increased, and there were major changes in the agricultural institutions that caused a decline in labor use in rice cultivation per ha and some concentration

of land ownership. During this period the balance of power in the land and labor markets shifted more to those who had land and who could control access to employment in rice cultivation.

4. 1973-1978 - A period of crisis in rice cultivation caused primarily by the brown planthopper which devastated major areas of rice fields in Java. The labor market was unable to respond adequately to this situation and many landless laborers and marginal farmers' were unable to secure sufficient employment. The land market responded by an acceleration in the sales of land owned by the marginal farmers to wealthier farmers and people living outside of the villages.
5. 1978-1981 - With the introduction and rapid adoption of the rice varieties (IR-32 and 36) resistant to the brown planthopper, improved water control, and more rain in the dry season, the rice farmers in Java were able to greatly increase their yields per ha, able to increase the number of crops per year because of the shorter growing period of HYV's, and to provide more employment per year in rice cultivation. An associated change which is not fully understood is the increased availability of off-farm employment which may be causing labor shortages in densely populated areas. Obviously, in this situation the labor market will respond by offering higher wages to laborers. The land market in East Java will respond by prices for land increasing and marginal farmers will try to hold on to their farm land.

Before presenting the analysis in this paper, it may be useful to explain why this author may have changed some of his ideas on rural development in the lowland areas of East Java.

In the 1968 to 1973 period, the author along with others was involved in a study of rice production in 37 villages scattered throughout the major rice producing regions in Indonesia. At that time several papers were published which suggested that major changes

had occurred in labor use in rice production.^{1/} These studies concentrated on labor use reductions in harvesting and milling of rice caused by changes in institutions related to agriculture. In general this is the postulated 1968-1973 period when major institutional changes related to rice cultivation occurred in primarily lowland Central and East Java.

These researchers continued their research on rice production primarily in East Java, during the 1976-78 period although the concentration was on land and labor relationships and the impact on land tenure.^{2/} At this time the brown planthopper infestation was either still in progress or only just overcome and the villagers were still suffering from its effect.

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- ^{1/} These are:
- a. William Collier, Soentoro, Gunawan Wiradi & Makali "Agricultural Technology and Institutional Change in Java", Food Research Institute Studies, Vol. XIII, No. 2, 1974.
 - b. William L. Collier, Gunawan Wiradi, and Soentoro, "Recent Changes in Rice Harvesting Methods", Bulletin of Indonesian Economic Studies, Australian National University, Vol. IX, No. 2, July 1973.
 - c. William L. Collier, Jusuf Colter, and Sinarhadi, "Choice of Technique in Rice Milling in Java: A Comment", Bulletin of Indonesian Economic Studies, Australian National University, March 1974.

- ^{2/} Three studies have resulted from this work:
- a. Soentoro, William Collier, and Kliwon Hidayat, Land Markets in Rural Java, paper presented at the IRRI-Rural Dynamics Study's jointly sponsored Village Studies Workshop in Los Baños, Philippines on August 26 to 27, 1980.
 - b. William L. Collier, "Declining Labor Absorption (1878 to 1980) in Javanese Rice Production", presented at the Agricultural Economics Society of South East Asia's Third Biennial Meeting on November 27 to 29, 1979, in Kuala Lumpur, Malaysia, and published in Kajian Ekonomi Malaysia (Malaysian Economic Studies), Vol. XVI, No. 1 and 2, June/December 1979, pp. 102-136. The mimeographed paper presented at the meeting had 36 appendices tables on labor use that were not included in the journal article.
 - c. Soentoro, William L. Collier, and Sri Hartoyo, Land Tenure and Labor Markets in E. Java, Indonesia, Rural Dynamics Study of the Agro Economic Survey, requested by and submitted to the World Bank for their Working Paper Series, August 1981, 207 pp.

This author and Mr. Soentoro were involved in research in East Java on rice production in 1980 and this is the time period (1978-1981) when rice cultivation made major progress. This research resulted in the formulation of several propositions that need to be examined by researchers to determine their validity. These propositions are based on the author's research in East Java since 1969 and a recent two week field trip to a number of villages in East Java by the author. These villages are in a study of rural change from 1924 to 1980 and students from Negeri Jember University and staff from Brawijaya University have been living for 6 months in these villages. The purpose of presenting these propositions is to suggest what has occurred recently in Java, and then to use these ideas in trying to explain labor absorption and small rice farm mechanization.

The following propositions are rather general and based on observations in all of the ten villages:

1. In the period of approximately 1976 to 1978 there was a change in the agricultural situation in the lowland predominantly rice producing areas in East Java. At this time the brown planthopper resistant varieties were widely used and the rice farmers after two or three years of very poor harvests because of this pest were able to achieve significantly higher yields per ha per season. Combined with these varieties, the seasons were wetter, the irrigation systems more efficient, and the rice farmers were able to plant an additional crop in a twelve month period which meant they either planted two crops of rice and one of palawija or three of rice in the year. This increased cropping intensity made it possible to increase the yearly demand for landless laborers. However, the changes in institutions related to the cultivation and harvesting of rice and the use of improved agricultural tools caused a decline in labor use per ha, primarily in hired female labor. Since these rural areas studied in East Java are relatively close (50 to 100 km) to Surabaya, the many factories (plastics, mi-won, sandals, soap, bicycle) are absorbing younger workers from the rural areas, especially those with an SD diploma (grade school 6 years). Therefore, large numbers of the grown children of the slightly better off families, especially those that educated their children, are able to find sufficient work in these semi-rural located industries causing a shift in employment from within the village to outside the village. The landless laborers and their children are able to achieve a higher income since 1978 because of more job opportunities as agricultural and non-farm laborers. This situation which has lasted from 1978-1981 is based on more rain-fall, more efficient water management, pest resistant rice varieties, and more jobs in small scale industries associated with the economic viability of Surabaya and other large cities in

Java. All of these factors are subject to change due to both internal and external forces and indicate that this improved situation is still very fragile and could easily be reversed by an outbreak of rice pests, a severe draught, and/or an economic downturn affecting the viability of the industries near the large cities in Java.

