The Micro-economics of Crop Diversification in a Diversion Irrigation System: A Progress Report from the UTRIS

Prabhu Pingali, Policarpio Masikat, Piedad Moya and Aida Papag [1]

Abstract

Even if irrigation infrastructure is geared towards rice production, the farmer has several optlons to grow non-rice crops during the dry season. Based on this hypothesis, the study aims to: (1) determine irrigation related constraints to choice of dry season crop at the farm level and examine related farmers' responses, (2) identify changes in water allocation and distribution at the system level in response to changing dry season crop mix, and (3) explore possible means of increasing water use efficiency at the farm level without physical rehabilitation. Thirty sample farmers under the Upper Talavera River Irrigation System (UTRIS) are being intensively monitored for one year. Data being gathered are farm input-output and current and historic issues related to dry season crop choice and decision making. This will be complemented with open ended interviews of the system personnel and officers of the farmer irrigators' association. Preliminary findings of the study revealed that under UTRIS, onion is the main alternative crop to rice during the dry season. Relative to rice, onion requires higher capital and labor and entails higher risk. To alleviate these constraints, farmers have arranged with onion traders for credit and/or resorted to seasonal tenancy arrangements to diffuse price risks and reduce the problem of high labor demand. On the other hand; the efficiency of irrigation water use at the farm level could be increased by: (1) adjusting the schedule and distribution of water to reflect the transition from rice monocropping to diversified agriculture, (2) adjusting irrigation fees to reflect for differences in water use, and (3) adopting ways to conserve water for less frequent applications. It was also observed that there has been changes in the land preferences of fanners in the area and in land values. When the returns to non-rice crop production dominate the returns to rice during the dry season, the demand for and the price of land with the least constraints to diversification out of rice will be the highest.

Introduction

Imgated lowland areas in the Philippines have been experiencing a gradual diversification from rice to non-rice crops during the dry season. The total area planted to dry season non-rice crops may be small but it is significant and increasing. The change in the crop mix has been induced by the declining profitability of dry season rice production systems (Rosegrant, et al., 1987; Ali, 1987). Current discussions on dry season crop choice emphasize the importance of existing irrigation infrastructure as a constraint to diversification (Schuh, et al., 1987; Levine, et al., 1988; Rosegrant, et al., 1987). Many studies have called for rehabilitation of existing irrigation structures in order to increase their flexibility for growing non-rice crops.

This study takes a different approach to the problem of diversification. It focuses on the argument that even if the irrigation infrastructure is geared towards rice production, the farmer has several options available to grow non-rice crops during the dry season. These options involve additional labor investments at the farm level for drainage and water control and tend to be used when the relative profitability of non-rice crop

[1] Agricultural Economist, Research Assistant, Senior Research Assistant and Research Aide, respectively, Agricultural Economics Department, The International Rice Research Institute, Los Baños, Laguna.

production makes these investments viable.

Assuming that farm level adjustments are possible despite system rigidity, then system rehabilitation becomes a software rehabilitation rather than a hardware rehabilitation. In other words, a more appropriate response to the changing dry season crop mix could then be an adjustment in system management rather than in physical structures.

This study aims to: 1) determine irrigation related constraints to dry season crop choices at the farm level, 2) examine how farmers respond to these constraints, 3) identify changes in water allocation and timing rules made at the system level in relation the changing dry seasoncrop mix as well as farmer's requests for change, and 4) explore possible solutions to existing problems in order to increase water use efficiency at the farm level.

System Description

The Upper Talavera River Irrigation System (UTRIS) is a run-of-the-river irrigation system within the Upper Pampanga River Integrated Irrigation System. UTRIS has a potential service area of 3779 hectares, cultivated by 2040 farmers (Table 1). UTRIS consists of 11 laterals and sub-laterals with a total canal length of approximately 60 km (Figure 1). Soil in the system is generally sandy loam except in lateral A which is composed of clay and clay loam; soil in some portion along the main canal turnout is also clay loam. During the wet season, the entire system except for a few hectares, is under rice cultivation (except for farms at the tail end, where year-round green onions are planted since the fields are predominantly gravel).

