THE IMPACT OF SMALL-SCALE COMMUNAL IRRIGATION PROJECT ON INCOME DISTRIBUTION

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ABSTRACT

The impact of small-scale communal irrigation project on income distribution was determined among factors of production, among earners, and across households. Farm survey data from Quezon Province, Philippines were obtained and analyzed using the "with-without" and "before-after" project comparative methods. Analysis of the relative factor shares was also made using the Constant Elasticity of Substitution (CES) production function. The return to each production factor was generally higher in the "with, or after" irrigation condition as contrasted to the return to each production factor in the "without" and the "before" irrigation situations. The increase in capital share, however, was generally larger than the increase in labor and management shares. This was mainly attributed to a significantly lower labor intensity on the irrigated farms compared with the labor intensity on the unirrigated farms. The real returns to the various earners were generally larger on the irrigated areas than on those without irrigation facilities. However, the farmers benefited from irrigation more than the landlords and hired laborers in the "before-after" comparison. The indices of income inequality on the distribution of income among the respondents in the "with, or after" and "before" irrigation situations showed that irrigation caused a little improvement in the income distribution across farmer-households.

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KEY WORDS: Communal irrigation. Income distribution. Factor shares. Earner shares. Farmer-households.

INTRODUCTION

Irrigation development has been considered a complement to other technological advances in increasing productivity and income of rice farmers. In fact, the productivity aspect has long been used as the primary basis in accelerating the development program of irrigation in the country. Agricultural development objectives, however, should not be limited to increasing farmers' productivity alone. It also includes, among others, the attainment of equitable income distribution and a provision for increased employment opportunities.

Majority of the economic researches dealing with technological advances centered on productivity and cost-return analysis. Not much cognizance has been given to the analysis of technology's impact on income distribution. Such situation is probably one reason why the issue of income-distribution impact of a technology is still controversial.

For instance, there has been much concern that technological advance might contribute to a deterioration in income distribution (Wharton, 1969; Falcon, 1970; Johnston and Cownie, 1969; Staub and Balse, 1974). On the other hand, others, like Sutawan (1977) and Hayami and Herdt (1977), believe that modern technology will cause a more socially desirable income distribution. Moreover, Kendrick (1964) and Day (1967) argue that the impact of technological change on the distribution of income will depend upon the kind of technology developed.

This study aimed to determine the impact of irrigation on income distribution among factors of production, among earners, and across households.

METHODS

Data for this study were gathered in Manggalang I, Sariaya, Quezon during the months following the harvest of the last cropping season of 1979. One-hundred rice farmers served as respondents, half of which were selected at random from rice farms "with" irrigation facilities and the other half from farms "without" irrigation project. Two sets of information were obtained from the respondents on the irrigated farms: (1) the "before" irrigation situation and (2) the "after" irrigation situation. Data for the "with, or after" and "without" irrigation conditions were limited to the crop year 1979 while the "before" irrigation data were focused mainly on crop year 1975, the year immediately preceding the establishment of the small-scale communal irrigation project.

The "with-without" and "before-after" project comparative approaches as well as the Constant Elasticity of Substitution (CES) production function analysis were employed to ascertain the effect of irrigation on the selected impact indicators.

The CES production function has the following form (Arrow, *et al.*, 1961):

(1)

$$Q = A[\delta K^{-P} + (1-\delta)L^{-P}]^{-(1/P)}$$

where Q, K, and L denote output, capital, and labor, respectively; A is a technological parameter; δ is a distribution or factor intensity parameter; and P is a factor substitution parameter. Under marginal productivity equilibrium, the share of labor relative to capital can be expressed as:

(2)

$$S = \frac{WL}{qK} = \left(\frac{1-\delta}{\delta}\right)\sigma\left(\frac{q}{w}\right)^{\sigma-1}$$

In terms of logarithms, the estimating form adopted in this study is therefore:

(3)

$$\log S = \sigma \log\left(\frac{1-\delta}{\delta}\right) + (\sigma \cdot 1)\log\left(\frac{q}{w}\right) + e$$

where:

S = labor-capital income ratio.
WL = return to labor and management.
qk = return to land and non-land capital.
σ = elasticity of factor substitution = 1/(P + 1).
$\frac{1-\delta}{\delta}$ = labor intensity.
q = rental rate of capital.
w = daily wage rate.
e = error term.

