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Income Inequalities and Different Levels of Water Availabilities in Irrigation Schemes: The Case of Minipe

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ABSTRACT. The objective of this study was to examine the relationship between income inequalities and the different levels of water availability in a selected major irrigation scheme in the country. A field survey was conducted to collect the necessary information for the analysis from a sample of 260 farmers in the Minipe agricultural settlement scheme. The Gini Coefficient, Elteto and Frigyes Indices and Sen Poverty Index were used to measure inequality among the settler farmers.

About 36 percent of the farmers fell into the category of poor, when the Rs. 700/- per month poverty line was used. Inequality among farmers in the tail-end of the canal was higher than the head-end, while head-end farmers were more affluent compared to the tail-end farmers. In order to overcome the negative aspect of inequality, rehabilitation, improvement of irrigation infrastructure and proper water management measures are suggested.

INTRODUCTION

Establishing irrigation projects of varying scales for various purposes has been a common activity of mankind in the world for many centuries. But, around the world, most irrigation projects have been considered as failures due to problems of inefficient management and also due to inequitable distribution of water (Abeygunawardena, 1986; Bromley *et. al.*, 1980; Upasena and Abeygunawardena, 1986; Heques, 1982). Equitable distribution of water is crucial to the success of irrigation systems (Baker, 1978). It has been found that even in some of the

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worlds finest projects only about 20 percent of the water diverted from its source is available for plant growth (Zimmerman, 1966).

Most large scale canal irrigation systems in the developing countries are planned to be egalitarian in that an equal quantity of water is allocated per unit of irrigated land (Bromley *et. al.*, 1980). Many problems arise in these irrigation schemes because the amount of water available is limited (Skold, *et. al.*, 1984). Mal – distribution of water may serve only a few farmers. Distribution problems are evident when upstream irrigators are compared with farmers at the furthest areas served by the irrigation system. Farmers whose fields (farms) are furthest from the source frequently have the least secure water supply (Chamber, 1984).

Inequality of economic conditions of settler farmers has been identified in many irrigation schemes in Sri Lanka. The differentiation between head and tail – enders is clearly distinguished and the inequitable distribution of irrigation water is the major cause for this disparity. Different levels of input use due to the different quantity of irrigation water availability to each farm has resulted in different productivity levels in the crop cultivation. Therefore, it is assumed that the variability of farmers income has created unequal economic condition among farmers. In this case, it is important to identify the pattern of the income distribution among the farmers in a system as the major criteria to assess the economic inequality. The income inequality is a prime concern of most policy makers.

The main objective of this study is to examine the economic inequality of the farmers by way of income distribution pattern at different levels of water availability in irrigation schemes. In addition, the perceived reasons for the unequal distribution of irrigation water are also investigated.

MATERIALS AND METHODS

Minipe, one of the major irrigation schemes located in the Eastern part of the Central Province of Sri Lanka, was selected as the area for this study. The information needed for the study was collected mainly from a sample of 260 farmers and their farm units by conducting a field survey. The sample was drawn using stratified random sampling

technique, based on type of canal *i.e.* main and distributory as well as the location of the fields *i.e.* head and tail ends.

Several inequality measures and indices were used to observe the income distribution patterns and the economic disparity of the farmers in this area. The measures are the Gini Coefficient, Elteto and Frigyes Indices and the Sen Poverty Index (Sing *et. al.*, 1982; Elteto and Frigyes, 1968; Sen, 1976; Sing and Asoken, 1981). Each of these inequality measures has different characteristics. Gini Ratio measures the income distribution pattern of the entire group of the farmers in the project. Elteto and Frigyes Indices explain not only the income disparity of the entire group but also between the poor and the rich farmers. Sen Poverty Index measures the poverty level of the farmers.
The equation to calculate Gini Coefficient (G) is:

$$G = 1 + (1/n) - (2/n^2\mu)\,[I_1 + 2I_2 + 3I_3 + \ldots + nI_n]$$

$$\text{for, } I_1 > I_2 > \ldots\ldots > I_n$$

Where, n is the number of observations (households), μ is the mean income and I is the total house hold income (farmer's net cash income + off farm income). The higher values of the measure indicate greater relative income inequality.