2. The improved agricultural situation has caused an accelerated demand for irrigated rice land by people (both urban and rural) who live outside the villages. The 1960 land reform made it much easier for the farmers in East Java to sell their land to both residents of their village and outsiders. In areas where the gogolan system (partially communally controlled) existed in East Java, the concept of control over land changed from a communal one to individual ownership and the agricultural situation improved, there was a very much increased level of land sales. Also, associated with this was an increase in long term renting from the smaller operators to the wealthier farmers and short-term sharecropping (and kedokan) from the wealthy farmers to the landless which results in increased control over the agricultural land by those who have capital or access to credit.
3. Agricultural institutions (bawon, ngasak, sakap, simpan pinjam) that have in the past provided security, income, and perhaps welfare to landless and marginal farmers have been weakened or disappeared and will not be functional in case of natural calamities in the future. As long as the prosperity is maintained, these institutions are not an important part of village life, but if this fragile situation should collapse the landless and marginal farmers may not be as capable of surviving as in the past.
4. During the last 50 years the rural villages have evolved in the following manner:
 - a. The number of landless has greatly increased
 - b. The average size of farm operations has declined
 - c. The number of large farm operations has declined
 - d. The number of people migrating, both permanently and seasonally, has greatly increased
 - e. The wage levels in real terms have remained reasonably the same
 - f. The price of land has greatly increased

- g. The opportunities for work outside of the villages has greatly increased
- h. The role of the village leader and his being from the village has changed
- i. Population pressure on the same amount of land has greatly increased
- j. The use of purchased agricultural inputs has greatly increased
- k. The distribution of land and income is much less equal than in the past
- l. The control over land has shifted from most of the people in the village to only a few of the people in the village.

Rice Production in Java.

Corresponding somewhat to the fourth and fifth postulated periods in Java's recent history, rice production rapidly increased after 1977 was shown by the following information from the Central Research Institute of Food Crops.^{3/}

Year	<u>Rice (dry, unhusked)</u> (kg/ha)	<u>Production</u> (['] 000 metric tons milled rice)	<u>Per capita</u> <u>availability</u> (kg/person/yr.)
1960	1765	9,401	98.4
1970	2652	12,681	108.0
1975	2842	15,141	114.6
1976	2993	15,799	116.9
1977	3028	15,829	114.4
1978	3171	17,547	124.4
1979	3239	17,918	124.5
1980	n.a.	19,908	136.4

^{3/}R. H. Bernsten, B. H. Siwi, and H. M. Beachell, "The Development and Diffusion of Rice Varieties in Indonesia", paper presented at the International Rice Research Conference, April 29, 1981, p.-59.

Obviously, there has been a major improvement in rice production in the last few years. One reason is the wide spread use of brown planthopper resistant varieties beginning in the 1975/76 season, and accelerating with the introduction of PB-36 in the 1977/78 season which spread rapidly covering 36% of the Indonesian rice area in 1979/80.^{4/}

In the lowland rice areas of Indonesia the brown planthopper attacked 352,000 ha in 1975, 317,000 ha in 1976, and 562,900 ha in 1977 and caused estimated losses of 747,000 tons in 1975, 713,000 in 1976 and 1,144,000 tons in 1977.^{5/} As is clear from the increased production of rice beginning in 1978 and the widespread use of IR-36, the destruction caused by the brown planthoppers has been greatly reduced. This corresponds with the previous observation of a major turnaround in rice production in the selected villages in East Java after the 1977-78 period and overcoming the planthopper problem. In East Java, 75.1% of the rice land was planted with IR-36 and 7.4% with IR-38 in the 1979/80 season.^{6/}

Indonesia had an estimated 16.236 million hectares of land in agricultural holdings (not including estate crops) in 1977, and this is made up of the following:-

<u>Sawah</u>	<u>'000 ha</u>	
	<u>Java</u>	<u>Total</u>
Irrigated rice fields	2,628	4,025
Rainfed rice fields	377	985
Swamp rice fields	0	500

^{4/} Bernsten, et. al., Ibid, p-24.

^{5/} O. Mochida, "Brown Planthoppers Reduce Rice Production", Indonesian Agricultural Research and Development Journal, Vol. 1, No. 1 and 2, 1979, p-4.

^{6/} Bernsten, et. al., Ibid, p-29.

^{7/} World Bank, Indonesia Supply Prospects for Major Food Crops, 1979, p-87.

However, this is the land areas, and since rice is planted two and three times per year, the harvested area of rice in sawah fields was a total of 7,210,000 ha for the entire country in 1977, and 4,146,000 in Java which had a sawah rice cropping intensity of 1.4 meaning more than one crop per year. ^{8/} However, based on the author's observations in East Java, there has been a major increase in the intensity of cultivation, and perhaps in the lowland, well irrigated areas the number of crops is between 2 and 3 per year, and intensity of more than 2.0.

The cropping intensity is primarily dependent on the type of water control available to the farmers. In Indonesia in 1977 the irrigation facilities covered the following amounts of agricultural land. ^{9/}

Existing Irrigation Systems (1977)

Type	<u>Java (ha)</u>	<u>Indonesia (ha)</u>
Technical	1,631,289	2,062,175
Semi-technical	384,667	991,538
Simple	551,288	978,916
Village	532,958	1,016,469
Swamp and Tidal	0	64,210

Most of the basic rehabilitation of the existing systems on Java have either been completed or are in progress. Consequently, the future pattern of development according to the World Bank will include the construction of tertiaries, and on increasing cropping intensity in existing irrigation systems through the augmentation of dry season water supplies. ^{10/}

The number of persons 10 years and older employed in agriculture, forestry, and fishing in Java has been estimated at 18,815,000 for October 1976 and approximately 40% were women. ^{11/} Although this estimate is rather cut-of-date, it does provide an estimate that can later be used in the estimates of the impact of mechanization on this labor force.

^{8/} World Bank, Ibid, p-88.

^{9/} World Bank, Indonesia Irrigation Program Review, 1978, p-54.

^{10/} World Bank, Ibid, p-18.

^{11/} 1976 Intercensal Population Survey, Number 2, Table 9 and Labor Force Survey 1976, Number 2, Biro Pusat Statistik.

After 1976	:	Padi - Padi - Padi
		IR38 IR33 IR33
		6 ton gabah 4-1/2 ton gabah 4 ton gabah
		per ha per ha per ha

Madurejo village (Lumajang)

Before 1973	:	Padi - Palawija
		2.0 ton gabah
		per ha

After 1978	:	Padi - Palawija
		IR 36
		5 to 7 ton gabah
		per ha

Sawo village (Ngawi)

Before 1977	:	Padi - Jagung - Tembakau
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After 1979	:	Padi - Padi - Tembakau
		IR36 IR36
		6 ton gabah 6 ton gabah
		per ha per ha

Karang Malang village (Ngawi)

Before 1974	:	Padi - Padi - Jagung
		3.3 ton gabah 3.3 ton gabah
		per ha per ha

After 1978	:	Padi - Padi - Padi/Kedele
		5 ton gabah 4.2 ton gabah 3.3 ton gabah
		per ha per ha per ha

Propopo village (Madura - rainfed rice)

Before 1975	:	Padi - Tobacco
		6 ton gabah
		per ha

After 1975	:	Padi - Tobacco - Palawija
		1.0 ton gabah
		per ha

Tjlanggo village (Madura - rainfed rice)

1948	:	Padi - Palawija
		1.0 ton gabah
		per ha

1974/75 : Padi - Palawija
IR
3.0 ton gabah
per ha

After 1979 : Padi - Tobacco - Corn
IR38
3.0 ton gabah
per ha

Although this obviously does not adequately represent East Java, it does help to explain how the increased production of rice was achieved. Confirming this trend in West Java the Rural Dynamics recent study in four villages also found that in 1981 in two of the villages 59.7% and 31.9% of the irrigated fields were planted with rice 3x during the year, though they actually harvest 5 times in a 2 year period (Table 1).