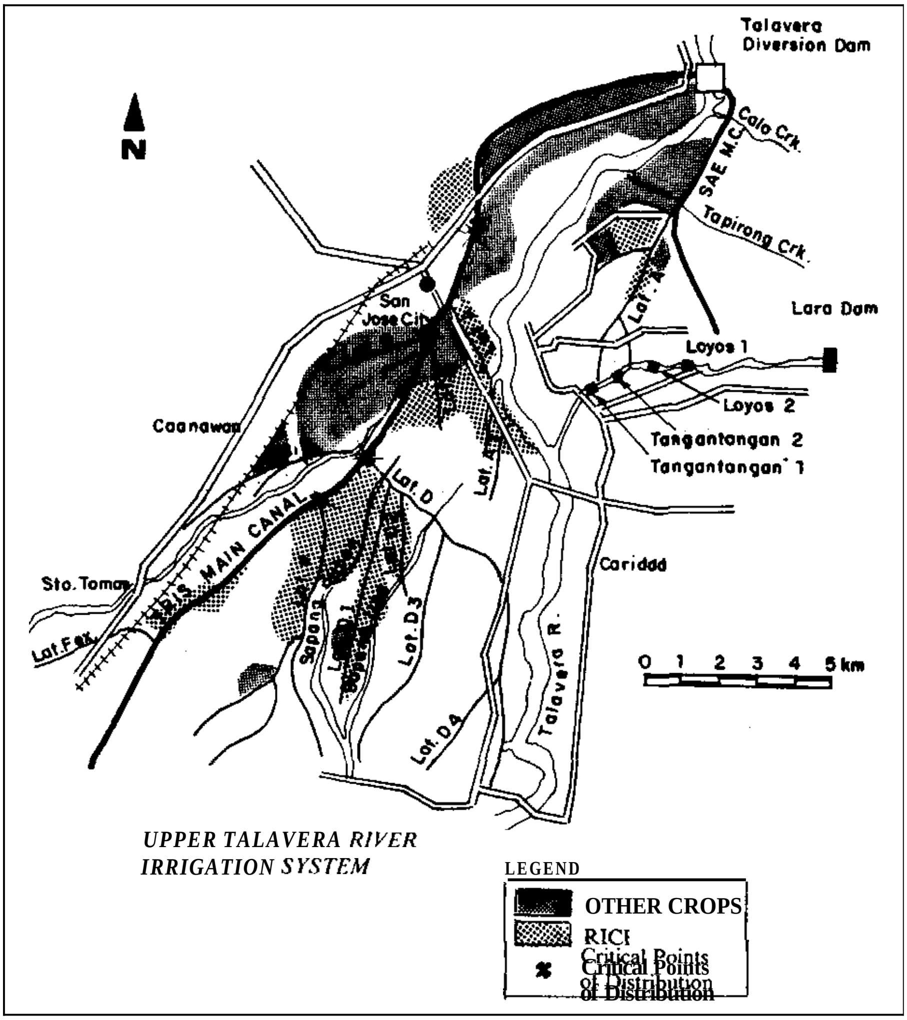

Figure 1. Map of the Upper Talavera River Imgation System (UTRIS) in Nueva Ecija and cropped area for 1987/88 dry season.

Table 1. Basic information, UTRIS.

	TRIS (Main)	San Agustin Extension (SAE)
Service area (ha)	3179	714
No. of farmers	2040	714
Wet season program area*	3632	592
Dry season program area (1988)*	870	242
No. of laterals and sub-laterals	11	3
Total length of canal (km)	60.56	11.42

Source: NIA
*Source: **IIMI**

During the 1988 dry season, only 870 hectares were irrigated which is roughly 20-25% of the potential service area of UTRIS (Table 2). Lateral **A**, upper sections of lateral B and turnouts along the main canal were the only areas with reliable water supply during the dry season. Farmers at lateral A grow only rice during the dry season; at lateral R, non-rice crops (onions and peppers), while farmers along the main canal plant rice acd onions. Within UTKIS, **54%** of the dry season irrigated area is planted to other crops.

Table 2. Program area and actual area harvested, UTRIS, 1987 and 1988 dry seasons.