Three indices (V, U and W) introduced by Elteto and Frigyes measure the degree of the inequality and its economic motivation in a given community. They are :

$$1.\quad V = \frac{m2 - m1}{m2}$$

$$2.\quad U = \frac{m - m1}{m}$$

$$3.\quad W = \frac{m2 - m}{m2}$$

Where, m is the mean income of individuals (farmers), m1 is the mean income of the lower half of the individuals and m2 is the mean

income of the upper half of the individuals. The V index measures the inequality in the entire income distribution while U and W indicate the inequalities of the two groups – the poor and the rich respectively.

Sen Poverty Index (P) is a more comprehensive measure of the relative inequality of income among groups of individuals. This is a measurement of the "absolute poverty" of those individuals. "Poverty" implies the conditions of inequality and social inadequacy (Samaranayaka, 1989). The Sen Poverty Index could be expressed as :

$$P = H \{ I + (1 - I) G \}$$

Where, H is the head count of the poor, I is poverty or income gap ratio (average income short fall of the poor) and G is Gini Coefficient of the distribution of income among the poor.

RESULTS AND DISCUSSION

The results of this study show that the inequality of the economic conditions of these farmers are apparent in each part of the project. The mean age of the farmer in the study sample was 40 years. The farmers living in the head section of the project (P – Head) is younger than the farmers in the tail – end section of the project (P – Tail) though the farm settlements of head section were started about 15 years earlier than when settlements in tail section of Minipe scheme were established. The major reason for this is that a large number of farmers who are living in the head – end area belong to the second and third generation of the original settlers.

Only about four percent of the heads of the households are female in the sample. The educational level of the majority in both sections were below grade eight. The tail – enders' educational levels were comparatively lower than the head – enders'. The average family size of the household was seven members.

The extent of irrigable lowlands was about 68 percent from the total land area covered in the sample and the rest (32%) was rain – fed highlands. The average extent belonging to the farmer in the P – Head section were 0.40 acres of highland and 0.92 acres of lowland. These figures for tail – end part were 0.31 and 0.88 acres respectively.

The ownership of capital items (consumer durables and production assets) also can be considered as one of the criteria to assess the economic condition of a farm family. It was revealed that the farmers in the P – Head section owned more of these goods than those in the P – Tail section. Not only the number of the items owned, but also the quality or the value of these items were found to be higher among those in the head section. For example, from among the 11 television sets owned by the sample farmers, only one belonged to a tail – ender farm family. The latter was half the value of the sets owned by the head – ender farmers. Only two of the 12 two wheel tractors in the area belonged to tail – ender farmers.

Paddy was the only crop cultivated in the lowlands during both *Yala* and *Maha* seasons. It contributes about 70 percent to the total household income of the farmers. Among the head – ender and tail – ender farmers, the average yield of paddy varies between 79.0 and 42.4 bu./acre. The cost of production per acre (including family labour) varies between Rs. 6681.65 to Rs. 4221.08 while the net returns (excluding family labour) varies between Rs. 4,005.11 and Rs. 1,101.09.

Relative income inequality and absolute poverty

Inequality of income distribution among the farmers in the sample was measured by the Gini Coefficient and the Elteto – Frigyes Inequality Indices. The Gini Coefficient values estimated for the project based on the sample is 0.448. It is a remarkably high value, indicating a wide disparity among the farmers (Table 1). The Gini Ratio estimating the level of inequality for the whole economy of Sri Lanka was 0.49 in 1978/79 (Central Bank of Sri Lanka, 1978/79).

The Elteto – Frigyes V Index showed a similar result. The overall inequality of the project is 0.735. In addition, the income inequality of each group of farmers, the poor (U) and the rich (W), were 0.523 and 0.445 respectively. The inequality within the poor themselves was very much higher than among the rich.

The poverty level revealed by Sen P index was 0.282. The number estimated as poor was 36 percent which is more than one – third of the sample. In this analysis a monthly average income of Rs. 700.00 was considered as the "Poverty Line" which was the income level that the

Table 1. Results of the measures and indices in different locations in the project area.

