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Income Distribution of Households in Different Type of Irrigation System and Different location from each irrigation system

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INTRODUCTION

In Myanmar, the agriculture sector has strong link with economic development, it has been undergoing rapid development due to policy reform. Since 1988, the transformation from a centrally planned economy to a market oriented economic system has led to increasingly intensified economic activities. Myanmar has great potential to extend cultivated area but water is the most important input for agricultural production. Therefore, the government of Myanmar (GOM) has been constructing many irrigation facilities especially in the areas where water is scarce due to erratic rainfall. The government has prioritized irrigation for paddy cultivation since rice is the key crop in the agriculture of Myanmar as it is the main food item for Myanmar people. It has also great significance for the national economy.

Myanmar is essentially an agrarian economy with two-thirds of total population engaged in subsistence agriculture. The rural households in Myanmar have suffered from low access to various services (education, health, water supply, etc.) and lack of assets such as land and livestock, which are strongly related to the rural poverty status (UNDESA, 1999) The Central Statistical Organization (CSO) has conducted the household income expenditure survey in 1997 and the survey data showed that the poverty incidence for urban area was 23.9 %, 22.4 % for rural area, and 22.9 % for the whole country. The World Bank (2001) noted that the country is trapped in abject poverty despite its rich resource base and the trend in poverty is increasing through time in the last ten years (Coller and Dollar, 2001). According to UNDP (2004), life expectancy rate, adult literacy rate, and GDP per capita in Myanmar are 57 years, 85 %, and US$ 1,027(PPP) in 2002. About half of the population does not have access to sanitation, and 28 % does not have access to safe drinking water in 2000. In order to reduce poverty through increase in household income, the provision of loans (for increasing income diversification) and irrigation water is essential (Kyaw *et al.*, 2006).

Agricultural development strategy includes the encouragement of double cropping and multi-cropping through the expansion of irrigation facilities such as construction of dams and river-water pumping stations UNCCD 2005-. These two irrigation systems mainly supply water for rice cultivation. The main element of rice production policy after 1988 was the summer paddy program initiated in 1992/93. In this case, investments in irrigation were indispensable in Myanmar.

The government of Myanmar has invested very huge amounts for construction of many types of irrigation infrastructure in order to expand crop sown area, increase crop production, and enhance the livelihood of farmers. However, it remains unclear whether the large amount of expenditures on irrigation development in the country has led to significant improvements in the livelihood of the poor. The distribution of irrigation water can be skewed due to improper management and illegal water cutting by farmers when it is not yet their turn. Thus, the farmers at the

tail end area would not have enough water for their farms (Ashraf *et al.*, 2007). Without proper water management, the crop production and consequently, socio-economic development of the area would be adversely affected.
A basic issue relates to whether or not irrigation development in Myanmar indeed brings significant improvement on the socio-economic status of farmers.

The objective of this paper is to determine the extent of proper management and efficient allocation of water resources in dam and pump irrigation systems by looking at the equity of income distribution in two irrigation systems; dam and river pumping irrigation systems and based on different location of farms from source of water in each irrigation system.

METHODOLOGY

The study purposively selected two areas, Wann Twin Township and Nyaung Oo Township in Mandalay Division which is located in the central dry zone area of Myanmar. The former is represented as an area for dam irrigation (Kinda dam) as well as for rainfed, and the latter is represented as an area for river pumping irrigation. The sample farmer-respondents were drawn using stratified random sampling technique based on type of irrigation scheme, i.e., dam/canal and river pumping irrigation. Within the same irrigation system, in terms of the location of the fields, i.e., head, middle and tail ends of farmers in dam irrigation; and upstream, there are middle and downstream areas in river pumping irrigation. The field survey was conducted for farmers in the rainfed area for the same study area. The farmer respondents were grouped as follows:

(i) Farmers in rainfed area (without irrigation) versus farmers in irrigated area
(ii) Farmers in pump irrigation versus farmers in dam/canal irrigation
(iii) Farmers in head, middle , and tail end in dam/canal irrigation system
(iv) Farmers in upstream, middle and downstream of the river in pump irrigation system

The study selected 10% of total households for each group of farmers. The sample size for rainfed, dam irrigators, pump irrigators, and groups of different locations from the water source (head, middle and tail users in dam; and upstream, middle and downstream users in river pumping irrigation system) are presented in Table 1.

