SUSTAINABLE AGRICULTURAL DEVELOPMENT: THE ROLE OF INTERNATIONAL COOPERATION

PROCEEDINGS
OF THE
TWENTY-FIRST
INTERNATIONAL CONFERENCE
OF AGRICULTURAL ECONOMISTS

Held at Tokyo, Japan
22–29 August 1991

Edited by
G.H. Peters, Agricultural Economics Unit, Queen Elizabeth House,
University of Oxford, England
and
B.F. Stanton, Cornell University, USA
Assisted by
G.J. Tyler
University of Oxford

INTERNATIONAL ASSOCIATION OF
AGRICULTURAL ECONOMISTS
QUEEN ELIZABETH HOUSE
UNIVERSITY OF OXFORD

1992

Dartmouth

KEIJIRO OTSUKA*

Green Revolution, Agrarian Structure and Income Distribution in Asia

INTRODUCTION

The rice sector in developing countries of Asia has achieved remarkable productivity growth for the last two decades as a result of the adoption of high-yielding modern rice varieties (MVs) – a phenomenon popularly known as the green revolution. As of now, about 50 per cent of the rice area is planted to MVs. The productivity effect of MVs, however, is constrained by production environments, particularly by the availability of irrigation water (Barker and Herdt, 1985). As a result, a significant productivity gap has emerged between favourable and unfavourable rice-growing areas. The critics argue that the green revolution has by-passed unfavourable areas, where farm populations are generally poor, and worsened the regional income distribution (for example, Lipton and Longhurst, 1989).

However, the impact of the MV adoption on the regional income distribution depends not only on the direct effects of MVs on productivity and factor demands, but also on the indirect effects on factor markets. Since the adoption of MVs increases labour demand, particularly for hired labour, wage rates will increase in favourable areas in the short run. In the longer run, higher wages in favourable areas may induce interregional migration from unfavourable to favourable areas leading to the equalization of regional wages. Furthermore, farm size in favourable areas may decline through land and tenancy market adjustments relative to unfavourable areas, as the demand for land increases with the MV adoption. Such factor market adjustments may alleviate the regional income inequality of farming households. Also important may be the availability of profitable alternative crops and lucrative non-farm employment opportunities in unfavourable areas.

The green revolution literature focused on the productivity impact of MVs in favourable areas without due attention to the factor market adjustments and the resulting income distribution between favourable and unfavourable areas. In order to explore the distributional consequences of the green revolution in Asia, the International Rice Research Institute (IRRI) organized the international collaborative project on the direct and indirect impacts of MV technology on income distribution in the Philippines, Indonesia, Thailand, Bangladesh, India and Nepal. Two sets of village surveys were conducted, for 1985–7 in the Philippines and for 1987–8 in other countries. The first covers 40 to 70

*Tokyo Metropolitan University, Japan.

villages across wide areas, and collects village-level information on technology adoption, rice production, factor prices and agrarian structure represented by farm size, tenure distribution and the incidence of landless labourer households. The second is an intensive survey of farmer and landless labourer households in several selected villages in representative production environments in each country, and aims to obtain detailed information on rice production and household annual income, including income from non-rice and non-farm sources. For the sake of cross-country comparability, essentially the same sets of survey questionnaire have been used.

This paper reports the major findings of this project. First, I summarize the adoption patterns of MVs and the productivity differential across production environments, using the extensive survey. Second, also using the extensive survey, I examine the difference in the agrarian structure across production environments. Third, I compare annual household income per capita by production environment and by status of households (owner-cultivator, tenant, and landless agricultural labourer), based on the intensive survey. Finally, I discuss the policy implications of our findings for future rice research and alleviation of rural poverty.