From equation 3, the value of log $(\frac{1-\delta}{\delta})$ can be derived from the intercept term and σ can be computed from the coefficient of log $(\frac{q}{w})$.

RESULTS AND DISCUSSION

Income Distribution by Factor Shares.

Analysis of the income distribution among the factors of production revealed that the real income of each production factor was generally higher on the irrigated farms as contrasted to the real income of each production factor on the non-irrigated farms (Table 1). However, the increase in real income associated with irrigation was not equally shared among the various factors of production.

The percentage share of fixed capital was found to be higher on the irrigated farms than those on the unirrigated farms. On the other hand, the percentage shares of labor and management were negatively associated with the presence of irrigation system.

Estimation of the labor-capital income ratio by means of the CES production function likewise revealed that irrigation was significantly associated with lower relative income share of labor (Table 2). This was mainly attributed to a significantly lower labor intensity $(\log\frac{1-\delta}{\delta})$ on the irrigated farms compared to the labor intensity on the unirrigated farms. The elasticity of substitution (σ) and capital-labor price ratio $(\log\frac{q}{w})$ were negatively but, generally, not significantly associated with irrigation. Each of these two forces was expected to cause a higher

Table 1. Allocation of total rice output among factors of production, by irrigation situation (per hectare basis).

IRRIGATION SITUATION	FACTOR SHARE			
	In Cavans		In Percent	
	Wet	Dry	Wet	Dry
Without, or rainfed				
Fixed capital				
Land	16.0	14.0	24.7	24.0
Non-land	5.9	5.5	9.1	9.4
Current inputs				
Fertilizers	5.5	4.0	8.5	6.9
Non-fertilizers	7.3	7.3	11.3	12.5
Labor	26.2	22.0	40.5	37.6
Management	3.8	5.6	5.9	9.6
TOTAL	64.7	58.4	100.0	100.0
With, or after irrigation				
Fixed capital				
Land	22.0	22.3	30.0	29.6
Non-land	6.3	5.7	8.6	7.6
Current inputs				
Fertilizers	6.8	6.7	9.3	8.9
Non-fertilizers	8.8	8.4	12.0	11.2
Labor	26.5	27.8	36.2	36.9
Management	2.9	4.4	3.9	5.8
TOTAL	73.3	75.3	100.0	100.0
Before irrigation				
Fixed capital				
Land	16.0	15.4	29.7	28.7
Non-land	4.3	3.9	7.9	7.3
Current inputs				
Fertilizer	4.9	4.4	8.9	8.3
Non-fertilizers	6.1	5.6	11.2	10.4
Labor	21.1	21.0	38.7	39.2
Management	2.2	3.3	4.0	6.1
TOTAL	54.6	53.6	100.0	100.0

relative income share for labor (log S) on the irrigated farms. But since the changes in σ and $\log \frac{q}{w}$ were very minimal, these forces were not able to offset the effect of $\log \frac{1-\sigma}{\sigma}$.

Table 2. Estimates of labor intensity $\log\left(\frac{1-\sigma}{\sigma}\right)$ elasticity of substitution (σ), relative factor prices $\left(\log\frac{q}{w}\right)$ and relative factor shares (log S) for various seasons and irrigation situations.

SAMPLE FARM	ESTIMATED VALUE			
	$\log\frac{1-\sigma}{\sigma}$	σ	$\log\frac{q}{w}$	log S
Wet season				
Without (n = 50)	-4.32	0.22	-2.34	0.14
With, or after (n = 50)	-9.77	0.30	-2.31	0.01
Before (n = 48)	-4.08	0.34	-2.27	0.06
Test of differences:				
With-without	-5.45**	0.08ns	0.03ns	-0.13**
	(1.81)	(0.05)	(0.03)	(0.03)
After-before	-5.65*	-0.04*	-0.04ns	-0.05*
	(2.24)	(0.02)	(0.03)	(0.02)
Dry season				
Without (n = 43)	-3.61	0.39	-2.35	0.15
With, or after (n = 50)	-4.75	0.34	-2.33	0.06
Before (n = 48)	-2.49	0.47	-2.30	0.10
Test of differences:				
With-without	-1.14*	-0.05ns	0.02ns	-0.09*
	(0.52)	(0.03)	(0.03)	(0.03)
After-before	-2.26*	-0.13*	-0.03ns	-0.04*
	(1.08)	(0.06)	(0.03)	(0.02)

$\log\frac{(1-\sigma)}{\sigma}$ = the logarithm of labor intensity, derived from the intercept term of equation 3.