Table 1. Sample size by type of water sources and different locations from water source in the same irrigation system.

Village	Type of group	Total number of households	Sample size
Myae Tine Kan	Rainfed	249	25
Ma Kyi Oke	Head user of Kinda dam	286	29
Na Bae Kan	Middle user of Kinda dam	547	54
Shwe Taung	Tail user of Kinda dam	524	52
Total dam irrigators			135
Nga Tha Yaunt	Upstream users	378	38
Thu Kaung Tae	Middle users	353	35
Lawka Nanda	Downstream users	163	17
Total pump irrigators			90
Total number of samples			250

The study estimated Gini Coefficient in order to examine the economic inequality and the poverty situation among farmers with and without irrigation (rainfed), by type of irrigation system (dam/canal versus pump) and locational difference within same irrigation system (i.e., head, middle and tail in dam irrigation; and upstream, middle and downstream in pump irrigation).

The Gini Coefficient (G) was calculated using the following equation:

$G = 1 + (I/n) - (2/n2\mu)$ [I1 +2 I3 +3I3 +........+nIn]

For I1> I2 > ……..>In

Where, n is the number of observations (households), u is the mean income and I is the total household income (farm income from lowland + farm income from upland + non- farm income). Higher values of the measure indicate relative income inequality.

RESULTS AND DISCUSSION

The percentage shares of all income sources in total income for the different farmer groups are shown in Table 2. In this case, total income is income from different sources, i.e., income from lowland crop production, income from upland crop production, and non-farm income. Income from upland and lowland crop production was estimated by subtracting the cost of cultivation of those crops from the revenue. For upland crops, farmers cultivated crops which need less water such as groundnut, sesame, onion, chili, tobacco, black gram, green gram, chick pea, and pigeon pea. For lowland crops, rice was the dominant crop in the rainy season since water was available. During the winter season, the farmers cultivated crops such as pulses, sesame, groundnut and other less water-using crops. In summer, according to the central planning agency, farmers had to cultivate rice, but based on their experiences from the previous year in terms of availability of water and also rainfall condition during the year, they also had to grow other crops aside from rice.

Non-farm income was calculated by adding income from agricultural labours and non-farm activities such as trading, personal services, and government services, among others.

Table 2. Percentage shares of all income sources in total income, Wann Twin and Nyaung Oo townships, Myanmar, 2011.

FARMER GROUP	LOWLAND FARM INCOME (%)	UPLAND FARM INCOME (%)	NON-FARM INCOME (%)
Irrigated area	69.71	21.12	9.17
Rainfed area	41.46	36.05	22.49
Dam irrigated area	74.66	17.55	7.79
Pump irrigated area	52.41	33.63	13.96
Head area of dam irrigation	73.74	19.96	6.29
Middle area of dam irrigation	84.83	6.32	8.85
Tail area of dam irrigation	65.49	27.11	7.40
Upstream area of pump irrigation	75.25	11.84	12.91
Middle area of pump irrigation	22.68	61.84	15.48
Downstream area of pump irrigation	46.79	39.33	13.88

Among all income sources, income from lowland crops contributed the biggest share in total income for all groups except in the case of farmers in the middle area of pump irrigation. In that area, the percent share of income from lowland crops was 22.68 %, share of income from upland crop was 61.84 % and that of non-farm income was 15.48 %. The share of income from lowland crops to total income was lowest in the middle area of pump irrigation system compared with other areas. Among all groups, the share of lowland farm income was highest in middle area of dam irrigation system. In most areas, more than 50% of total income was contributed by income from lowland crop production. Therefore, lowland crop (rice) cultivation was the main source of income for farmers in the study area. Since water is necessary in rice cultivation and rice is the main crop in Myanmar, it can conclude that irrigation is important in the development of agriculture sector in Myanmar.