MV ADOPTION AND REGIONAL PRODUCTIVITY DIFFERENTIAL

It is widely believed from the green revolution literature that larger farmers adopt MVs more rapidly than smaller farmers and that tenants, particularly share tenants, are slower to adopt MVs than owner-cultivators. It is consistently found in our country studies, however, that those socio-economic factors did not significantly affect the adoption of MVs (for example, David and Otsuka, 1991). This may be because the dynamic process of MV adoption had largely ended by the late 1980s and because share tenancy and small farms are not generally inefficient in Asia, as argued by Hayami and Otsuka (1991). In contrast, favourable physical production environments, particularly the presence and the quality of irrigation as well as the rain-fed condition free from flood and drought problems, were decisive factors affecting MV adoption. It is also statistically found that productivity of rice production, as measured by rice yield, is primarily affected by the production environments and the adoption of MVs.

Table 1 reports the adoption rate of MVs during the wet season across highly irrigated areas, favourable shallow rain-fed areas without or with very low rates of irrigation, and unfavourable rain-fed areas prone to drought and flood. It is clear at a glance that the adoption rate of MVs is positively associated with the production environments. In Indonesia and the Philippines, where rainfall is relatively plentiful during the wet season and the problem of drainage is not generally serious, the rate of MV adoption is particularly high, not only in irrigated areas but also in favourable rain-fed areas. It is low in Bangladesh, where the production environments are harsh because of the climatic and topographical conditions prone to flood and drought. In unfavourable rain-fed areas, the adoption rate is low in Nepal and the Philippines mainly because of the drought problems in hilly environments and

TABLE 1 *Adoption rate of MVs and paddy yield by country and environment*[a]

Country	Irrigated	Favourable rain-fed	Unfavourable rain-fed
Bangladesh[b]			
MV (%)	31	20	13
Yield (t/ha)	3.6	2.6	2.5
India[c]			
MV(%)	100	66	—
Yield (t/ha)	5.8	3.5	—
Indonesia[d]			
MV (%)	90	81	0
Yield (t/ha)	5.5	4.1	1.7
Nepal[e]			
MV (%)	74	46	24
Yield (t/ha)	3.0	2.5	1.8
Philippines[f]			
MV (%)	97	99	42
Yield (t/ha)	3.6	3.3	2.6
Thailand[g]			
MV (%)	71	11	0
Yield (t/ha)	3.8	2.2	1.8

Notes: [a]The data pertain to the wet season between 1985 and 1988.
[b]Source: Hossain *et al.* (1991). Irrigated area refers to highly irrigated area, favourable rain-fed area to low irrigated area, and unfavourable rain-fed area to drought- and flood-prone areas.
[c]Source: Ramasamy *et al.* (1991). Favourable rain-fed area refers to rain-fed area with supplementary tank irrigation. The data pertain to Tamil Nadu.
[d]Source: Sudaryanto *et al.* (1991). Unfavourable rain-fed area refers to saline water area in South Kalimanthan.
[e]Source: Thapa and Upadhyaya (1991). Unfavourable rain-fed area refers to drought-prone area mostly located in the hills.
[f]Source: David *et al.* (1991). Unfavourable rain-fed area refers to both flood- and drought-prone areas.
[g]Source: Isvilanonda and Wattnutchariya (1991). Owing to the distinctly different patterns of rice production among major rice-growing regions, only data from Central Plain are shown. Unfavourable rain-fed area refers to deep-water area growing floating rice.

even zero in Indonesia (South Kalimanthan) and Thailand (Central Plain), where flooding is a major problem. Thus, MVs favour favourable areas, even though MVs recently developed are more resistant to drought and submergence problems than the 'first-generation' MVs.

Reflecting partly the differential adoption of MVs and partly the differences in the physical production environments, rice yields are significantly higher in more favourable areas (Table 1). The average yields range from 3 to 6 tons per hectare in irrigated areas, 2 to 4 tons in favourable rain-fed areas and 1.7 to 2.6 tons in unfavourable areas. Yields in irrigated areas are particularly high in India (Tamil Nadu) and Indonesia (mostly Java) partly because of the high adoption rate of MVs and partly because of the well-maintained gravity irrigation system. In Nepal, yield in irrigated areas is lowest among the six countries because popular MVs are not IRRI-type semi-dwarf, fertilizer-responsive varieties but 'Masuli', which is more tolerant to drought but less high-yielding than IRRI-type MVs.