	Program area (ha)		Area harvested (ha) Dry season 1987				Area harvested (ha) Dry season 1988			
	DS 87	DS 88	Rice	Other crops	Total area har	Percent area Other crops	Rice	Other crops	Total area har	Percent area Other Crops
TRIS Upper ***(Main)***										
Division B										
TRIS MC	460	500	178	309	437	64	205	275	480	57
Lat B	100	80		100	100	100		92	Y2	100
PAC	40	40	29	14	43	33	37	3	40	8
Division C										
TRIS **MC**	60	100	40	29	60	33	91	13	104	13
Lat A	50	30	50		50		24		24	
Lat C		20					17		17	
Division D										
Lat E	20	15		18	18	100		10	10	100
Lat F	20	50	10	2	11	13	50		50	
MC	15	35	13		13		35		35	
Sub-total	765	870	320	463	782	59	459	393	[illegible]	46
SAE										
'Div A										
SAE **MC**	50	60	10	40	51	19	17	46	62	73
SAE Lat A	100	100	46	69	115	60	31	57	94	61
SAE **Lat A-1**	50	32		35	35	100	2	30	32	93
SAE Lat A-2	50	50	7	15	22	68	19	41	60	68
Sub-total	250	242	64	158	222	71	14	174	248	70
Grand total	1015	1112	384	621	1004	62	533	567	1100	52

Source: IIMI

Waterallocutiondecisionmaking. Scheduling and allocation of water is facilitated by water-masters in consultation with the zone engineer and hydrologist. The irrigators' associations decide on water allocation at the lateral or turnout level. These associations decide on the scheduling of water to the individual turnouts within their lateral. An organizational chart is provided as figure 2. The figure also shows the division of decision making responsibilities.

The following biases in water allocation rules persists at the system level: a) water is allocated based on the water requirements of rice even during the dry season and for laterals known to grow exclusively non-rice crops, and b) preference is given to upstream farmers on the pretext that conveyance losses are minimized and output maximized. The above biases lead to the following implications: a) farmers who plant non-rice crops during the dry season have to invest in farm level water control to suit the requirements of their crops, and b) farmers whose farms are located farther away from the source of irrigation water have to invest in supplementary irrigation (shallow well pumps) to meet dry season water requirements.