Table 3 shows the level of household income and Gini ratio for farmers in irrigated and rainfed areas. The result indicated that the average household income of irrigated farmers was 50 % higher than that of rainfed farmers. However, there was a huge gap in income among irrigated farmers since the maximum income was very high while the minimum income was negative. Income inequality in irrigated area as shown by Gini ratio was higher at 0.49 than in rainfed area at 0.38. The maximum income in irrigated area was ten times higher than that in rainfed area but minimum income in the former area was lower than the latter, even negative. This brought about the higher Gini ratio in irrigated area.

Table 3. Average annual household income (Kyats/ household) and Gini ratio for irrigated and rainfed areas, Wann Twin and Nyaung U townships, Myanmar, 2011.

ITEM	IRRIGATED	RAINFED
Average income (US$)	2594.64	1193.5
Minimum income(US$)	-520.91	208.79
Maximum income(US$)	41511.80	3851.68
Gini ratio	0.49	0.38

Between pump and dam irrigation systems, Gini ratio for dam irrigated area (0.47) was found to be higher than for pump irrigated area (0.42) as shown in Table 4. This indicates that the distribution of income in dam irrigated area was more unequal than in pump irrigated area. The average income of farmers in dam irrigated area was higher than that of farmers in pump irrigated area. Similarly, income of the farmer who received the highest income in dam irrigated area (41511.80 US$) is much higher than that for farmer (4804.78 US$) in pump irrigated area. For minimum income, both groups had negative income but the negative value is higher for farmers in pump irrigated area. This caused the greater variation of income among farmers in each irrigated area. But the variation is more in the dam irrigated area, therefore, it has higher Gini ratio.

Table 4. Average annual household income (Kyats/household) and Gini ratio for dam and pump irrigated areas, Wann Twin and Nyaung U townships, Myanmar, 2011.

ITEM	DAM	PUMP
Average income(US$)	3362.46	1,226,4831442.92
Minimum income(US$)	-76.025	-520.92
Maximum income(US$)	41511.8	4804.78

Gini ratio	0.47	0.42

Comparison of Gini ratios for head, middle and tail areas of dam irrigation is shown in Table 5. In this case, inequity in distribution of income was larger in tail area than in head and middle areas. The values of Gini ratio were 0.33, 0.39 and 0.57 for head, middle and tail area, respectively. This shows that the farther the farms are from the water source, the larger is the inequality in income distribution. The average income was lowest for head users and highest for tail users. The highest maximum income and the lowest minimum income were found among the tail users. Therefore, the income variation among farmers in tail users is very high causing the highest value of Gini ratio among three groups. For the head users, the maximum income for farmers was the lowest but the minimum income was the highest among the three groups. This resulted to the lowest Gini ratio in this area.

Table 5. Average annual household income (Kyats/ household) and Gini ratio in head, middle and tail areas of dam irrigation, Wann Twin township, Myanmar, 2011.

ITEM	HEAD	MIDDLE	TAIL
Average income(US$)	2667.74	3373.20	3733.35
Minimum income(US$)	318.85	93.68	-76.32
Maximum income(US$)	822.01	13127.12	41511.8
Gini ratio	0.33	0.39	0.57

Similar results for Gini ratio were found in upstream, middle and downstream areas of pump irrigation system (Table 6). The Gini ratios were 0.43, 0.51 and 0.67 for upstream, middle and downstream areas, respectively. Among the three groups, the highest average income and maximum income were in the downstream area. This group also has negative minimum income, therefore, the Gini ratio was highest in this area. The lowest minimum and maximum income were found in the upstream area and so, it has the lowest variation of income across farmers. Therefore, the value of Gini ratio was the smallest among them.

Table 6. Average annual household income (Kyats/ household) and Gini ratio in upstream, middle and downstream areas of pump irrigation, Nyaung U township, Myanmar, 2011.