In our extensive survey, we collected recall data on yields of traditional varieties (TVs) before MVs were introduced. According to the farmers' recall, yields of TVs have been essentially unchanged over time and were largely similar across production environments. Therefore the adoption of MVs undoubtedly created the significant yield differential across production environments. Though unreported here, our country studies also found that MVs were conducive to multiple cropping of rice because of the shorter growth duration and non-photo period sensitivity. Thus the statistical evidence strongly supports the popular view that the green revolution has created the large productivity gap between favourable and unfavourable areas.

GREEN REVOLUTION AND AGRARIAN STRUCTURE

Our country studies found that MVs as well as irrigation significantly increased the labour use per hectare by increasing labour requirements for crop care, harvesting and threshing. Particularly pronounced was an increase in the hired labour use, which in some cases led to the absolute decline in family labour use. Because of the increased rice cropping intensity with the adoption of MVs, the labour use per year further increased. Therefore we expect that the wage rate in favourable areas will tend to increase faster than in unfavourable areas, unless interregional migration from unfavourable to favourable areas took place. Unfortunately, however, we failed to collect reliable information on migration in the past from farmers' recall. Yet, studies in the Philippines (David *et al.* 1991; Otsuka *et al.*, 1991a) and India (Ramasamy *et al.*, 1991) found according to the population census statistics, that the growth rate of village population during 1970, when MVs were rapidly diffused, was positively and significantly associated with MV adoption. Casual observation also suggests that a large number of landless agricultural labourers, who are geographically more mobile than farmers, migrated from unfavourable to favourable areas, permanently as well as seasonally. The increase in the labour–land ratio in favourable areas must have increased the demand for land. Also the demand for land would have increased in favourable areas with the adoption

of MVs. The increased demand for land may have triggered changes in farm size and tenure structure, which, in turn, may have affected the income distribution.

Table 2 compares farm size, ratio of tenanted areas and ratio of landless agricultural labourer households across production environments. Farm size differs vastly among countries, reflecting the difference in rural population and the endowment of cultivable land. More important for our analysis is that farm size is found to be largely similar among irrigated, favourable rain-fed, and unfavourable rainfed areas in each country, even though it is, in general, slightly larger in unfavourable rain-fed areas. Such observation indicates that farm size did not change substantially with changes in rice technology. In some countries, farm size did not adjust, partly because land reform law prohibits the transfer of cultivation right. For example, in the Philippines, land reform was effectively implemented in favourable rice growing areas (Otsuka, 1991), which prevented the farm size adjustment to a considerable extent. The market for land is known to be inactive in Asian countries, which might also have been reflected in the lack of the farm size adjustment. In any case, the fact that farm size is not significantly smaller in more favourable production environments indicates that rice income of farming households in favourable areas increased relative to unfavourable areas owing to the differential adoption of MVs.

Income of farmers depends not only on farm size but also on their tenure status. We may expect that the larger number of farmers in favourable areas are tenant cultivators, given the inactive land market and the larger demand for land. Data in Table 2, however, do not support such expectations. Except in the Philippines and Nepal, the ratio of tenanted area is not substantially higher in more favourable areas. Moreover, owner-cultivation tends to dominate, except in the Philippines, where large rice haciendas prevailed before land reform was implemented from 1972. Therefore there is no strong indication that the tenancy market adjusts to changes in rice technology. Being owner-cultivators, the majority of farmers in favourable areas seem to have benefited from the gain from technological change in rice farming.

