Income Distribution and Poverty in Irrigated and Rainfed Ecosystems

The Myanmar Case

Myanmar, a socialist country with a distinct political set-up began a nationwide programme to intensify rice production through the expansion of irrigation facilities and use of modern technology in the early 1990s. This paper assesses the impacts of recent government initiatives on income distribution and poverty under two varying ecosystems, irrigated and rainfed, based on an intensive household survey in four villages during 1996. Major findings indicate that the recent government's policy on the promotion of modern rice technology and irrigation did not increase household income due to farmers' inability to cope with the economic and technical demands of the new rice-based technologies. The study also identifies household size, education and higher proportion of female members in the household as major factors that affected poverty. Finally, the paper suggests strategies and policy reforms to help reduce income inequality and poverty in rural Myanmar.

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I
Introduction

Myanmar, previously known as Burma, has a land area of 68 million ha with a population of 47 million growing at the rate of 1.8 per cent per year. Three-fourths of the population live in the rural areas. Compared with other south-east Asian countries, urbanisation is proceeding relatively slowly because of sluggish economic progress. On the other hand, it is one of the few remaining countries in Asia where agricultural production can be increased through the opening of new land frontiers. Only 15 per cent of its total land area is being used for crop production. About 12 per cent of its total land (8 million ha), equivalent to 80 per cent of its current arable land, is cultivable wasteland which can be tapped for increased agricultural production [MAI 1996].

The country's economy basically depends on agriculture. Two-thirds of its labour force is engaged in the agricultural sector [Hossain and Marlar 1995]. Rice is the main staple food crop and is grown extensively, covering about 50 per cent of the country's total cropped area. Of the 5 million ha planted to wet season rice, only 20 per cent (1 million ha) are double cropped due to lack of irrigation facilities. About 63 per cent of its gross domestic product is contributed by the agricultural sector, 34 per cent by rice production alone [MAS 1997a]. Rice is also a major source of foreign exchange earnings, contributing 47 per cent of the total agricultural exports [MNPED 1995].

Increased rice production has always been the government's major thrust in crop production. Rice policies were geared toward meeting not only the local rice demand but also providing surplus production for export. In the early 1990s, the government launched a nationwide campaign to boost rice production. To achieve these objectives, the ministry of agriculture and irrigation focused on the following strategies: (1) expansion of agricultural areas by reclaiming new lands; (2) construction of dams and expansion of irrigation canals; (3) use of modern rice varieties, and (4) adoption of new cropping practices to enhance production, such as summer rice, double monsoon rice, and rice-fish culture [MAS 1997a].

The success of these strategies, however, depended heavily on the availability of irrigation water especially during the summer season. Despite the government's effort to construct small to large dams and instal pumping stations along the banks of major waterways, area under irrigation in all of Myanmar showed a modest increase from 12 per cent of the total cultivable land in 1992 to 18 per cent in 1995. It is worthwhile to note that about 80 per cent of the country's total irrigated area was devoted to rice production. Development of irrigation infrastructure in the early 1990s was basically designed to support the dry season rice production popularly known as the summer rice programme of the government, which started in 1992.

The government's strategies to boost rice production in the countryside resulted in differential access to agricultural inputs among farmers in the villages. In turn, it brought about significant implications on the distribution of income among the rural households. This paper is aimed at assessing the impact of adoption of new rice-based technologies on incomes and employment of rural households under varying agro-ecosystems. Specifically, it aimed to measure the composition of household incomes, the degree of inequality in income distribution in different ecosystems, and isolate the sources of income that contributed significantly to inequality. Finally it sought to investigate the incidence, intensity and severity of poverty in the selected study sites and to identify the factors affecting poverty.

II
Data and Methods

A survey of all households belonging to four purposively selected villages in the Nyaungdon township of the Ayeyarwardy division was conducted in 1996.The Ayeyarwady delta is located in the southern part of Myanmar and is the largest rice-producing region in the country, contributing 37 per cent to total national production [MAS 1997b]. The topography of the area was characterised by gentle rolling plains, which can be divided into deepwater, lower, and upper terraces. Differences in slope between the upper and lower terraces, however, vary by only about 5 to 10 per cent. Most of the government's new irrigation infrastructure was established in these areas.