Table 1 - Crop rotations in the four selected villages in West Java.

I t e m s	Villages			
	Sentul (Serang)	Jatisari (Cianjur)	Mariuk (Subang)	Balida (Majalengka)
1. Total sawah land (ha)	606	251	1110	564
2. Crop rotation (ha):				
a. Rice	556 (91.7)	24 (9.6)	0	19 (3.4)
b. Rice-secondary food crops	25 (4.15)	25 (10.0)	0	58 (10.3)
c. Rice-rice	25 (4.15)	49 (19.5)	1110 (100)	288 (51.0)
d. Rice-rice secondary food crops	0	3 (1.2)	0	19 (3.4)
e. Rice-rice-rice	0	150 (59.7)	0	180 (31.9)
f. Sugar cane	0			

Source: Faisal Kasryno, "Land Tenure and Labor Relations in West Java Indonesia: Preliminary Analysis", Rural Dynamics Study, Agro-Economic Survey, August 1981, Table 7.

() = %

V. Non-Farm Employment

Besides the information on the cropping systems, the author also interviewed village leaders, farmers, and laborers, in the villages about employment opportunities for the landless laborers and marginal farmers. Since many of these responses were contrary to the situation in the mid-70's, it was felt that not only had agriculture but also non-farm employment opportunities had undergone a major change. This may be correlated with the foreign exchange surplus from oil that began accumulating in 1977 and 1978.

Observations on non-farm employment in the East Java villages visited by the author were:

Junwangi village (Sidoarjo)

They claimed many opportunities for the children to find work. There are at least 50 people from this village who work in the plastic, mi-won, sandals, soap, and bicycle factories. They must have an SD diploma. They felt that some non-land owning families are wealthier than the land owners. This has occurred only in the last 10 years.

Jetis village (Mojokerto)

The laborers are better off now than ten years ago. They claimed that there are more opportunities now to find work outside. Most are young people and they should have an SD diploma. They estimated several hundred people from this village are working in these factories.

Jatisari village (Lumajang)

In the 1960's the landless worked in the village, but in 1980 many of these people working outside the village in the tobacco drying sheds, stores, construction projects. One village leader claimed that it is easy for the landless to find work with PROSIDA, the government, construction of houses in the cities. He estimated they can earn Rp 1500 to Rp 2000 per day. Since they plant rice 3 x per year, they felt many opportunities to work throughout the year.

Tempeh Tengah village (Lumajang)

This village is next to a town. The village leader felt that the laborers were much better off now than in 1965. He felt people can find work.

Sawo village (Ngawi)

We talked with harvesters in the field. They claimed many job opportunities, especially since planting 3x per year. The village leaders claimed that many of the young people worked outside of the village. They stated that there are many opportunities for laborers outside of the village, both in factories and in other villages. At least 40 residents work in a sugar factory in Madiun, 10 residents work in a factory in Malang.

Karang Malang village (Ngawi)

The lurah claimed that he has to look for laborers for his rice field. There are not enough and the farmers are competing for their contract labor (borongan) services. They felt that not many people are leaving the village to work outside because there are no factories close to this village.

Propo village (Madura)

The village leaders said that many people migrated from this village and very rarely return, maybe twice a year. In 1980 twenty people left this village. They work as becak drivers, traders.

Tjlanggo village (Madura)

Of the 300 families in this village, 15 have applied for transmigration and the village leader wants to lead this group. Of the village residents, there are at least 50 families who live and work outside of this village. They are in Surabaya and Malang and return only once or twice a year.

Consequently, in these villages there are sufficient opportunities for both off-farm and farm employment for the children of the farmers, the landless laborers, and the marginal farmers.

VI. Labor Use per Season in Rice Cultivation from 1875 to 1980.

In a recent paper this author and several other researchers compiled extensive data on labor use in rice cultivation between 1875 and 1980.^{12/} The information covers four periods:

^{12/} William L. Collier, Soentoro, Kliwon Hidayat, and Yayuk Yuliati, "Labor Absorption in Javanese Rice Cultivation," presented at the Technical Meeting on Labor Absorption in Agriculture, organized by the Bogor Agricultural University and the Asian Employment Program (ILO) at Bogor, Indonesia, 11-13 June 1981, 68 pp.

1875 - 1878
1924 - 1930
1968 - 1969
1977 - 1980

The labor use information for the first period (1875-1878) comes from two Dutch agriculturists who lived in East Java in the 1870 to 1890's. ^{13/} They did not give information on how they collected the data nor the number of respondents. It may be that this is based on a group interview by either the writer or one of his assistants. In the second period (1924-1930) a group of Dutch and Indonesian agricultural economists carried out very detailed studies of rice based cropping systems in primarily East Java, Madura, and South Sulawesi. They had a sample of between 20 and 60 farmers who were practically followed day by day and their labor use recorded by research assistants who were present in the villages at each step in the cultivation of the rice, tobacco, and secondary crops. The information for the third period (1968-1969) is from rice production studies by the Agro Economic Survey. Thirty farmers in each village were interviewed five to seven times between 1969 and 1972. The study was carried out in 37 villages throughout Indonesia, but included in this analysis is only those villages in the lowland areas of Central and East Java. The final period (1977-1980) has information from an M. Sc. thesis and the work of the Agro-Economic Survey in East Java. Both were very intensive studies of labor use and had between 25 and 60 respondents in each of the studies and the author of this paper was involved in one way or another in that research.

The detailed information on the four periods is in the paper mentioned in footnote 12. In summary the results of the comparison of labor use are presented in Table 2.

^{13/} a. J.N.F. Sollewijn Gelpke, Naar Aanleiding van Staatsblad, No. 110, 1878.

b. J.N.F. Sollewijn Gelpke, Rapport over de Padi - Cultur in de Afdeeling Ngrowo (1875/1876), Batavia, 1877.

c. F. A. Enklaar van Guericke, "Padicultuur, Halfjaarlykch Rapport van den Binnenlandsch Bestuur van den Gecommitteerde voor de Padicultuur in de Afdeeling Keboemen, Residentie Bagelen", Tijdschrift van het Indisch Landbouw-Genootschap, Semarang, 1876.

Table 2. Labor use in rice cultivation (hours/ha) from 1875-1980.

