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IRRIGATION PRICING AND MANAGEMENT

ANNEX 6

Annotated Bibliography

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Abbie, Leslie; Harrison, James W.; and Wall, John W. Economic Return to Investment in Irrigation in India. Staff Working Paper No. 536. Washington, D.C.: World Bank, 1982.

The report investigates the efficiency of investment in surface and groundwater and public and private irrigation in India. A brief history of irrigation development is provided as are expenditures and rates of return. In 1976-78, estimates show that only 34-45 percent of operating costs were recovered in government surface irrigation schemes. Rates of return on public surface projects are low compared to investment in groundwater development.

In examining the causes for low returns in surface irrigation, the authors compare the northern with the southern systems and find the former more successful than the latter. In the north, irrigation is by run-of-the-river, irrigation intensities are very low and only a fraction of the land can be irrigated. But the water is delivered on a fixed schedule through the warabundi system. The farmers have learned to stretch scarce water supplies and are aware of their rights (established through law and custom) and insist on their turns. In the south, irrigation intensities are high, water is stored in reservoirs, conveyed through elaborate mechanisms and discharge rates can be adjusted. However, efficiency is low and allocated water is used on one-half to three-quarters of the intended area at the upper reaches. Management problems below the outlet are an important factor in lower efficiency levels as is management of water between the reservoir and the outlet.

The authors suggest that the problem of water wastage is difficult to solve without mechanisms to enforce more efficient use. Rates of return can be increased through design improvements combined with clear-cut legal water rights, efficient and timely water delivery and improved management by trained professional cadres. Imposing water scarcity on all users will be a powerful incentive to water use efficiency. Design that incorporates greater flexibility of water delivery is also useful, as are smaller areas to be served by each outlet and greater portions of the system being lined. These developments would require a greater government role. Improved operating procedures will require efficient water scheduling and equitable water allocation and the ability to overcome resistance to reallocation of water by farmers now benefitting disproportionately. Cooperation among farmers can be enhanced through controlled and reliable water supplies to outlets.

The main factors limiting returns to groundwater investment include geologic conditions, energy availability (especially power shortages) and lack of adequate technical advice. Private wells function more efficiently than do public wells because individual control enables water application in a timely and flexible manner. Returns from groundwater irrigation can be increased through improved supply of complementary factors (electricity, credit availability, etc.) and land consolidation.

Abu-Zeid, Mahmoud. "On-Farm Water Management Programs in Egypt." Water Use and Management Project. Vol. IV: Appendix C: Technical Articles by Egyptian and American Teams. Cairo and Fort Collins, Colorado: Colorado State University, September, 1980.

Alwis, J. "An Overview of State Intervention in Irrigation Development in Sri Lanka." Presented at the Conference on Organization as a Strategic Resource in Irrigation Development. Manila, November 15-19, 1982.

This paper reviews the history of state involvement in irrigation systems in Sri Lanka. Traditionally, farmer participation in irrigation systems was based on equity and productivity and a strong, self-reliant management organization developed around the village tank. Initially, the British promoted local participation in irrigation management with local leadership, local enforcement of rules and codification of local irrigation rules. But the government's policy changed with a shift in emphasis to large schemes. Management became more centralized and institutionalized, and as traditional systems were neglected, farmers became alienated.

The Special Program of the 1960's utilized intensive management to provide a coordinated supply of inputs to farmers but since it neglected to focus on farmer participation, farmers' problems and long-term management plans, the program was unsuccessful. It has provoked changes in the irrigation system which now utilizes farmer organizations and resources in conjunction with government funding for rehabilitation of minor irrigation systems. Small scale projects which promote farmer participation are encouraged and channel-based user organizations have been formed and institutionalized.

"An Analysis of the Philippine Economic Crisis--A Workshop Report". Quezon City: University of the Philippines, School of Economics, nd.

Anderson, B. et al. Project Paper: On-Farm Water Management Project. Draft. Prepared for USAID/DR with support of Science and Technology Bureau sponsored WMSII Project. Santo Domingo: US Agency for International Development, 1983.

Anderson, D.C. Irrigation Institutions and Water Users in Ecuador.
Washington, D.C.: US Agency for International Development, 1977.

Public irrigation schemes have higher costs than private schemes, but are worthwhile in directing benefits to poor communities. Public scheme users pay higher fees than those in private schemes, but charges do not cover costs. Much of the difference in costs is attributed to large overheads and administrative costs in public schemes, and better use of voluntary services for O and M in private schemes.

Angeles, Honorato L.; Gavino, Romeo B.; and Cubos, Arturo T.
Community Managed Irrigation System. Nueva Ecija, Philippines:
Central Luzon State University, 1983.

This paper describes the operation of the San Roque Communal Irrigation System (SRNIA) in allocating water, managing O and M and resolving problems encountered during operation. The SRNIA strives to help farmers develop systems which are more responsive to their needs using a participatory approach. Methods for comparing and improving Water-Use Efficiency (WUE) are discussed as are the effects on WUE of changes in the system.

The SRNIA employs continuous flow irrigation at times of frequent rainfall and rotational irrigation when water is scarce. The rotation system is based on equal time allotments to each farmer.

The organization of the SRNIA has shifted from a centralized to a decentralized structure, enabling expeditious conflict resolution, improved fee collection, and greater farmer participation. Conflicts have been minimal within the organization, but they have occurred among leaders as a result of local politics and among farmers over water rights. Conflicts among farmers have been resolved by a third party. The most serious ongoing dispute is with a non-member over the use of water. The legal costs of this dispute have increased user fees greatly. Recently, fees have been regularly collected at harvest time. Previously, collections were made only when the need arose. Several other changes such as giving commissions to collectors and collection on a per hectare basis are being considered in an effort to improve the collection capability.

Ansari, Nasim. Economics of Irrigation Rates: A Study in Punjab and Uttar Pradesh. Delhi: Agricultural Economics Research Centre, 1968.

This study examines the different factors involved in irrigation pricing with special reference to the conditions in Punjab and Uttar Pradesh. It describes the evolution of the structure of irrigation rates in the two states and the theoretical issues associated with irrigation pricing, as well as

two case studies and an analysis of a field survey. Theories that would have the state subsidize irrigation are dispensed with and methods for calculating higher interest rates are discussed. Costs of new irrigation systems are estimated and yields of revenue required for irrigation are compared with currently obtained revenue.