To represent the diversity of the ecosystems, availability of irrigation facilities and elevation of land were the criteria used to select the sample villages. Two villages under irrigated conditions were selected to represent the different toposequence: a) upper terrace [Tazin Yae Kyaw village) and b) lower terrace (Tuchaung village). Likewise, two rainfed villages were selected to represent the lower and upper toposequence: a) deepwater area (Hteik Wa Kyi village), and b) a typical rainfed lowland (Nat Pay village). These villages were identified in consultation with local government officials. Data on the operation of the rural household economy were generated for all households in the selected villages. A total of 739 households were surveyed in the four villages; 358 households belonged to the rainfed villages and 381 households belonged to the irrigated villages.

Effects of irrigation on income and its distribution were assessed by estimating total income from different sources and measuring the concentration of incomes through the Gini ratio [Sen 1973]. Income from crop production was estimated using detailed accounting of costs and returns for all farm activities. The Gini decomposition analysis proposed by Pyat, Chen and Fei (1980) was carried out to identify the sources of income inequality. On the other hand, the incidence, intensity, and severity of poverty in irrigated and the rainfed villages were estimated using the Foster, Greer, and Thorbeck (FGT) index [Foster et al 1984]. Finally, a probit model with a qualitative dependent variable representing poverty (1 for poor and 0 for non-poor) was fitted to identify important bio-physical and socioeconomic variables associated with poverty.

III
Characteristics of Sample Households

Household size in both irrigated and rainfed villages was found to be the same, each averaging five members (Table 1). The percentage of working members in each household (16-60 years old) was slightly higher in the rainfed villages (57 per cent) than in the irrigated villages (52 per cent). The breakdown of adult members into male and female workers, however, did not show any variation.

The education level of people in the villages (both in rainfed and irrigated areas) was observed to be fairly low, averaging about six schooling years. This implies that adult individuals in the villages had received, at most, primary schooling. Generally, the education level of male members exceeded that of the female members by one year. On the whole, there were no significant differences between rainfed and irrigated villages with respect to sociodemographic characteristics of household samples.

Ownership and Characteristics of Land Resources

Table 2 presents the distribution of landholdings in the sample villages. Nearly 41 per cent of the total households were landless. Despite the socialist form of government and the vast expanse of land area in the country, the incidence of landlessness was found to be surprisingly high. This implies unequal access to land resources in the villages, which may contribute to income inequality among households.

The incidence of landlessness was observed to be higher in the irrigated villages (48 per cent) compared with the rainfed villages (34 per cent). This was attributed to the presence of common lands in deepwater areas that were open to the public. These marginal lands were located in the deepest portion of the rainfed villages and were generally submerged throughout the monsoon season. During the dry season, however, residual moisture in the soil allowed the landless to grow rice, groundnut, and pulses.

Table 3: Characteristics of Rice Farming in Irrigated and Rainfed Ecosystem

Item	Irrigated	Rainfed	All
Rice cropping intensity (per cent)	158	123	141
Area under crop (per cent)			
Rice	100	69	84
Nonrice	–	31	16
Irrigated area (per cent)	30	-	15
MV adoption rate (per cent)			
Wet season	33	78	56
Dry season	92	–	92
Rice yield (t ha^{-1})			
Wet season			
MV	20	2.4	2.2
TV	1.5	1.8	1.6
Dry season			
MV	1.8	–	1.8
TV	1.2	–	1.2

Table 1: Demographic Characteristics of Households in Irrigated and Rainfed Ecosystems, 1996.