However, remarkable difference in the agrarian structure is observed across production environments with respect to the incidence of landless agricultural labourer households. In India (Tamil Nadu), as many as a half of households in the irrigated villages are landless labourer households, whereas about one-fifth are labourer households in favourable rain-fed villages. In the Philippines, the ratio varies from 31 per cent in irrigated villages to 14 per cent in unfavourable rain-fed villages. While the ratio of labourer households is generally low in the Central Plain of Thailand, it is highest in irrigated villages. Since landless labourers are geographically mobile, these observations strongly indicate that inter-regional migration from unfavourable to favourable areas took place, corresponding to increased labour employment opportunities in favourable areas.

Such interregional migration has contributed significantly to the equalization of wage rates across production environments. According to the estimation results of wage determination functions, which include the technology factors (the rate of MV adoption and irrigation ratio) and some socio-economic

TABLE 2 *Farm size, ratio of tenanted area and ratio of landless labourer households, by country and environment*

Country	Irrigated	Favourable rain-fed	Unfavourable rain-fed
Farm size (ha)			
Bangladesh	0.5	0.6	0.6
India	1.4	1.8	–
Indonesia	0.5	0.5	2.3
Nepal	1.5	1.8	1.0
Philippines	1.7	1.7	1.6
Thailand	3.9	5.4	5.3
Ratio of tenanted area (%)			
Bangladesh	25	26	18
India	22	22	–
Indonesia	23	14	27
Nepal	31	29	10
Philippines	78	81	57
Thailand	47	42	51
Ratio of labourer households (%)			
India	49	21	–
Indonesia	26	11	8
Nepal	18	19	2
Philippines	31	18	14
Thailand	12	7	9

Notes: As for Table 1.

factors as explanatory variables, no significant regional difference in wage rates between favourable and unfavourable areas is found in Indonesia (Sudaryanto *et al*, 1991), Nepal (Upadhyaya *et al*, 1990; Thapa and Upadhyaya, 1991) or the Philippines (Otsuka *et al*, 1991a; David *et al*, 1991). The significant difference is found in Bangladesh (Hossain *et al*, 1991), India (Ramasamy *et al*., 1991) and Thailand (Isvilanonda and Wattanutchariya, 1991), but the rate of difference between favourable and unfavourable areas is of the order of only 10 per cent – 15 per cent. Such difference may well be explained by the cost of migration rather than the lack of interregional labour market adjustments.

Not only migrants, but also those who have remained in unfavourable areas would have benefited from the MV adoption in favourable areas because the wage rate should have increased in unfavourable areas owing to out-migration of working population. In this way the income gain from the technological change in favourable areas seems to have been shared by landless labourers at large. Therefore, as far as the well-being of poor landless labourers is con-

cerned, the impact of the green revolution does not seem to be as inequitable as is generally thought.

THE GREEN REVOLUTION AND REGIONAL INCOME DISTRIBUTION

While agricultural wage rates are found to be largely equalized across production environments, some studies found significant regional difference in land rents (Isvilanonda and Wattanutchariya, 1991; Sudaryanto *et al*, 1991). Further, the analysis of the recall data of transacted land prices, collected by the intensive household survey in South Sumatra in Indonesia by Jatileksono (1991), demonstrates that the adoption of the series of improved MVs significantly and substantially increased land prices. Also our country studies consistently found, through the factor share analysis based on the intensive survey data, that the residual return to land, which is estimated by subtracting actual and imputed costs of current, labour and capital inputs from the gross value of production, is far larger in favourable areas than in unfavourable areas. In fact, it is common to observe that the factor share of the residual return is 40–50 percent in irrigated areas, whereas its share is typically less than 30 per cent in unfavourable rain-fed areas. Since the value of production is significantly higher in favourable areas because of the higher rice yields, the absolute difference in the estimated return to land per hectare was more than three-fold between the most and the least favourable environments. The estimated return to land in unfavourable areas is found to be intermediate.

