Main Irrigation System Management for Rice-Based Farming Systems in the Philippines

Amado R. Maglinao
Research Coordinator, IIMI-IRRI Project
International Irrigation Management Institute, PCARRD Liaison Office
Los Baños, Laguna, Philippines

Danilo M. Cablayan
Research Associate, International Irrigation Management Institute
Philippines Field Operations, NIA Compound, EDSA, Diliman
Quezon City, Philippines

Rodolfo C. Undan
Director of Research, Central Luzon State University
Muñoz, Nueva Ecija, Philippines

Tolentino B. Moya
*Research **Fellow,** IIMI-IRRI Project, PCARRD Liaison Office*
Los Baños, Laguna, Philippines

Carlos M. Pascual
Assistant Professor, Mariano Marcos State University
Batac, Ilocos Norte, Philippines

INTRODUCTION

MOST IRRIGATION SYSTEMS in the Philippines and in other developing countries of Asia have been designed for rice irrigation. The majority of such systems are run-of-the-river type, with fairly adequate water supply to irrigate their design areas during the wet season. However, during the dry season, they experience water scarcity so that only part of the design area could be served. This situation somehow encouraged the adoption of diversified crops in some of these systems.

While the need to produce more rice to support the demand of the increasing population is recognized, the production of nonrice crops during the dry season provides opportunities for increasing the productivity of irrigation systems. It could provide a means to optimally utilize the available land and scarce water resources for agricultural production.

The cultivation of upland crops in the dry season with or following lowland rice is not really a new practice in some irrigation systems. However, much more management inputs from both the irrigation agency and the farmers may be needed when nonrice crops are grown. Variability in demand in time throughout the season and at any moment of time within the system is expected. As most irrigation systems have been designed for rice cultivation, management modifications may have to be introduced.

This paper presents a synthesis of the results of the three-year study on irrigation management for rice-based cropping conducted by the International Irrigation Management Institute (IIMI) and the International Rice Research Institute (IRRI) in collaboration with national institutions in the Philippines. It was primarily based on the reports presented during the National Workshop on Irrigation Management for Rice-Based Farming Systems held from 10 to 11 September 1990 at the Continuing Education Center, University of the Philippines at Los Baiios, College, Laguna. It focuses on the system level considerations to improve the performance of irrigation systems for diversified cropping.

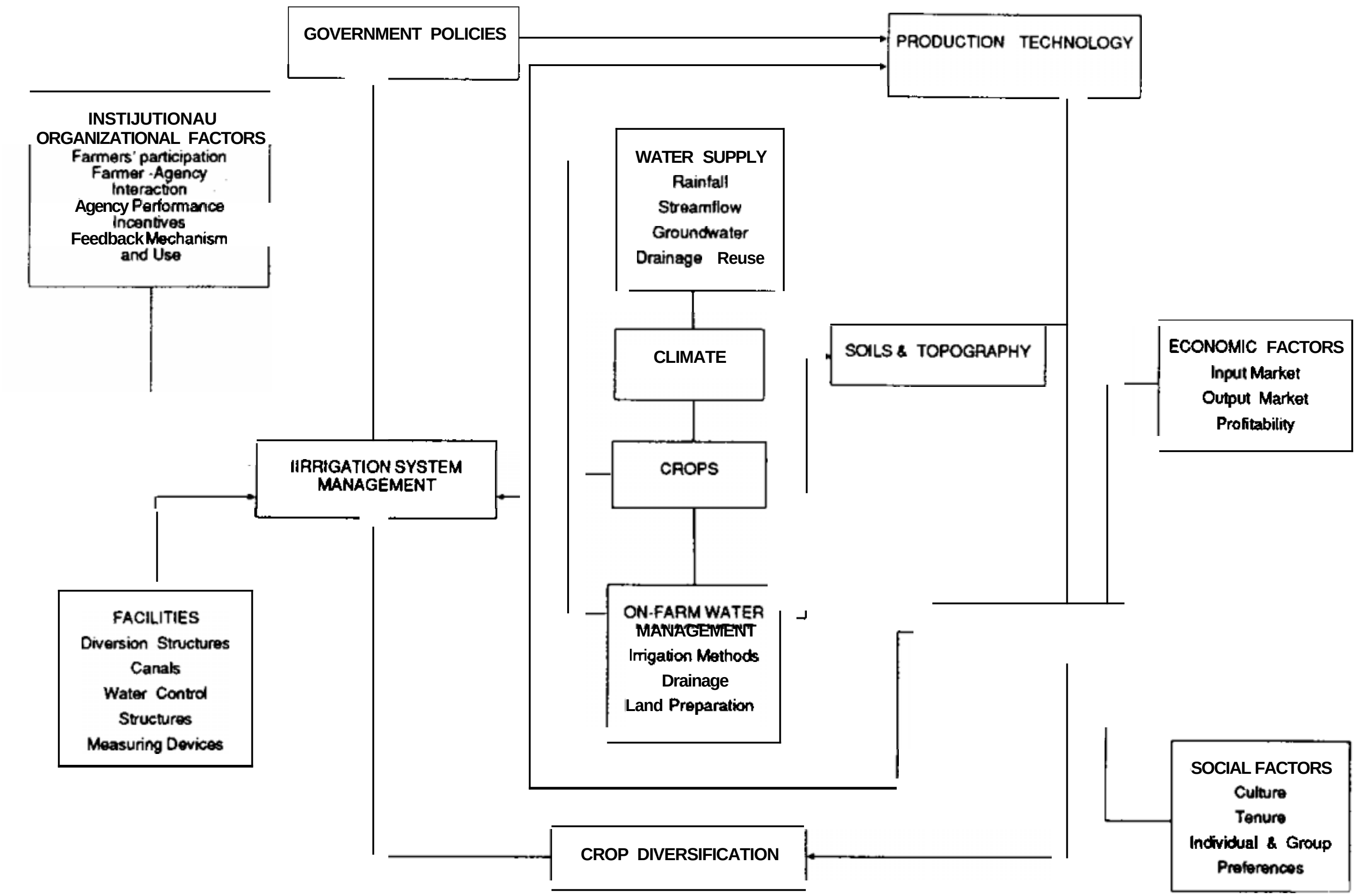
SCOPE AND OBJECTIVES

In accommodating nonrice crops during the dry season it is expected to address the three overall objectives of irrigation systems, namely; productivity, equity, and sustainability. By planting nonrice crops, larger areas can be served and made productive while improving equity of water distribution since more farmers will be benefited. Through improved irrigation management, sustainable farming systems could ultimately be achieved. When farmers feel assured of receiving water deliveries that correspond in timing and quantity to the requirement of field crops, they will be more willing to take the risk of diversifying into new crops. The diversification of cropping systems reduces economic and biological risks associated with growing a single crop.

In addressing these overall objectives, each system has to develop its own set of specific objectives and plan out the processes that will be employed. Essential to these tasks is an assessment of the conditions of and the resources that may be tapped by the system (Figure 1). These resources include: 1) water source; 2) land; 3) crops; 4) finances; 5) facilities; 6) support services; and 7) organizations. In one way or other, these are important considerations that have to be looked into. The project had given more emphasis on the aspects of management of water and management of organizations.

Management of **water.** Management of water concerns processes in the physical system. It encompasses the operation and maintenance of a canal system from the source down to the farm. It includes the delivery of water to farmers or farmer groups and the removal of the excess water not needed by the crops. Thus, it implies awareness of the water requirement of crops and of the constraints on water delivery that may be imposed by such aspects as soil type or land shaping.

Figure 1. Interrelationship of factors affecting crop diversification



Canal operations are still the predominant area of water management. Many of the present problems of canal operations result from the changing objectives of canal systems, like changes in cropping patterns as farmers adjust to economic changes.

The development and utilization of the groundwater resources could augment the surface water supply in most irrigation systems. The conjunctive use of groundwater and surface water resources may modify the seasonality of irrigation supplies.

Management of organizations. Institutional arrangement and organization and management changes that will facilitate the implementation of improved practices should go hand in hand with the aspect of management of water. Increased accountability of the irrigation agency, particularly to the farmers, and improved coordination among agencies should be looked into. Techniques to enhance communication and information management processes of the irrigation agency are also important. Thus, management of organizations essentially concerns people and includes information management.

Management should monitor not only the inputs but also the outputs, the process, and the feedback, and make necessary changes in real-time operations in response to such feedback. Enhancing the management capacity of the decision-making and operating personnel of irrigation agencies, is the key to achieving and sustaining high levels of irrigation system performance. If irrigation agencies are to adopt better canal operation practices and use them on a large-scale and sustained basis, profound changes in both their internal structures and processes and the policy environment influencing them will be required.

The relationship between the agency that manages irrigation and the users of water or the farmers must be given due attention. They are joint participants in the business of crop production, and irrigation cannot succeed without the best efforts of these two groups. The farm community, however, is not under the direct control of the managing organizations. But because the performance of the system is affected by those aspects that are outside an agency's direct control, it cannot ignore what happens in these sectors. It should be able to find ways of influencing them.

Objectives of the Project

In support of the overall goals of the IIMI-IRRI Project, the Philippine component aimed to: 1) document and analyze the planning and management procedures of irrigation systems with rice-based cropping; 2) explore strategies to efficiently and effectively manage irrigation systems for crop diversification; and 3) draw up recommendations for possible use by irrigation managers, farmers and policymakers.

IMPLEMENTATION ARRANGEMENTS

Study Sites

T[illegible] y v[illegible] ducted in three operating irrigation systems in Luzon. [illegible] es[illegible] th[illegible] pp[illegible] Talavera River Irrigation System (UTRIS) in Nueva Ecija, Laoag-Vintar River Irrigation System (LVRIS) in Ilocos Norte and the San Fabian River Irrigation [illegible]SI[illegible] in Pangasinan (Figure [illegible] The criteria used in the [illegible] l [illegible] c[illegible] 1) irrigation system type and size; 2) presence [illegible] e [illegible] opp[illegible]; 3) current activities of IIMI and IRRI; 4) presence of a variety of soil classes; 5) rainfall p[illegible] r [illegible]6) existence of farmers' [illegible] a[illegible]i: [illegible] i [illegible] d 7) location and environment (whether peaceful or not).

All three are run-of-the [illegible]r[illegible] ri[illegible]gat[illegible] st[illegible] November and dry the rest of the year, it[illegible] g[illegible] [illegible], 5[illegible] [illegible] nd 4,000 ha for UTRIS (including the San Agustin Extension area), LVRIS, and SFRIS, respectively [illegible]T[illegible] [illegible] 1) Uplan[illegible] [illegible]r diversified crops such as onion, tobacco, cotton, [illegible]rli[illegible] [illegible] [illegible] etc., have been grown in portions of the service areas during

Talavera River Irrigation System. The UTRIS has two main ca[illegible] s [illegible] a b[illegible] [illegible] [illegible] The left bank main canal (facing downstream) is called the San Agustin Extension (SAE) and the right bank main canal is called the UTRIS main (Figure 3). The SAE serves 750 ha (under one watermaster division) in the wet season and 150 h[illegible] the dry season. It has one main lateral and three sub-laterals with a total canal length of 10 k[illegible]

The UTRIS main serves 3,900 ha in the wet season and 500 to 750 ha [illegible] It has six main laterals and seven sub-laterals with [illegible]

Table 1. General description of study sites.