σ = elasticity of substitution, derived from the coefficient of $\log\left(\frac{q}{w}\right)$ in equation 3.

$\log\left(\frac{q}{w}\right)$ = the computed mean of the logarithm of relative factor price.

log S = the computed mean of relative factor shares as specified in equation 3.

** = significantly different at 1% level.

* = significantly different at 5% level.

ns = not significantly different at 5% level.

Figures in parenthesis are pooled standard errors of estimates.

Income Distribution by Earner Shares.

Analysis of the distribution of real share going to various earners or participants of the production process likewise indicated that the shares of the various earners were generally larger on the irrigated farms vis-a-vis those found on the "without" and "before" irrigation farms (Table 3). However, it was noted that the increase in real income associated with the irrigation project was not equal among the different participants of the production process.

In the "without-with" comparison, landlords were slightly favored by irrigation over those of other earners. In the "before-after" comparison, however, the percentage shares of farm operators were positively associated with irrigation. This was an indication that the establishment of an irrigation project

Table 3. Allocation of total rice output among various earners in the production process, by irrigation situation (per hectare basis).

IRRIGATION SITUATION	EARNER SHARE			
	In Cavans		In Percent	
	Wet	Dry	Wet	Dry
Without, or rainfed				
Landlords	16.0	14.0	24.7	24.0
Hired laborers	15.3	13.0	23.6	22.3
Current input earners	12.8	11.3	19.8	19.3
Other earners [1]	2.4	2.9	3.7	5.0
Operators	18.2	17.2	28.1	29.4
TOTAL	64.7	58.4	100.0	100.0
With, or after				
Landlords	19.9	19.3	27.1	25.6
Hired laborers	16.9	17.6	23.1	23.4
Current input earners	15.6	15.1	21.3	20.1
Other earners [1]	2.8	2.9	3.8	3.8
Operators	18.1	20.4	24.7	27.1
TOTAL	73.3	75.3	100.0	100.0
Before irrigation				
Landlords	15.2	14.8	27.8	27.6
Hired laborers	12.7	12.7	23.3	23.7
Current input earners	11.0	10.0	20.1	18.7
Other earners [1]	2.8	2.4	5.1	4.5
Operators	12.9	13.7	23.6	25.6
Total	54.6	53.6	100.0	100.0

[1] Recipients of rents on tractors and mechanical threshers.

was more beneficial to the farmers but less to the landlords, hired laborers, and other earners.

Income Distribution Across Farmer-Households.

Computations of the Gini ratios and coefficient of variations were made to ascertain if the increases in the level of income to the households had a desirable effect on the overall income distribution. Based on the "before-after" analysis, irrigation was found to have improved the income distribution across farmer-households. This was indicated by the lower inequality indices in the "after" than in the "before" irrigation situation (Table 4). In the "without-with" analysis, the relatively lower inequality indicators in the "without" than in the "with" situation was attributed to differences in factors other than irrigation.

Table 4. Distribution of recipients and receipts among different income categories of Quezon farmers, average of wet and dry seasons by irrigation situation.

INCOME CATEGORY	CUMULATIVE PERCENTAGE OF RECIPIENTS			CUMULATIVE PERCENTAGE OF RECEIPTS		
	Without	With	Before	Without	With	Before
Below ₱ 400	3	5	9	1	1	1
400 — 799	13	25	46	3	6	16
800 — 1,199	33	35	60	12	11	26
1,200 — 1,599	45	49	71	19	20	37
1,600 — 1,999	61	55	74	32	25	40
2,000 — 2,399	66	67	85	29	38	51
2,400 — 2,799	73	71	88	48	43	63
2,800 — 3,199	79	78	91	55	53	71
3,200 — 3,599	84	83	92	64	61	73
3,600 and above	100	100	100	100	100	100
Gini Ratio	0.37	0.39	0.44			
Coefficient of Variation	0.70	0.76	0.92			

$1.00 = ₱7.80

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