It was found that the rate of demand for water depends more on the degree of agricultural development than on the rate structure. Therefore, it is necessary to maximize irrigation potential by increasing availability of inputs in order to raise production and the farmers' ability to pay higher rates.

Arruda, Zenith Joao. "Pricing System for Irrigation Water as an Incentive to Conservation." (Xerox) California: The Central Valley Project, April 15, 1980.

Asian Development Bank. Irrigation Development and Management Proceedings of the ADB Regional Seminar on Irrigation Development and Management. Manila, Philippines: Asian Development Bank, 1980.

The seminar proceedings provide a useful summary of the Bank's experience in a range of countries. The conclusions have recommendations concerning management and financing of irrigation projects.

Asopa, V.N., et al. Irrigation System On-Farm Development and Extension Service in Chambal Project, Rajasthan. Ahmedabad, India: Indian Institute of Management, 1978.

This study examines the Chambal Valley Development Program in the Kota and Bundi districts of Rajasthan and the state of Madhya Pradesh in India with respect to the on-farm development of physical structures. Water scheduling, pricing, and delivery policies are examined in reference to a new agricultural extension program in the region. The authors recommend a new water management approach that improves upon the transportation and communication facilities, and the education and training of village extension workers. A close interaction with state irrigation offices is also recommended.

The article describes a four-part strategy for developing water user associations and catalogues some of the problems encountered in each case. The first strategy is to give construction help to local associations with costs financed on a loan basis. This is necessitated by the temporariness of farmer constructed diversions which often do not survive the rains and result in inefficiencies and crop losses. Problems with established institutions include poor member participation, passive and/or corrupt leadership, divergent desires regarding government aid and repayment of construction costs. Good

technical help and construction of durable structures are necessary conditions for solving or preventing some of the organizational problems.

The second strategy is for preconstruction development of the skills and viability of the associations by encouraging cooperation, active participation of all members and development of effective management skills. Group dynamic seminars can be employed for this purpose. The third strategy of fostering farmer participation in all key decisions and activities is based on several assumptions about the beneficial effects of this on institutional development. The problems include the fact that agency management systems are often designed for centralized planning and implementation; the pressures upon engineers to finish construction on time causes conflicts because the participatory approach may take longer to implement; and hiring and procurement are often done by outside agencies though farmers would like to do it themselves.

The fourth strategy is to maintain the independence of the associations by putting accountability at the local level. The first three strategies can help accomplish this but assistance is also needed after the construction phase for helping to develop farmer capacity for routine managerial tasks including record keeping, financial management, water management, etc.

Bagadion, Benjamin V. and Kortzen, Frances F. "Developing Irrigators Organizations: A Learning Process Approach to a Participatory Irrigation Program." Draft for inclusion in Michael Correa, ed., Putting People First to be published by the World Bank.

"Developing Viable Irrigators' Associations: Lessons from Small-Scale Irrigation Development in the Philippines." Agricultural Administration 7 (1980).

Bayo, Jose Luis. "Sondeo Descriptivo Sobre Irrigacion en el Peru." Lima Peru: Mimeograph, September, 1982.

Bhuiyan, Sadiqul I. Irrigation System Management Research and Selected Methodological Issues. IRRI Research Paper Series No. 81. Los Baños, Philippines: The International Rice Research Institute, 1982.

Recent field research findings indicate there is great potential to improve performance of existing irrigation systems in Asian rice growing regions. Crop yield, water use efficiency, irrigation efficiency, water adequacy, relative water supply, and water distribution equity criteria can be used to assess irrigation system performance. These criteria for areas with crop planning (zoning) should consider net returns for all farmers, as well as soil suitability. Equity issues may be complicated by water rights questions. Once the equity criteria are determined,

it is possible to assess water distribution equity. Methodological options available for evaluating field research on irrigation system management improvement are analyzed. Also discussed are applicability requirements and field considerations of practical alternatives for measuring critical hydrologic and hydraulic factors which enable the determination of water-related criteria for irrigation system performance evaluation.

Blankstein, E. and Cadman, J., "Report of Evaluative Rural Savings Mobilization Project (517-0179)." Mimeo Report. Santo Domingo: US Agency for International Development, February 1985.

Bottrall, Anthony F. Comments on Management Structures for Irrigation. Irrigation Management Network Paper 106, London: Overseas Development Institute, 1984.

A discussion of different organizational structures and their effectiveness in relation to the method of management and accountability.

Comparative Study of the Management and Organization of Irrigation Projects. Staff Working Paper No. 458. Washington: The World Bank, 1981.

This paper presents an analytical framework for monitoring and evaluating administration of irrigation projects in developing countries. A review of four field studies in South and East Asia is included, which focuses on the organizational procedures affecting tail-end farmers. The appendix summarizing "Guidelines for Analysis Using a Checklist Format" is particularly useful for monitoring and evaluating irrigation projects.

"Evaluating the Organization and Management of Irrigated Agriculture." Paper presented to Commonwealth Secretariat Workshop in Irrigation Management. Hyderabad, India, 1978.

Evaluation of irrigation projects tend to be limited to technical and economic performance. The processes of management require increased attention in evaluation. Paper includes a checklist for evaluating performance and returns to irrigation projects.

Financing Irrigation: Central-Local Financial Relations Review for the Government of Indonesia. Sectoral Study No. 3. Birmingham: Development Administration Group, September, 1981.

An analysis of conflicts for technical, organizational and financial responsibility for post construction works and O and M in Indonesian irrigation systems. Report includes recommendations for financing, budgeting and administration of irrigation operation. The report highlights the common problem of

administrative (Government) and irrigation management geographic boundaries not being coincidental.

_____. "Technology and Management in Irrigated Agriculture."
Overseas Development Institute Review, II (1978): pp. 22-50.

The study draws attention to the debate over whether the poor performance of established irrigation systems is due to inadequate technology and/or inadequate management. Areas of management, technology and policy are examined focusing on the characteristics and problems of large and small surface schemes, and groundwater schemes. Criteria for good management are discussed using case studies in Taiwan, Kenya, and South and South East Asia. The criteria include farmer participation, communication between local irrigation users and officials and government attention to local needs. Authoritarian schemes where all aspects of irrigation are government-run may work initially but institutions become ossified. Management of small surface schemes sometimes suffers because of the lack of clarity of defined duties between officials and farmers.

Bromley, Daniel W. Improving Irrigated Agriculture: Institutional Reform and the Small Farmer. Staff Working Paper No. 531. Washington: The World Bank, 1982.