Measure/Index	Head Section of the Project (P-Head)							Tail Section of the Project (P-Tail)							Project Total
	HDH			HDT			Total (HD)	TDH			TDT			Total (TD)	
	HDHH	HDHT	Total (HDH)	HDTH	HDTT	Total (HDT)		TDHH	TDHT	Total (TDH)	TDTH	TDTT	Total (TDT)		
1. Gini ratio	0.366	0.384	0.387	0.418	0.294	0.345	0.376	0.421	0.436	0.836	0.347	0.355	0.375	0.453	0.448
2. Elteto and Frigyes indices															
i. V index	0.653	0.668	0.691	0.742	0.590	0.663	0.684	0.811	0.843	0.813	0.699	0.691	0.695	0.766	0.735
ii. U index	0.414	0.478	0.461	0.571	0.418	0.476	0.478	0.655	0.735	0.668	0.547	0.372	0.547	0.626	0.523
iii. W index	0.408	0.401	0.427	0.400	0.295	0.356	0.392	0.453	0.408	0.438	0.337	0.319	0.328	0.389	0.445
3. Poverty index															
i. San poverty index	-	-	0.164	-	-	0.106	0.139	-	-	0.500	-	-	0.347	0.426	0.282
ii. Head count of the poor	-	-	28%	-	-	16%	22%	-	-	54%	-	-	40%	51%	36%

Government of Sri Lanka used to select the poorest category of people for the poverty elevation "Janasaviya Programme" (Ministry of Policy Planning and Implementation, 1989).

Head *vs.* tail section of the project

Disparity of income and the absolute poverty between head-end and the tail-end farmers of the project are described well by all measures used in the analysis (Table 1). Inequitable distribution of income of tail-enders was comparatively larger than that of the head-enders. The values of Gini Coefficient for the head section were 0.376 and 0.453 for the tail section. The V index values were 0.684 and 0.766 for head and tail sections respectively. The inequality among the poor (U) were 0.479 for head and 0.616 for tail-end farmers. However, income variability of the rich farmers in both sections was almost the same.

The average income per unit of land obtained by the head-enders was Rs. 5,525.64 and that was Rs. 2,923.32 for tail-enders. This information clearly shows that since paddy is the major source of income dependent on water availability, the variation of the income from paddy cultivation is the major reason for the prevailing inequality. The highest per acre income reported from the head-end section was Rs. 9,562.50 while in the tail-end area this was Rs. 6,906.67. The lowest income of the head-end farmers was Rs. 2,187.50 and the tail-end farmers reported negative income. With regard to the average net household income, the lowest twenty percent of the income receivers in the P-Head section have earned an annual income of above Rs. 4,000.00 and this was less than Rs. 2,000.00 for tail-end farmers. The highest five percent of net household income receivers in the P-Head section have reported an income above Rs. 54,000.00 while the corresponding group reports less than Rs. 37,000.00 for the P-Tail section.

The poverty level of the farmers in the tail-end part of the project was threefolds higher than that of head-end farmers. This index for tail-enders was 0.139 and was 0.426 for head-enders. The estimated number of poor in the tail-end part was over twofold than that in the head-end part.

Distributory canal level of the project

The income inequality and the poverty levels in the head – end and tail – end parts of the distributory (D) canals is complicated. The head – end sections of the D canals (HD) showed a larger income inequality than among the tail – end sections of the distributory canals (TD). For instance, the Gini Ratio in the head part of the HD level (HDH) and the tail part of the HD level (HDT) were 0.397 and 0.345 respectively and the same for the head part of the TD level (TDH) and the tail part of the TD level (TDT) were 0.526 and 0.374. The P index was 0.164 in HDH and 0.106 in HDT parts. This index for TDH part was 0.500 and 0.347 for TDT (Table 1).

According to the conventional theory, it was hypothesized that the farm income will vary negatively with the distance of flow of irrigation water on the ground. When the distance between the field and the water source is far, the farmers income obtained from crop yield is lesser. But the above results do not substantiate this proposition. However, this situation may have occurred due to the effects of irrigation water on the farmers' total income through the farm productivity in each section.

The average yields of paddy per acre in HDH and HDT parts were 75.14 and 76.64 bushels respectively. This implies that the effect of irrigation water on the farm productivity, *ceteris paribus*, is more or less the same for the two parts. The water distribution patterns in each part were similar. It was revealed that the main reason for this disparity was the income of a few rich farmers in the respective areas. Their total household income was extremely high compared to that of the other farmers. Further their off farm income contributed more than 60 percent to their total income. They have not only large incomes but also they own large amount of wealth when compared to the other farmers. An analysis was conducted excluding their income from the sample, the results were consistent with the theory and hence forth with the former hypothesis. Gini Coefficients changed from 0.397 to 0.327 and from 0.345 to 0.336 for HDH and HDT sections respectively.