Characteristic	Irrigated	Rainfed	All
Sample size	381	358	739
Household size	5	5	5
Working members of household (per cent)	52	57	54
Male	26	28	27
Female	26	29	27
Education (years of schooling)			
Male working members	5	6	6
Female working members	4	5	4
Children (6-15 years old)	3	4	3

Table 2: Distribution of Landholdings by Ownership in Irrigated and Rainfed Ecosystems

(Per Cent)

Ecosystems	Land Ownership Category					Average Landholding (in hectares)
	Landless	Marginal (<1 ha)	Small (1-2 ha)	Medium (2-4 ha)	Large (>4 ha)	
Irrigated	48	14	22	11	5	2.0
Rainfed	34	20	23	15	8	2.0
All	41	17	23	13	6	2.0

The average size of landholding was 2 ha in both rainfed and irrigated villages. Generally, a higher proportion of households in the rainfed category owned more than 2 ha (23 per cent) than the irrigated villages (16 per cent), implying a relative advantage of the rainfed farm households in terms of land access.

All farming households in the irrigated villages cultivated rice (Table 3). About half of them participated in the summer rice programme of the government. On the other hand, 31 per cent of the farmers in the rainfed villages cultivated non-rice crops such as groundnut, pulses, chili, and many minor crops that were common in the deltaic region. About 13 per cent of the rainfed farmers were engaged in rice-fish farming, which was suitable only for the deepwater areas.

Despite the presence of irrigation facilities in the irrigated villages, availability of water especially during the summer season was still inadequate to cover the whole township. Only about 31 per cent of the sample farms in the irrigated villages had access to irrigation. Hence, majority of the farmlands in the irrigated villages were still operated under rainfed conditions. Given the disparity in the access to irrigation, adoption of rice double cropping was found to be exceptionally high among irrigated farmers as a result of the government's top-down policy toward technology dissemination. Cropping intensity, therefore, was observed to be significantly higher in the irrigated villages (158 per cent) than in the rainfed villages (123 per cent).

The adoption of high-yielding modern varieties (MVs) was another important strategy that the government actively pursued in conjunction with the introduction of intensive rice cultivation. Among rainfed farmers, the adoption of MVs was 78 per cent, which was unusually high, depicting the resilience of Myanmar farmers to government-pushed technologies. On the other hand, the adoption of MVs among farmers who engaged in rice double cropping was found to be lower in the wet season (33 per cent) than in the dry season (92 per cent). The wet-season crop was normally planted to traditional varieties due to the geographical location of most summer rice fields, where excessive flooding occurred at the height of the monsoon season. Hence, traditional tall varieties were preferred. The second rice crop, on the other hand, was generally planted to semi-dwarf MVs.

Farmers' rice harvests were subjected to a production quota of 0.5 t ha^{-1} per year, which were sold to the government at predetermined prices. On the average, the government procurement price, however, lagged behind the market price by as much as 62 per cent (i e, $ 125/t vs $ 333/t, respectively). The production quota was required only for one crop season per year. Summer rice cropping, therefore, provided an incentive for farmers to invest in a second rice crop whenever water is available. All harvests from the second rice crop can be privately sold at existing market prices.

The quota system of the government in effect created an indirect tax that penalised the rice farmers [Garcia, Hossain and Garcia 1999]. Results of the study showed that about 27 per cent of the total harvest was sold to the government as production quota. The average "tax" per farmer was valued at $85, assuming that the quota could be sold privately at market prices. In turn, this implicit tax was estimated to be 7 per cent of the farmers' total farm income. The tax burden of the production quota became more acute for farmers with smaller landholdings, for whom the proportion of the production quota to total harvest can go as high as 63 per cent. During crop failure, farmers needed to buy paddy from the market to fulfil their quota for the cropping season.

The quota system, on the other hand, provided a de facto credit scheme to the farmers. The government usually advanced the payment for quota production to enable the farmers to purchase the necessary inputs, especially fertilisers. Since one of the major constraints to increased rice production in the country was inadequate use of chemical fertilisers [Garcia et al 1998, 2000], the ministry of agriculture and irrigation extended agricultural loans to farmers in kind, mostly in terms of fertiliser inputs.