The paper focuses on the need and offers recommendations for developing institutions which better protect the needs of the farmer on the tailend of a watercourse and the small farmer (often the same person fits into both categories). Three themes emerged: 1) Farmers along a watercourse are physically interdependent. Therefore, independent activity is inefficient and unequal. Also downstreamers are especially subject to the actions of those upstream. Institutional provisions were seen as a way to correct these inequalities; 2) Uneven water supply causes institutional uncertainty. Often the cause is that farmers ignore many rules and conventions for water allocation; and 3) Small farmers tend to be cautious optimizers. Based on uneven water supply and other uncertainties, they will choose safe routes of production, at the expense of maximizing yield.

Several case studies were cited to incorporate these facts in Mexico, Sudan, India, Malaysia, Philippines and Taiwan. Especially in Taiwan, it was noted that an increase in farmer water control resulted in a decrease in overall water requirements.

The author concluded that intensification, or structuring the needs of the small farmer into an institutional system, was correlated to good water management and to higher crop yields. Two ways to assure intensification are:

- lowering an individual farmer's costs of making mistakes; and
- making institutions predictable and dependable--i.e., not constantly changing the "rules".

Bromley, Daniel W.; Taylor, Donald C.; and Parker, Donald E. "Water Reform and Economic Development: Institutional Aspects of Water Management in the Developing Countries." Economic Development and Cultural Change, Vol. XXVIII (2) (1980): pp. 365-387

This article addresses the effect of water security (quantity and timeliness of water supply) and water reform (institutional modifications which alter current water allocations) on irrigation farmers, particularly the less advantaged. Water security has a direct bearing on production as unreliable water supply causes farmers to take less risks or put less effort into their production activities. Water security depends on the physical characteristics of the system (water supply, losses due to transport, drainage and seepage, and distance to and number of irrigators) as well as the management of the supply (scheduling, allocation, maintenance and enforcement procedures). Farmers who are poorer, less politically influential and/or more distant from the water source are more vulnerable to water security issues.

The authors emphasize the need for a workable association to monitor and maintain water security and the need to protect the interests of the least advantaged so that water equity can be assured. The Philippine Irrigation Service Association is cited as a positive example of a working institution. Association members participate actively in the formation of the association and in the decisions which ultimately affect their access to water. In turn, their responsibilities to the association range from obedience of rules and regulations established by the association, to payment of dues and fees, to contributions to construction and maintenance of the irrigation system.

The success of the association lies in its formalized structure and functions which require full involvement by its members, and in the cultural compatibility of the institution to the traditional structure of the society.

The authors conclude that policy changes are needed to address associations with operational or organizational problems or in situations where no associations exist. They advocate continued research into user organizations as a means of making more effective irrigated agriculture.

Cabanilla, Liborio. Study of Operation and Maintenance Problems in Irrigation: The Philippine Case. Manila: USAID, November 1984.

California Department of Water Resources. The California State Water Project--1978 Activities and Future Management Plans. Bulletin 132-79, November, 1979.

Caponera, Dante A. "Institutional and Organizational Requirements for Water Development and Management." Farm Water Management Seminar--Manila. Rome: Food and Agriculture Organization, 1972.

Carruthers, Ian. Irrigation Development: Implications of Recent Experience for Aid Policy. Paris: Organization for Economic Cooperation and Development, 1982.

"...The greatest potential for increased agricultural production lies in reorganizing, rehabilitating, modernizing and improving management of the existing irrigation network." This conclusion by the author is supported by a review of cost/benefit issues in several areas, including the opportunity cost of irrigation, equity of water allocation, pre-planning needs, investment in local financing and recurrent costs, and improved design of construction and O and M.

Competition for resources is not necessarily between irrigation and rainfed farming, but between irrigating new land versus supplying existing developed land. Great care must be taken in the planning stages to avoid mistakes since water has such a high opportunity cost. Applied research of scientific and social factors affecting irrigation (such as plant/water/soil interactions and farmer water allocation patterns) should be a necessary prerequisite to planning for irrigation. Steps should be taken by donors to support schemes for giving the poorer farmer a larger share than what is traditionally considered "equitable" (i.e., a greater share than proportionate to amount of land owned).

Recurrent costs, which are largely local costs for operation and maintenance, have often been the most productive use of donor finances; however, donor support for O and M is "relatively rare." Table 2 (page 18) considers several aid options for O and M. The author supports greater aid for local financing and recurrent costs. He also advocates better design of O and M sections of an irrigation plan, including utilization of existing organizations versus establishment of new ones, development of manuals and maintenance workshops, provision of machinery and equipment, and financing such as water charges, land taxes, and sales or value-added taxes. He urges consideration of lower discount rates for projects, and increased support of drainage projects, small-scale irrigation, private irrigation development, groundwater development, and most importantly, modernization of

existing irrigation systems instead of building new, costly systems.

_____. "Neglect of O and M in Irrigation--The Need for New Sources and Forms of Support." Irrigation Development: Implications of Recent Experience for Aid Policy. Annex II. Paris: Organization for Economic Cooperation and Development, 1982.

The objective of this paper is to determine the validity and implications of the hypothesis that potential performance in the O and M phase of irrigation projects is not realized because of shortages of recurrent financial resources and neglect of O and M. It is asserted that inadequate O and M adversely impacts agricultural productivity, adds costs to the irrigation agency, leads to substandard working order, decreases yield, worsens social conditions, and negatively impacts projects in other sectors.

Because planning is an ex ante procedure, planners typically "expect the worst and plan for the best." Often, appraisals focus on technical, economic and financial aspects of a plan, but not on organizational, managerial, and operational aspects, and village-level analysis. Constant feedback of data from those in charge of O and M to project planners and more attention to lessons learned from past mistakes is needed. Problems cited are poor construction standards, unfinished projects, poor financing and training of personnel, failure of water rate collections to raise sufficient funds, corruption, and various problems unique to each irrigation management system. Solutions and future strategies include government consideration of devices related to extending credit on loans, (sub)sector lending with agreed O and M amounts, more input from aid donors in protecting O and M services, contract clauses making new investment contingent upon satisfactory O and M of original project, more careful planning of recurrent costs, external audits of the budgeting system, and assessments of farmer capability to pay for adequate O and M.

_____. Aid for the Development of Irrigation. Report on the Development Assistance Committee Workshop on "Irrigation Assistance," Paris, September 29-30, 1982. Paris: Organization for Economic Cooperation and Development, 1983.

Carruthers, Ian and Clark, C. The Economics of Irrigation. Liverpool, United Kingdom: Liverpool University Press, 1983.