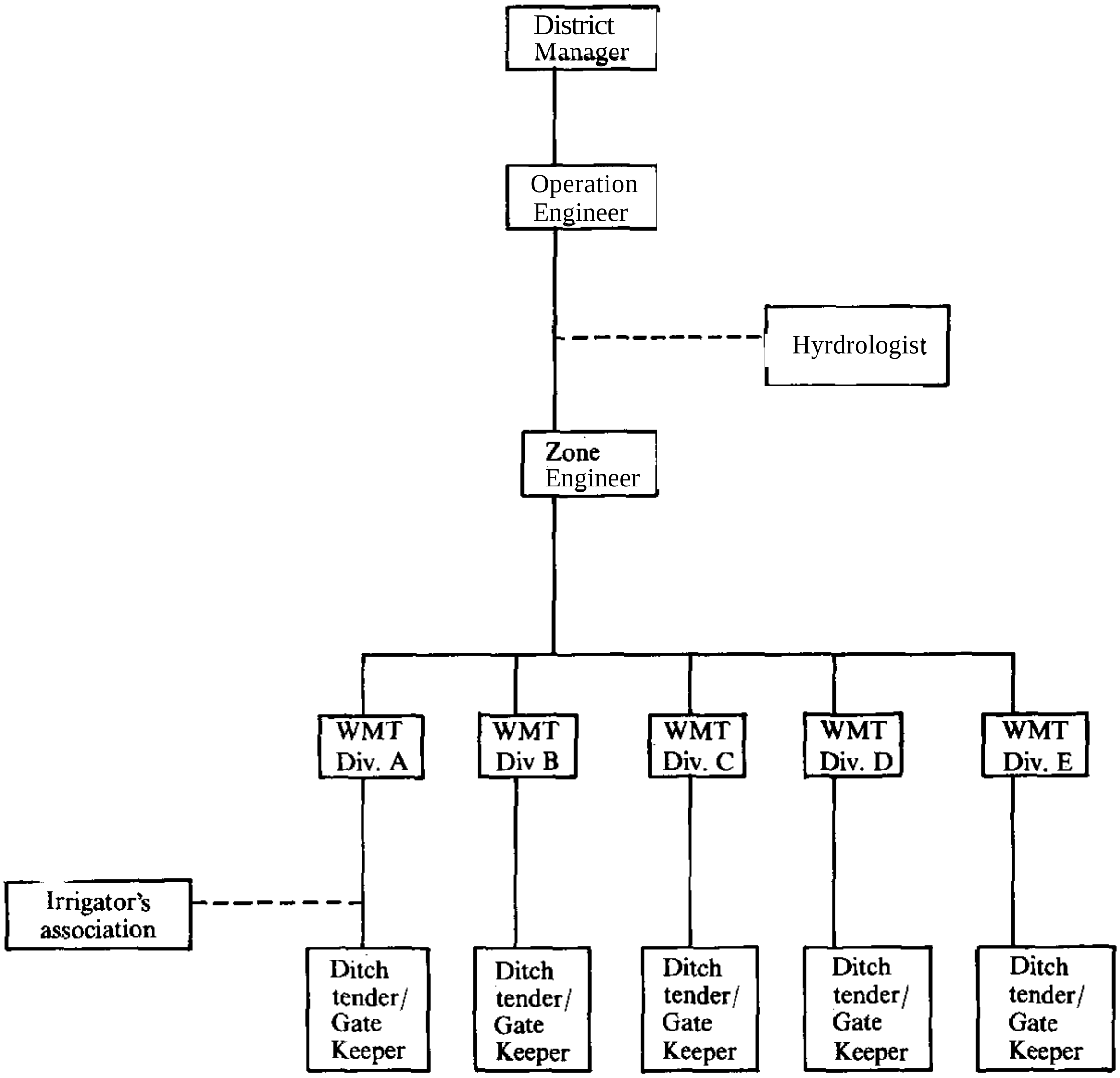

Figure 2. Organization chart, UTRIS.

Irrigation fees. There is a uniform irrigation fee for all farmers in the system, whether they are located at the head, middle or tail and whether they are near or far from the irrigation canals. Fees do not vary even if a farmer irrigates his crop a number of times. However, there are differences in irrigation fees depending on the season and crop. For wet season rice crop, the fee is 125 kg of paddy per hectare or its peso value. During the dry season, irrigation fee for rice is 175kg of paddy per hectare. For non-rice crops, fees are 60% of the fee charged for rice.

income information were being monitored. It was planned to monitor for a year to be able to get a complete picture of the alternative income earning opportunities available to the farmers, considering the crop and agricultural versus non-agricultural activities.

This intensive monitoring will be accomplished by frequent visits to the farmers. Open ended questions on current and historic issues related to dry season crop choice decision making were being asked from the farmers with the help of the system management (zone engineer, hydrologist, watermasters and ditchtenders) and the management of the irrigators' associations at each lateral and turnout. The objective of the management related interviews is to study the flow of information from the system management to the farmers and vice-versa.

There is a distinct soil type bias in cropping patterns (Table 4). Farmers tend to grow rice only during both seasons in the heavier clay soil. Most farms with sandy loam soil are planted to onion during the dry season. However, five parcels with clay and clay loam soil were planted to rice. These parcels were being closely monitored.

Table 3. Characteristics of the samples being studied.

Characteristics	Lateral A	Lateral B	MCs
Number of farmers	7	11	12
Number of parcels	8	15	22
Distance from irrigation canal			
– near	4	6	8
– far	3	5	4
Cropping pattern			
-- rice-rice	6		2
-- rice-onion	1	8	5
– rice-onion+vegetable		3	2
-- rice-rice+onion			3
Soil type			
-- galas		11	6
-- lagkit	6		4
– mestizo lagkit	1		2
Dry season water stress			
-yes	7	10	8
- no		1	4

Sample Selection and Characteristics

A stratified random sample of 30 farmers were selected from the head, middle and tail sections of UTRIS. The sample was also stratified between farmers whose paddies are near to or far from the irrigation canals. Within each lateral, the sample was also stratified by major soil type. Farmer classification of soils were used for this stratification, namely Galas (sandy loam), *Lagkit* (clay) and Mestizo *Lagkit* (clay loam). Table 3 describes the stratifed sample.

For each parcel, weekly input-output, technology, investment, crop choice, labor use and

Table 4. Dry season cropping pattern by parcel and soil type.

Soil Type	Rice	Onion	Others
Galas (sandy loam)	4	20	4
Lagkit (clay)	10	3	
Mestizo Lagkit (clay loam)	2	2	

The relative input requirements and the relative returns to rice and onion production are shown in Table 5. On a per hectare basis, onions required thrice the financial outlay of rice while net returns were at least five times as large. However, the average area planted to onions was about 0.5 hectare and that to rice was about 1.5 hectares. The net returns per average area planted to rice and onions are ₱10,413 and ₱26,498 respectively. Table 6 and 7 shows the labor input requirements for onions and rice. Onion production is three to four times more labor intensive than rice.