In the study area, fertiliser use among farmers who practiced intensive rice cultivation was very low but generally higher than that of the rainfed farmers. On the average, irrigated farmers applied 44 per cent more urea fertiliser than the rainfed farmers in their wet-season crop (Table 4). In the case of the dry-season rice, irrigated farmers used 39 per cent more urea fertiliser than for wet-season rice. Notably, fertiliser use for MVs was higher than for traditional varieties. However, despite higher levels of fertiliser use, the amount used was only 40 per cent of the recommended level [MAI 1995]. The inadequate use of chemical fertilisers among farmers is attributed

Table 5: Cost and Return Analysis of Rice Production by Ecosystem and Season

Item	Rainfed	Irrigated	
	WS	WS	DS
Costs			
Material cost	5,105	15,226	16,707
Labor cost	13,483	15,094	21,170
Total cost	18,588	30,320	37,877
Returns			
Marketed			
Amount	2,518	966	1,724
Price	10.00	11.10	11.80
Quota			
Amount	593	593	-
Price	3.75	3.75	-
Sale from rice straws	845	1,154	2,838
Total returns	22,219	14,101	23,181
Net returns $season^{-1}$	3,731	(16,219)	(14,696)
Non-cash costs	7,755	8,187	8,847
Return over cash cost	11,846	(8,032)	(5,849)

Table 6: Occupational Distribution of Economically Active Population (16-60 Years Old) by Ecosystem
(Per Cent)

Occupation	Rainfed	Irrigated	All
Dependents			
Minor	2	2	2
Student	4	3	4
Housewife	17	22	20
Total	23	27	26
Agricultural workers			
Farmer	48	39	44
Farm labourer	18	25	22
Livestock holder	0.6	0.2	0.4
Fisherman	0.5	1.2	0.8
Total	67	65	67
Non-farm workers			
Rural industry/processing	1	0.6	0.8
Transport operator	1	2	2
Trade/shopkeeping	5	4	4
Construction worker	0.2	0.3	0.6
Personal service	0.8	0.3	0.6
Government service	0.7	0.3	0.5
Total	8.7	7.5	8.1

Table 4: Fertiliser Use (kg ha^{-1}) under Modern (MV) versus Traditional Varieties (TV) by Ecosystem and Season

Fertiliser	Rainfed		Irrigated			
	Wet season		Wet season		Dry Season	
	TV	MV	TV	MV	TV	MV
Urea	35	28	41	51	62	65
Farmyard manure	3,272	2,863	2,045	3,272	818	2,045

to the insufficient fertiliser supply in the villages, which resulted in higher prices. This problem can be traced to the government's inability to import chemical fertilisers due to foreign exchange constraints. The inadequate use of fertiliser was the major factor for the very low yield of MVs in the study area and elsewhere in the country.

The use of farmyard manure (FYM), on the other hand, was found to be higher among rainfed farmers (3,068 kg ha^{-1}) than among irrigated farmers (2,658 kg ha^{-1} for wet-season rice and 1,432 kg ha^{-1} for dry-season rice). This implies that rainfed farmers tried to compensate for the deficiency in chemical fertiliser by using more organic fertiliser.

To determine the profitability of rice production, cost and return analysis was done for each production system adopted by the farmers (Table 5). The construction of the cost accounts in the analysis was based on the imputation of existing wage rates and rental fees for all activities using family labour and self-owned resources. To value total harvest, the government price was used for quota sale, while the market price was used for all private sales. The net return should therefore be seen as an indicator of the farmer's ability to recover both cash and noncash costs of rice production instead of the conventional idea of profit. Results showed that rice monocropping in the rainfed villages generated positive net returns. This implies that rainfed farmers were able to recover their cost of production given their paddy output. On the other hand, net returns of the irrigated farmers were observed to be negative in both wet and dry seasons. These results were principally due to increased cost of production brought about by the higher use of expensive fertilisers and the added cost of irrigation for dry-season cropping, i e, the cost of diesel fuel and rental fees for irrigation pump. However, despite the increased use of fertilisers in the irrigated rice farms, yields did not increase enough to cover the higher cost of production since fertiliser use was still inadequate.