Centro de Estudios para el Desarrollo y la Participacion (CEDEP), Diagnostico Técnico-Económico de la Actividad Agropecuaria del Valle de Chancay-Lambayeque. Lima, Peru: CEDEP, 1984.

Chambers, Robert. In Search of a Water Revolution: Questions for Managing Canal Irrigation in the 1980's. Brighton: Institute of Development Studies, University of Sussex, 1980.

Irrigation Management: Ends, Means and Opportunities.

Paper for Workshop on Productivity and Equity in Irrigation Systems in India. Lucknow, India: Giri Institute of Development Studies, September 21-23, 1982.

Views differ about objectives and criteria for irrigation and irrigation management - between individuals, groups, disciplines, professionals and departments; according to whether one or several objectives and criteria are considered; according to who is meant to benefit; and according to where objectives and criteria are located on long causal chains. As a practical framework, five focal objectives and criteria are proposed: productivity, especially of water; equity, especially in its distribution; long-term stability, both environmental and through maintenance of works; carrying capacity (livelihood-intensity), reflecting the size of population supported at a decent and secure level; and well-being, including health, amenity, nutrition and psychological factors. Measures to optimize achievement of these objectives include decisions about the size and location of area to be irrigated; changes in farm size; the scheduling and delivery of water; choice of cropping system and crop zoning; the frequency with which different zones receive irrigation; the staggering of cultivation; and the spatial and temporal spread of cultivation rights. Bringing this repertoire to bear, there appear to be rather few serious conflicts between the objectives. Perhaps the main one is between productivity and equity where high transmission losses reduce the productivity of system water distributed to tailends, but this is often offset by the highly productive use of groundwater supplied by seepage losses. In contrast, complementarities are very strong, especially with redistribution of water from head to tail which can at once be more productive, more equitable, reduce waterlogging, support more livelihoods, and enhance well-being. Many constraints on optimizing are linked with who gains and who loses from current practices, and who would gain and who would lose from changes. Facing these questions, the approach of practical political economy seeks realistic opportunities by asking how all can gain, or how losers can be reconciled to their losses. Three major problems and opportunities are presented by, first, the professional training and incentives of irrigation managers, second, the search for ways in which headreach farmers can gain while receiving less water, and third, the purchase and distribution of land to landless and very small farmers at the time when irrigation comes. To proceed further, four next steps are proposed.

Chaudhary, Muhammed Ali. "Determination of Cost of Tubewell Water and Estimation of Economic Rent in Canal Irrigation." Pakistan Development Review, XVII (2) (1978): pp. 139-168.

Economic rent is defined in this paper as the "...residual of the value of surface irrigation at its market price..." and computed as the "...value of tubewell water cost less water rates..." Of the various types of irrigation systems in Pakistan, canal irrigation generates the highest economic rent. The author suggests that to remove economic rent, especially for segments of the irrigation system disadvantaged by canal position, water rates have to be revised in accordance with net income from crop production. Furthermore, to justify increases in water rates, the increments from revenue must be channeled to improvements in water delivery efficiency. Detailed estimates of selected irrigation systems in Pakistan are included in the paper.

Cheng, S.C., et al. A Study on Area's Agricultural Productivity for Farmers' Capability for Membership Fee for Irrigation Association. Chungli, Taiwan: Agricultural Engineering Research Center, 1980.

Farmers find the irrigation association membership fee a heavy burden because of low income, rather than because of the level of the fee. The study examines agricultural productivity and farmers' ability to pay the irrigation fee. It is argued that the government should continue to subsidize irrigation and try to increase agricultural productivity and farm families' revenue. In the long run, a soundly organized, self-governed irrigation association is desirable.

Chin, L.T. "Management, Operation and Maintenance of a Completed Project." Farm Water Management Seminar--Manila. Rome: Food and Agriculture Organization, 1972.

_____. "Irrigation Associations." Farm Water Management Seminar--Manila. Rome: Food and Agriculture Organization, 1972.

Clyma, W. and Ley, T.W. "Furrow Irrigation Practices in Northern Colorado." Water Use and Management Project. Vol. IV: Appendix C: Technical Articles by Egyptian and American Teams. Cairo and Ft. Collins, Colorado: September, 1980.

Clyma, W.; Lowdermilk, M.K.; and Lattimore, Dan. "On-Farm Water Management for Rural Development." Agricultural Engineering, (February, 1981).

This article outlines a three-phase water management development model that the authors have found, through field studies, increases food production and has significant positive effects on energy use and the environment in developing countries. The three phases are problem identification,

development and assessment of solutions, and implementation of solutions in a development program at the farm level.

An interdisciplinary team of specialists which includes agricultural engineers, agronomists, sociologists, and economists then applies this model so that a variety of factors and solutions are considered and evaluated. For example, in Pakistan the technologically best solution to the irrigation problems might have been to install concrete-lined watercourses to the farmers' fields, but economic conditions did not permit this. So, a program was developed to restore existing watercourses. This reaped many positive results, including for some a doubling of water supply, a steadier and more dependable supply, more land areas for farming, and improved yields. Indirect benefits included more efficient energy use in pumping water and less water logging and salinity.

Commonwealth Secretariat. Proceedings of Commonwealth Workshop on Irrigation Management. Hyderabad, India, 1978.

Effective water pricing will only be achieved with timely and reliable water supplies which are allocated fairly. High water charges were recommended to encourage efficiency, increase Government revenue, and as a means of taking the privileged users of irrigation.

Coward, E. Walter, Jr. "Institutional and Social Organizational Factors Affecting Irrigation: Their Application to a Specific Case." Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

This paper examines the institutional and organizational influences on water-use behavior. The author analyzes the nature of interaction between Philippine farmers and the administration and organization of three gravity irrigation systems by focusing on the role played by the government-employed ditch tenders. The nature of this interaction is analyzed by looking at three specific factors: 1) the scale of the interaction; 2) the form of the interaction; and 3) the content of the interaction.

The scope, form, and content of interaction between ditch tenders and water users shows a pattern of integration that is authoritarian, minimal in farmer participation and is coincidental with high levels of uncertainty and frustration. As long as the water user is inhibited from being more directly involved in water distribution decisions, the system will lack feedback information for improvement and development. Greater farmer participation is urged so that the system can be developed and improved in the areas of efficiency and equitable distribution. It is noted that frequent contact between the ditch tender and the water user places the ditch tender in the role as a potential source for the

farmers for information regarding technical innovations--a role the ditch tender is not now filling.