System	Dam type	[illegible]ig[illegible] (h[illegible])	Soil type	Benefited area, crop year, 1989-90		
				Wet-season rice (ha)	Dry season	
					Rice (ha)	Other crops*(ha)
LVRIS	Ogee-dam	2,377	Silty clay loam to clay loam	2,377	700	700
UTRIS**	Ogee-dam	1,650	Silty clay loam to clay loam	3,900	1,150	500
SFRIS	Ogee-dam	4,000	Silty clay loam to clay	2,765	2,765	1 000

Notes:

* for LVRIS, predominantly garlic with tomato, mungbean and vegetables.
f[illegible] U[illegible]IS, p[illegible] [illegible] predominantly [illegible] with some vegetables.

including San Agustin Extension area

Figure 2. Map of the Philippines showing location of study sites

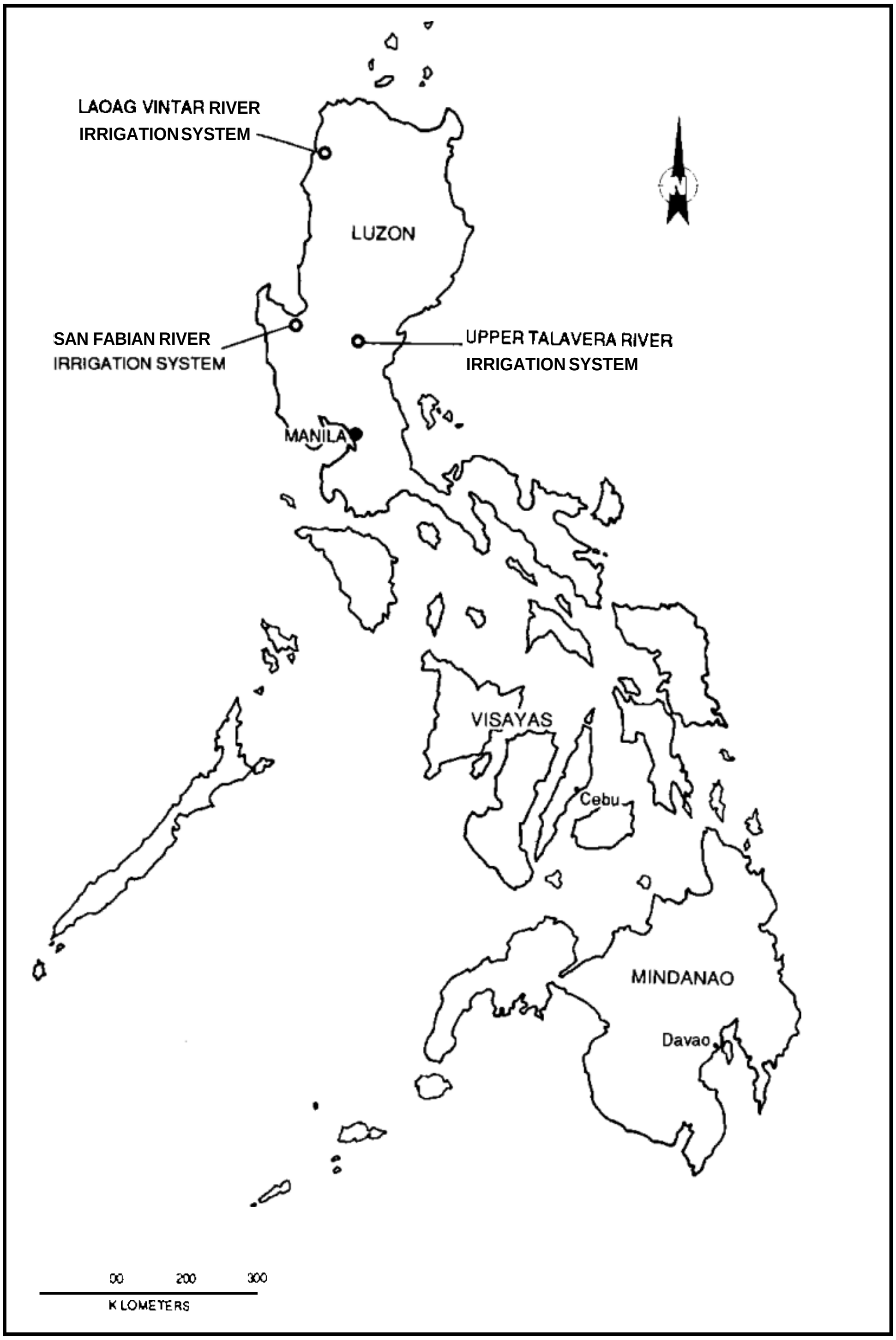
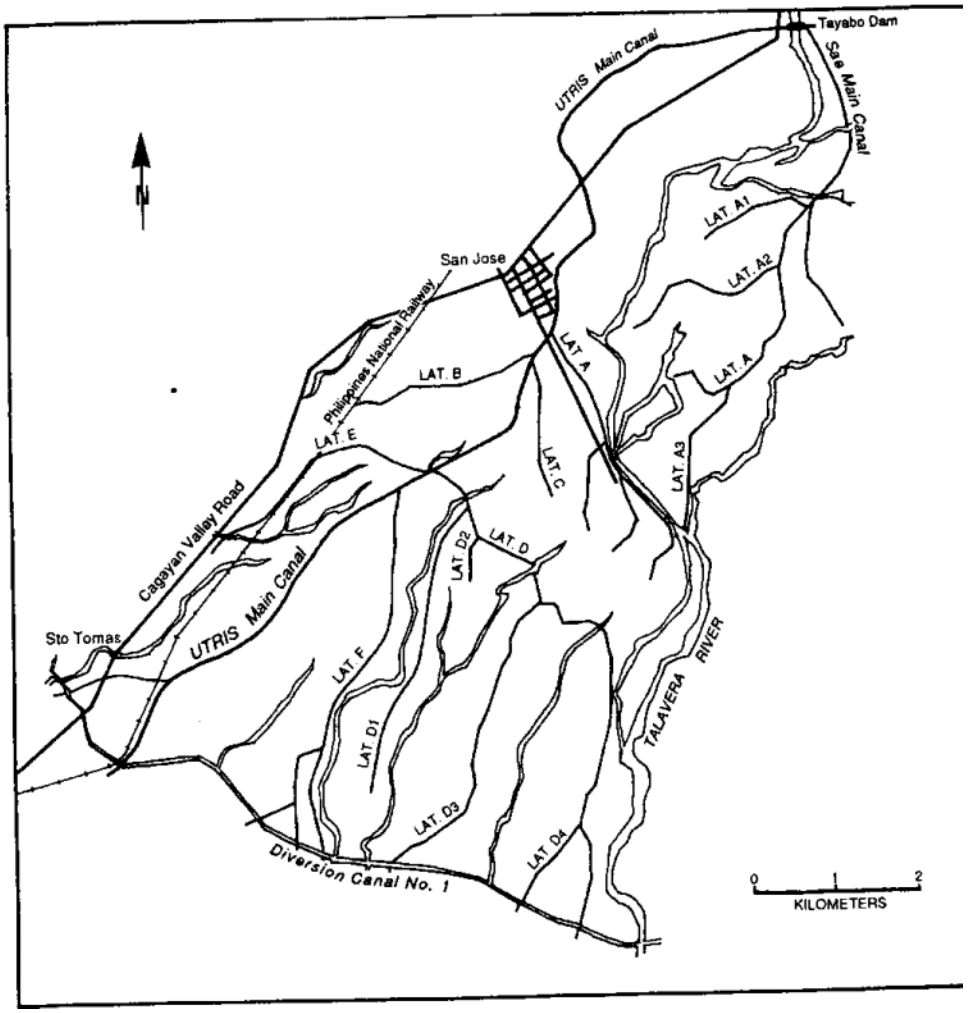


Figure 3. *Map of* **the** *Upper Talavera River Irrigation* **System.**



During the dry season, about 200 to 300 ha are planted to diversified crops, mostly onion. Besides the income from the crop, the physical characteristics of the soils in the area may have contributed to the practices of diversification. The agro-hydrological characterization conducted by the Bureau of Soils and Water Management (BSWM) showed that the system has generally lighter soils which suit upland crops (Figure 4). An earlier study by Cablayan and Pascual (1989) identified some 41 percent of the area as highly suitable for irrigated diversified crops, 54 percent as moderately suitable and only 5 percent as marginally suitable.

Laoag-Vintar River Irrigation System. The LVRIS has a total service area of 2,377 ha covering Laoag City, Vintar and some areas of Bacarra and Sarrat in the province of Ilocos Norte. It has a total canal length of 72.98 km composed of a 27.5-km main canal, seven laterals and five sub-laterals (Figure 5). Curved sections of the main canal which are susceptible to erosion are lined. It was recently rehabilitated through the National Irrigation Systems Improvement Project (NISIP).

The total area planted in the dry season is about 1,500 ha with about 800 ha planted to rice. Rice is generally planted in the upstream portion, near the main canal and in low elevation areas. Diversified crops, mainly garlic, are planted in well-drained light soils, mostly at the tail sections. More than 50 percent of the area of the system have been identified as highly suitable to diversified crops.

San Fabian River Irrigation System. The SFRIS also has two main canals on both banks of the Bued River. The left bank main canal (facing downstream) serves the San Jacinto area and the right bank main canal serves the San Fabian area (Figure 6). The San Fabian area has three main laterals and 5 sub-laterals.

The potential service area of the system is more than 4,000 ha but only half of it is served for the wet season rice. The water control system is only capable of irrigating 2,765 ha of rice in the wet season and 1,500 ha of rice and tobacco in the dry season. Tobacco and other upland crops are usually planted in the upstream laterals overlying alluvial fan terraces with soils of moderate to rapid internal drainage (Figures 7 and 8).

Research Implementation and Coordination

The different research studies were conducted primarily through contracts with national research institutions and by research scholars and fellows as part of the project's professional development objective. The National Irrigation Administration (NIA) was the primary collaborator. The other agencies involved were the Department of Agriculture (DA), Bureau of Soils and Water Management (BSWM), Central Luzon State University (CLSU) and the Mariano Marcos State University (MMSU). Coordination of the different activities was encouraged through regular meetings of the different researchers. Some of the studies were also included in the regular review and evaluation of researches conducted by the National Agriculture and Resources Research and Development System (NARRDS) through the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD).

Figure 4. Soil classification map of **Upper** *Talavera River Irrigation* System ***based*** on ***agro-hydrological soil characterization.***

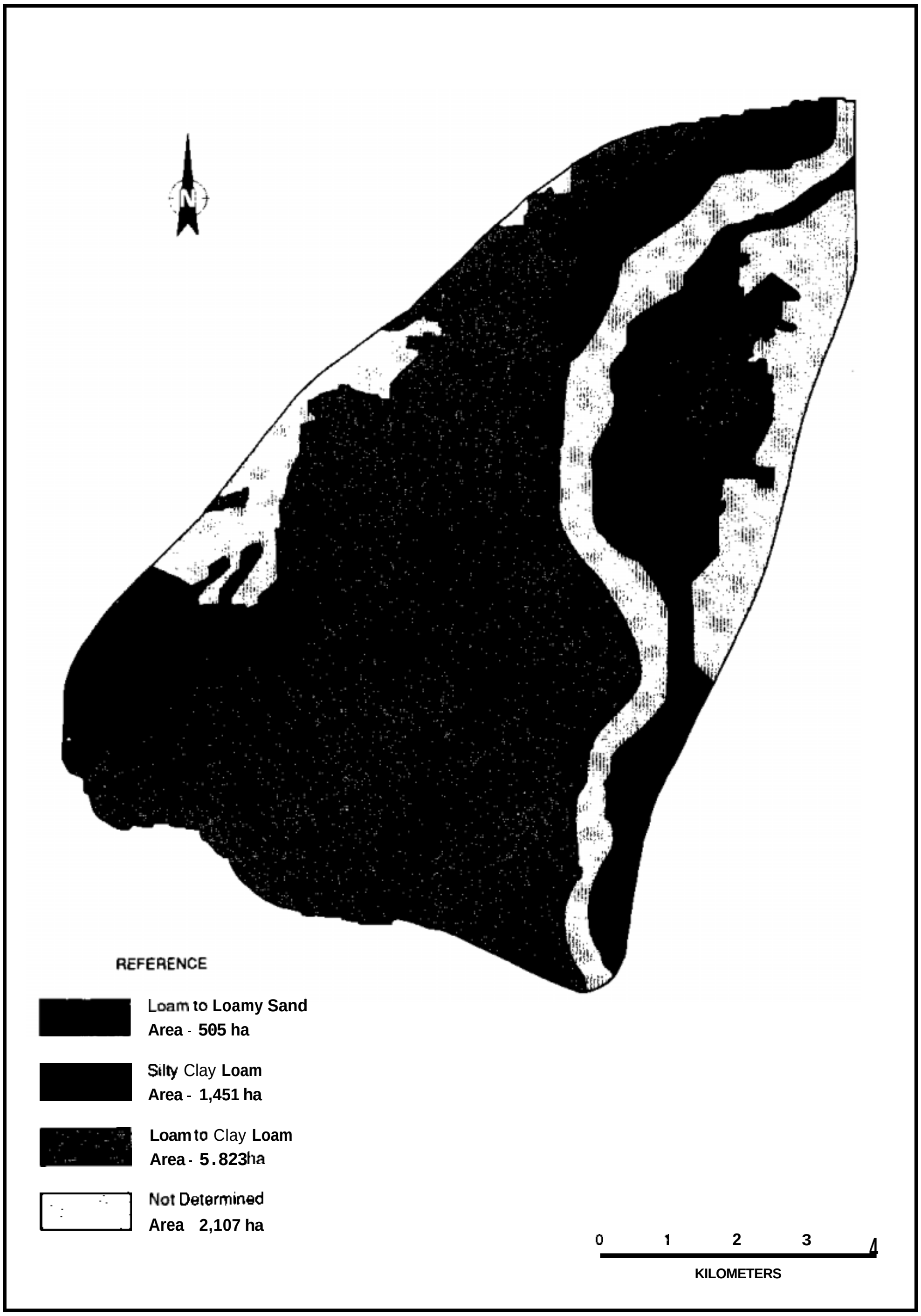


Figure 5. Map of the Laoag-Vintar River Irrigation System.