Period	Seed bed	Field preparation	Trans-planting	Fertil-izing & spraying	Weeding, Guarding, Water Management	Harvest-ing	Drying and storing	Total
1875-78	93	573	233	-	466	390	134	1889
1924-30	51	267	386	-	220	531	68	1523
1968-69	66	279	224	41	346	260	59	1275
1977-80	58	184	212	22	334	294	48	1152

Source: Based on the data in Appendix Table 1 in the paper mentioned in footnote 12

Obviously, labor use per ha during the last one hundred years has steadily declined. The greatest decline has been in the field preparation; in the selected villages they still use traditional methods and not padi tractors. Harvesting labor increased from 1875 -78 to 1924-30, and then declined which seems quite logical. Unfortunately, the averages do not reflect what has occurred in harvesting labor use between 1968 and 1980.

Another important aspect of changes in labor absorption in rice cultivation is what has occurred in hired female labor use. Table 3 gives the percentages of family and hired labor use, and female and male labor use for the 1926-31 period, 1968-1969 period, and the 1978-80 period.

The percentage of family and hired labor was about the same in each period, though the 68/69 period the hired labor percentage was more than the other two periods. The reason may be that the sizes of rice farm operation are somewhat larger for this period and is due more to sampling procedures than an increase in size. The major change during this 50 years period has been a shift from predominantly female labor to male labor in rice production. The major operations in which women are primarily active are transplanting, weeding, harvesting, and milling. Both transplanting and harvesting have declined in the total work hours between 1924-30 and 1977-80. This decline has been in hired female labor. Although, hand pounding is not included, this has almost completely disappeared, while before the early 70's it was a major operation, and many women in the village were able to provide their families with rice since they were paid 10% of what they hand pounded.

Table 3. Percentage labor use by family and hired labor and by female and male labor from 1926-1980 (%).

	Family	Hired	Female	Male
1926-31	40	60	66	34
1968-69	23	77	38	62
1978	45	55	39	61

Source: Based on information in Appendix Table 2 in the paper cited in footnote 12.

VII. Labor Use in Rice Based Cropping Systems for 12 Month Period (1979/80).

As indicated previously, the author feels that especially in East Java there has been a major change in the number of crops the farmers can plant in a year's period or cycle. It appears that these farmers in areas with reasonable water control have been able to add an additional crop to the yearly cycle. In some cases it has been a shift from two crops of rice to three crops of rice in a 12 or 13 month period. In other villages they have been able to plant two crops of rice and after the mid-70's add a secondary crop. A few villages with poorer water control have gone from one rice and one secondary crop (palawija), to two rice crops, or to one rice crop and two secondary crops (palawija).

Confirming these observations on changing cropping patterns, Suparmoko in his research in the Pekalan Sampean Irrigation project in East Java found that after rehabilitation the farmers were able to produce an additional crop in a twelve month period.^{14/} He clearly demonstrated that almost all of the farmers in the selected tertiary Block representing high water flow discharge in both seasons had rice-rice-rice cropping patterns in 1977 and 1978, but only a rice-palawija-

^{14/} Suparmoko, "The Impact of Irrigation Rehabilitation on Cropping Patterns, Labor Use, and Income Distribution in the Pekalen Sampean System of East Java", unpublished Ph. D. Dissertation, Department of Agricultural Economics, University of Hawaii, 1980, p. 134, 136, and 138.

palawija cropping pattern in 1972 and 1973 before the system was rehabilitated. In his selected Block of high water discharge only in the wet season and low in the dry season cropping pattern changed from rice-palawija-palawija in 1972 and 1973 to rice-rice-palawija in 1977 and 1978. Rather amazingly, his selected village that represented an area (not in the system) that had a low water flow discharge in both wet and dry seasons, also experienced a major change in cropping patterns without any rehabilitation. In 1972 and 1973 they had a rice-palawija-palawija pattern and in 1977 and 1978 it had changed to a rice-rice-palawija pattern. However, as mentioned previously, the farmers felt that there has been more rainfall in the last couple of years.

To study the impact of these changing cropping patterns, the Rural Dynamics Study and the Brawijaya Study both examined the labor use for cropping systems by estimating labor use in each of the three planting seasons in the 12 month period. Table 4 presents the estimates of labor use for each crop or maturity (tea, tobacco, fish in brackishwater ponds) by season. These village are all in East Java, through Petung and Sukosari are in hilly regions which can not be considered representative of lowland, well irrigated, major rice producing areas. Madurejo has a water problem and is unable to grow rice in the dry season but it is interesting because of the combinations of rice and secondary crops (Table 4). Sungunlegowo lies in a coastal area and has a major brackish water pond area. Some of the farmers in this village have both rice and fish but not competing for the same land. In the table the percentage of hired labor is also shown to give an indication of the absorption of hired labor which is clearly much greater than family labor for these Javanese rice farmers. Only in Petung is there a very low percentage of hired labor, and this is due to a traditional institution of exchange labor among the farmers which is still strong, partly because this village is rather isolated, in a limestone area, and on the Southern coast of East Java.

As is shown in Table 4, there are various cropping patterns by the farmers in these villages. Depending on the farmers location, water control, and credit, they choose various combinations in the three seasons. Table 5 presents the combinations and the estimated total labor used in hours per ha per year in these selected villages in East Java. Since rice cultivation normally absorbs the most labor per ha per season, the cropping patterns of rice-rice-rice in the villages of Gemarang, Sukosari, Jatisari, and Tempeh Tengah used the most labor per year (Table 5). In Gemarang the three rice crops used 13% more labor than the next highest pattern of rice-rice-soybeans. In Sukosari the rice-rice-rice pattern used 9% more labor per year than the next highest pattern of rice-rice-tobacco. The same held for the other villages with these cropping patterns.

Table 4. Labor Use (hours/ha) by commodity in Selected Villages in East Java for Three Planting Seasons in 1977/78 and in 1980.

Type of Commodity		
<u>Gemarang (n=90)</u>		
1. Rice, WS 77-78 (first season)	1071	76
2. Rice, DS 78 (second season)	1056	74
3. Rice, DS 78 (third season)	894	84
4. Soybeans (third season)	500	72
<u>Sukosari (n=90)</u>		
1. Rice, WS 77-78 (first season)	790	91
2. Rice, DS 78 (second season)	955	93
3. Rice, DS 78 (third season)	1026	94
4. Corn (third season)	462	74
5. Tobacco (second season)	783	87
<u>Sungunlegowo (n=90)</u>		
1. Rice, WS 77-78 (first season)	154	67
2. Rice, DS 78 (second season)	280	72
3. Tambak fish, WS 77-78 (first season)	693	13
4. Tambak fish, DS 78 (second season)	655	7
<u>Petung (n=75)</u>		
1. Rice, WS 77-78 (first season)	1197	16
2. Rice, DS 78 (second season)	1209	12
3. Cassava (one year)	1089	14

Table 4. (cont.)

