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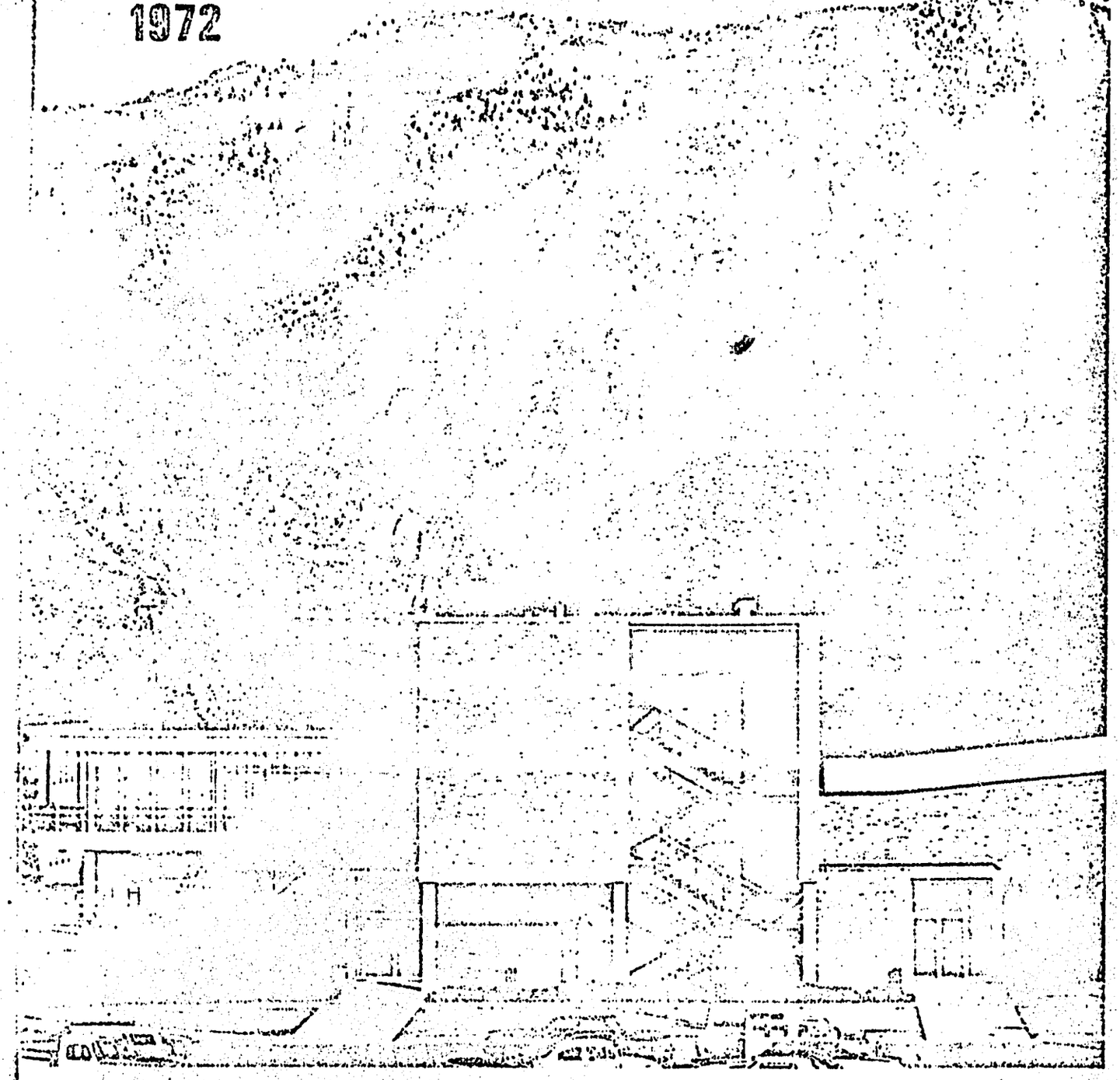

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PUBLIC IRRIGATION PROJECTS, WINDFALL GAINS, AND THE DISTRIBUTION OF RURAL INCOME: THE CASE OF MILAGRO, ECUADOR

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This paper focuses on the effect of public irrigation projects on rural income and wealth, both within and among various groups of farmers classified by land tenure in the setting of a developing country. A side issue is the probable impact of selective changes in water fees over time. Some appreciation of these effects is important to developed nations, but such knowledge is especially significant to the less-developed countries (LDC) where income distribution problems are relatively more serious.