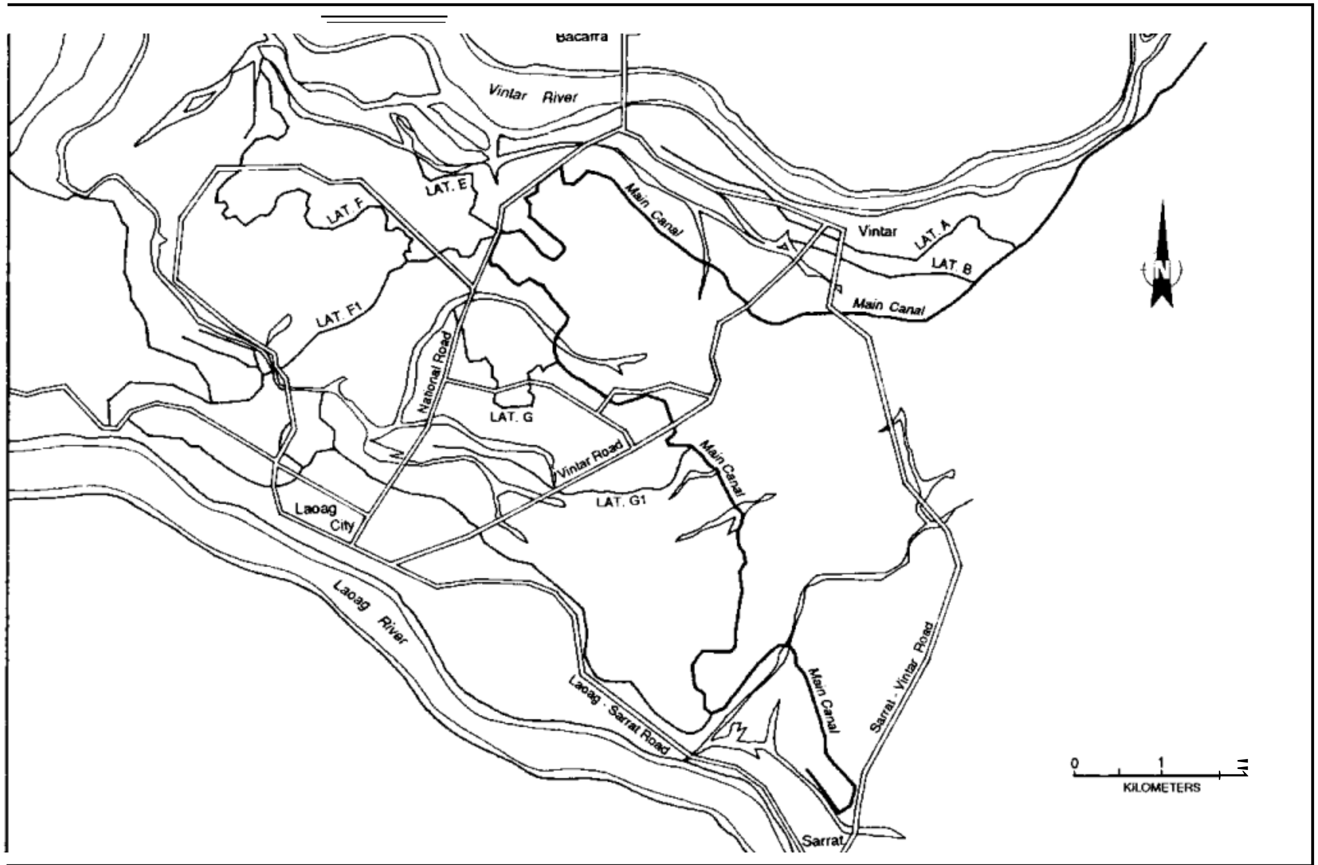


Figure 6. Map of the San Fabian River Irrigation System.

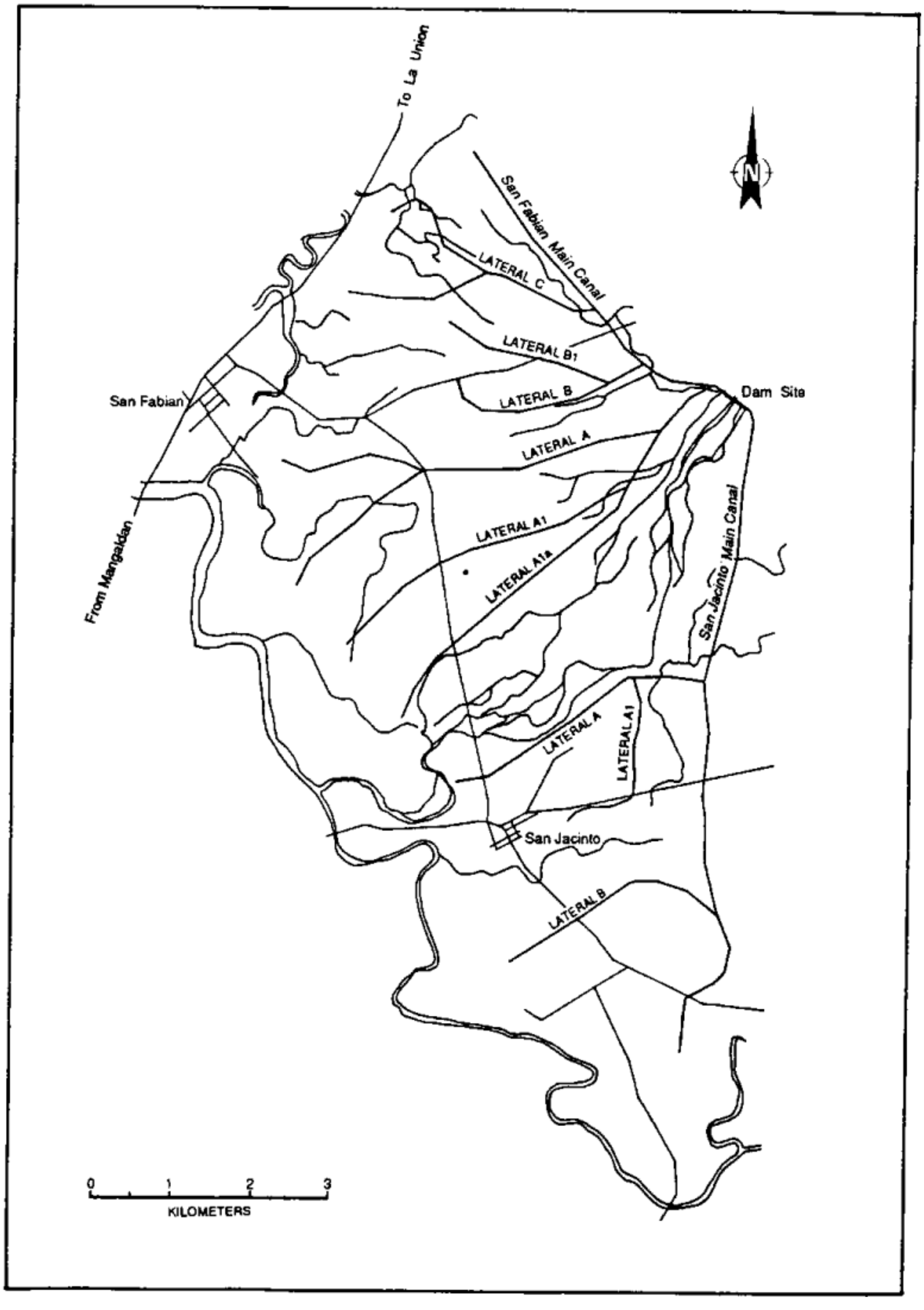


Figure *7.* Agro-hydrological soil characterization *map, San* Fabian River.

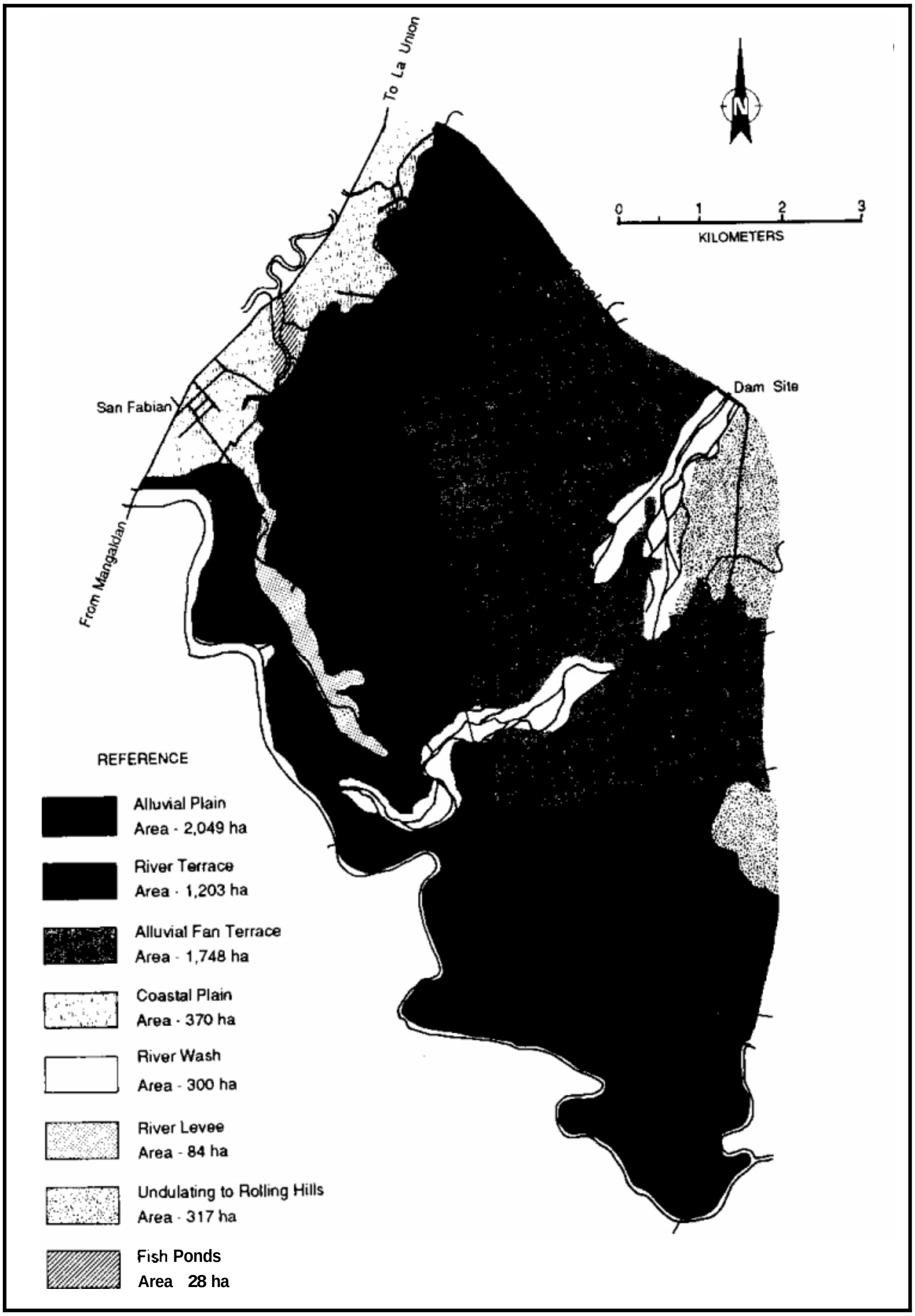
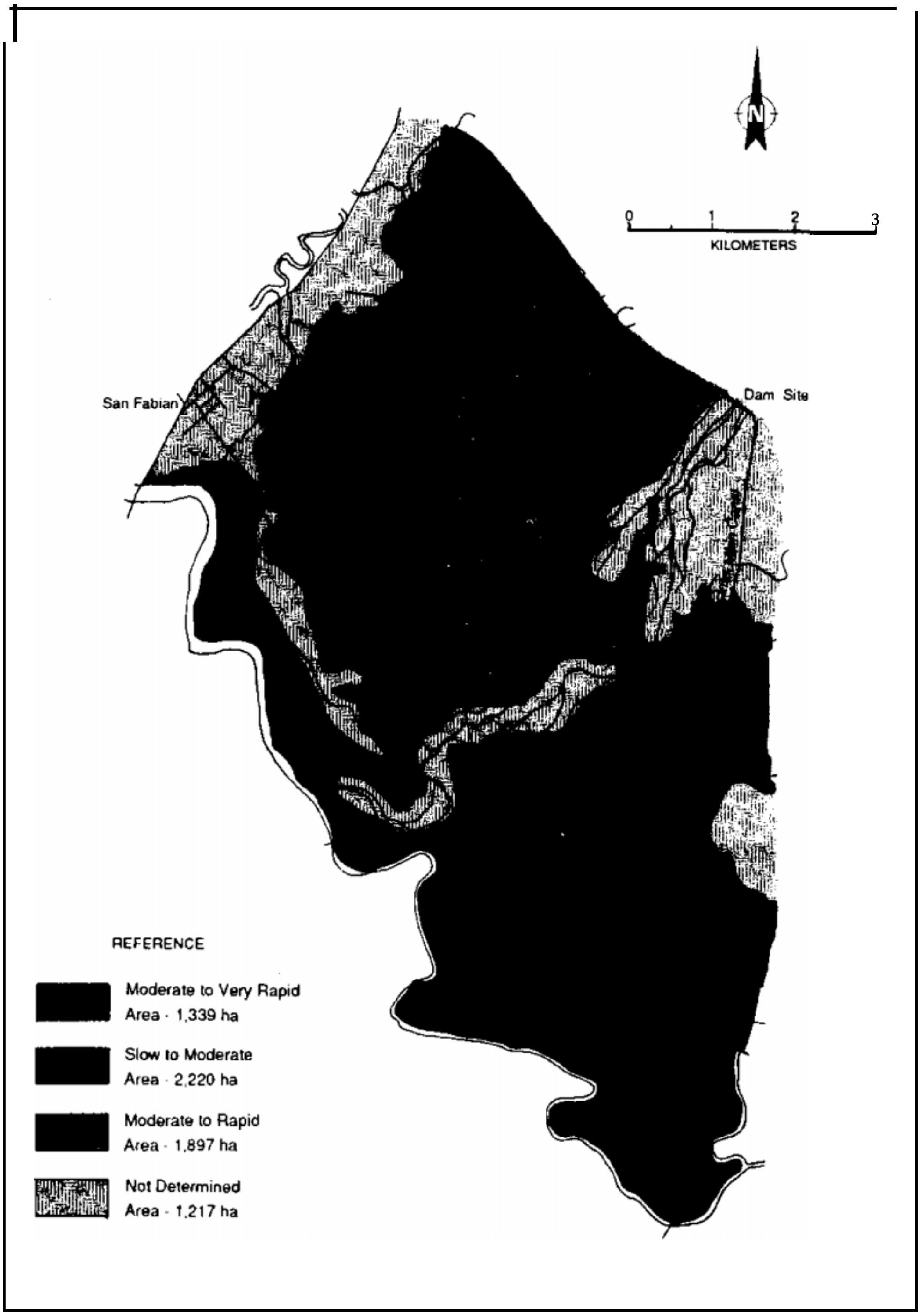


Figure 8. Soil permeability class map, San Fabian River Irrigation System, based on Agro-hydrological soil characterization.