Thus a major income inequalizer associated with the differential adoption of the modern rice technology is identified to be land income. There is, however, a tendency for owner-farmers, who have captured the increased returns to land, to allocate less time to farm and non-farm activities, presumably because of the income effect on the preference for leisure. Moreover, we found that income from non-rice and non-farm sources is generally important, even though our survey villages are typical rice-dependent villages commonly observed in Asia. In fact, the share of non-rice income exceeds 50 per cent in most cases, particularly in unfavourable areas. It appears that, depending on the availability of alternative crops and non-farm employment opportunities, farmers and landless labourers in unfavourable areas allocate more resources to non-rice activities in accordance with the regional comparative advantage of rice production and non-rice activities. To what extent the total household income remains different across favourable and unfavourable areas, and among owner-cultivators, tenants and agricultural labourers, is an important empirical question.

Table 3 compares annual per capita household income among owner-cultivator, tenant and landless labourer households across production environments by tenure status. The data are based on the intensive survey of the relatively small number of villages. The income is expressed in US dollars, using the prevailing official exchange rates in survey years of each country. Since survey years are somewhat different, and the official exchange rates do not necessarily reflect the difference in the purchasing power of local currencies,

caution must be exercised in the comparison of the income levels across countries. In this paper, I focus on the difference in per capita income across regions and by tenure status in each country.

The major findings with respect to the inter-village comparison may be summarized as follows. First, per-capita income of landless labourer households tends to be similar across production environments, even though the income data of the landless are not reported in all countries. This finding supports the hypothesis that labour income tends to be equalized across production environments, owing to the inter-regional labour market adjustments. Second, per-capita income of owner-cultivator households is substantially larger in more favourable areas. A major exception is Indonesia, where income from non-farm jobs is high in favourable rain-fed villages and income from non-rice crops is high in unfavourable villages located in upland areas. The

TABLE 3 *Comparison of annual income per capita among members of owner, tenant and labourer households (US $) by country and environment*[a]

Country	Irrigated	Favourable rain-fed	Unfavourable rain-fed
India[b]			
Owner	339	151	n.a.
Labourer	162	114	n.a.
Indonesia[c]			
Owner	149	116	110[d]
Tenant	114	90	134[d]
Nepal[e]			
Owner	267	110	n.a.
Tenant	99	81	n.a.
Labourer	66	54	n.a.
Philippines[f]			
Owner	302	202	71
Tenant	232	152	81
Labourer	129	116	70
Thailand[g]			
Owner	681	245	313
Tenant	614	232	384
Labourer	244	n.a.	n.a.

Notes: [a] Sources and definition of environments are the same as Table 1, except for Indonesia.
[b] The data pertain to two villages in Tamil Nadu.
[c] Source: Jatileksono (1991). The data pertain to six villages in Lampung, South Sumatra.
[d] Upland area.
[e] The data pertain to two villages in the western Tarai region.
[f] The data pertain to two villages in Central Luzon and three villages in Panay island.
[g] The data pertain to three villages in the Central Plain.

detailed income decomposition analysis demonstrates that a major part of the difference in the income of owner-cultivators across production environments can be explained by the difference in land income in rice production. Third, the regional difference in income of tenant households is much smaller than in the case of owner-cultivator households, but larger than in the case of labourer households. Since land rent corresponds to the return to land, tenants receive essentially the return to labour. Therefore we expect that their income tends to be equalized so long as wage rates are equalized across production environments, unless the land rent is distorted. This is the case in the Philippines, where the majority of tenants in favourable areas are land reform beneficiaries and leasehold rents and amortization fees are regulated at very low levels (Otsuka *et al*, 1991b). Thus tenants in favourable areas received part of the increased returns to land, which otherwise would have accrued to the wealthy landlord class. Income of tenant households in irrigated areas is also substantially higher than in other areas in Thailand. This may be explained by the sluggish adjustment of land rents in the irrigated village, where MVs were introduced from the early 1980s.