However, the role of irrigation water is an important factor associated with the inequality of income and poverty among P – Tail farmers. Of TDT farmers, 83 percent have reported having inadequate irrigation water during the period of study. In TDH section, this was

only 34 percent. The average yield per acre received by the TDH farmers was 48.44 bushels while the TDT farmers received 44.19 bushels. The average gross returns per unit of land were Rs. 3,052.69 and Rs. 2,766.29 for TDH and TDT farmers respectively. This difference was mainly due to the degree of water availability. The application of other inputs such as fertilizers, agro – chemicals were also dependent upon the quantity and timely availability of irrigation water at the farm. The analysis has shown that the same reasons which affected the P – Head section are responsible for the larger disparity in TDH than TDT. Gini Ratio changed from 0.526 to 0.336 after removing the outlier effects.

Field canal level of the project

The water distribution pattern along the field (F) canals has not made a significant impact on the yield of the farmers in the P – Head section. Among these farmers, the paddy yield was positively related to the distance of water flow. This was not consistent with the conventional economic theory of production. For instance, average yield in the head section of the F canals of HDH part (HDHH) was 71.79 bushels per acre and 77.84 bushels in the tail section of the F canals of HDH part (HDHT). The reason for this disparity was the influence of other production factors such as fertilizer, soil characteristics of the farms *etc.*

But the farmers of F canals in the tail – end part of the main system reported having a strong relationship between the water availability and the yield level. The average yields of these farmers vary positively with the irrigation water supply. The highest average yield of 52.78 bushels per acre was reported from the head section of the F canals of TDH part (TDHH) and the lowest, 42.42 bushels, from the tail section of the F canals of TDT part (TDTT).

Gini Coefficients of each section of this part were comparable to the yield variation (Table 1).

Reasons for water inadequacy

The amount of water available to the farms in the Minipe scheme is determined by several factors. Among them, climatic conditions, physical infrastructure, the length of the water ways, and the problems

generated due to the farmers' interdependence to access the irrigation water are important.

Due to the farmers' interdependence, the quantity of water available by the tail-end farmers depends on the various irrigation practices done by the head-end farmers. In Minipe, many incidents were reported about the wastage of irrigation water due to various actions of the farmers. In considering the project as a whole, many farmers (63%) did not close their water inlets after obtaining their water requirements. Sixty two percent farmers were reported closing other farmers water inlets. About 50 percent farmers blocked the canals to receive water unnecessarily. One fourth of the farmers were getting water to their farms through open water inlets. About 90 percent of farmers irrigated at nights and majority of them practiced it to steal water or to prevent their water inlets being closed by other farmers. Exactly two third of farmers were sharing water from the inlets with some other farmer or farmers. These practices leads to excessive wastage of irrigation water. Tail-enders of the project were suffering due to these actions of head-enders all the time.

Several policy alternatives can be suggested to upgrade the farmers living conditions, minimizing the economic inequalities. Priority must be given to improve the water distribution pattern and to reduce the effect of the problem of farmers' inter-dependence. Mechanisms such as the establishment of farmer organizations to obtain collective participation and responsibility in water management is needed. Rehabilitation of the water delivery system especially the field canals and the supply of infra-structural facilities such as roads, marketing and transport have to be developed to increase the efficiency of resource utilization. Introducing appropriate technology and education of farmers in skills such as, cost reduction cultivation methods, use of high yielding varieties, transplanting *etc.* may help to increase the production per unit of land. Finally, it is not unfair to suggest some market oriented solutions for efficient allocation of irrigation water within the scheme. In these circumstances, redefining the existing property rights of irrigation water and the pricing or valuing of irrigation water might be two possible alternative actions.

CONCLUSIONS

A little more than one third of the farmers in the Minipe project are absolutely poor. The economic conditions of the farmers showed wide variations among different groups. It is well established that these disparities increase from the head-end to the tail-end of the project area. The absolute poverty of the tail-enders was three times larger than that of the head-enders. Inequitable distribution of irrigation water was the major cause of the disparity. The major source of the income was the paddy cultivation in the area and water was one of the most crucial factors in deciding the yield of paddy.

Nearly half of the farmers living in the Minipe scheme have been suffering from inability to receive their complete water requirement for each season. The water inadequacy increases when water goes from the head section to the very tail-end of the system and the degree of water availability depends on the climatic conditions, physical infrastructure, location of the farm, and the inter-dependencies among farmers.

In taking the policy actions to solve the above mentioned problems of inequalities, farmer participation in irrigation management, development of physical and infra-structural facilities will be more effective and essential to achieve the expected goals. In addition, some market oriented solutions may also be selected as policy recommendations.

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