RESULTS AND DISCUSSION

System Water Control

Given the water control setup, current farmer water application practices, and field physical configuration, a pressure energy two-thirds larger than that for rice should be developed for tobacco and other crops. This is needed to produce high flow rates to achieve a flash flooding effect such that water is applied quickly to a field and drained immediately to prevent waterlogging.

The higher flow rates required by nonrice crops further require higher water level in the supply canals. However, adequate mechanical control is usually absent in such supply canals. In UTRIS, steel gate turnouts and some check structures are already missing. Flashboards are sometimes used but these easily get lost and tree trunks and other debris are used. In such situations, adjustments in canal flows cannot be easily done. This induces the farmers to use debris on check structures which worsens canal maintenance problems.

The operating head requirement for nonrice crops likewise, results in the implementation of a rotational schedule not only by sections of the main canal system but even up to individual farmer level. As observed, however, not all areas in a certain section can be irrigated within the prescribed schedule. This results in sliding of the schedule, i.e., water is not diverted to the next area until all areas in the scheduled section are irrigated. Sometimes, areas unirrigated during the prescribed schedule have to wait for the next schedule.

Inadequate structural control facilities also hamper the implementation of the rotational schedule. If a turnout gate is missing in the upstream area, water supply remains continuous even when rotational distribution is implemented. Such an event causes problems in implementing an effective rotational distribution scheme.

Water Augmentation for Dry-Season Cropping

An inventory of shallow groundwater within UTRIS has shown the areas which have potential shallow groundwater even during the dry season which can be tapped particularly for upland crop production. Based on the persistence and depth of the water table, about four-tenths of the nonirrigated, non-waterlogged sites had usable resources of shallow groundwater early in the season and about one-fourth still had usable reserves at the end of the season. Early in the season, shallow water table was near the main canal and near areas irrigated for a second rice crop while at the peak of the dry season, shallow water table was found along the lower portion of the main canal.

Farmers, especially those owning farms located in the lower sections of the irrigation system where water is limited during the dry season, have been practicing water augmentation. The augmentation system consists of a centrifugal pump drawing groundwater either from open concrete-cased wells or drilled tubewells.

Monitoring of the water table depths, discharges and drawdowns indicated that there are reliable groundwater yields in the sites for augmenting water for irrigation systems for crop diversification. In the UTRIS, more or less 60 pump systems were observed operating within the service area in the 1989-90 dry season. Furthermore, there are farmers, observed to be constructing more new wells. It is important though to examine the effect of the increase in density of these systems on groundwater yield.

The conjunctive use of groundwater and surface water and even rainwater is worthwhile considering. Hence, managers of existing imgation systems in the country are encouraged to pilot test a water augmentation scheme, using shallow-well pump systems within their jurisdiction to determine the feasibility of adopting this system-wide.

Alternative Crops and Cropping Patterns

The results of simulation studies showed that diversified crops could result in higher total income for the farmers and higher collectible irrigation service fees for their irrigation agency (Table 2). Garlic was shown to be a very profitable crop in both UTRIS and LVRIS. Potato and onion have very high potential in LVRIS and UTRIS respectively. However, these crops have very volatile prices which could also cause losses to farmers.

Hybrid corn was shown to be the most viable crop compared to rice. Since the crop is to be produced only during the dry season, it would barely affect prices in other areas because corn is mostly raised as rain-fed during the wet season. The adoption of the crop will also reduce importation of the crop during the dry season. Field tests at UTRIS have shown that employing the present production technology coupled with supplemental irrigation, producing hybrid corn can be profitable. In San Manuel and Moncada towns in Tarlac Province, farmers have practiced the growing of hybrid corn with irhgation coming from shallow tubewells.

For leguminous crops and tropical wheat, there is still a need to improve technologies in growing these crops and the development of better varieties which could give higher yield to farmers comparable to rice production.

Irrigation Management at UTRIS

At UTRIS, the seasonal plan development starts with the submission by the Assistant Water Management Technicians (AWMTs) of their target imgable area, based on estimated available flow. It also includes weekly discharges necessary to support the programmed areas. These plans are submitted to the Zone Engineers (ZE) who consolidate them into the seasonal plan for the zone.

The zone plans are further consolidated into the district plan by the Operations Engineer (OE) which is then submitted to the Water Control Coordinating Council (WCCC) of the Upper Pampanga River Integrated Irrigation Systems (UPRIIS).

Table 2. ***Simulated crop areas, total production costs, gross production value, farm family income and collectible irrigation service fee,*** **LVRIS and UTRIS.**

crops	Crop area (ha)		Productio costs	Total gross productio value	Total farm family income	Collectibl irrigation service fee
	Rice	Nonrice	................thousand pesos..................			
Potato	690	1.254	35,820	423,546	387.726	1,082
Garlic	557	1,600	57,648	139,685	82,037	1,138
Tomato	557	1,600	15.258	90.725	17,792	1.138
Corn	557	1600	12.933	53,925	38,667	1,138
Peanut	690	1,254	12.721	46,970	34,667	1,082
Wheat	**551**	1.600	12,933	35,557	25,416	1,138
Rice	1,305	0	7,887	32,625	24,738	979
Mungbean	557	1,600	8,249	30,821	22,572	1,138
The Upper Talavera River Irrigation System						
Garlic	300	1,600	50,702	135.500	93,189	1.103
Onion	300	1,600	42,312	115,500	64,798	1,103
Corn	300	1,352	11,776	41,300	29,525	912
Peanut	224	1,500	16,725	39.350	22,624	984
Mungbean	240	2,000	13,849	30,000	23,951	1,138
Rice	897	0	6,911	22,425	15,514	785
Soybean	368	1,580	18,635	30,530	11,895	1.152

Based on the OE district plans, the WCCC makes the plan for the entire **UPRIIS,** depending on the available water from all sources. The WCCC makes revision in the plan if the available water is not enough to support the program areas.

The entire plan for UPRIIS also includes that for the UTRIS even if it does not get water from the Pantabangan Reservoir. However, in a recent decision by the new Operations Manager of UPRIIS, the **UTRIS** management has been asked to treat the system separate from the reservoir-supported areas. **Thus,** a separate plan has to be prepared regardless of the plan for UPRIIS.

The UTRIS irrigation plan is prepared by NIA before the start of a season. This plan is disseminated to farmers through farmers' meetings, preseasonal trainings and *patalastas*. Sometimes, farmers do not understand the reasons behind the plan. Most of them do not know the specifics of the plans such as whether they are included in the program or not. The patalastas specify locations by watermaster division sometimes by laterals and villages. If only a part of such laterals or villages is programmed, the location of the area programmed is not specified. It is not uncommon to find farmers not knowing the Divisions to which they belong. Information dissemination seems to be a problem.

System operation in 1987-88 to 1989-90. At SAE, the Farmer Irrigators' Association (FIA) leaders helped in water distribution, taking full charge at night when the NIA personnel were not on duty. SAE can serve its whole service area during the wet season if the main canal is not silted. The main canal of SAE is built on the sideslopes of a hill and during heavy rainfall, runoff carrying large amounts of silt enters the main canal. These accumulate in canal bottoms and clog the canals. Removal of accumulated silt from canals requires the use of heavy machinery. SAE can only serve a limited part of the system during the dry season.

The UTRIS main canal can serve its whole service area during the wet season. Excess water flow was also diverted to the reservoir-supported area downstream of UTRIS. In the dry season, it can only serve 30 percent of the whole service area due to limited water supply. Low water supply usually started in late January to the beginning of the wet season. In the months of November to January, there was more than enough water to serve the programmed areas. This flow was used by downstream farmers who were not programmed to plant a second crop of rice, but they usually have shallow well pump systems to support their crop when water from canals becomes scarce. More often than not, farmers resorted to night irrigation. They walked along the canals during the night and removed checks in the main canal to divert water downstream. This deprived the programmed areas of night water supply.

In the past three years, the dry-season water supply of UTRIS was further reduced by illegal diversion of water from the Talavera River, by a log-dam upstream of the UTRIS Dam. There is a water right connected to this log-dam, but it is only for the wet season when the river flow is more than what UTRIS requires. However, it diverted water even during the dry season.

Water delivery to all sections of the system was continuous in the wet season until the beginning of the dry season (December to January). When water scarcity occurred in February until the end of the season, rotational water delivery was resorted to in the system. Areas under critical stages of crop growth were given priority to get water. The schedule was disseminated to the farmers before implementation. Rotational schedules in the past years, however, were not adhered to. Farmers did not follow the schedule especially during the night.

Progress of farming activities. Farming operations started earlier in 1989-90 than in the previous years. The cumulative land-soaked area showed that the start of operation for the 1989 wet season was two weeks earlier than in the previous years

(Figure 9). This is also shown in the cumulative planted area for the whole system during both the wet and dry seasons (Figure 10). It is worth noting that the area planted during the dry season of 1989-90 was almost twice that cropped during the previous years.

Somehow, these results showed a positive action on the recommendations given to both NIA and the farmers. Areas planted to two crops of rice (wet and dry seasons) in the downstream portion of the system had been recommended to plant early in the wet season. This would result in early planting of the dry season crop, and harvest of such crop in late February to early March. Water scarcity in the system usually starts in February and becomes extremely low in late March until the end of the dry season.

Analysis of the historical flow of the Talavera River showed that if the second crop is harvested in March, water scarcity could be avoided. This was explained to the NIA personnel and the farmers in a joint workshop in December 1988. It was then proposed that downstream areas mostly planted to rice start wet-season operation as early as possible. However, this will require extra effort by the NIA management to bring whatever flow available from the river during such period to the downstream area. During the last coordination meeting among the researchers, NIA and farmers, held in March 1990, this was agreed to be implemented during the 1990 wet season. However, repairs done in the system in May and June 1990 delayed this plan.

Water distribution. The system showed no improvement in dry-season water use efficiency (WUE) from 1987 to 1989 (Table 3). However, there was a clear improvement in water distribution. The water sharing was almost the same as the area ratio (60 percent upstream and 40 percent downstream) for the 1989-90 season. During the wet season, the downstream area was about 60 percent of the whole system in area irrigated. In other years, especially crop year 1987-88, inequitable distribution was prevalent.

Figure 11 shows that total system diversion in the wet season did not differ in different years. However, diversion in the dry season for the two later years was higher than in the first year of observation. Because of rainfall during the dry season 1988-89, there was higher diversion during February and March compared to 1989-90.

Figures 12, 13 and 14 show how the total diverted flow by the system was shared between the upstream and downstream sections of the system. In 1987-88 season, although the downstream section irrigated a larger area during the wet season, it was diverting much less water (Figure 12). The same situation was observed in 1988-89 except during the late wet and early dry seasons when diversion to the downstream area was greater than to the upstream area (Figure 13). In 1989-90, there was a marked improvement in terms of water sharing between upstream and downstream areas compared to previous years (Figure 14).

Figure 9. Cumulative land-soaked area, (started operation), crop years 1987-88, 1988-89, and 1989-90, whole system, Upper Talavera River Irrigafion System.