Type of Commodity	Total Labor Hours Used per ha	Percentage of Hired Labor
<u>Jatisari (n=24) 1980</u>		
1. Rice (first season)	1102	58
2. Rice (second season)	1131	63
3. Rice (third season)	1080	66
4. Corn (second season)	776	18
5. Corn (third season)	807	65
6. Soybeans (second season)	389	82
7. Soybeans (third season)	516	91
<u>Tempeh Tengah (n=10) 1980</u>		
1. Rice (first season)	1153	91
2. Rice (second season)	1106	91
3. Rice (third season)	1254	89
4. Corn (second season)	410	80
5. Corn (third season)	639	79
6. Soybeans (second season)	439	95
7. Soybeans (third season)	301	97
8. Peanuts (third season)	238	100
<u>Madurejo (n=20) 1980</u>		
1. Rice (first season)	1156	89
2. Corn (first season)	504	84
3. Tobacco (first season)	1638	35
4. Corn (second season)	561	79
5. Soybeans (second season)	600	98
6. Peanuts (second season)	325	21
7. Corn (third season)	589	79
8. Peanuts (third season)	148	50

Source: Field studies sponsored by the Agro Economic Survey and Brawijaya University.

v/ The crop was destroyed by rats is the reason the labor use is low.

VIII. Labor Use in Gemarang and Sukosari Villages in 1969 and 1978, and Jatisari Village in 1930 and 1980.

The previous tables on labor use are made up of a large number of villages in each period and a reasonable sample of respondents for each village. Yet, the value of the comparisons is greatly reduced because these are mostly not the same villages in each period. In Gemarang village (Ngawi Kabupaten) and Sukosari village (Jember Kabupaten) in East Java the labor use data for 1969 and 1977/78 are from the same village though not the same respondents. Since the averages are by operations in Table 6, they can be compared to determine which ones have changed during the 10 year period.

Gemarang is very interesting because it clearly indicates the trends hinted at in the previous table. The labor use has drastically declined and since there have been a number of studies in Gemarang, one can conclude that it is due to institutional change that has reduced labor use in the rice harvest. In the 1969 period anyone could join the harvest but in 1978 there were contractor groups of males who harvested with sickles. Weeding has also declined and is partly due to the use of straight row planting and a rotary weeder in the 1977/78 period. Weeding was done by many women, but now they are being replaced by one or two men, pushing the rotary weeder in the rows. Transplanting has also declined and this greatly reduces the number of hired female labor. Gemarang can be considered a lowland village in a major rice producing area, but Sukosari is located in a hilly area where corn, cassava, and tobacco predominate. In this village labor use in rice production was quite low in both periods, though rather surprisingly harvest labor increased. Either Sukosari experienced the labor reducing changes in institutions before 1969, or these more upland village have different characteristics than the lowland villages.

In 1924 to 1931 several agricultural economists in Indonesia carried out very detailed studies of labor use for various cropping systems. One of these studies was in Lumajang Kabupaten in 1929/30 and Table 7 gives the labor use data for one of the villages in both 1929/30 and in 1980 which is from a study comparing the village over this 50 year period. The major decline was for the harvesting and transplanting activities.

To compare labor use per ha per year in the 1969 period and in the 1977 and 1978 periods and the changing cropping patterns' effect on labor absorption, the two villages of Gemarang and Sukosari provide interesting and representative examples of a lowland rice village and a hilly area multicropping village. In 1969 the farmers could only grow two rice crops per year, yet in 1977 and 1978 period most of the farmers could cultivate rice three times per year.

Table 5 . Labor utilization by type of land and cropping sequence (one year production cycle)

Type of Land and Cropping Sequence	Total labor hours per ha per year						
	Gemarang	Sukosari	Petung	Sunguniegowo	Jatisari	Tempoh Tengah	Madurejo
A. Sawah							
1. Rice-rice	2132	1745	2406	2434	2233	2259	-
2. Rice-rice-soybeans	2632	-	-	-	2749	2560	-
3. Rice-rice-corn	-	2207	-	-	3040	2898	-
4. Rice-tobacco-corn	-	2035	-	-	-	-	-
5. Rice-rice-tobacco	-	2528	-	-	-	-	-
6. Rice-rice-rice	3021	2771	-	-	3313	3513	-
7. Rice-corn-corn	-	-	-	-	2685	2202	2306
8. Rice-soybeans- soybeans	-	-	-	-	-	1893	-
9. Tobacco-corn-corn	-	-	-	-	-	-	2788
10. Rice-corn-peanuts	-	-	-	-	-	-	1865
B. Upland							
1. Cassava (one year)	-	-	1089	-	-	-	-
C. Brackish waterponds (Tambak)							
1. Wet and Dry Seasons	-	-	-	1348	-	-	-

Source: Studies by the Agro Economic Survey and Brawijaya University.

Table 6. - Average labor use (hours/ha) in rice cultivation in Gemarang and Sukosari villages in East Java from 1969 to 1978.

Village and period	Seed bed	Field preparation	Trans-planting	Fertilizing & spraying	Weeding, Guarding, Water Management	Harvesting	Drying and storing	Total
<u>Gemarang:</u>								
1969 Local	69	393	303	53	518	647	49	2112
1969 HYV	40	245	249	29	366	678	33	1640
1977/78 HYV	32	197	169	n.a.	333	340	n.a.	1071
1978 HYV	37	220	188	n.a.	285	326	n.a.	1056
<u>Sukosari:</u>								
1969 Local	111	231	243	0	346	125	16	1072
1969 HYV	143	257	202	35	354	83	50	1124
1977/78 HYV	58	112	147	n.a.	228	185	n.a.	790
1978 HYV	66	152	184	n.a.	337	216	n.a.	995

Source: Village studies by the Agro Economic Survey

Table 7. - Average labor use (hours/ha) in Rice Cultivation for Jatisari (Djatisari 1930), Lumajang Kabupaten, East Java in 1929/30 and 1980.

Year	Seed bed	Field preparation	Trans-planting	Fertilizing & spraying	Weeding, Guarding, Water Management	Harvesting	Drying and storing	Total
1929-30	39	223	258	-	290	501	68	1377
1980	38	172	165	24	425	220	58	1102

Source: The 1929/30 data is from: J. van der Ploeg and Koesno Adirno, "Landbouwkundige Beschrijving van het Regentschap Loemajang (Oost-Java)" *Landbouw*, 1935/36, Buitenzorg, Indonesia, pp.224,225.

The 1980 data is from a study carried out by the author and two staff members of Brawijaya University.