Another important reason often cited by farmers to explain their failure to recover production costs was their inability to cope with the technological demands of intensive rice cultivation in terms of time, labour, and capital resources. However, the farmers were optimistic that given enough time to learn the new rice technologies, their efforts will start to pay off.

IV
Employment and Income Distribution

Table 6 presents the occupational distribution of the economically active population (aged 16-60 years old) in the study villages. As many as 67 per cent of the people were engaged in agriculture as farm operator, hired labourer, or livestock holder. More farmers were found in the rainfed villages (48 vs 39 per cent), whereas more farm labourers were observed in the irrigated villages (25 vs 18 per cent).

The second largest population group was composed of dependents (26 per cent), e g, housewives, minors, and students. About 8 per cent of the population were engaged in non-farm activities, of which half were involved in trading and market vending. The remaining one-fourth were transport operators. The group of government employees working as teachers, clerks, and extension workers was less than 1 per cent. Job opportunities in the rural industry, construction, and personal services were very low, averaging less than 1 per cent for each employment group.

Table 7 presents the composition of annual total income by type of households. Most of the income of the landless households (63 per cent) was generated from non-farm activities. Trading, transport operation, personal services and construction labour were the major sources of non-farm income, with shares of about 9-15 per cent of total income. On the other hand, 37 per cent of the income of landless households was generated from agricultural sources, basically from work as farm labourers and livestock herders. In the rice-fish area, many landless labourers worked as caretakers of fishponds and as fishermen during fish harvesting.

In the case of landowning households, a larger proportion of their income was generated from agricultural activities, i e, 74 per cent in the rainfed farms and 59 per cent in the irrigated farms. The lower share of farm income found in irrigated farm households can be attributed to losses in rice farming due to farmer's inability to adapt quickly to intensive rice cultivation. Income from agricultural labour contributed a higher percentage in the irrigated villages (10 vs 3 per cent) because of the increased opportunity for farm work brought about by double cropping. Incomes from non-farm sources – e g, trading, transport operation and personal services – also contributed a significant proportion to total income among landowners. The higher share of non-farm income in the irrigated farm households compared with the rainfed (41 vs 26 per cent) implies that more family members in the former can engage in off-farm activities with higher wage by hiring landless agricultural workers to do the farm tasks.

Table 7: Composition of Household Income by Ecosystem and Source

Income Source	Rainfed		Irrigated	
	Landless	Landowner	Landless	Landowner
Agriculture				
Farm/garden	7	66	4	44
Agricultural labour	11	3	14	10
Animal husbandry	6	3	1	1
Fishing	6	–	9	4
Forestry	7	2	9	–
Total	37	74	37	59
Non-agriculture				
Industry	8	2	9	10
Trading	14	3	14	16
Transport	15	1	9	4
Construction	9	2	11	2
Personal service	12	10	2	1
Government employee	5	4	6	4
Rental service	–	4	9	4
Income transfer	–	–	4	–
Total	63	26	63	41

Table 8: Distribution of Income and Land Resource by Ecosystem

Rank of Household	Per Capita Income		Land Resource	
	Irrigated	Rainfed	Irrigated	Rainfed
Bottom 40 per cent	15	15	0	2
Middle 40 per cent	34	37	34	36
Ninth decile	15	16	22	20
Top 10 per cent	36	32	44	42
Gini ratio	0.45	0.42	0.68	0.63

To establish a clearer picture of the effects of intensive rice cultivation that was being promoted by the government on the distribution of household incomes, the degree of income inequality was investigated for both the irrigated and rainfed villages using the Gini concentration ratio. The sample households were ranked with respect to their per capita income and the corresponding income shares of successive decile groups were estimated. The income distribution was found to be relatively homogeneous in both irrigated and rainfed villages. About 15 per cent of the total income was shared by the bottom 40 per cent of the households in all villages together (Table 8). On the other hand, about 34 per cent of the total income accrued to the top 10 per cent of the households.