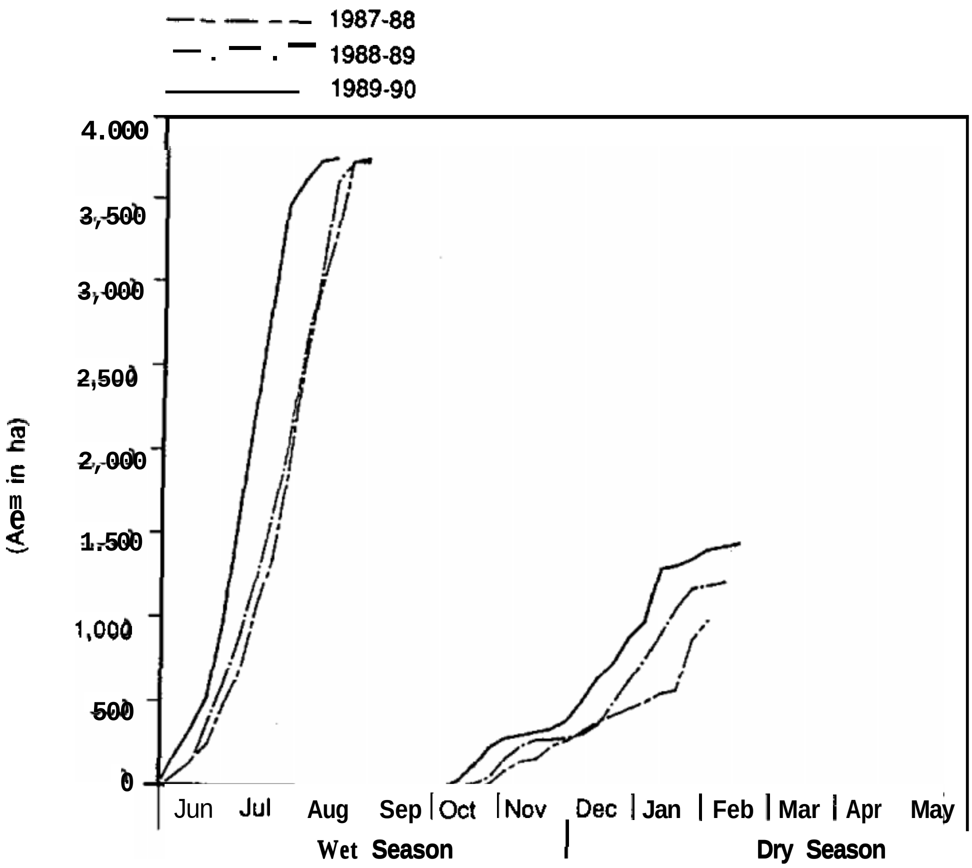
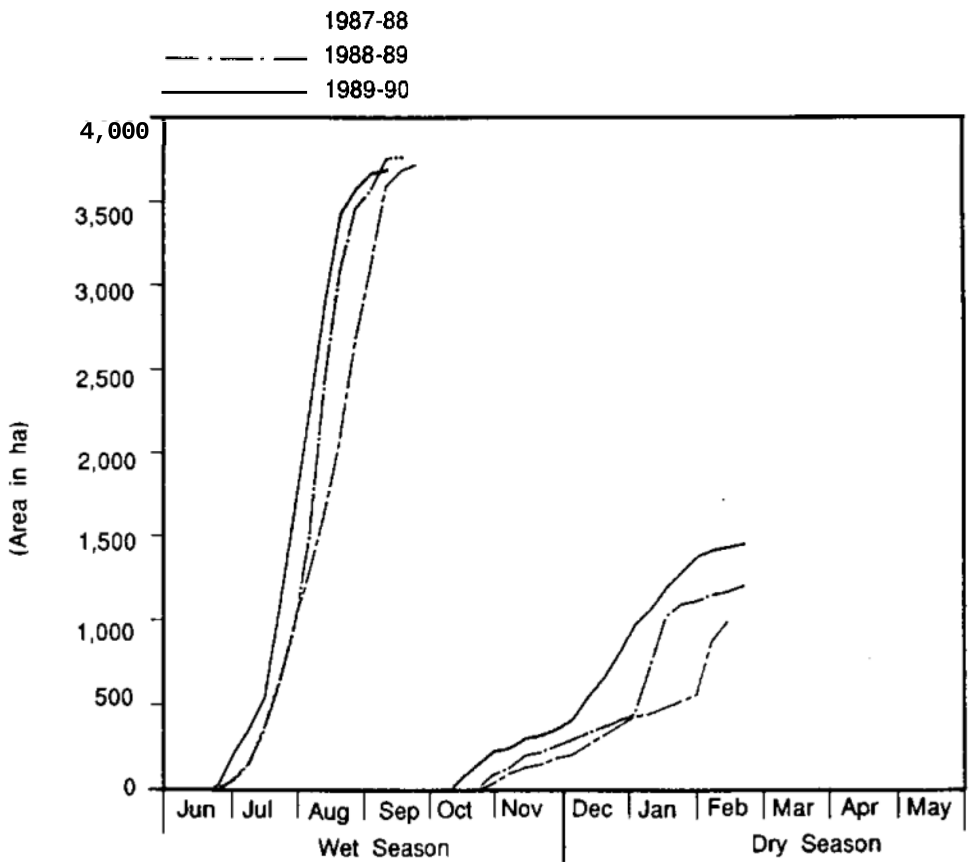


Figure 10. Cumulative planted area, crop years whole system, Upper Talavera River Irrigation System



Year	IDR	RF	AID	WUE (percent)	Water sharing, percent		
	.......(mm/wk)........				Upstream	Downstream	System
1987-88	85	4	144	66	77	23	100
1988-89	70	6	219	42	49	51	100
1989-90	79	I	279	60	56	44	100

WUE = IDR/(AID + RF) X 100

Irrigation Management at LVRIS

Before the beginning of the dry-season cropping at LVRIS, NIA determines the area to be planted with rice, based on several criteria, foremost of which is the estimated available water supply. The area to be planted to nonrice crops is determined using the conversion factor based on the irrigation fee for nonrice crops which is 60 percent of the prevailing rate for rice.

The areas programmed for rice were mostly in the upstream and midstream portions, while those programmed for nonrice crops were in the downstream portion. Rice areas in the downstream portion are those not suited for nonrice crops because of their low elevation and the type of soil.

The plan of operation is discussed in several farmers' meetings either called by the NIA management or by the IA leadership in coordination with the LVRIS field staff. The farmers are given the option to decide on the kind of crops they wish to grow in their areas. The NIA management recognizes that based on experience, the farmers know very well the kinds of crop they should grow in their farms.

In the early part of the cropping season, there is enough irrigation water and it flows continuously in the main canal. Rotation is resorted to when the supply becomes low.

System *operation from 1987-88* to *1989-90*. At the start of each crop year (June), a one-year cropping calendar was developed through a preseasonal meeting between the *cabecillas* (head of the IA at the district level) and NIA. Lectures on proper water management, operation and maintenance, and evaluation and assessment of system performances were conducted by NIA.

Farmers were given eight weeks to finish land-soaking and land preparation during the wet season and six weeks during the dry season. NIA programmed the tail section first during the wet season.

NIA's watermasters and ditchtenders informed farmers beforehand of the planned schedule of farming activities, water delivery and deadlines of transplanting and necessary maintenance work through the cabecillas. Water was generally

Figure 11. *Weekly diverted flow at main canal headgate for crop years 1987-88 and 1988-89, Upper Talauera River Irrigation System.*

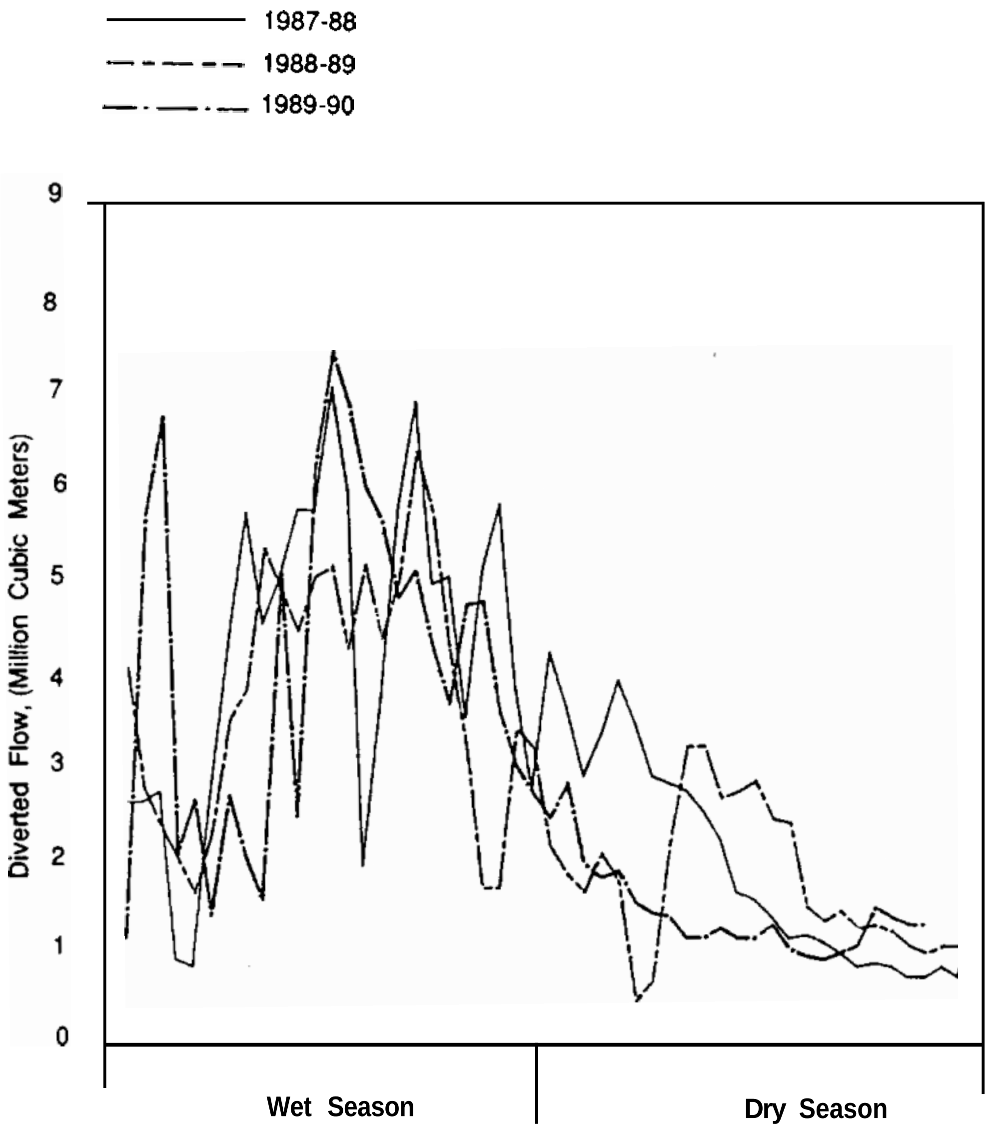


Figure 12. Weekly diverted flow at canal headgate, upstream and downstream areas for the crop yenr 1987-88, Upper Talavera River Irrigation System.

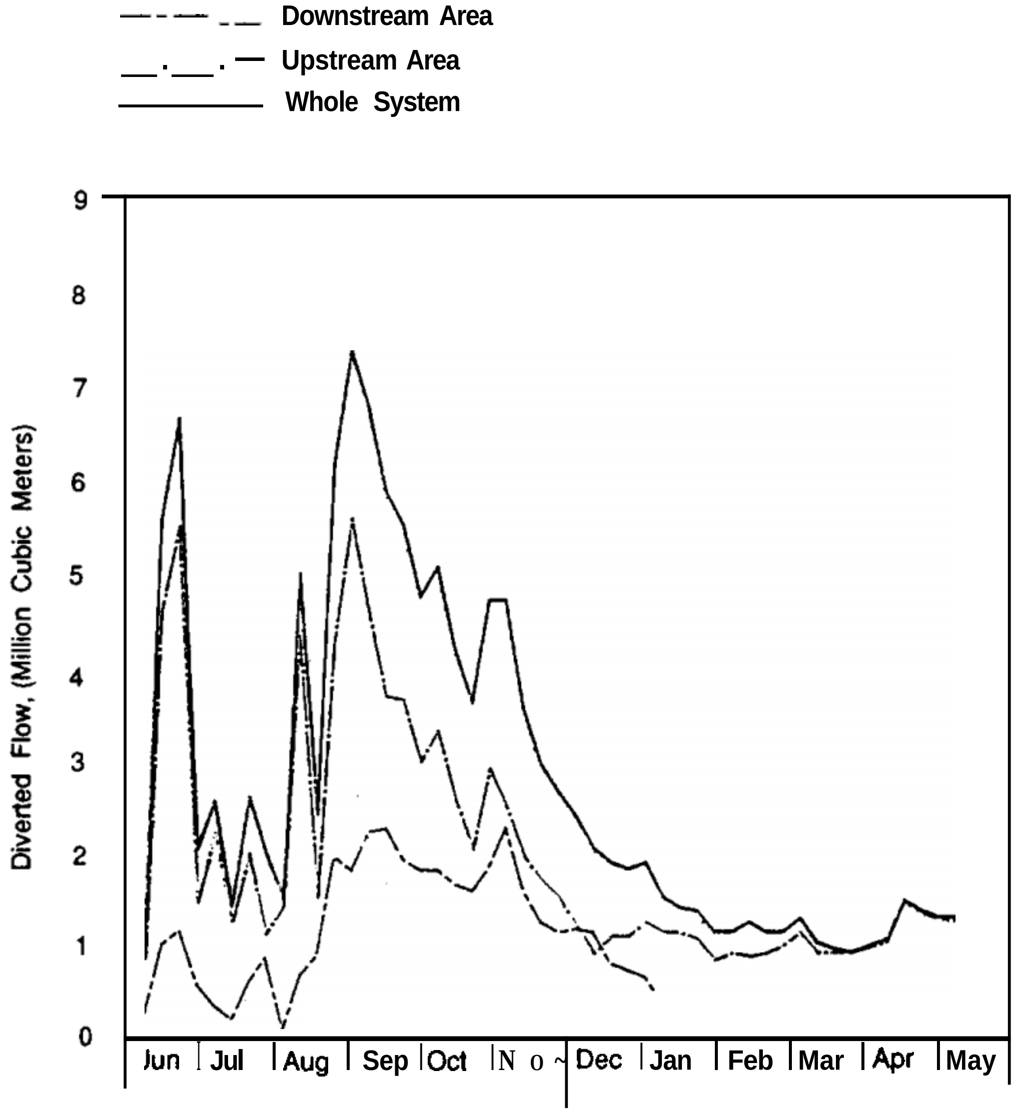


Figure 13. *Weekly diverted flow at canal headgate, upstream and downstream areas for the* crop *year 1988-89, Upper Talavera River Irrigation System.*