Irrigation and Agricultural Development in Asia.
Ithaca, N.Y.: Cornell University Press, 1980.

Coward, E. Walter and Ahmed, Badaruddin. "Bangladesh: A Case Study of a Successful Decentralized Village Irrigation Organization." Mimeo: Condensation of original paper. Ithaca, N.Y.: Cornell University, 1977.

The key to a successfully operated program of irrigation development and water distribution is an effective collaboration between local cooperative water users and government regulatory agencies. The following are significant aspects from the example of Comilla, Bangladesh which contribute toward its success:

The use of small-scale, village-based pump systems enable the local government and village level to exercise more control of O and M and water distribution.

Bangladesh's local government system operates a great deal at the thana (or country) level, enabling flexible collaboration. The Bangladesh Agricultural Development Corporation (BADC) allows for a good deal of variation, to enable villages to adapt their procedures to local needs. Three examples of this adaptability are taken from an example in Nabagram: 1) the village hired a water distributor, who was selected by village coop members each season; 2) the village coop set different rates for coop member users, non-coop village users and non-village water users. Since coop members attended weekly meetings and contributed labor, they received the lowest rate. Non-coop villagers contributed labor for irrigation system cleaning and repair, so received the next lowest rate. Non-villagers paid the highest rate since they contributed no time or labor; and 3) villagers hired their own mechanic instead of relying on the BADC mechanic. Although the cost was much higher, they preferred the local control and accountability this arrangement afforded.

The paper emphasized the importance of close collaboration between the local government agency (in this case BADC) and the village to ensure timely distribution of irrigated water. It also noted that irrigation management institutions are often not effective because they are too removed from the on-farm level.

Tables included rainfall patterns, landholdings and water use categories for payments.

Coward, E.W., Koppel, B. and Siy, R. Organization as a Strategy Resource in Irrigation Development. Report of Conference, East-West Center, Honolulu, Hawaii: Asian Institute of Management, 1982.

The conference reviewed the role of management and organization for water delivery, utilization and system maintenance. Existing irrigation users may provide a major area for investment to improve resource mobilization and improve returns, in preference to investment in new schemes.

Crespo, M. Costos de producción de arroz por tarea. Santiago, Republica Dominicana: 6 de Marzo de 1985.

Crosson, Pierre R., Ronald G. Cummings, and Kenneth D. Frederick, eds. Selected Water Management Issues in Latin American Agriculture. Baltimore, Maryland: The John Hopkins University Press, 1978.

This book addresses the questions of how current government policies in Latin America must change in order to meet the rising demand for water in addition to other questions concerning agriculture water management in Argentina, Colombia, Mexico and Peru.

Using the case-study approach, the authors deal with several of the more important emerging water issues, such as competition between agricultural and non-agricultural uses, pricing to encourage more efficient and equitable allocation, optimal uses for crop production and control of salinity, and the effectiveness of multipurpose flood-control projects.

Two principal responses to water management were identified: construction of additional control facilities or more efficient use of water in existing systems.

The authors challenge the traditional view-widely held in Latin America and elsewhere--that water is not like other economic resources and that therefore its management must be highly centralized, with economic criteria having little effect on its allocation. This traditional view has resulted in water management institutions which generally are rigid and slow to respond to changing technological, economic and social realities affecting water demand and supply.

In the case of Peru, the authors note a conflict between water laws, prescriptions of economists and real world management and division of resources by farmers. The law specifies full cost recovery, economist recommend special pricing schemes, and in practice, irrigated water is highly subsidized with fees bearing little relationship to the amount of water used. Neither laws, nor the recommendations of economist, seem to have taken into account important real world factors such as the seasonal nature

of rainfall or the many political, social and cultural practices of water users.

Cruz, M.C.; Briones, N.D.; and Mufschmidt, M.N. "Water Resources Management in Asia: A Selective Bibliography with Introduction Essays." Working Paper 505. Honolulu, Hawaii: East-West Center, 1984.

A comprehensive bibliography with annotations, covering many related issues in management, pricing and resource use in irrigation.

Cruz, M.C. and Siy, R. "Issues in Irrigation Water Management in the Philippines." Agricultural Policy Working Group Mini-Workshop on Rice Policy. Los Baños, Philippines: University of the Philippines, January 3-4, 1985.

de Jesus, Ed C. Bureaucratic Reorientation at the National Irrigation Administration: A Philippine Case Study. Manila, Philippines: Asian Institute of Management, 1982.

This document is a case study on the NIA communal project done recently by de Jesus of the Asian Institute of Management. Its focus is not on the work of the famous Community Organizers, but on the changes in attitude and policy within NIA which were necessary first to initiate the program and then to accommodate it.

The critical shift in NIA objectives from expansion of irrigated area to the development of functioning irrigation systems was reinforced by a presidential mandate to recover, partially, the costs of construction of new communal systems. Support at the center for an innovative approach involving farmer participation in design and construction had to be converted to support by regional and provincial NIA field offices. This involved both changing attitudes toward the new objectives and strategy through training courses and workshops, and also changing structures and procedures by which NIA operated. These changes included significant modifications in NIA planning, budgeting, and accounting procedures and changes in the criteria by which the performance of Provincial Irrigation Engineers is evaluated.

Not treated here is the critical role played throughout this process by the Communal Irrigation Committee, a group of engineers, anthropology planners, and management specialists who helped to chart the course taken, set the strategy, and develop the tools and mechanisms that allowed continuous monitoring of activities and which guided the unfolding of the entire effort.

de Los Reyes, R.P. Managing Communal Gravity Systems. Farmers Approaches and Implications for Program Planning. Manila, Philippines: Institute of Philippine Culture, 1980.

The study analyzes variations in communal system organization, approaches to management, and the water rights status for commercial irrigators groups.

"Managing Through Persuasion: Experiences in a Philippine Community Irrigation System." Paper prepared for the Joint International Conference of the Canadian Council for Southeast Asian Studies and the Institute of Southeast Asian Studies. Singapore: International Development Center, June 21-24, 1982.

This article analyzes the institutional aspects of existing irrigation systems in the Philippines and the organizational principles relating to managerial reform programs. Emphasis is placed on development and improvement of human support structures which increase irrigation efficiency and, in turn, increase yield per ha of riceland area. A strengthening of the indigenous organizational structures is seen as most effective in terms of water management. The major focus is on a specific community-managed system (HMT) in the province of Camarines Sur where management is by local farmers. Community systems comprise approximately 50 percent of irrigated cropland in the Philippines and 25 percent of irrigated land in Indonesia.