ITEM	UPSTREAM	MIDDLE	DOWNSTREAM
Average income (US$)	1691.05	1302.79	11765.02
Minimum income(US$)	-520.91	16.68	-121.45
Maximum income(US$)	4397.19	4623.79	4804.78
Gini ratio	0.43	0.51	0.67

To investigate the sources of income inequality in all farmer groups, a Gini decomposition analysis was undertaken. Table 7 presents the results of the Gini decomposition analysis for irrigated and rainfed areas. In this case, the total income was disaggregated into three components: farm income from lowland, farm income from upland, and non-farm income. The Gini ratio for each income source was estimated (B in Table 7). By multiplying the share of each income source (A in Table 7) with the respective Gini ratio, the absolute share of each income source to the total income was estimated (C in Table 7). The actual share in total income inequality of each income source (D in Table 7) was obtained by dividing the absolute share of each income source by the Gini ratio for the total income. This approach was adopted by Garcia et al. 2000.

Table 7. Sources of inequality in household income distribution in irrigated and rainfed areas, Wann Twin and Nyaung U townships, Myanmar, 2011.

SOURCE OF INCOME	SHARE OF HOUSEHOLD INCOME (%) (A)		GINI RATIO (B)		ABSOLUTE SHARE IN INCOME INEQUALITY (C)		SHARE IN TOTAL INCOME INEQUALITY (%) (D)	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Lowland Farm income	69.71	41.46	0.55	0.48	0.38	0.20	78.25	52.37
Upland Farm income	21.12	36.05	0.78	0.67	0.16	0.24	32.65	63.56
Non-farm income	9.16	22.49	0.84	0.76	0.08	0.17	16.33	45.26
Total income	100	100	0.49	0.38	0.49	0.38	100	100

To quantify the difference in income distribution across households in the irrigated and rainfed areas, in dam and pump irrigation systems, and according to the location from the water source (i.e., head, middle and tail in dam irrigation system; and upstream, middle and downstream in pump irrigation system), Gini ratio for each stratum was computed.

To investigate the sources of income inequality in all farmer groups, a Gini decomposition analysis was undertaken. Table 8 presents the results of the Gini decomposition analysis for irrigated and rainfed areas. In this case, total income was disaggregated into three components: farm income from lowland, farm income from upland, and non-farm income. The Gini ratio for each income source was estimated (B in Table 8). By multiplying the share of each income source (A in Table 8) with the respective Gini ratio, the absolute share of each income source to the total income was estimated (C in Table 8). The actual share in total income inequality of each income source (D in Table 8) was obtained by dividing the absolute share of each income source by the Gini ratio for the total income. This approach was adopted by Garcia *et al.* 2000.

Table 8. Sources of inequality in household income distribution in irrigated and rainfed areas, Wann Twin and Nyaung U townships, Myanmar, 2011.

SOURCE OF INCOME	SHARE OF HOUSEHOLD INCOME (%) (A)		GINI RATIO (B)		ABSOLUTE SHARE IN INCOME INEQUALITY (C)		SHARE IN TOTAL INCOME INEQUALITY (%) (D)	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Lowland Farm income	69.71	41.46	0.55	0.48	0.38	0.20	78.25	52.37
Upland Farm income	21.12	36.05	0.78	0.67	0.16	0.24	32.65	63.56
Non-farm income	9.16	22.49	0.84	0.76	0.08	0.17	16.33	45.26
Total income	100	100	0.49	0.38	0.49	0.38	100	100

The results showed that income from lowland crop cultivation was the highest contributor to total income followed by income from upland crop cultivation. The Gini ratios of income from lowland cultivation were 0.55 and 0.48, for irrigated and rainfed areas, respectively. Therefore, the share in total income inequity was 78.25% for the former and 53.27% for the latter. The reasons for the high income variation among farmers in irrigated area can be attributed to variations in land holding size, productivity due to differential adoption of farming techniques, managerial skills of household heads, amount of inputs used, and availability of irrigation water for the crops. The variation in land holding size was greater in irrigated area than in rainfed area. The average, maximum and minimum land holding sizes in irrigated area were 1.65 ha, 6.07 ha and 0.14 ha, respectively. Therefore, there was a high variation between maximum and minimum land holding sizes in irrigated area. Since land holding size had significant contribution to farm production and also farm income, the variation in land holding size can cause the income inequality among farmers. However, in rainfed area, the variation in land holding sizes was smaller than in irrigated area. The maximum and minimum land holding sizes were 2.02 ha and 0.4 ha, respectively.