With respect to the intra-village income distribution among owner, tenant, and labourer households, the following points can be made. First, unless farm size is very small (as in Indonesia) or land rents are lower than the rental value of land (as in the Philippines and Thailand), income of owner-cultivators is much higher than that of tenant and labourer households in irrigated areas. Note that per capita income of tenant households in Nepal is substantially lower than that of owner households, partly because the family size of tenant households is 50 per cent larger owing to the larger number of children. Second, the income difference among the three types of household in favourable rain-fed areas is much smaller than in irrigated areas. Third, the income difference is almost nil in an unfavourable production environment. These intra-village income differences can be consistently explained by the difference in land income in rice farming.

CONCLUDING REMARKS

We found in this study that, while labour income tends to be equalized across production environments because of interregional labour market adjustments, significant regional difference in land income has emerged owing to the differential adoption of the modern rice technology. We also found that the poorest in rural areas of Asia are landless labourers, whose livelihood depends on labour earnings. Owing to the increased labour demand associated with the MV adoption and the subsequent interregional labour market adjustments, the landless, even in unfavourable areas, seem to have benefited from the green revolution. It is therefore misleading to argue that the green revolution bypassed unfavourable areas, where no technological change took place. If large social weight ought to be given to the fate of those poor landless in the evaluation of the distributional consequences of the green revolution, it seems fair to conclude that the distributional impact of the green revolution is not as inequitable as is generally thought. We admit, however, that the green revolu-

tion brought about larger economic gains to wealthier owner-cultivators as well as landowners in favourable areas, thereby aggravating the income distribution in rice-growing rural areas.

One may be tempted to conclude that larger research efforts should be directed to the development of MVs suitable for unfavourable areas so as to attain more equitable distribution of income. Scientifically, however, it is more difficult to develop such varieties. Moreover, unfavourable environments are highly heterogeneous, so that a single superior rice variety, even if successfully bred, can be diffused only in limited areas. In other words, there is a trade-off between efficiency and equity in research resource allocation. In evaluating the equity impact of the green revolution,we must recognize that MVs developed for favourable areas benefited the rural poor at large, in addition to the fact that rice is a staple food for both the urban and rural poor.

Since the rural poor are typically the landless, the policy effort should be directed to enhancing the labour demand to alleviate rural poverty. Since human capital measured by schooling, is generally found to be an important determinant of labour earnings from non-farm sources in our country studies, the investment in human capital should be strengthened. Also important is land tenure policy. As Otsuka (1990) argues, the tenancy regulations in some Asian countries created the labourer class by inducing tenant eviction and by restricting the tenancy transactions. If the purpose of land reform is to enhance social equity, it must be so designed as to transfer wealth from landowners to landless labourers, particularly in favourable areas, through land taxation and other means.

REFERENCES

Barker, R. and Herdt, R.W., *The Rice Economy of Asia*, Resources for the Future, Washington DC.

David, C.C., Cordova, V.G. and Otsuka, K., 1991,'Differential Adoption of Modern Rice Technology across Production Environments: The Philippine Case', IRRI, Los Baños.

David, C.C. and Otsuka, K., 1991, 'The Modern Seed-Fertilizer Technology and Adoption of Labor-Saving Technologies: The Philippine Case', *Australian Journal of Agricultural Economics*, August, 1991.

Hayami, Y. and Otsuka, K., 1991, *The Economics of Contract Choice: An Agrarian Perspective*, Clarendon Press, Oxford.

Hossain, M. *et al.*, 1991, 'Differential Adoption of Modern Rice Technology across Production Environments: The Bangladesh Case", IRRI, Los Baños.

Isvilanonda, S. and Wattanutchariya, S., 1991, 'Differential Adoption of Modern Rice Technology across Production Environments: A Case Study of Thai Rice Villages', IRRI, Los Baños.

Jatileksono, T., 1991, 'Differential Adoption of Modern Rice Technology across Production Environments: The Case of Lampung in Indonesia', IRRI, Los Baños.