The Gini ratio for the rainfed villages (0.42) was found to be lower than that for the irrigated villages (0.45). This indicates that the distribution of income in the irrigated villages, where technology adoption just began in the early 1990s, was more unequal compared with that in the rainfed villages. However, it is not unusual to notice higher income inequalities at the initial stage of technology adoption as experienced in many Asian countries in the early 1970s and 1980s [David and Outsuka 1994].

To investigate the possible sources of this income inequality, the Gini ratio of the various income-generating resources owned by the households in the two ecosystems such as land, human, and physical capital were compared. The Gini ratio for land distribution was found to be higher in the irrigated villages (0.68) than in the rainfed villages (0.63), which implies that access to land was more unequal in the former than in the latter. This could be related to the higher incidence of landlessness in the irrigated villages compared with the rainfed villages as discussed earlier. At the same time, Table 9 shows that the distribution of physical capital (e g, ownership of livestock, farm machinery, and other equipment) was also found to be relatively more unequal in the irrigated villages (0.66) compared with the rainfed villages (0.63). However, in terms of human capital, the distribution of adult workers in the family was observed to be fairly the same in the irrigated and rainfed villages, 0.36 and 0.38, respectively. The same case was observed in terms of access to education. Both village types exhibited the same Gini ratio (0.25) for the aggregated years of education among all working members of the household. These results suggest that higher income inequality found in the irrigated villages was likely to have been brought about by the relative inequity in terms of access to land and capital resources.

To trace the sources of income inequality in the two village types, a Gini decomposition analysis was undertaken. The procedure involved disaggregation of total income into its components, e g, labour income, non-farm income, and agricultural income, which was further divided into rice and non-rice income. For each income component, the pseudo Gini concentration ratio was estimated. Multiplying the relative share of each income component with the pseudo Gini ratio yielded the relative contribution of each income source to the Gini ratio of total income.

Tables 11 and 12 present the results of the Gini decomposition analysis for the irrigated and rainfed villages, respectively. In both cases, the largest contribution to income inequality was agricultural income, i e, 67 per cent for rainfed villages and 55 per cent for the irrigated villages. However, it is interesting to note that most of the income inequality brought about by agricultural income was contributed by the non-rice income, i e, 57 per cent and 44 per cent, respectively. Further, rice income was less unequally distributed in the irrigated villages as compared with rainfed villages.

The second major source of income inequality was non-farm income with the contribution of 23 per cent and 29 per cent in irrigated and rainfed villages, respectively. Thus, the cropping pattern adopted by the farmer and their differential access to land and capital resources were identified as the major contributory factors to income inequality. These results were observed in both the rainfed and irrigated villages.

V
Incidence and Determinants of Poverty

All the three measures of poverty indices (FGT indices) – i e, incidence, intensity, and severity of poverty – were estimated and compared in the rainfed and irrigated villages. To estimate the FGT indices, a poverty income threshold must be established. Since no official poverty line was available in Myanmar, the poverty line was established by assuming a per capita income level that will be sufficient to purchase the national average for rice consumption (about 27 kg per person per month) and some other non-food necessities. Following this norm used by the Vietnamese government for estimating poverty threshold, the value amounted to 5,850 kyats or US$48.75, of which 60 per cent would be used to acquire food in terms of rice and 40 per cent to meet the non-food basic needs. At this estimate, the entitlement of food in rice equivalent would be 195 kg per person per year, which will provide 1,680 kilocalories of energy. Below this income level, a household is considered poor.