Table 5. Relative cost and returns to rice and onion production.

	Rice	Onion
Inputs (₱/ha)		
Seeds	644	6,087
Fertilizer	1,150	2,471
Insecticide	352	715
Herbicide	81	262
Rice straw		142
Labor cost	3,743	7,630
Irrigation fees	612	367
Total Inputs (₱/ha)	6,581	17,674
Average yield (t/ha)	3,967	9,063
Gross income (₱/ha)	13,863	71,751
Net income (₱/ha)	7,282	54,077
Average area harvested (ha)	1.43	0.49
Net income per average harvested area (₱)	10,413	26,498

Note: Land rent will he included as more accurate data become available.

Table 6. Labor inputs per hectare for onion during the dry season

Activities	Man-days	Total cost
Land preparation		
Plowing		
machine	0.9	550 } 852
animal	6.0	302
Harrowing		
machine	1.1	515 } 853
animal	6.8	338
Seedbed preparation/seeding	10.3	206
Pulling seedlings	30.0	600
Transplanting	80.0	1600
Mulching	16.0	320
Application of fertilizer	4.3	86
Application of insecticide	5.1	102
Weed control		
manual	61.6	1232
chemical	1.3	25
Irrigation management	11.3	225
Harvesting, bundling, drying	88.5	1170
Total	323.2	7270

Table **7.** Labor inputs per hectare for rice during the dry season.

Activities	Man-days	Total cost
Land preparation		
Plowing *and harrowing*		
machine	5.1	1028 } 1440
animal	8.3	412 }
Seedbed preparation	1.6	40
Pulling of seedlings*	0.4	105
Transplanting/direct seeding	17.6	353
Application **of** fertilizer	1.6	33
Pest and disease control	2.2	45
Weed control		
manual	4.0	80
chemical	0.7	15
Irrigation management	12.2	244
Harvesting	21.0	420
Threshing		
manual		
thresher.'	2.0	819
Haulina	3.5	150
Total	80.4	3743

Note: *By pakyaw contract

Sharing **is 6% of **gross** value of production.

Preliminary Results

The following are some of the initial findings of the study; The findings are extremely tentative and will be substantiated with rigorous empirical evidence as data become available. This paper should therefore be considered a progress report designed to stimulate discussion.

Dynamics of Farmer Land Preferences

Over the last five years, changes in the preferences for dry season land cultivation and consequently in land values has been observed at UTRIS. UTRIS consists of areas with heavy clay soil (lateral **A),** areas with sandy loam soil and a small area with very stony soil (lateral **B).** During the last five years, land preferences have switched from the heavy clay **soils** to the sandy loam **soils.**

Within an irrigated micro-environment, the lands with the greatest preference for rice production are those with heavy clay soils and those that have the best access to irrigation water (lands in the head section and paddies close to irrigation canals). The unit cost of rice production would be the lowest on these lands as compared to paddies at the tail section, those far from the irrigation canals and those with more sandy soils. **As** long as the returns to rice production dominate all alternative crops within the system, the demand for and the price of these lands will be higher than in other areas of the system.

As the relative returns to dry season non-rice crops increases, preference for lands normally considered marginal for rice production increases. In irrigated lowlands, the following could be considered marginal to dry season rice production: upper paddies that are difficult to irrigate, well drained soils, sloping lands, and stony gravelly land. These lands are more suitable for dry season non-rice crop production due to their good drainage characteristics. Investment requirements for drainage are lower on these lands as compared to: low lying paddies, heavy clay soils and land with better access to irrigation water.

The following generalization is possible: In irrigated lowlands, when the dry season returns to non-rice crop production dominate the returns to rice production, the demand for and the price of land with the least constraints to diversification out of rice will be the highest. Under UTRIS, lateral A had aconcentration of heavy clay soil and therefore is most constrained to diversify out of rice production. Areas at lateral B and at the main canal turnout have several options for dry season crop production, including rice. During the last five years the returns to dry season onion production dominated the returns to rice production. A change in land demand from lateral A to other parts of the system was also noted. Land values at lateral A which were once the highest under UTRIS are now dominated by lateral B.