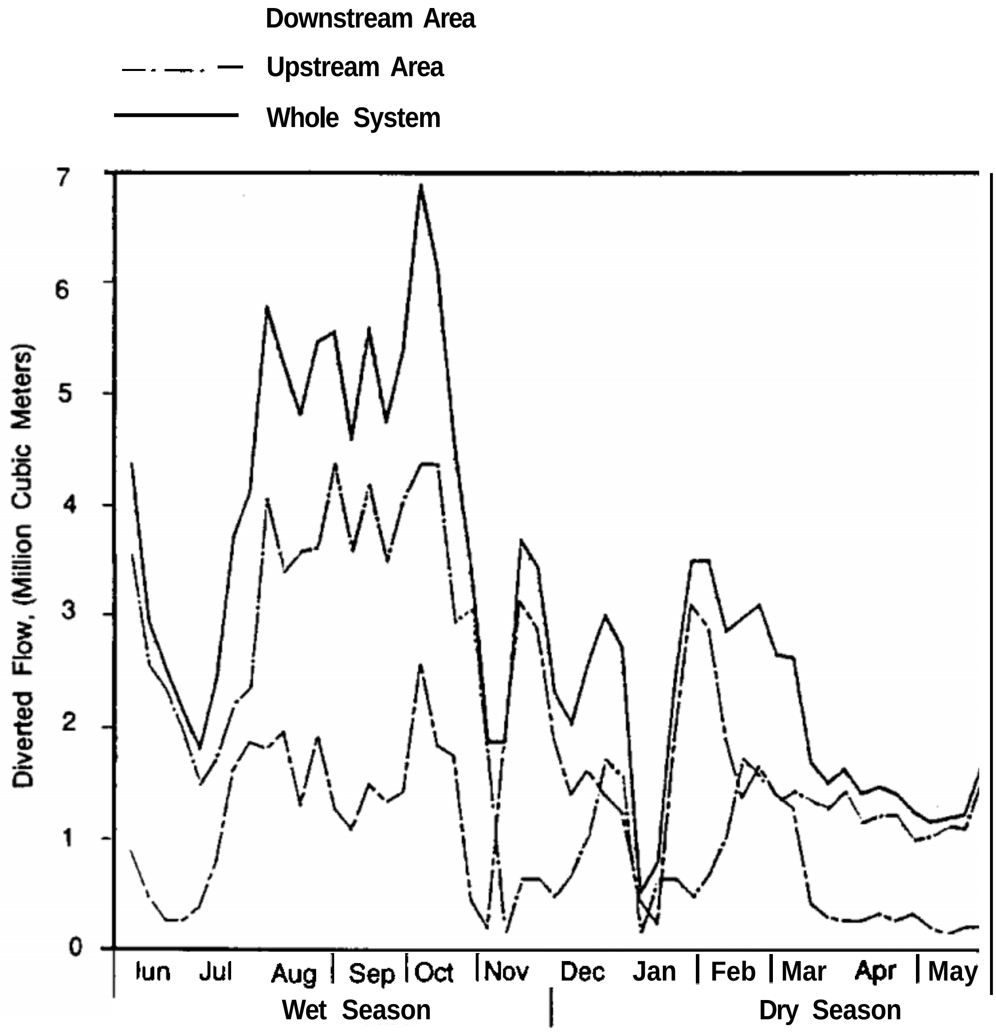
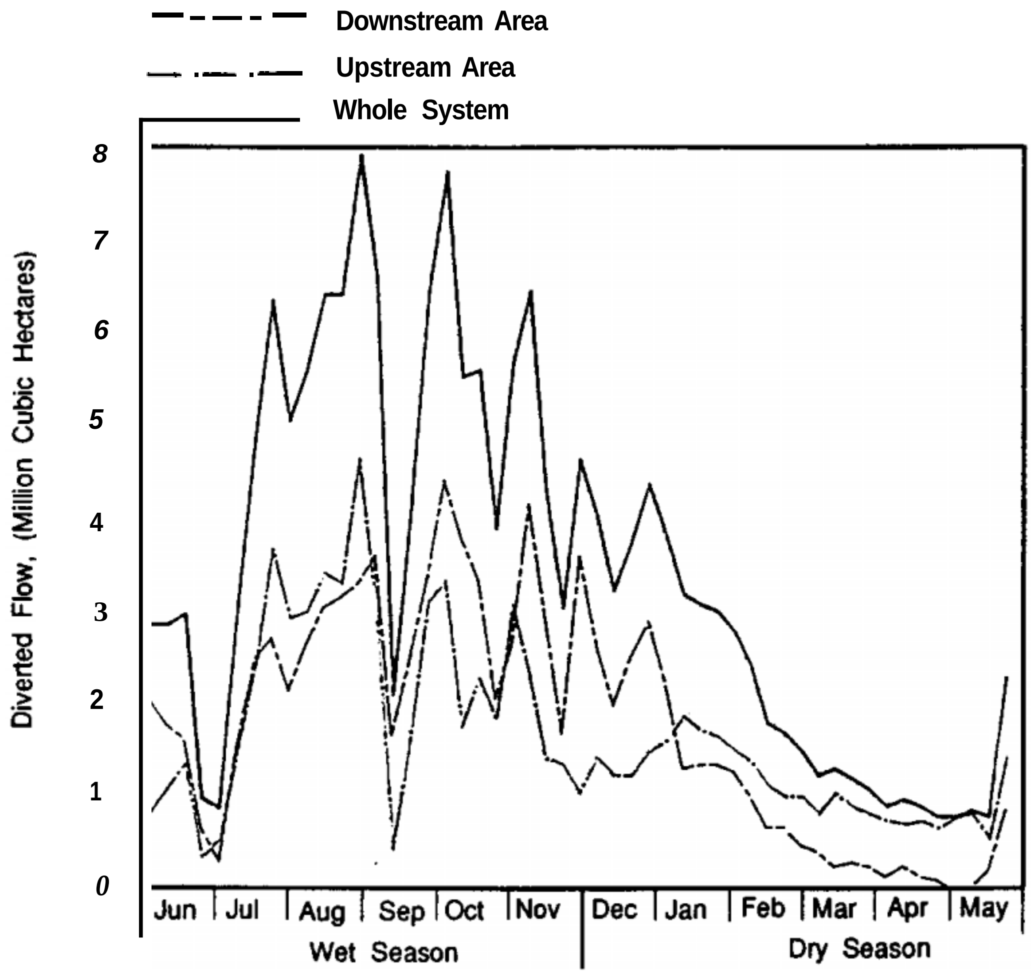


Figure 14. Weekly *diverted flow at canal headgate, upstream and downstream areas for the crop year 1989-90, Upper Talavera River Irrigation System.*



delivered continuously to all divisions; however, there was a fixed rotational schedule to irrigate areas which needed a large delivery in order to irrigate their service areas. During water shortage, rotational schedule was implemented throughout the system. The usual rotational schedule in a division was 1-2 days per district starting from the upstream to the downstream portion. Water delivery schedule was usually decided in situ by the watermasters, depending on the situation and status of water supply.

Progress of farming activities. Figure 15 shows the cumulative land-soaked areas (areas starting operation) for the crop years 1987-88 to 1989-90. In earlier years, some farmers started operation as late as February. In the preseasonal meetings for the dry season, 1989-90, the latest date of start of operation specified by the plan was mid-December. However, only about 30 percent of the farmers followed the plan. The main reason for the delay was the late release of certified rice seeds for the Rice Production Enhancement Program (RPEP) of the DA. This was solved by allowing the fanners to use their own seeds. However, it was already late when the farmers were informed of this decision.

There was not much difference in the cumulative land-soaked areas in the different years. However, in 1989-90, land-soaking was finished a month earlier than in the previous years. This was attributed to the vigorous campaign conducted to enforce the plan developed jointly by NIA and the farmer leaders.

Figure 16 shows the progress of planting for the system. A larger area was planted for the crop year 1988-89. This was due to the late rainfall during the wet season which made the farmers raise a second crop to offset the low wet-season production. In 1989-90, the planting date was earlier compared to the previous years due to the vigorous campaign to induce farmers to adhere to the schedule.

Water distribution. Figures 17 to 19 show the weekly water diversion of the system. Low water supply was observed earlier in the crop year 1989-90 compared to the other years. While low water supply occurred in mid-January in other years, it occurred as early as mid-December or a month earlier than usual in 1989-90. Water diversion to Division I was also reduced in 1989-90. This shows an improvement considering that in the other years, Division I had been diverting much water to the detriment of other divisions. This is considered an achievement for the system personnel and the farmers because water supply in 1989-90 was more critical.

There was no marked improvement during the years in terms of water use efficiency. However, there was an improvement in terms of water distribution (Table 4). In the earlier years, there was always a division getting less water than it required. In 1989-90, all divisions got more than what was required. This was due to the timely action on problems through monthly meetings. The weekly rotation schedule was not very effective because the desired critical flow diversion to the different sections of the system was not being met. This was recognized during the study and late in the season, for each week, and diversion was concentrated in one division only.

Figure 15. *Cumulative land-soaked area (started operation), Laoag-Vintar River Irrigation System, dry seasons, 1987-88, 1988-89 and 1989-90.*

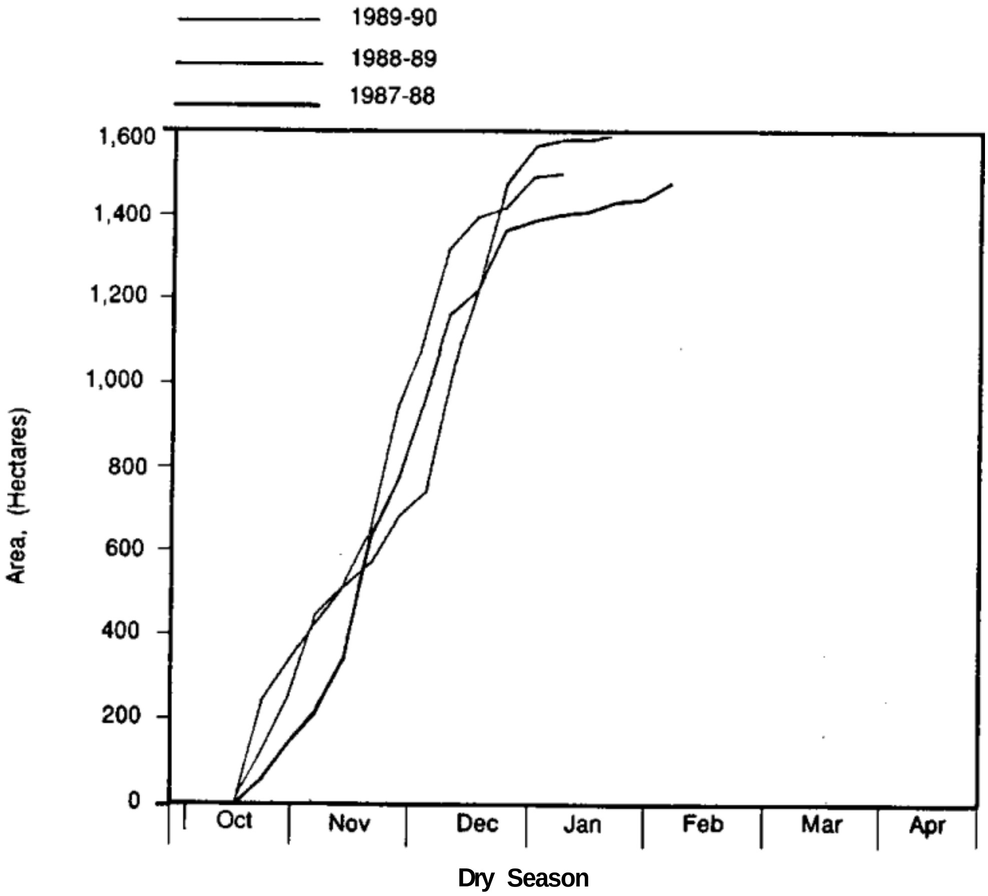


Figure 16. Cumulative planted area, Laoag-Vintar River Irrigation System, dry seasons 1987-88, 1988-89 and 1989-90.