Examination of community systems reveals socio-organizational challenges such as: capacity to maintain facilities; equitable allocation of water among users; resolution of farmer conflict; and mobilization of resources for O and M. Specifically, system maintenance is critical as damage and deterioration caused by monsoons and high levels of humidity necessitate effective labor mobilization for maintenance. Farmers' perceptions of water use benefits affect motivation levels and reinforce importance of mobilizing both upstream and downstream users. Difficulty in securing farmer contributions and the need for social organization in resolving allocation disputes among farmers is also addressed.

Among findings of HMT mechanisms for O and M are:

(1) culture-specific mechanisms pertaining to those employed in mobilizing labor, cash resources and conflict resolution; and (2) cross-cultural "mini-unit" structures which disperse leadership geographically throughout the system. Social stratification within HMT serves to mobilize resources for system O and M, thereby reinforcing the author's assertion that the most effective forms of irrigation can be achieved once planners and implementors gain knowledge of existing social and cultural conditions.

- _____. "Stereotypes and Facts in Irrigation Management: Preliminary Findings from a Case Study of a Philippine Communal Gravity System." In Irrigation Policy and Management in Southeast Asia (Ed.). Los Baños, Philippines: The International Rice Research Institute, 1978.
- Direction General de Agua Suelos e Irrigaciones (DGASI), Estudio de Tarifas de Agua Proyecto Tinajones. Lima, Peru: DGASI, 1982.
- Directorate General of Water Resources Development, Ministry of Public Works. General Information on Irrigation Operation and Maintenance Activities in Indonesia. Jakarta, Indonesia, July 1984.
- Directorate General of Water Resources Development, Ministry of Public Works. "Kaliprogo Irrigation Project Yogyakarta." nd
- Doherty, Victor S.; Miranda, S.M.; and Kampen, J. Social Organization and Small Watershed Development. Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 1981.

This paper discusses the findings of a multidisciplinary investigation potential for cooperation by small groups of farmers in semi-arid tropical southern India. This investigation was undertaken as part of an overall assessment of the prospects for the development of small agricultural watersheds in the region.

Two types of cooperative behavior amongst the farmers are identified by the authors: 1) rule-based behavior, which is predominantly passive, can persist over the long term, and can be carried out by individuals, small groups, or large groups alike; and 2) decision-based behavior, which is situational, requires management judgments, and can be carried out effectively only by individuals or small groups formed only for the short-term, decision-making task at hand.

The authors found that the system of cooperation followed by farmers who share rights to wells is rule-based, and that decision-based interaction was excluded by custom. They then conclude that the farmers would prefer small sources of irrigation water--such as runoff collection points on small watersheds--to be individually owned unless simple rules for the distribution of water could be enacted. The farmers' aim is to minimize interaction and common decision-making among owners.

- Doppler, W. "Determining and Levying of Water Charges on Irrigation Schemes." Workshop on Choices in Irrigation Management, University of Kent, 1976.

Towards a General Guideline of Irrigation Water Policy.
Agricultural Administration. No. 4, 1978.

A phased approach to developing water charge would initially use indirect charges with close attention to administrative control to encourage adoption. The second stage would combine a basic charge and water pricing as farmers gain experience. In most developing countries equilibrium price based charges should be used in conjunction with basic charges. This approach would encompass a number of objectives and by orientation to the farm reduce risks of project failure.

Duane, Paul. A Policy Framework for Irrigation Water Charges. Staff Working Paper No. 218. Washington, D.C.: The World Bank, 1975.

The Bank's policy has been to require a recovery of at least the public sector's O and M costs, and up to 100 percent of all direct public costs of any irrigation project, with revenues and costs in future years suitably discounted and adjusted for general inflation and with costs measured at domestic market prices. In practice, negotiated recovery rates in Bank projects have indeed exceeded O and M costs, but have fallen well short of total costs. According to a survey of 17 Bank irrigation projects, anticipated recoveries averaged only 30 percent of total costs. The policy has therefore allowed wide discretion in setting the level of charges, at least in relation to public costs. Justifications of proposed charges have referred mainly to the need to help users, especially the poorer ones and, occasionally, the need to preserve user incentives. Unfortunately, the absence of a sound framework for incorporating distributional and other objectives into the assessment of charges has led to rather simplistic and vague rules for setting their level; and these rules may have contributed to the poor record of estimated recoveries. This paper is intended to assist decisions on cost recovery by providing an appropriate framework for determining the desirable means and degree of cost recovery.

Recommendations for improved cost recovery are through efficiency pricing and through discriminatory benefit taxes, for example, a land betterment tax. The betterment tax should accurately reflect size of the potential rent. The requirements necessary for instituting market prices for water are: measured deliveries; auctioning of water to highest bidders; blocs of buyers; and capability to deliver water to buyers and withhold it from non-buyers. The desirable characteristics for any cost recovery instrument include: 1) capacity to discriminate between water users and non-users; 2) ability to guide efficient allocation of resources; 3) at least one instrument with the capacity for progressive rates; and 4) fair rates in the sense that they are linked to service provided in terms of timing and amounts of water delivery. The author clarifies that market clearing prices for water would have no relation to accounting

costs such as O and M; use of crop rates could distort cropping patterns and there is no opportunity to apply progressivity; and indirect production taxes may cause resource misallocation if they discourage use of taxed factors.

Easter, K. William. Capturing the Economic Surplus Created by Irrigation. Staff Paper P80-114. St. Paul: University of Minnesota, Department of Agriculture and Applied Economics, 1980.

The economic basis for determining water charges will vary with project type and objectives. To better capture a share of the economic rent through water charges, planners should be flexible at project design stage, so the project can accommodate different allocation procedures and water charges. Flexible fees and price rationing may improve efficiency, and allow fee increases with inflation, with less farmer protest than attempts to alter a fixed fee system.

_____. "Neglected Opportunities in Irrigation." Economic and Political Weekly, IX (14) (April 6, 1974); pp. 557-64.

This article discusses two different kinds of programs in Eastern India designed to improve water use and management by installing field channels in order to give farmers better control over the water in each field. The two programs represent the two ends of the cost spectrum, one being capital intensive and costly and the other involving the introduction of a simple system of village field channels at minimum cost.