Results, however, do not imply that lands at lateral A are not suitable for non-rice production. Other areas with similar soil and hydrological characteristics may have diversified out of dry season rice production. The study emphasizes that investment costs for drainage required for making the switch to non-rice crops would be substantially higher at lateral A than at other laterals of the system and would not be viable given the current returns to rice relative to the best alternative possible. In other words, there is a price at which it becomesviable to make investments in overcoming the agronomic and hydrologic constraints to diversification.

Credit, Labor and Risk Constraints to Crop Diversification

Under UTRIS, the main alternative to dry season rice production is onions. Relative to rice, onions require more fmancial outlay for inputs (Table 5), more labor and supervision (Table 6), and more effort to diffuse the impact of price risks. Several ways in which farmers had overcome these constraints in their switch from rice to onions were identified.

Constraint in credit in onion production had been alleviated by arrangements with onion traders. Onion traders from San Jose City provided credit for the purchase of inputs in exchange for a commitment from the farmer that they have the exclusive right to purchase all output at the market price at harvest time. No interest is charged for this credit, but the traders benefit substantially from the substantial price increase between the harvest and post-harvest months. This price increase more than offsets the foregone interest charges and the storage costs.

Relative to rice, the per hectare labor requirements for onions were substantially higher. Planting, weeding, harvesting and post-harvest operations in onion production were labor intensive. Also, farmer supervision of farm operations was significantly higher for onions. Supervision time rather than the higher labor requirements were the dominant labor constraint in onion production. This is due to the highly inelastic nature of management labor available in the farm household, while hired labor supply being augmented by seasonal migrants is relatively more elastic. In order to overcome the supervision constraint, several of the larger onion producers with farms greater than two hectares divided their farms into two -cultivating one part and providing the other part to seasonal tenant farmers. Seasonal tenant farmers either come from lateral A or from neighboring areas to cultivate onions during the dry season. These farmers till the land and provide one-half of the farm inputs in exchange for 50% of the total production.

Seasonal tenancy arrangements could also be a method of diffusing price risks associated with onion production. The means by which the smaller onion growers do this is to divide their farms into two - cultivate one part and give the other to a seasonal tenant who pays a fixed rent of ₱3000 per hectare plus water charges. In this way, the landowner gets a certain income from part of his land and gambles on the remainder. The supply of seasonal tenants has been increasing over the last few years especially from lateral A and similar lands with agronomic constraints to diversification.

Efficiency of Warer Use for Non-rice Crop Production

Two factors affect the efficiency of irrigation water use under UTRIS. These are the system of charging irrigation fees and the distribution scheduling and timing of water supply.

Considering these systems, upstream (head and upper middle section) farmers and those nearer to irrigation canals do not have an incentive to alter their water use practices to increase efficiency. The traditional irrigation technique for these farmers is to flood and drain their fields.

Table 8 shows the frequency of irrigation by location along the system and distance from the canals. In this table MCs stand for main canal turnouts and B is lateral B. The MCs are at the upper section of the system than **B.** In general, farmers in the MCs applied water more frequently than farmers in B. Over **50%** of the sample in the MCs used more than five irrigation which is higher than the highest number of irrigation in B. The highest number of irrigation in MCs is **12.** Within a lateral, farmers near to the canal used more irrigations than farmers far from the canal (Table 8).

The above also implies that farmers at the lower sections of the irrigation system and those farther away from irrigation canals ought to be more efficient in their water use. Water supply **is** not reliable for these farmers and even if they do get the water, the quantity available to them per hectare **is** only a fraction of that available to the more favorably located farmers. These farmers do not have a choice except to conserve water at the maximum to enable them to grow onions. Thus, farmers at the outer (less favorable) sections subsidize the water use of farmers in the inner (more favorable) sections of the system.

Farmers at the outer sections (tail and far paddies), availed of supplementary irrigation from shallow well pumps. Table 9 shows the frequency of supplementary irrigation use by distance from the irrigation canal. Two-thirds of the near parcels in lateral Bused exclusively canal water while only one-fifth of the far parcels used exclusively canal water.

Table 8. Dry Seasons Onions: Frequency of irrigation by distance from irrication canals.