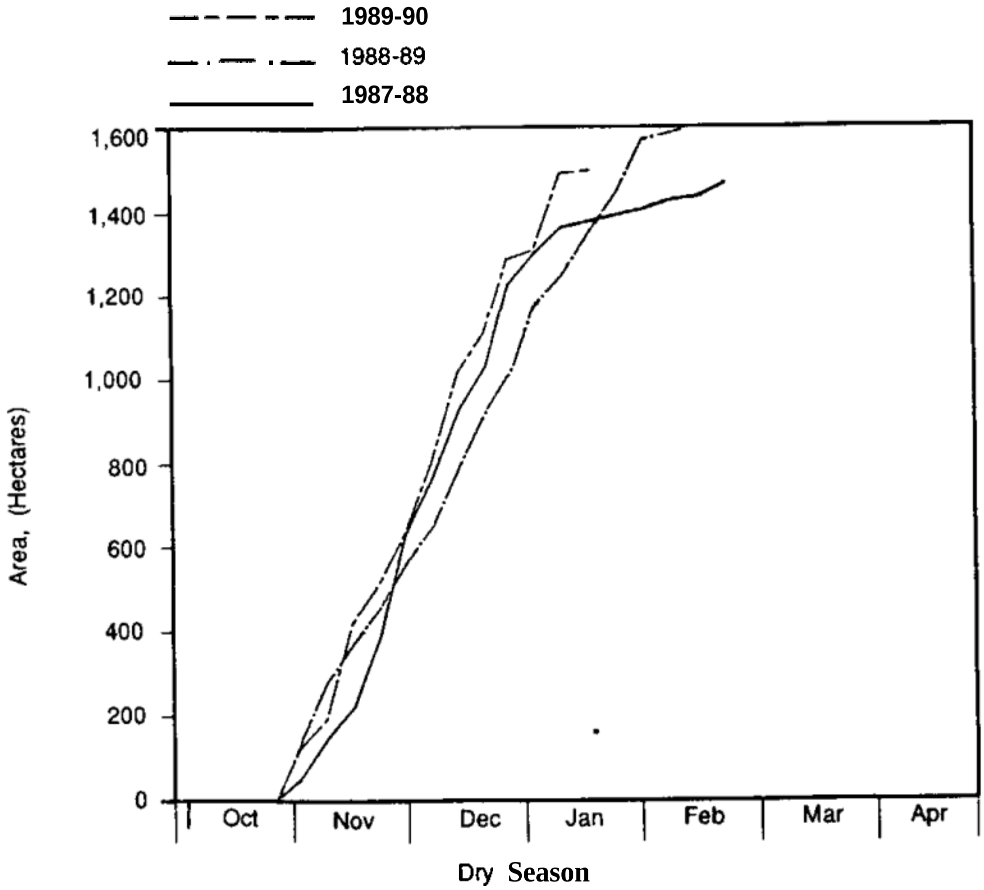


Figure 17. Weekly *diverted flows* at *main canal* and *divisional* kendgates, *Laoag-Vintar River* Irrigation System, *dry* season, *1987-88.*

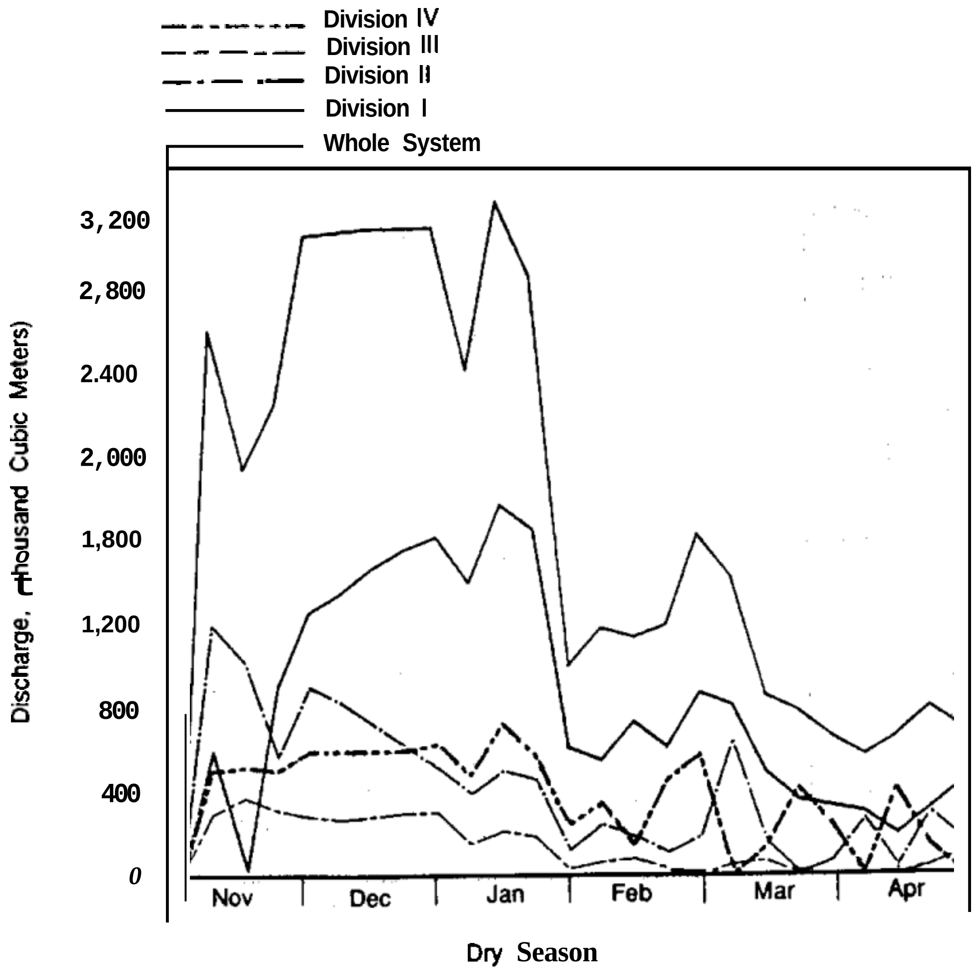


Figure 18. Weekly *diverted flows at main canal and division headgates, Laoag-Vintar* Riwr *Irrigation* System, *dry season, 1988-89.*

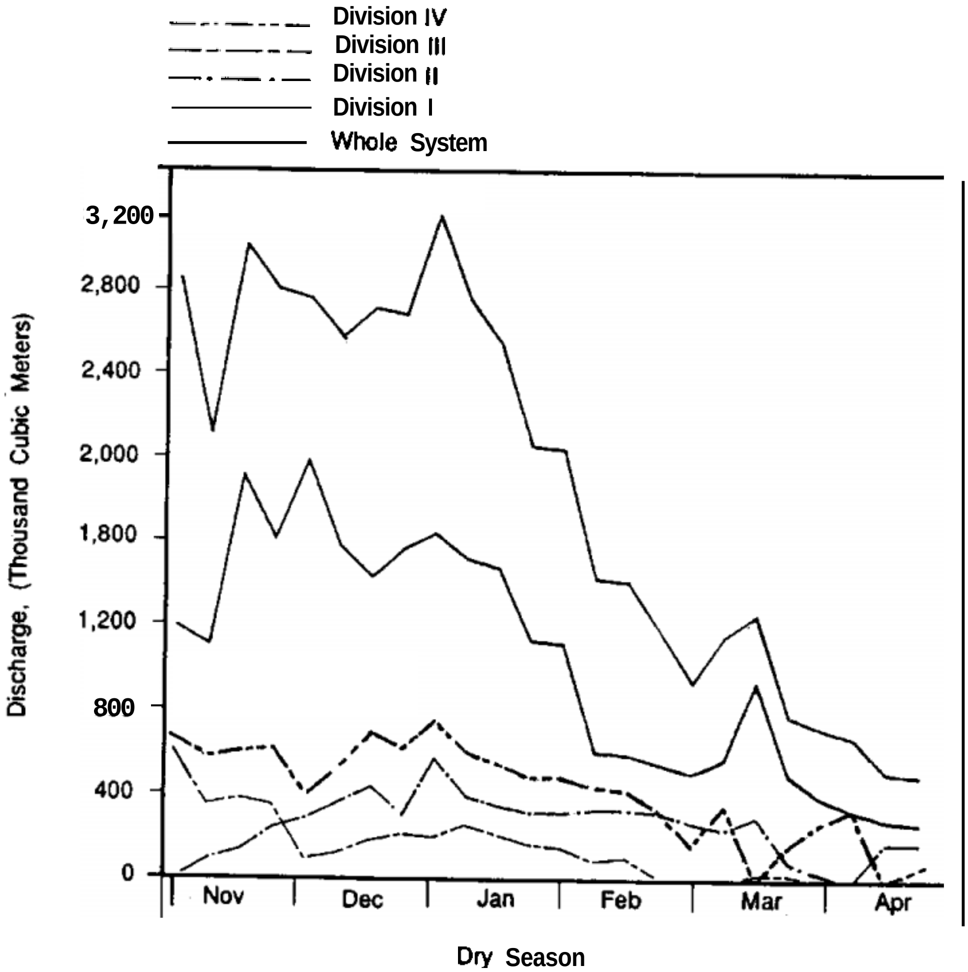


Figure 19. Weekly diverted flows at main canal and division headgates, Laoag-Vintar River Irrigation System, dry season, 1989-90.

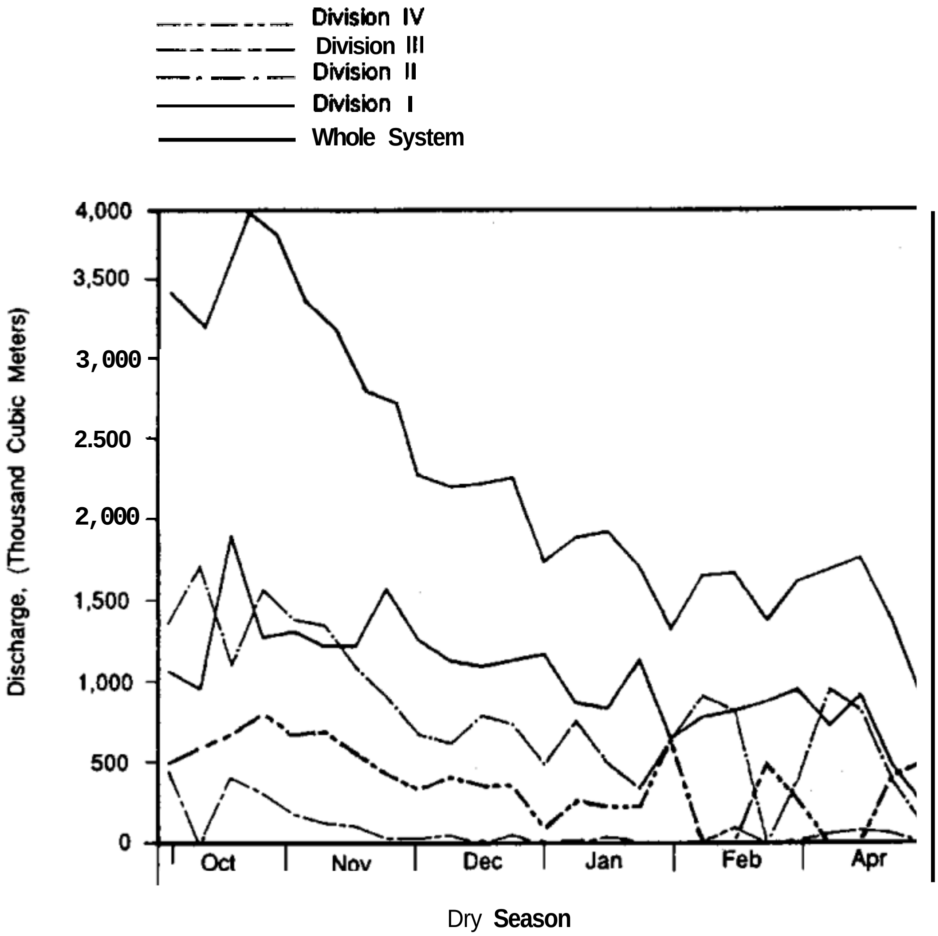


Table 4 seems to indicate that there was more water available in 1989-90. Considering the total diverted flow for the season, this is true, since the late season flow was quite larger compared to the other years. However, the early season flow in the previous years was larger compared to that in 1989-90.

Table 4 also shows that there should have been no problem in 1989-90. The total water supplied for the season was 2.3 times the required amount. However, the system was designed for rice at a value required for land-soaking. Diversified crops even need higher flows than these designed flows. Reduction in area irrigated compensated for the change in crops. However, the diverted flow could not be reduced, for it would have resulted in low turnout flows which would not satisfy the critical flows needed by the farmers. When the total supply is low, this is concentrated to a section to satisfy the critical flows. To compensate for individual farmers' critical flows, the flow diverted to each turnout is concentrated to a few individuals only. This is being followed in the system.