Table 9: Distribution of Labour and Capital Resources by Ecosystem,

Rank of Household	Human Capital		Physical Capital	
	Irrigated	Rainfed	Irrigated	Rainfed
Bottom 40 per cent	17	16	2	2
Middle 40 per cent	41	40	32	37
Ninth decile	17	17	23	33
Top 10 per cent	25	27	43	38
Gini ratio	0.36	0.38	0.66	0.63

Table 10: Sources of Inequality in Household Income Distribution, Irrigated Ecosystem,

Source of income	Percentage Share of Household Income	Pseudo Gini Ratio	Absolute Share in Income Inequality	Percentage Share in Total Income Inequality
Agriculture	42	0.60	0.25	55
Rice	14	0.33	0.05	11
Non-rice	28	0.70	0.20	44
Farm Labour	36	0.20	0.07	16
Non-farm	22	0.59	0.13	29
Total household income	100	0.45	0.45	100

Table 12 presents the estimates of the three poverty indices, i e, head count ratio, poverty gap ratio, and squared poverty gap ratio. On the average, the overall head count ratio in all four villages was 28 per cent. This implies that 28 per cent of all households have incomes below the poverty line. Interestingly, the head count ratio was found to be higher in the irrigated villages (35 per cent) than in the rainfed villages (21 per cent). Likewise, both the intensity and severity of poverty as measured by the poverty gap ratio and squared poverty gap ratio, respectively, were also found to be higher in the irrigated villages. This implies that households in irrigated villages were worse off in terms of income generation compared with those in rainfed villages. This can be attributed to the higher percentage of the landless in the former compared with the latter, of which 30 per cent and 24 per cent, respectively, reported annual per capita income lower than the poverty threshold. At the same time, more farm households in the irrigated villages reported income levels below the poverty line compared to the rainfed villages, i e, 40 per cent and 20 per cent, respectively. Expectedly, the average per capita income was found to be lower in the irrigated villages than in the rainfed villages, i e, $ 91 and $ 118, respectively. This may also be due to negative income from the rice crop in the irrigated villages because of increased cost of production as previously stated.

These results, therefore, suggest that the newly adopted rice-based technologies such as MVs and summer rice production have not resulted in poverty alleviation, especially in the irrigated villages. One reason is the inability of the irrigated farmers to cope with the technical demands of the new rice-based technologies due to the top-down process of technology adoption. Such results were expected, since the rice intensification programme of the government had just started to take off when this study was conducted in 1996. However, adoption of these technologies in the long run, supported by adequate availability of fertilisers (when the foreign reserve of the country improves), is expected to increase yield and farm incomes in the irrigated villages. Several other indirect effects may also contribute to this change. First, with higher cropping intensity brought about by irrigation and double rice cropping, there will be more employment opportunities for the landless agricultural workers. Second, productivity growth that is induced by the diffusion of MVs is expected to contribute to poverty alleviation through their linkage effects to the rural non-farm sectors. These expectations, however, are purely hypothetical and can be verified only through further analysis involving panel data.

To determine factors that can significantly explain poverty in the study area, a probit regression model was estimated. The poverty variable was defined as a dummy, which is equal to 1 if per capita income of a particular household was lower than the stated poverty line and 0, otherwise. The explanatory variables used in the model were: (a) LAND (cropped area); (b) HHSIZE (household size); (c) EDAP (total years of schooling of adult workers in the household); (d) MALE (number of male workers in the household); (e) FEMALE (number of female workers in the household); (f) CAPITAL (value of capital resources); and (g) MV*IRR (interaction of modern variety with irrigation).

Table 13 presents the generated coefficients of the probit model. Results of the analysis showed that the variables exhibiting significant effects on poverty were HHSIZE, EDAP, and FEMALE. The positive sign of HHSIZE indicates that the larger the family size, the more mouths to feed, thus increasing the probability of the household being poor. One interesting observation with respect to gender of family members was the opposite effects of male and female workers in the household. The variable representing the number of male workers exhibited a negative sign, while the female workers showed a positive sign. These imply that having more male workers in the household can potentially move the family out of poverty. On the other hand, having more adult females in the family can increase the probability of being poor. This suggests the superiority of male workers in terms of income generation under the present socio-cultural context and the gender disparity in employment and earnings. The negative sign of the variable education suggests that with more educated members of the household, the probability of the household to move away from poverty is greater. This implies that education enhances labour productivity, which can lead to higher incomes.