Lateral	Distance from irrigation canal	Frequency of irrigations											
		I	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
B	Near	**1**	**1**	**1**	**2**	**1**							
	Far	*3*			1	1							
MCs	Near				1	1			1	1		1	1
	Far		1		1			1					

Table9. Frequency of supplementary irrigation using pumps at Lateral **B.**

Distance from canal	Frequency **of** irrigations					
	0	I	2	3	4	5
Near	**4**	-	**2**	-		
Far	I		1	**1**	2	-

It was, however, surprising to find that farmers near the irrigation canals were the most delinquent payers of irrigation fees (Table 10). Farmers whose farms are located far from the lateral had to pay their fees promptly to ensure timely and adequate water supply while farmers whose farms are close to water source could acquire water even if they do not pay their fees. Farmers far from the canals therefore, bear the burden of irrigation costs while at the same time receive lesser benefits from the system.

Table 10. Payment of irrigation fees.

Lateral	Distance	Paid	Not paid
A	Near	I	**2**
	Far	**2**	2
B	Near	**2**	**4**
	Far	**3**	2
MC	Near	*3*	**5**
	Far	**13**	I
		14	**16**

In order to increase the farm level efficiency of water use at the head and in adjacent fields, three conditions are required: 1) irrigation fees have to be based on the number of applications rather than on a fixed rate, 2) water scheduling and supply for areas planted to non-rice crops has to be different from areas planted to rice, and 3) more involvement of irrigators' associations in monitoring water use and fee collection. If water in the upper sections of the system can be used more efficiently, then the total area for which water is available will increase significantly resulting in increase in income and equity.

Efficiency Increases versus System Rehabilitation

Should the priority of irrigation management be in making investments in system rehabilitation or in increasing the efficiency of water use?

Under UTRIS, the above discussions imply that significant increases in actual irrigated area could be achieved by improving the efficiency of water use at the upper and in more favorably located sections of the system. Can significantly greater income gains be achieved by system rehabilitation to warrant greater investment? This question has to be examined in detail.

Improving the efficiency of water use would require adjustments at system and farm levels. At the system level, this would imply changes in water scheduling and rules of allocation to reflect the shift from rice monocropping to diversified agriculture. Irrigation fees have to be revised to account for differences in water use rather than a fixed rate for water use (Ghate, 1987 provides a review of the different structures of irrigation fees and the system and farm level benefits of each). At the farm level, efficiency increases could be achieved by adopting ways to conserve water. Mulching is one way to conserve water in onion production.

Demand for Membership in Irrigation Association

More farmers are expected to join the irrigators' association if the benefits they receive would exceed cost of membership which are monetary (membership fees and annual dues) and non-monetary (time spent in association activities, etc). The benefits of belonging to an irrigators' association are high when collective action is needed and when collective action is feasible, Collective action is needed to: a) ensure adequate water supply, b) regulate timing of water supply, and c) prevent the flow of excess water into the non-rice crops.

Consider the cases of laterals A and B under UTRIS: lateral B has a well organized irrigators' association, while at lateral **A,** attempts to organize an association failed. The reason for failure at lateral A was because of its being located at the upper portion of the system; thus, farmers had adequate water supply during the dry season. Moreover the entire lateral is planted to rice, hence there is minimal need for in-season regulation of timing because farmers do not encounter problems of having too much water in the field. Farmers at lateral B, grow only onions during the dry season. Timing of water supply is different for onions than for rice and in-season regulation of timing of water supply is important. Water has to be regulated to prevent excess in the onion fields; hence, the need for a collective action in B which attributed to the success of irrigators' association.

Collective action, although desirable may not always be feasible like the group of fanners at the tail end of lateral B. These farmers organized themselves into an irrigators' association but their efforts to increase their water allocation were futile. There was not enough water during the dry season. After two years these farmers ceased paying their membership fees and relied on pumps for their water needs.

The following generalization may be possible: the benefits of joining an irrigators' association are high if the farm is favorably located and where farm level decisions on timing of irrigation need to be made (otherwise costs exceed benefits).

References

Ali, Ifzal. 1987. Implications of falling primary commodity prices for agricultural strategy in the Philippines. ADB Economic Staff Paper No. 36, Manila.

Ghate, Prahhakar, B. 1987. Determining irrigation charges: a framework. ADB Economic Staff Paper No. 37, Manila.

Levine, G., R. Barker, M. Rosegrant and M. Svendsen. 1988. Irrigation in Asia and the Near East in the 1990s: Problems and Prospects. Written for the Irrigation Support Project for Asia and the Nearest, Asia/Nearest Bureau, USAID.

Rosegrant, M.W., L.A. Gonzales, H.E, Bouis and J.F. Sison. 1987. Price and Investment Policies for Food Crop Sector Growth in the Philippines, IFPRI, Washington D.C.