Problem

Access to public irrigation water by some farmers may permit fixed resources of those persons to earn relatively greater returns. In order for any farmer to use the water, additional capital investment might be necessary, and some change in technique may be necessary. If unit costs of production are decreased, and if production prices are not affected, fixed factors will earn relatively greater returns. 1/

Project irrigation water is fixed in supply and is distributed to a fixed number of farms that are advantageously located to the distribution system. Such locations, plus the institutional management system, tend to insure access to the water over the life of the project and usually at a constant price. Moreover, any increased returns will not be eroded by the entrance of new firms. Farmers fortunate enough to obtain the water will earn the greater returns as long as they are able to purchase the resource at a profitable price. These returns may be such as to constitute windfalls in income and wealth.

This familiar reasoning suggests that within a rural sector, project users within all land tenure classes improve their income and wealth position relative to non-users in the rest of agriculture, ceteris paribus. A priori, however, little can be said about the effect of project development on the relative income position of tenure classes among project users. One may assume (if the land tenure pattern is of the latifundio - minifundio type) that such projects tend to improve the relative position of large land holders. However, this would be offset to some degree if returns per unit were larger on small farms.

As it turns out, the small farmers in the Milagro Project do rather well only when project impacts are measured on a per-hectare basis.

Conceptual Model, Data, and Procedures

Are returns to fixed investment on farms using project irrigation greater than the opportunity cost of the investment? What is the relative position of such returns by land tenure class? What are the magnitudes of pure economic profits (by tenure classes) conferred on farms using project irrigation?

Two general levels of technology are found in the project area. Some farms use traditional farming methods and no supplementary irrigation (F_1); others use traditional farming methods plus project irrigation during the dry season (F_2). Our method is to calculate the average net returns (NR_1) on F_1, with opportunity costs of all labor and capital included in the calculations. The average net return to F_2 (NR_2) is also calculated, except the costs of on-farm distribution systems (C_0) are not included. 2/ Net returns are estimated on an annual basis for F_1 and F_2 over the life of the project. Under an assumption of production homogeneity (see below) the difference in net returns for each year ($NR_2 - NR_1 = R_W$) is attributed to irrigation. The differences (R_W) are treated as an income stream over the life of the project, and the rate of return (i) is found that equates the present value of R_W with C_0. 3/ By comparing this rate with the opportunity cost of capital, we can determine if fixed irrigation resources are earning economic profits.

Such calculations are made for four land tenure classes:

Size I (minifundio) - not capable of supporting one family without family members working off the farm;
Size II - supports one family;

Size III - supports two or more families in an extended family;
Size IV (latifundio) - characterized by hired managers and hired day laborers.

Comparison of the internal rates of return among tenure classes permits a determination of the relative impact of the project.

In order to estimate the magnitude of economic profits, the water fees are imagined to rise until the internal rate of return falls to 12 percent (the opportunity cost of capital). 4/ The difference between the current water tariff and one which would force the internal rate of return to fall to 12 percent is defined as annual economic rent. Since water tariffs are expressed on a per-hectare basis, the annual economic rent per farm is determined by multiplying the "maximum tariff" by the farm size.

In order to attribute R_W to irrigation, all aspects of farms (within tenure class) with and without irrigation must otherwise be homogeneous. Mean farm size by tenure class was compared for F_1 and F_2; statistically there is no difference in land areas. Soils, climate, factor and product prices, transportation costs, and cultural and management practices (within tenure classes) appear to be identical or very similar. The only apparent difference is the cropping patterns on F_2, which is due to irrigation. Thus, we conclude that R_W closely represents returns due to irrigation [1].