The positive although non-significant coefficient of the variable MV*IRR posed an important implication. Despite its contrary sign, it yielded consistent interpretation with the general results of the study. Due to the widespread promotion of double rice cropping, the farmers were enticed to embark on the technology of summer rice and double cropping short-duration rice varieties during the monsoon season without sufficient turnaround period and irrigation facilities. As a result, most of the summer rice crop and the late-season monsoon rice failed, which led to financial losses on the part of the farmer.

VI
Summary and Implications

Myanmar has a vast potential to increase crop production, especially for rice, given the appropriate technological support for the farmers and sufficient infrastructure

Table 12: Poverty Indices by Ecosystem

Poverty Index	Irrigated	Rainfed	All
Headcount ratio	0.35	0.21	0.28
Poverty gap ratio	0.13	0.07	0.10
Squared poverty gap ratio	0.07	0.03	0.05
Average per capita income (US$)	91	118	104

Table 13: Estimated Coefficients of the Probit Model for Poverty

Predictor Variable	Coefficient	Standard Error	Chi-square Value
Intercept	-1.11 **	0.14	65.60
LAND	– 0.02	0.02	0.99
HHSIZE	0.18 **	0.03	30.10
EDAP	-0.03 **	0.01	10.49
MALE	– 0.08	0.08	0.90
FEMALE	0.15*	0.07	4.15
CAPITAL	-0.000003	0.000002	2.59
MV*IRR	0.04	0.03	1.46
Log likelihood	-406.45		
N	738		

Table 11: Sources of Inequality in Household Income Distribution, Rainfed Ecosystem

Source of Income	Percentage Share of Household Income	Pseudo Gini Ratio	Absolute Share in Income Inequality	Percentage Share in Total Income Inequality
Agriculture	59	0.48	0.28	67
Rice	11	0.41	0.04	10
Non-rice	48	0.50	0.24	57
Farm Labour	22	0.18	0.04	10
Non-farm	19	0.52	0.10	23
Total household income	100	0.42	0.42	100

development like irrigation. However, results of the study showed that this potential had not been maximised due to insufficient coverage of irrigation and the top-down push by the government to adopt modern rice technology. Hence, the farmers were caught unprepared for the adoption process, which adversely affected income especially from the irrigated areas. This is exemplified by the higher Gini ratio of total income in the irrigated villages and the higher incidence of poverty. However, since the survey was done in 1996, when rice double cropping was just recently introduced by the government, some of the income effects of the new rice-based technologies were expected to be unfavourable. Over these years, farmers would have adapted to the new technologies and started to reap the benefits of irrigation and double cropping.

It is also interesting to note that landlessness is a pervasive problem in Myanmar, despite its socialist set-up and vast land area. This brought about a significant effect on the inequality of income distribution among the village population. Without land, the landless had limited sources of livelihood. Hence, their income generating capacity was severely hampered. As a result, poverty among this group was most pronounced. Efforts to address this problem through land development for agricultural production were already in-place since 1992. Reclamation of cultivable wastelands and fallow lands in the delta area and elsewhere proved to be a strategic policy for extending the land frontier for rice and other crop production. However, due to limited public funds, the process was deemed slow and its poverty alleviation effect had been elusive.

To address income inequality and poverty in the rural areas of the country, there is a need to focus policy reforms of the government on the major sources of income inequality. The study had shown that incomes from non-rice crops and non-agricultural capital resources contributed mostly to income inequality. Specifically, farmers whose cropping pattern also included non-rice crops were found to be betteroff than the pure rice farmers. Hence, to reduce income inequality, the ministry of agriculture and irrigation should not only focus on the adoption of modern rice technology but should likewise promote programmes for intensive cultivation of non-rice crops.

At the same time, income from non-farm capital resources was found to contribute significantly to income inequality. This suggests the need to promote higher access to physical capital in the villages, e g, livestock raising and small backyard industries. This can be made possible if households will have access to small-scale credit schemes, which will enable them to acquire income-generating capital resources. Increasing labour productivity through skill development (either through formal or informal education) is another promising strategy that can be tapped to increase income and alleviate poverty in rural Myanmar. EPW

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