The article reports on the internal rates of return from these projects and highlights the importance of technically trained people and alternative project designs in making the project viable. The author concludes that new institutional arrangements are necessary within the villages for the maintenance of the new irrigation systems, and also finds that improved means of water allocation are needed.

The author advocates pricing water on the basis of the volume used--perhaps measured at the village level rather than at individual farms--plus better policing of actual water use, as means for improving the efficiency of on-farm water use. In addition, for the minimum cost projects, farmers should pay the full cost of installing the simple small unlined channels because their increased returns cover costs in the first year.

Easter, K. William and Ellingson, D. A Review and Bibliography of Studies Regarding Irrigation Institutions, Management and Investment in Asia. St. Paul, Minnesota: Department of Agricultural and Applied Economics, University of Minnesota, 1982.

Easter, K. W. and Martin, Lee R. Water Resource Problems in Developing Countries. Bulletin No. 3. St. Paul, Minnesota: University of Minnesota, Economic Center, July 1977.

This paper focuses on pricing, economic and management issues. Important issues were (a) the inefficiency of resource use for irrigation, (b) conflicts for scarce water use, particularly between irrigation and hydropower, (c) the increasing tradeoffs between agricultural and environmental issues, and d) effect of irrigation projects on already shared wealth distribution.

Easter, K. William and Welsch, Delane E. Socioeconomic Issues in Irrigation Development and Distribution. St. Paul, Minnesota: Department of Agricultural and Applied Economics, University of Minnesota, 1983.

In this article, the authors address the issue of the socioeconomic problems facing irrigation managers and how these problems impact upon overall failures in reaching expected levels and distribution of output and income. Three topics are examined: 1) water allocation procedures and policies; 2) institutional arrangements for irrigation management; and 3) irrigation investment alternatives. They summarize the findings of many earlier studies and then raise their own questions about key issues for the future.

Farmer participation in the form of users' organizations is discussed in the Institutional Arrangements for Irrigation Management portion of the article. The authors find in their survey of the literature that farmers' organizations clearly facilitate farmer cooperation in the areas of operations and maintenance, distribution, management, and sometimes even in the financing of the project. The key question left unanswered, however, is how to establish effective users' organizations to meet the project objectives and at the same time be adaptable to local conditions. Other areas of concern include the disparity in land ownership and the underlying local power structure and how these factors often determine who derives the benefits from the projects, and also the need for institutional changes in order to achieve the objectives of equity and efficiency. The authors believe more must be done to develop incentives, training programs and institutions which will make better use of management talent available among farmers.

The authors also briefly discuss water pricing in the section on institutional arrangements, noting how rules and procedures for water pricing affect both the distribution of water and benefits. Conflicts over the equitable distribution of water, efficiency of distribution, and means for meeting government objectives including cost recovery and influencing allocation are all influenced by water pricing policies.

- Echevarria, Jose Francisco Niño and Ramos, Alfonso Quiroz. Aplicación de un modelo de programación matemática para determinar el plan de cultivo en función del recurso agua en el subdistrito de riego regulado; Chancay-Lambayeque. Tesis, Ingeniero Agrícola, Lambayeque, Peru: Universidad Nacional Pedro Ruiz Gallo, 1984.
- El Kady, Mona; Clyma, Wayne; and Abu-Zeid, Mahmoud. "On-Farm Irrigation Practices in Mansouria District, Egypt." Water Use and Management Project. Vol. IV: Appendix C: Technical Articles by Egyptian and American Teams. Cairo and Fort Collins, Colorado: Colorado State University, September, 1980.
- Elumalai, G. Farmers' Organizations for Efficient Water Use in Irrigated Agriculture; A Case Study in Tamil Nadu. Workshop Paper. Madras, India: Madras Institute of Management, 1980.
- Espaillet A., L.S. and Melo A.H.M. "Funcion de Producción del Agua in Interacción con Nitrogeno en el Cultivo del Tomato Industrial (lycopersicum sculentum): Azua, Republica Dominicana." Thesis No. 21 papa Ingeniero Agronomico, Santo Domingo, Republica Dominicana, Facultad de Ciencias Agronomicas y Veterinarias, Universidad Autonoma de Santo Domingo, 1984.
- Estudio: "Establecimiento de Tasas de Utilización de Agua y Cargas por este Concepto en el Distrito de Riego Chili." Lima, Peru: Ministerio de Agricultura, 1983.
- Evangelista, D.L.; Faigmane, M.M.; and Torres, R.D., "The Economics of Groundwater Irrigation". Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

The Philippine government, in an attempt to increase crop production, has distributed thousands of pumps to tap the country's groundwater resources. The authors conducted a survey to determine the effects of this distribution, especially on the pumps' performance and their effects on farmer economic status. Surveys were conducted in the Batangas and Quezon provinces; the sample consisted of 52 pumps serving 65 farms. Results were tabulated on farm characteristics, cropping patterns, pump characteristics, pump investment, pump performance, costs and returns for pump irrigated rice fields, reasons given for irrigation charges, satisfaction of irrigation charges, and problems regarding pump use.

Flexible arrangements in water distribution resulted in a strong spirit of cooperation, since each farmer was guaranteed enough water to meet their farm needs. Although the survey revealed that there was no sound or systematic basis for charging irrigation fees, most of the pump users seemed content with the fee arrangements. However, the authors believe that, since

farmers are so dependent on pumps for their irrigation needs, they do not want to protest the fees. Problem areas cited included lack of cash for pump repairs (aggravated by difficulty in securing spare parts), lack of skilled mechanics to repair pumps, and (less frequently cited) poor quality of repair services.

Farmers' Participation in Tank Irrigation Management. Vol. I.
Bangalore, India: Indian Institute of Management, February 1982.

This paper is a feasibility study for the establishment of farmer organizations in tank irrigated areas of Karnataka. Current practice is for the farmers to maintain their own channels below the outlet and maintenance is often unsatisfactory.

From questionnaires administered to farmers and officials, it was found that water distribution was decided by the Taluk Tank Irrigation Committee, but below the outlet farmers were responsible for distribution. Farmers also maintained field channels, although they expected the government to maintain the main channel. Communication between Department officials and farmers was not good and interactions were mainly through the soudi (operator) and the Maistry (engineer) who were Irrigation Department officials. They were generally well perceived by the farmers and they had no conflicts with the farmers. There was conflict between farmers over water distribution. Resolution was generally by villagers themselves though sometimes officials were called in for mediation.