Impact of the Milagro Project on Rural Income Distribution

The internal rates of return (i) on the investment in an on-farm distribution system (C_0) are presented in Table 1 for the four different tenure classes, assuming the return to such capital is the stream R_W, over the life of the project. These rates are compared to the opportunity cost of capital (12 percent).

Table 1. Internal Rates of Return on Investment in On-farm Distribtuion Systems, by Tenure Classes, Per Hectare.

Tenure Class	Internal Rate of Return i	Opportunity Cost of Capital	Net Internal Rate of Return
		(percent)	
I	44.4	12.0	32.4
II	41.3	12.0	29.3
III	35.5	12.0	23.5
IV	24.4	12.0	12.4

The internal rate of return is greater than opportunity cost for all land tenure classes suggesting that investment in on-farm distribution systems does earn economic profits. The minifundios are the most profitable, with the rate of return decreasing over the range of land tenure from Class I to IV.5/

The economic rents (profits) captured per hectare and per farm are presented in Table 2. Such rents are calculated by allowing the cost of water to rise from S/.200 until the internal rate of return (i) falls to the opportunity cost of capital (12 percent).

Evidence in Tables 1 and 2 indicates that farms in any tenure class improve their income and wealth position relative to non-users, ceteris paribus by adoption of irrigation. This is also demonstrated by the increased value of irrigated land in the Milagro area.6/ Project development apparently shifts income in favor of project water users in Milagro on an annual basis, and wealth in the form of an augmented capital structure.

We are concerned with the effect of project development of the distribution of income among tenure classes, as well as between users and non-users. If the economic profits accruing to each tenure class from irrigation and the income distribution among tenure classes before the adoption of irrigation are known, the impact of the project on area rural income distribution can be determined.

Table 2. Economic Profit Earned by On-farm Investment in Irrigation Infrastructure by Tenure Class, Per Hectare and Per Farm.

Tenure Class	Maximum Tariff	Present Tariff	Economic Profit per Hectare	Average Farm Size	Economic Profit per Average Farm
	(S/.)	(S/.)	(S/.)	(hectares)	(S/.)
I	1,608.39	200.00	1,408.39	2.32	3,267.46
II	1,491.33	200.00	1,291.33	7.09	9,155.53
III	1,178.30	200.00	978.30	14.20	13,891.86
IV	810.36	200.00	610.36	43.39	26,483.52

Economic profits per hectare are largest on minifundios and decline as tenure changes to Class IV. However, economic profits per farm are positively correlated with farm size. This would imply that tenure Classes III and IV experience relatively greater gains in income. But this also depends on the number of farms in each tenure class. The economic rent from irrigation per class is presented in Table 3.

Table 3. Total Project Area Economic Profits from Irrigation Capital by Tenure Classes

Tenure Class	Number of Farms	Economic Profit per Farm	Economic Profit per Tenure Class	Percent of Total
		(S/.)	(S/.)	
I	21	3,267.46	68,616.66	4
II	41	9,155.53	374,376.73	21
III	62	13,891.86	861,295.32	48
IV	18	26,483.52	476,703.36	27
Economic profits for project			1,781,992.07	100

As can be seen, Class III gains the largest share of economic rents conferred by project irrigation. However, whether this increases the relative income position of Class III depends on its share in income before the beginning of the project.

For present purposes, we assume all farms (irrigated or unirrigated) were in existence before the project, and that part of them (irrigated) later adopted irrigation. Further, the samples of farms (irrigated and unirrigated) are representative of the population and stratified by tenure class. Finally, the net return of the average farm in a tenure class can be multiplied by the number of farms in a class and the income of that class estimated. The calcualtions are presented in Table 4.

Table 4. Income Distribution by Tenure Class Before Project Irrigation.