Therefore, labor absorption for a 12 month period in these two villages was the following:^{15/}

	<u>Wet Season</u>	<u>Dry Season</u>	<u>Total hours/ha</u>
Gemarang:			
1968 and 1969	Rice (Local) 1681 hrs/ha	Rice (Local) 2112 hrs/ha	3793
1968 and 1969	Rice (HYV) 1744 hrs/ha	Rice (HYV) 1640 hrs/ha	3384
Gemarang:			
1977 and 1978	Rice (HYV) 1071 hrs/ha	Rice (HYV) Rice (HYV) 1056 hrs/ha 894 hrs/ha	3021
Sukosari:			
1968 and 1969	Rice (Local) 1072 hrs/ha	Rice (Local) 1072 hrs/ha	2144
	Rice (HYV) ^{16/} 1124 hrs/ha	Rice (HYV) 1124 hrs/ha	2248
Sukosari:			
1977 and 1978	Rice (HYV) 790 hrs/ha	Rice (HYV) Rice (HYV) 955 hrs/ha 1026 hrs/ha	2771

In Gemarang which was selected as representative of lowland, rice producing, Javanese villages, the labor absorption in rice cultivation declined even though the farmers added a third price crop in the 12 month period in 1977 and 1978. The decline was 20% if comparing the cropping pattern of rice (local variety) - rice (local variety) in 1968 and 1969. If high yielding varieties in 1968 and 1969 are compared with the 1977 and 1978, then the labor use in rice cultivation for a 12 month period declined by 12%.

^{15/} More complete information on labor use in these villages is in the study by Collier, Soentoro, Hidayat, and Yulianti shown in Footnote 12.

^{16/} Since there was not an estimate for the first season, the one estimate was used for both seasons.

In Sukosari which is in hilly region, the labor use per 12 months, increased during the 10 year period by 23% if comparing local varieties and high yielding varieties (HYV's), and by 19% if comparing HYV's in both periods.

Obviously, this information is not complete enough to make generalizations about Javanese rice production during the last 10 years. However, it does provide an indication that labor use per ha per crop has declined in lowland villages though in areas where they can now produce three crops, this decline has been somewhat offset by the change in cropping patterns since they can produce an additional crop.

IX. Small Rice Farm Mechanization

Rice milling. Beginning in the early 1970's a technological revolution occurred in rice milling in Indonesia. The traditional method of hand pounding the rice by women who were generally paid 1/10 of what they pounded was very quickly displaced by small rice mills (motor powered hullers) owned by a few wealthy men in each village.^{17/} The use of these rice hullers was the first step in small farm agricultural mechanization in Java. The motive force behind this change in technique was clearly economic since the farmers paid \$1.45 per 100 kg. of gabah (rough rice) for handpounding and only \$.54 per 100 kg for the small rice mills (hullers). Farmers in the 12 villages studied in 1972/73 used an average of 2 hired female workers for 8 hours per day to hand pound rice. As a potent of future developments it was estimated that 1,200,000 jobs were lost in each rice harvest in Indonesia because of this mechanization of milling of rice.^{18/} Furthermore, this was a shift from employing primarily women from landless laborer and marginal farmer families to young men with some mechanical skills.

^{17/} This situation was discussed in the following articles:

a. C. Peter Timmer, "Choice of Technique in Rice Milling on Java", Bulletin of Indonesian Economic Studies, Australian National University, Vol. IX, July 1973.

b. William L. Collier, Jusuf M. Colter, and Sinarhadi, "Choice of Technique in Rice Milling in Java: A Comment", Bulletin of Indonesian Economic Studies, Australian National University, March 1974, pp. 104-121.

^{18/} William L. Collier, Jusuf M. Colter, and Sinarhadi, Ibid, p.

Rice Harvesting. The next step in small rice farm mechanization was the shift from the hand held rice knife (ani-ani) to the sickle for harvesting rice. Although there have been reports of harvesters using sickles in the early 1900's^{19/}, this very simple tool only began to be used on a wide scale in the early 1970's. Two studies by the Agro Economic Survey based on interviews of a large number of farmers in Central Java in January 1973 were perhaps one of the first to report on this second step in mechanization of rice cultivation.^{20/} This shift was greatly accelerated in the first few seasons by institutional changes in the rice harvest, primarily the partial closing of the rice harvest by using the tebasan institution. Yet, the switch to the sickle in the last few years is no longer associated with tebasan but has spread throughout East and perhaps Central Java. Labor use in the rice harvest has been reduced by one third to one half as shown in Table 8.

19/

W. F. Wertheim and the Siauw Giap, "Social Change in Java 1900-1930", Pacific Affairs, Fall 1962, p-228

20/

a. William L. Collier, Gunawan Wiradi, and Soentoro, "Recent Changes in Rice Harvesting Methods: Some Serious Social Implications", Bulletin of Indonesian Economic Studies, Australian National University, July 1973.

b. William L. Collier, Soentoro, Gunawan Wiradi, and Makali, "Agricultural Technology and Institutional Change in Java", Food Research Institute Studies, Stanford University, Vol. XIII, No. 2, 1974, pp. 169-194.

Table 8. Comparison of harvesting tools, yields and wages in three villages in Central and East Java.

	Banyutowo Central Java		Gemarang East Java		Sumokembangsri East Java	
	1969	1973	1969	1979	1972	1977/78
1. Harvesting tool used	ani-ani	sickle	ani-ani	sickle	ani-ani	sickle
2. Rice variety planted	Local, C4, IR5	HYV, C4	Local, HYV	HYV	Local, HYV	HYV
3. Ave. rice yield (ton gabah/ha)	3.22	4.83	3.16	5.78	3.44	5.47
4. Harvesters share (%)	10	8	10	9	20	20
5. Labor use in harvest (hrs/ha)	422	321	647	340	670	431
6. Harvest labor productivity (kg/hour)	7.6	15.0	4.9	17.0	5.1	12.7
7. Harvesters wage (Rp/hour)	.76	1.20	.50	1.51	1.0	2.50

SOURCE: Various studies by the Agro Economic Survey.

What this does not indicate is that the use of a sickle means many more men and younger women participate in the harvest whereas in the past older women were primarily involved in the rice harvest with the ani-ani.

A more recent institutional change which affects the rice harvest is Gepyokan. Previously, labor use in the rice harvest in Gemarang village was shown to have declined by more than 50% between 1969 and 1978 (Table 6). What would cause a major shift of this magnitude in a densely populated village and thus cause a major decline in the

demand for non-family labor? The explanation in Gemarang is the emergence of a new institution and change in tools to harvest rice. In this village there was a change in rice harvesting tools from the ani-ani hand held rice knife to the sickle together with the emergence of harvest laborer groups which are called gepyokan and is a new institution in this village. This term in Javanese means to thresh a bundle of stalk paddy (seikat padi) and in this instance means a group of harvest laborers who use a sickle and thresh the paddy in the field. A significant change is that the groups contract with the farmers to harvest which means that the harvest has been closed to others. In the past anyone could join the rice harvest but with this institution the leader of the gepyokan group contacts the farmer, bargains about the price, and competes with others for the job contract.