The average income per unit of land from lowland cultivation obtained by the irrigated farmers was 1330US$ and that was 411US$ for rainfed farmers. This information clearly shows that since lowland cultivation which is dependent on water availability is the primary source of income, the variation of income from this source is the major reason for the prevailing inequality. This implies that increased production efficiency due to irrigation has greater contribution to total income and this could increase overall income inequality in the irrigated area. Such difference in production efficiency could be due to variation of water availability in the various locations of farms within irrigated area.

Since farm productivity is the main factor affecting income of the farmers, it is important that all farmers must be provided opportunities for improving productivity. Aside from adequate irrigation facilities, extension services for disseminating modern farming techniques should reach all farmers. Otherwise, variation in farm productivity and therefore household income would be large.

The second major source of income inequality in irrigated area was farm income from upland cultivation. But in rainfed area, this sector contributed most to total income inequality. The Gini ratios were 0.67 and 0.78 and the shares of upland cultivation to total income inequality were 33.62% and 63.56% for irrigated and rainfed areas, respectively. Farmers cultivated several kinds of upland crops such as groundnut, chili, onion, tobacco, black gram, green gram, and chick pea. Their income was based on their preferences of which crops to grow. Since there is less rainfall in both areas, the farmers usually cultivated less water consumptive crops and also devoted less area for those crops since irrigation water was not available for upland crops. But in rainfed area, the share of income from upland crop cultivation to total income (36.05 %) was higher than that for irrigated area (21.12 %). It can be noted that upland crop is the second source of income for farmers in both areas. However, due to unavailability of irrigation water for lowland cultivation in rainfed area, farmers cultivate more upland crops than in irrigated area in to generate income.

The lowest contribution to income inequality in both areas came from non-farm income. The share of this sector to total income was higher for rainfed area compared with irrigated area. The same result was found for its contribution to total inequality. This means that farmers in rainfed area participated more in non-farm activities in the summer season when they usually do not cultivate any crops due to unavailability of water.

The results for sources of income inequality in dam and pump irrigation systems are presented in Table 9. The Gini ratio of total income for dam irrigated area was slightly higher than pump irrigated area, 0.47 and 0.42, respectively. The higher Gini ratio in dam irrigated area implying that the income variation among farmers in this area is higher than pump irrigated area. Moreover, the share of farm income (lowland) to total income inequity was highest among all sources of income in both irrigation systems. It was 74.66 % for dam irrigation and 69.88 % for pump irrigation. Therefore, the inequality of income in both areas was mainly caused by variation of farm income (lowland) among farmers. This could be affected by the performance of each irrigation system on farm productivity.

Table 9. Sources of inequality in household income distribution in dam and pump irrigation systems, Wann Twin and Nyaung U townships, Myanmar, 2011.

SOURCE OF INCOME	SHARE OF HOUSEHOLD INCOME (%) (A)		GINI RATIO (B)		ABSOLUTE SHARE IN INCOME INEQUALITY (C)		SHARE IN TOTAL INCOME INEQUALITY (%) (D)	
	Dam	Pump	Dam	Pump	Dam	Pump	Dam	Pump
Lowland Farm income	74.66	52.41	0.47	0.56	0.35	0.29	74.66	69.88
Upland Farm income	17.55	33.63	0.84	0.65	0.15	0.22	31.36	52.04
Non-farm income	7.80	13.96	0.80	0.85	0.06	0.12	13.28	28.25
Total income	100	100	0.47	0.42	0.47	0.42	100	100