Table 4. Summary of water sharing (percent), by divisions for dry seasons 1987-88, 1988-89, 1989-90, Laoag-Vintar River Irrigation System.

Crop Year	Divisions				
	I	II	III	IV	System
1987-88					
IDR	8.6 (42)	5.7 (28)	4.9 (24)	5.4 (26)	24.6 (100)
AIF	22.6 (44)	13.7 (27)	4.1 (08)	11.8 (23)	52.2 (100)
IDR/AIF	2.6	2.4	0.8	2.2	2.2
1988-89					
IDR	10.4 (39)	5.9 (22)	3.3 (12)	8.1 (30)	27.7 (100)
AIF	24.0 (55)	5.9 (14)	3.4 (08)	9.7 (22)	41.0 (100)
IDR/AIF	2.3	1.0	1.0	1.2	1.5
1989-90					
IDR	10.9 (54)	4.1 (20)	1.8 (9)	7.6 (37)	24.4 (100)
AIF	25.0 (45)	19.0 (34)	2.1 (4)	9.2 (17)	55.3 (100)
IDR/AIF	2.3	4.7	1.2	1.2	2.3

IDR = Irrigation division requirement, total of the season in million cubic meters.
AIF = Actual irrigation flow, total for the season in million cubic meters.

Numbers in parentheses are ratios of the division share over the whole system in percent.

IMPROVED MANAGEMENT FOR DRY-SEASON IRRIGATION

The results of the different studies have identified a number of strategies and options which may be worth considering by the imgation managers, not only for irrigating nonrice crops during the dry season but also in the overall management of the systems. Some imgation procedures and practices can be further improved to effectively irrigate rice and nonrice crops or a mixed cropping system. The following suggested improvements focus on the existing planning, implementation, monitoring and evaluation procedures of NIA (Table 5).

Improved Physical Facilities and System Water Control

The physical condition of the irrigation system (e.g., canals and ditches, turnout structures, etc.) will have a direct bearing on the amount of water that will be required as it determines conveyance losses and consequently, efficiency of water delivery. Efficient control structures are not only necessary for imgation of upland crops but for rice as well. An efficient water distribution plan could be implemented, only with effective water control and measurement structures.

It is necessary to provide the needed volume of water to a certain section. Canal limitations should be considered in this aspect. Canals have critical flow limitations, that at a certain flow diverted to such canals, no flow occurs at turnouts unless excessive checking is done. At such low flows, farmers create their own checkpoints to divert water to their fields. Efficient operation of the system cannot be achieved in such situations. Canal flows should be maintained at a level where checking is done only at designed check structures.

System Characterization and Mapping

The agro-hydrological characterization of the system indicated the heterogeneity of the soils within the service areas of the irrigation systems. In UTRIS, six physiographic units had been identified while eight units were identified in SFRIS. These units showed variation in texture, infiltration rate and permeability. These characteristics have influence on the type of management that has to be employed.

A more detailed characterization of the system also provides more reliable data which could be input into a computer aided mapping program developed earlier. This program can be used as a tool for identifying parts of systems suitable for irrigated nonrice crop production and help improve the planning procedure in allocating water for rice and nonrice crop areas. Consequently, this will help in determining the demand for water. Since this technique requires reliable data inputs, it is necessary to have more detailed survey of the imgation systems. Updating existing maps will prove useful.

Table 5. Existing NIA procedures and recommended methodology/tools to further improve system management.

ACTIVITY	Methc	ılogy/tools	\ctual/recommended methodologies for UTRIS	
	Existing	Recommended	Existing	Recommended
Planting				
Estimation of Available Water Supply				
- Dependabl rainfall	5-year noving ıverage	Incomplete gamma distributionanal Augment existing data and re-analyze annually	Veekly rainfall m a n based n 5-year previous data. Vhen Instrument for rainfall neasurement breaks down, o data is added and data ase is not updated and plan or last year is adopted	Veekly lependable ainfall values to e adjusted unnually as data s added to previous ecords.
Stream flow (River discharge)	5-year noving average	Lon-Normal/Low Distribution Analysis augment existing data and re-analyze annually	Streamflow observations not sing done (stopped). data ase on out-dated data hence nnual program is inchanging and personnel cgards planning as just opying previous plans for ubmission as just copying revious plans for ubmission as requited.	Veekly lependable river low values to e adjusted unnually as d a b s added to revious ecords.
· Other sources	isting drainage re-use dams, and private ' shallow well pumps	Identify other points where re-use dams could be constructed to fully utilize all possible water sources.		
3 Estimation of Irrigation Demand				
· crop water duty	Based on rice	Based on particular crop grown using crop coefficients and pan evaporation data. Existing data be verified during actual system operation.	Out-dated data results in mequal distribution of water n day to day operation of system due to incorrect ssessment of water needs	Verified dam for use in planning and actual system operation.

Continued on page 93

\ctivity	Methodology/tools		Actual/recommended methodologies for UTRIS	
	Existing	Recommended	Existing	Recommended
- Soil demand	Existing data but are they still in use or already lost in words?	Based on agro-hydrologic soil characterization.	Data may be outdated already, resulting in uneven distribution of water in daily system operation due to incorrect assessment of water needs	Verified data per area and crop for use in planning and actual system operation.
Efficiency distribution losses, application losses, system efficiency	Existing data but are they still in use or already lost in records?	Verification of data based on roil types, farmers practices, crops grown and existing structures and other irrigation facilities.	Data may be out-dated already resulting in same situation as above.	Verified data far use in planning and actual system operation.
Irrigators' Associations Involvement				
Planning	No or minimal involvemen	Active farmers involvement in decisions on which areas to be served, crops to be grown, operation dates and irrigation methods to be used.	Farmers not following plans resulting in inefficient performance due to disruption of planned activities thus no semblance of farmers' discipline in diverting water especially when there is no immediate water stortage.	Plans that M acceptable and followed by farmers.
Water distribution	No or minimal involvemen	Active involvement, in plan implementation. feed-back mechanism for evaluation of water distribution strategies.	It is only during critical water supply situation when: strict supervision is implemented where efficient operation is achieved.	Operation strategies responsive to farmers' needs and system limitation. efficient use of available water resources.

More Accurate Methods of Prediction

In determining water availability from river and rainfall, continuous data collection is recommended to account for climatic and terrestrial changes. More reliable analytical methods should be used in analyzing such data. The methods used in the simulation studies are recommended and considered as more reliable than the present analytical tools being used.

The probable amount of water that will be available is estimated primarily from the analysis of river and rainfall data. NIA presently uses the 5-year moving average to determine river discharge. However, streamflow observations are not being done and therefore outdated data are used. Hence, the annual program is unchanging and personnel regard planning as just copying previous plans for submission as required. Regular monitoring and calibration of the NIA systems diverting water for irrigation could provide weekly river flow values which could be adjusted as data are added to previous records.

The present five-year moving average method for determining rainfall probability is less reliable on the weekly prediction compared with the 50 percent probability level of the incomplete gamma function. It overestimates the actual rainfall and when measurement breaks down, the database is not updated and the previous year's plan is adopted.

The incomplete gamma distribution function (IGDF) is a hydrologic frequency analysis tool which is appropriate for analyzing daily, weekly or 10-day period rainfall data. It produces more reliable data than arithmetic means. For instance, in analyzing a five-year rainfall data for a certain week with four years when rainfall was zero and one year when rainfall was 50 mm, the arithmetic mean will say that 10 mm of rainfall can be expected while the IGDF will say that zero rainfall is expected once in four years, which best describes the probability.

Groundwater Utilization

The contribution of groundwater in upland crop production during the dry season can be tapped by planting in areas where the water table is shallow enough for the plants to use the water through capillarity. Existing drainage reuse dams and private shallow wells can provide supplemental water, particularly during scarce water supply situations. It was observed that farmers use these pumps even during the rainy season to be able to start their rice crops earlier when irrigation water is not available in the canal or when rainfall is very low. During the dry season, these pumps are the primary source of irrigation water although farmers still use water from the canal whenever it is available.

Crop Scheduling

In run-of-the-river type systems, cropping operations should be well-scheduled so that available water resources could be effectively used. Since water scarcity comes at the end of the dry season, earlier crop establishment would result in efficient use of available water supply and wider area planted. This aspect could also be useful in reservoir-supported systems, by timing operations requiring large volumes of water such as land-soaking in months with heavy rainfall to economize on water releases.

It was observed in UTRIS that in the past years, wide areas suffered from stress due to lack of water during the late dry season. This could be avoided by scheduling earlier planting than usual. Water supply situations in this system showed that harvest of the second crop of rice by late February to mid-March would result in a larger volume of available water to supply crop needs and may even enable planting in a larger area than usual. Analysis of the water supply graph for this system showed that this is possible.

Involvement of Farmers and Fanners' Organizations

Plans are usually developed by NIA for farmers. The main problems happen during implementation. Though farmers are informed of the plan, they do not understand well, the basis of such plans. Thus, many violations are committed.

The involvement of farmers and farmers' organizations as early as the planning stage may reduce the problems during implementation. In systems with active Irrigators' Associations (IAs), the determination of the program area is facilitated through the participation of the IA. Involvement of farmers during planning does not necessarily mean teaching them to plan for themselves, but to explain to them the necessity of the plan and the reasons for the actions taken. This ensures farmers' commitment to abide by the plan. This also gives a feeling of importance to the farmers.

The area served during the dry season at UTRIS has increased since 1987. Before 1987, the area served by the system ranged from only 500 to 700 ha. At present, it is more than 1,000 ha. Active participation of the farmers in decision making and managing the system, growing farmers' awareness of the systems capabilities, increasing rice prices, and government support programs to produce more rice have contributed to this endeavor. The study conducted in the system has helped in better management of the system, despite increased cropped areas.

Information Control and Use

Information should be considered important for making decisions pertaining to the management and operation of the imgation system. The status of farming activities, flows or discharges at critical points and amount of rainfall are important variables to be monitored. Farming activities should be noted on a weekly basis so as to provide enough data to base decisions as to which sections of the system will need water. Flows on the critical points in the system should likewise be used for making decisions and not for recordkeeping only.

A regular meeting between the IA and the NIA field staff during the cropping season is an effective means of monitoring the operations of the system. The meeting could provide the feedback mechanism to make the schedule realistic and the opportunity to revise the schedule and settle conflicts in water distribution.

SUMMARY

The production of nonrice crops in some irrigation systems in the Philippines could be a promising alternative to increase the productivity of these systems, particularly during the dry season. Based on the studies conducted in three systems practicing diversified cropping, a number of options and strategies are recommended which may help improve system performance not only for rice irrigation but for considering nonrice crops during the dry season. Implementing these recommendations necessarily requires some modification in the existing physical facilities and management procedures of the system. It is thus necessary to further field-test these recommendations for ultimate institutionalization.

References

Cablayan, D. M. and C. M. Pascual. 1989. Methodology for identifying parts of irrigation systems suitable for crop diversification during the dry season. In Crop Diversification in Irrigated Agriculture in the Philippines. A. Valera, (ed.) International Imgation Management Institute. Los Banos, Laguna, Philippines: IIMI Liaison Office. pp 37-53.

Cablayan, D. M.; C. M. Pascual; M. Caluya; C. Acosta and A. N. Francisco. 1990. Field testing of management innovations for irrigation systems adopting diversified crops during the dry season. Paper presented at the National Workshop on Irrigation Management for Rice-Based Fanning Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Cablayan, D. M.; C. M. Pascual; I. Agulto and H. Angeles. 1990. Simulation for optimum cropping pattern. Paper presented at the National Workshop on Irrigation Management for Rice-Based Farming Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Maglinao, A. R.; D. M. Cablayan and T. B. Moya. 1990. Management of irrigation systems to accommodate nonrice crops in the dry season. Synthesis paper presented at the National Workshop on Irrigation Management for Rice-Based Fanning Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Maglinao, A. R. and A. D. Valdeavilla. 1990. Imgation management for dry season production of corn in rice-based farming systems. Paper presented at the National Workshop on Irrigation Management for Rice-Based Fanning Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Moya, T. B. 1990. Control of irrigation system water supplies for mixed cropping pattern. Paper presented at the National Workshop on lmgation Management for Rice-Based Farming Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Natividad, R. A. and H. L. Angeles. 1990. Irrigation system management for mixed cropping. Paper presented during the National Workshop on Irrigation Management for Rice-Based Farming Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.

Tenedora, M. E.; T. R. Savares-Salire and T. Woodhead. 1990. Tillage and soil-water management for legumes following irrigated lowland rice. Paper presented at the National Workshop on Irrigation Management for Rice-Based Farming Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos (UPLB), College, Laguna, Philippines.

Undan, R. C; J. L. Tabago and O. F. Ringor. 1990. Water augmentation and drainage studies in crop diversified areas. Paper presented at the National Workshop on Irrigation Management for Rice-Based Farming Systems on 10-11 September 1990 at the Continuing Education Center, University of Philippines, Los Banos, College, Laguna, Philippines.