The number of members in a gepyokan group varies between 8 and 15 males which is also a major change from women doing the rice harvesting to men doing it. Of the 31 sample respondents who joined these gepyokan groups 77% stated that their membership was fixed and permanent, and that 40% had a specific leader. Any member of a gepyokan group must pay a fee of Rp 500 to Rp 1500 per person. This money is used to purchase plastic sacks and other items for threshing the paddy. The requirements for membership in gepyokan group are that the members must be male and have a strong physique, their age should be from 18 to 45, though most are between 25 and 34 years of age, and have a similar social status. ^{21/}

This gepyokan system emerged in Gemarang village in 1974, six years after the introduction of new rice varieties. The first gepyokan group appeared after a rice harvesting demonstration of using the sickles to cut the stalks and then threshing in the field in the village's trial plots (demplot) set up by the extension service. Then, the use of this gepyokan system steadily increased and in the planting season of 1978/79, apparently 88% of the sample farmers in the study were using the gepyokan groups to harvest their rice. The farmers indicated that the main motive was economic and was to reduce the number of laborers in the harvest. Thus, these farmers in employing gepyokan groups are thinking in a rational economic way. Yet, from the view of the harvesters, this gepyokan system discriminates against women and those males who are older than 45 years in this rural labor market.

^{21/}

Sri Hartoyo and Suradi, "Gepyokan: Suatu Bentuk Kerjasama Buruh Tani Di Pedesaan (Kasus di Desa Gemarang, Jawa Timur)", Research Note no. 1, Rural Dynamics Study East Java, Agro Economic Survey, 1979, p-18.

Of the 52 respondent families in the study by the Agro Economic Survey whose main income is from farm labor, sixty percent have a family member in a gepyokan group, only 15% were laborers in a harvest using the ani-ani tool, and 25% did not joined a harvest. The laborer households who were not able to participate in a gepyokan group were headed by divorced or widowed women and families who did not have any young, male members. Thus, due to the spread of this institution, approximately 40% of the laborer households were prevented from joining the rice harvests in Gemarang. These laborers however find work in the sugar cane fields, plant secondary crops, and are involved in non-agricultural work.

Weeding. The third innovation in Javanese rice cultivation is the use of a very simple, rotary weeder that is pushed by one man down the rows between the rice plants. This hand pushed weeder was introduced at the time farmers began to transplant their seedlings in a straight row. Although the date of this is not definite, the extension service has been encouraging straight row planting in their Panca Usaha (improved practices) program of advice to the farmers for the last 10 years. At the present time the use of these weeders is a common sight.

Examining the impact of these weeders on rice cultivation, Sinaga observed that:

The tendency is for hand weeding (women) to be replaced by "landak/ceplak" (toothed/rotary weeders), used by men and only possible when straight-row planting is used: this type of planting is almost universal in Sukagalih. Eight man-days weeding with the landak replaces approximately 20 women-days of handweeding.^{22/}

Since one usually sees only one or two men with weeders in a field, the estimate of 8 mandays per ha may be rather high, yet this still has reduced labor use by 50% and shifted from women to men doing this operation.

Land preparation. In Java there are many methods for land preparation in the irrigated fields (sawah). These methods include only men using a large hoe (pacul) to prepare the field; both carabao and men working in the field; men actually replacing the carabao and

^{22/} Rudolf S. Sinaga, "Rural Institutions Serving Small Farmers in Village of Sukagalih, Garut Regency, West Java", prepared for the ESCAP Expert Group meeting on Rural Institutions Serving Small Farmers, Bangkok, December 13-17, 1976, p-6.

pulling the plow; and power tillers (padi traktor). These power tillers have been in use for at least 10 to 15 years in certain areas in Java. One of the first published reports was:

In one of the villages there are nine padi tractors owned by the larger farmers. These farmers want padi tractors and feel it is better to use these tractors than hired laborers. One padi tractor can plow one hectare of sawah in one day and half of the night. During the soil preparation period one padi tractor could handle approximately 24 to 30 hectares, a process which would otherwise entail ten laborers and seven kerbau and one person with each kerbau to prepare one hectare of sawah. If the nine padi tractors were each used on 20 hectares of sawah, in the preparation period, this would displace from 2060 to 5400 man days of labor.^{23/}

Besides this brief report, a more systematic study of hand tractors found that "without a concomitant increase in production, employment losses for each 5-hp tiller adopted and used at three fourths utilization are an estimated 128 and 688 days per year for the displacement of carabou and manual methods, respectively"^{24/}

Consequently, it was found in these early studies that the power tillers were creating serious labor displacement problems in these villages. In a situation where landless laborers are unable to find other employment, this type of displacement can create disruptions in the harmony of village life.

^{23/}William L. Collier, Jusuf Colter, and Chaerul Saleh, Observations on Recent Rice Problems at the Farm Level in Subang Kabupaten", Research Notes, No. 12, December 1972, p.3

^{24/}Richard Morris, The Potential Impact of Mechanical Land Preparation in the Indonesian Small-holder Production Sector, International Rice Research Institute, Bogor, 1975, p. 101.

During the late 1970's these power tillers spread throughout the lowland regions in West Java (Karawang, Subang, Indramayu) where the holdings are relatively large and population pressure less intense than in East and Central Java. In these two regions the size of the larger farm operations are much smaller, perhaps 10 to 20 ha in West Java and 2 to 5 ha in East and Central Java, so that the spread of these power tillers has been much less rapid and they are still a rather rare sight in Central and East Java.

Threshers, Harvesters, Direct Seeders, Transplanters and Dryers. In the various studies of rural villages in Java which have examined small rice farm mechanization there is not yet any mention of motor powered threshers, harvesters, direct seeders, transplanters or dryers. Although this type of machinery may possibly be in Java, it is almost definitely only in the trial stage. The rice huller is the only motor powered equipment that is widespread throughout Java, though the power tiller is obviously popular in certain areas in Java, and could become widespread in the future. Therefore, the use of small rice farm machinery is still very limited, and time remains to analyze the impact of this machinery on the social and economic conditions in the rural villages of Java. This analysis should include an estimate of the costs and returns to the farmers, an estimate of the amount of labor displaced by the machinery, and an estimate of the impact of the machinery on the incomes and employment opportunities of the landless laborers and marginal farmers. An important related study is the employment potential and present demand for workers from these rural villages in both agricultural and non-agricultural activities. If there are sufficient job opportunities available for these laborers, then the economic potential should be the main criteria for adoption by the farmers. In the next section of this paper, only the possible labor displacing impact of this further mechanization will be studied. The question of non-agricultural employment has not yet been adequately examined.