In the dam irrigation system, the maximum farm productivity (monsoon rice) was about three times higher than the minimum farm productivity. It was 6,541.7 kg/ha for maximum and 2,272.38 kg/ha for minimum. On the other hand, the average income per unit of land from lowland cultivation in dam irrigated area was about two times higher than in pump irrigated area. This implies that the income from lowland cultivation is highly dependent on the productivity of monsoon rice. The higher variation in productivity and income of monsoon rice among farmers in a particular irrigation system caused by variation of availability of water resulted in higher inequality of income. This appears to be more true in large irrigation system like dam irrigation system. Therefore, the share of farm income from lowland cultivation was highest among income sources and that share was higher in dam irrigated area than in pump irrigated area.

The second main income source for both irrigation systems which contributed to total income inequity was upland cultivation, with shares of 17.55 % and 33.63 %, respectively. This indicates that farmers in pump irrigated area were relying more on farm income from upland cultivation compared with farmers in dam irrigated area. This can be due to lower lowland farm income since it had low productivity which could be attributed to lesser years of farming experience of farmers and unsecured irrigated water in this area. The shares of this income in total income inequity in dam and pump irrigated areas were 31.36 % and 52.04 %, respectively. This shows that the share to total income inequality was higher in pump irrigated area compared with dam irrigated area. The inequity of income in this source is caused by the differences in income due to different crop cultivation practices among farmers. Some farmers utilize their land by cultivating high value crops such as green gram and black gram but some farmers cultivated crops for home consumption such as chili and onion.

The percentage share of non-farm income to total income inequity is the lowest among all income sources, 7.80 % in dam irrigated area and 13.96 % in pump irrigated area. The share of this income source to income inequality was also lowest for both areas compared with other income sources, 13.28 % for dam irrigators and 28.25% for the pump irrigators. This indicates that farmers in pump irrigated area were participating more in non-farm activities compared with farmers in dam irrigated area to increase their income.

CONCLUSION

Income inequality across farmers as shown by Gini ratio was higher in irrigated area (0.49) than rainfed area (0.38). For dam and pump irrigation systems, income inequality was 0.47 and 0.42, respectively. Within dam irrigation, it was 0.33 for head area, 0.39 for middle area and 0.57 for tail area. Therefore, the farthest from the water source, the more income inequality occurred. Similar trend was found in pump irrigation system, with Gini ratios of 0.43, 0.41 and 0.67 for upstream, middle and downstream areas, respectively.

For a clearer picture regarding which income sources contributed to income inequality, decomposition of Gini ratio was done for each income source. The share of lowland income to total income is highest for all farmer groups i.e., irrigated (dam and pump irrigation) and rainfed area. Comparing irrigated and rainfed areas, income variation among farmers was higher in irrigated area than in rainfed area. The average income per unit of land from lowland cultivation obtained by the irrigated farmers was 1329.98 US$ and this was 410.65US$ for rainfed farmers. This information clearly shows that since income from lowland cultivation which is dependent on water availability is the major source of income, the variation of this income could explain the prevailing inequality. This implies that variation in production efficiency due to variation in water availability could increase overall income inequality in the irrigated area.

The second major source of income inequality was income from upland cultivation in irrigated area. But in rainfed area, this sector contributed the most to total income inequality.

In both dam and pump irrigated areas, the share of farm income from lowland cultivation to total income inequity was the highest among income sources. Therefore, inequality of income in both areas was mainly caused by variation of farm income from lowland cultivation among farmers. The second main source of income that contributed to overall inequity was income from upland crop cultivation. For both areas, the lowest contribution to inequity in income came from non-farm income.

Poor management in irrigation system can cause variation in income among farmers and could have negative impact on the environment. Therefore, there is a need to study how existing water management system could affect the environment. In addition, the authorized agency and farmers should cooperate in improving water management that could lead to better performance of irrigation system. This will result in equal distribution of water, reduction of loss of soil nutrients, higher farm productivity and reduction of risk of negative environmental problem. Therefore, there is a need to improve water management, operation and maintenance of existing irrigation facilities.

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