Lipton, M. and Longhurst, R., 1989, *New Seeds and Poor People*, Unwin Hyman, London.

Otsuka, K., 1990, 'Land Tenure and Rural Poverty in Asia', paper presented at the Finalization Workshop on Rural Poverty in Asia, Asian Development Bank.

Otsuka, K., 1991, 'Determinants and Consequences of Land Reform Implementation in the Philippines', *Journal of Development Economics*, 35(2) April.

Otsuka, K., Cordova, V.A. and David, C.C., 1991a, 'Modern Rice Technology and Regional Wage Differential in the Philippines', *Agricultural Economics* 4(314).

Otsuka, K., Cordova, V.G. and David, C.C., 1991b, 'Green Revolution, Land Reform, and Household Income Distribution in the Philippines', *Economic Development and Culture Change*, (forthcoming).
Ramasamy, C., Kandaswamy, A. and Paramasivam, P., 1991, 'Differential Impact of Modern Rice Technology across Production Environments: The Tamil Nadu Case', IRRI, Los Baños.
Sudaryanto, T., *et al.*, 1991, 'Differential Adoption of Modern Rice Technology across Production Environments: The Indonesian Case', IRRI, Los Baños.
Thapa, G. and Upadhyaya, H., 1991, 'Differential Adoption of Modern Rice Technology across Production Environments: The Nepalese Case', IRRI, Los Baños.
Upadhyaya, H., Otsuka, K. and David, C.C., 1990, 'Differential Adoption of Modern Rice Technology and Regional Wage Differential in Nepal', *Journal of Development Studies*, 26(3) April.

DISCUSSION OPENING – DIBYO PRABOWO*

Over the past two decades there have been fundamental and far-reaching changes in the Asian rice economy. Many of these have been associated with the so-called 'green revolution', which has led to a rapid increase in the use of both modern high-yielding varieties and fertilizer. Dr Otsuka provides an analytical description of these changes. He summarizes the adoption of modern varieties and the productivity differential across production environments. In addition, he comments on differences in agrarian structure and associated variation in annual household incomes. Dr Otsuka has reviewed a large body of research into the nature and impact of new rice technology in order to address the major policy issues confronting planners and researchers. Also, in drawing conclusions, he uses material from an intensive collaborative study which was recently completed.

The theme of Dr Otsuka's paper is to challenge critics who argue that the green revolution has by-passed unfavourable areas, where farm populations are generally poor, and worsened the regional income distribution. I feel that these assertions need to be considered rather more carefully and need further elaboration.

Basically, the view put forward is that increased labour demand associated with use of modern varieties, and subsequent inter-regional labour market adjustment, results in the landless obtaining benefit from the green revolution. Using lessons from Indonesia, let me describe briefly the long-term effects of the green revolution on employment and income. Because of the increased number of rice harvests, higher yields and the more even pattern of cultivation over the year, employment in rice production rose, as did the absolute income of farmers and farm hands. On closer inspection, however, the situation is found to be rather more complex and has produced a surprising outcome.

In Indonesia, the higher costs of seed-grain for the more expensive new varieties, together with fertilizer and pesticide costs, have led to an increase of the *tebasan* system, with crops being sold prior to harvest. At the same time, the introduction of rice mills eliminating the task of pounding rice by hand, as well as the use of the sickle instead of a less efficient knife (especially by female labour), has tended to increase the supply of labour looking for em-

*Gadjahmada University, Indonesia.

ployment. As a result, harvesters now appear to earn a smaller hourly wage in the tebasan than in owner harvesting, but this disadvantage has clearly been more than offset by the additional work generated by the increased overall yield. In spite of a relative drop in wages, the harvesters appear to be better off in aggregate. Farmers' income has risen because of higher yields. Increased income for the total group involved in rice production, but with greater income inequality, is thus the paradoxical outcome of the green revolution.