Tenure Class	Irrigated Farms 1971	Unirrigated Farms 1971	Assumed Number of Unirrigated Farms 1966 (pre-project)	Average Net Returns	Net Income of Class	Percent of Net Income
				(S/.)	(S/.)	
I	21	338	359	2,823.73	1,013,719.07	7
II	41	237	278	9,072.46	2,522,143.88	17
III	62	170	232	16,513.77	3,831,194.64	26
IV	18	106	124	48,813.17	7,292,833.08	50
Total Income					14,659,890.67	100

The average Class II farm shared in 17 percent (Table 4) of the income before the project, but this is changed to 21 percent of the economic profits conferred by irrigation. The average farm in Class III had the largest relative increase as it shared in 26 percent of the income before the project, and 48 percent of the increase after. Farms in Classes I and IV worsened their relative positions in the distribution of rural income because they did not maintain at least 7 and 50 percent of the increase respectively.7/ These results are dominated by the percentage of each tenure class which actually got water.

Conclusion

Farmers view the present fees as their marginal factor cost and adjust purchases accordingly. Whether private and social costs diverge has yet to be determined. However, the present water fees of S/.200 per hectare per year appear to fully cover the average unit cost of the public portion of the Milagro project. Nevertheless, there may well be pressure for increases as the rents earned by private capital become more evident.

Depending on the goals of the country, several results could be obtained via water fee policy. If land reform is a goal, and society also wishes to recapture some of the direct economic rents conferred by the project, then differential taxing, based on land tenure, would take rents from large landholders and encourage the formation of smaller units (which earn higher rents per hectare). If gross production rather than income redistribution is the goal, then the best strategy might be to leave the incentive for larger farmers to increase the percentages of their lands under irrigated cultivation by restricting water sales to minifundistos. However, if increased production depends on more water, project expansion may be possible only if some rents are extracted by society. For example, INERHI (the Ecuadorian Water Management and Development Agency) might operate at a profit and interpret the fee income as the "green light" for further investment in irrigation structures and delivery networks in the Milagro area. Water fees could also be increased considerably if society desires to extract some of the conferred rents to use for other purposes.

FOOTNOTES

1/ We assume that fixed resources of all firms are being paid at least their opportunity cost before the adoption of irrigation. Thus, all firms that adopt irrigation earn economic profits or increase the level of economic profits. In reality, it is likely that at a point of time there is an approximately normal distribution of earning experience with some firms incurring economic losses, some firms breaking even, and some firms earning pure profits. Those that adopt irrigation improve their relative position as costs of production decrease. In the long run, only firms that at least break even remain in production.

If production from the project is a small part of the total product, selling prices might not be affected. However, commodity markets in LDC's are sensitive to small changes in supply.

7/ Implicit costs of labor and other capital are included in calculating this net return.

8/ R_w is not constant in each production period.

9/ In practice, any increase in the price of water would be expected to decrease it use, cut output, and decrease the net returns on farms with irrigation. However, we are not attempting to determine the production effect of a rise in the price of water. The system is only a convenient way to let the computer measure the difference between the "ATC and AR curves".

10/ The apparent inverse relationship between land tenure and returns on investment in irrigation infrastructure may be explained by the level of management input per unit of land. It is possible that the amount of management of standard quality per unit of land declines rapidly as we go from tenure Class I to IV. However, we cannot specify the exact cause; we have data for another situation where the same result obtains.

11/ Although data is sparse on this point, irrigated land apparently sells for at least S/.1500 per hectare more than unirrigated land in the Milagro area.

12/ The shares, by tenure class, in total 1971 irrigated income are estimated to be 3.1, 18.1, 45.8, and 32.9 percent respectively. On this basis, I and IV still decline, but I is the only class that loses absolutely and relatively in its share of the total as well as the increase in income.

REFERENCES

1. Lloyd, P.H., Impact on Rural Incomes of Improved Water Management Practices in Milagro County, Ecuador, unpublished M.S. thesis, Utah St. Un., May, 1971.