X. Potential Impact of Mechanization of Small Rice Farms in the Lowland Areas of Java.

In order to determine what the potential impact of mechanization will be on employment in Java, this study has used information from IRRI on the various types of small rice farm machinery. Table 9 gives the field capacity, labor required, and labor use per ha of the IRRI equipment. Perhaps this information is for the ideal situation, but it does give us estimates of labor use. In this table, the labor use per ha for most of the equipment is quite low.

Using these estimates, in Table 10 is a hypothetical Javanese farm that is completely mechanized. It has an IRRI transplanter, IRRI power tiller, IRRI plow sole fertilizer applicator, IRRI reaper for harvesting, and an IRRI portable thresher. This completely mechanized small rice farm uses only 111.1 man hours per ha of labor (Table 10). One can speculate that a small farmer could actually cultivate rice by using only his family labor also in the table are the averages for the various cultivation operations of a traditional rice farm. Three estimates are presented, the first is the average of all the estimates for the 1968/69 season in Table 2, the second is the 1969 estimates for Gemarang village, and the third is the 1929/30 labor use estimates in Jatisari village. These time periods are assumed to be before the institutional changes and limited use of farm tools occurred. Next, in the table are estimates of the average labor use for the present day representative farm which has experienced some institutional changes especially in harvesting. The estimates are from the previous tables for the averages in 1977-80, Gemarang 1978, and Jatisari 1980. The last column in Table 10 has a hypothetical Javanese small rice farm that is using a power tiller (padi traktor), rotary weeder, and the gepyokan rice harvesting system. The total labor use for this modern (but hypothetical) farm is 508 hours per ha per season, the present day representative farmers used twice as much labor, and the traditional farmers employed from 1275 hours to 1640 labor hours per ha (Table 10). The completely mechanized farm using only 111.1 man hours thus eliminates most hired labor, all female labor, and a substantial amount of family labor if we recall in Table 3 that the Javanese farms in the 1978-80 period had 39% female labor and 55% hired labor. Unfortunately, there was not enough information available on the investment costs to compare the economic impact on the farmers. Though, one can assume that since labor cost is the main component of the production cost, the operating costs of the mechanized farm are considerably lower. However, only small rice farms in the perhaps 5 to 20 ha range would be able to purchase all of this equipment.

Although it is a rather unfair comparison because of the impossibility of mechanizing all of the irrigated land in Java, yet in Table 11 the impact on employment is very striking. If the irrigated land area of 2,628,000 ha is multiplied by the average total hours of labor used in cultivating rice for the four types of operation. Obviously, the mechanized farm model greatly reduces labor use on Java. As mentioned this is not a realistic model. However, tables 10 and 11 do illustrate what may occur if the transplanter or the harvester are used by at least the larger farmers in Java.

Table 9. - Capacity and labor use of IRRI developed small rice farm mechanical equipment

Type	Field capacity	Labor	Labor use per ha
IRRI power tiller	1 to 1½ ha/ 8 hrs day	one man	8 man hours/ha
IRRI transplanter	.25 ha/day	one man	30-35 man hours/ha seedbed 30-35 man hours/ha transplanting
IRRI plow sole fertilizer applicator	10% increase in time required for plowing only	one man	.8 man hours/ha
IRRI reaper	.3 ha/hour	one man	3.3 man hours/ha
IRRI portable thresher	600 kg/hour (rough rice)	2 to 3 men	(assuming yield of 5 ton rough rice) 21 man hours/ha
IRRI Vertical bin batch dryer	2 ton paddy/load	n.a.	n.a.

Source: Various information bulletins distributed by the Agricultural Machinery Development Program, International Rice Research Institute, Los Banos, Philippines.

The information on the reaper is from the IRRI Reporter, March 1981.

Table 10. - Labor use in rice production for Javanese rice farmers using traditional methods, present day representative farm and completely IRRI mechanized farm per ha per season (hours/ha)

Operation	Completely mechanized by IRRI <u>a/</u>	Traditional rice farm in Java			Present farm in Java			Hypothetical Javanese farm with new institutions	
		Average for 1968/69 ^{b/}	Gemarang 1969 HYV <u>c/</u>	Jatisari 1929/30 <u>d/</u>	Average for 1977/80 ^{e/}	Gemarang 1978 HYV <u>f/</u>	Jatisari 1980 <u>g/</u>		
Seedbed	35 man hours	66 man hours	40 man hours	39 man hours	58 man hours	37 man hours	33 man hours	58 man hours	Ave. 1977-80
Field preparation	16 man hours (2x plow)	279 man hours	245 man hours	223 man hours	184 man hours	220 man hours	172 man hours	24 man hours (2x plow)	Padi traktor (p-36)
Transplanting	35 man hours	224 woman hours	249 woman hours	258 woman hours	212 woman hours	188 woman hours	165 woman hours	212 woman hours	Ave. 1977-1980
Fertilizing & Spraying	.8 man hours	41 man hours	29 man hours	-	22 man hours	n.a.	24 man hours	22 man hours	Ave. 1977-1980
Weeding, etc.	assumed weedicide 0.0 man hours	346 woman hours	366 woman hours	290 woman hours	334 mixed man+woman hours	285 mixed man+woman hours	425 mixed man+woman hours	64 man hours	Rotary weeder (p-36)
Harvesting	3.3 man hours	260 woman hours	678 woman hours	501 woman hours	294 mixed man+woman hours	326 mixed man+woman hours	220 mixed man+woman hours	80 man hours	Gepyokan 10 men @ 8 hrs/ha (p-33)
Threshing	21 man hours	n.a.	n.a.	n.a.	included in harvest	included in harvest	included in harvest	included in harvest	(p-33)
Drying and storing	n.a.	59 woman hours	33 woman hours	68 woman hours	48 woman hours	n.a.	58 woman hours	48 woman hours	Average 1977/80
Total	111.1 man	1275 hours	1640 hours	1377 hours	1152 hours	1056 hours	1102 hours	508 hours	

Table 10. (cont.)

- a/ Based on information in Table 9
- b/ Information from Table 2 for 1968-69
- c/ Information from Table 6 on Gemarang village for 1969 using HYV's
- d/ Information from Table 7 on Jatisari for 1929-30
- e/ Information from Table 2 for 1977-80
- f/ Information from Table 6 on Gemarang for 1978 HYV's
- g/ Information from Table 7 on Jatisari for 1980

Table 11: - Total labor use in rice cultivation for the 2,628,000 ha of irrigated land (sawah) in Java for one season.

Type of small farm operation	Ave. hours per ha per season	Total labor use on 2,628,000 ha assuming entire area in type
	<u>hours</u>	<u>hours</u>
Labor use IRRI mechanized	111.1	291,970,800
Labor use Hypothetical Java	508	1,335,024,000
Labor use Modern Java	1152	3,027,456,000
Labor use Traditional Java	1275	3,350,700,000

Source: Table 10 and page 11.

CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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