Water rates were levied in some areas and collected by the village accountant. A wide divergence of opinion existed among farmers about the level of the charge and their willingness to participate in O and M on an organized basis. Maintenance of the physical structure was important to the farmers and they expressed willingness to participate if the government assisted in maintenance. Since rotational water distribution was needed to ensure greater equity, greater farmer participation would be required for new tank schemes. The study concluded that establishment of farmers' organizations was feasible for water distribution and conflict management and for maintaining the system below the outlets. However, the presence of the government in the form of the soudi was necessary for effective functioning of the organization.

Fell, A.M. "An Overview of Irrigation Strategy and Results in the Sahel." In Aid for the Development of Irrigation. Edited by Ian Carruthers. Paris, France: Organization for Economic Cooperation and Development, 1983.

Finney, C.E. "Least-Cost Analysis of the O and M Problem." Water Resources Development. Vol. 2, No. 1. 1984.

Inadequate O and M are analyzed in terms of shortages in public funds and foreign exchange. The author suggests use of varying discount rates for different expenditures in a project to better account for opportunity costs. If O and M costs are valued at higher opportunity costs than construction, the result is likely to be a higher, but perhaps more appropriate net present cost than using a single discount rate for the whole project.

Food and Agriculture Organization (FAO) and United Nations Development Program (UNDP). Estudio para el mejoramiento de los Sistemas de Riego Existentes: Republica Dominicana: Resultados y Recomendaciones del proyecto: Informe Técnico AG: DP/DOM/81/012. Prepared for the Government of the Dominican Republic. Rome: FAO and UNDP, 1984.

Frias, M.C. Metodologia EMESIRE. Informe Técnico No. 1, preparando para el Gobierno de la Republica Dominicana: AG: DP/DOM/81/012. Rome: FAO and UNDP, 1984.

_____. Resultados-Diagnostica-Jerarquización de los Proyectos. Informe Técnico No. 2, preparado para el Gobierno de la Republica Dominicana: AG: DO/DOM/81/012. Rome: FAO and UNDP, 1984.

The Gadjah Mada University Team. Executive Summary: Study of Regional Capability to Finance the O and M Costs for Irrigation Systems in the Prosida Projects in the Pemali-Comal Area, Central Java and in the Bantimurung and Lanrae Project Areas, South Sulawesi. Gadjah Mada University: May 1982.

Gardner, B. Delworth; Coppock, R.H.; Lynn, C.D.; Rains, D.W.; Loomis, R.S.; and Snyder, J.H. Background Paper No. 1 for Conference on Competition for California's Water: Alternative Resolutions Agriculture. Draft, October 17, 1981.

Geller, Sheldon. Planning, Management, and Participatory Development Issues in Irrigation Projects: A Selected Annotated Bibliography. Prepared for the Club du Sahel/CILSS, 1981.

Gomex Teofilo. Organización de Usuarios/Reunión con German Pichardo. (Mimeo of an interview concerning organizational history of users on the new INDRHI canals). Santo Domingo: INDRHI Central Files, 1985.

Gustafson, Eric W., and Reidinger, R.B. "Delivery of Canal Water in North India and West Pakistan." Economic and Political Weekly, VI (52) 1971, pp. 157-62.

In most of the canal systems in north India and west Pakistan, the principal problem affecting water delivery is the lack of predictability, certainty, and controllability of canal water supplies. The practice of water trading and sale is viewed as a way in which water deliveries can be controlled, especially if a water users' association is organized to negotiate with government agencies or with large landowners.

Hafid, Anwar; and Hayami, Y. "Mobilising Local Resources for Irrigation Development: The Subsidy Case of Indonesia." In Irrigation Policy and the Management of Irrigation Systems in South-East Asia, edited by Taylor, D.C. and Wickham, T.H. ADC, Bangkok, Thailand: 1979.

With adequate local leadership and attention to technical detail, government subsidy to mobilize local, low opportunity cost labor resources for irrigation rehabilitation produced high rates of return. A similar study in the Philippines showed similar results, with a relatively greater share of benefits to farm laborers than owners.

Hagan, Robert M.; Houston, C.E.; and Allison, S.V. Successful Irrigation. Rome, Italy: Food and Agriculture Organization, 1968.

This general discussion of irrigation includes the issues of financing and repayment, organization, operation and maintenance and appropriate water use management. The authors state that charges for water service should be established on a basis which will encourage the undertaking of irrigated farming in new projects and also discourage the misuse of water. Also, repayment of project costs can be realized by special taxes on the lands benefitted and by charges for the use of water, power, and other services. The authors also believe that the organization, operation and maintenance of irrigation projects are as important to their success as are the original design and construction, and that experiences with irrigation enterprises throughout the world suggest that local control of final water distribution is often desirable. But, the selection of the method and necessary preparations should not be left to the farmer.

Hancock, Karl; Anderson, Craig; Daines, Samuel; Buttars, Randle; and Daines, David. Small Farm Irrigation Improvement in Salcedo Ecuador: Technical, Economic and Institutional Feasibility. Quito, Ecuador: US Agency for International Development, 1980.

Hartshorn, G., et al. Dominican Republic Country Environmental Profile. AID Contract AID/SOD/PDC-C-0247. McLean, VA: JRB Associates, July 1981.

Holloran, Susan; Corey, G.L.; and Mahoney, T. Sederhana: Indonesia Small-Scale Irrigation. AID Project Impact Evaluation Report No. 29. Washington, D.C.: US Agency for International Development, 1982.

Hondale, George. Farmer Organization for Irrigation Water Management: Organization, Design and Implementation in Bula and Libmanan. A Report to the USAID and the Bicol River Basin Development Program. Washington, D.C.: Development Alternatives, Inc., 1978.

Hotes, Frederick L. "World Bank Irrigation Experience." Prepared for DAC/OECD Meeting, September 29-30, 1982, on Lessons of AID-Financed Agricultural Water Projects. Washington, D.C.: The World Bank, 1982.

The costly nature of irrigation projects suggests that better preparation should be undertaken to adequately plan project costs, management and O and M. Cost recovery on World Bank project varies greatly, and the fiscal viability of both Government and farmer need to be better assessed.

_____. "The Experience of the World Bank," In Aid for the Development of Irrigation. Edited by Ian Carruthers. Paris, France: Organization for Cooperation and Development, 1983.

Howes, Mick. Alternative Approaches to Small-Scale Irrigation: The Implications for Production Distribution and Social Organization. Brighton, England: Institute of Development Studies, University of Sussex, 1981.

Howitt, R.E. "Agricultural Water Pricing is a Means to Water Conservation." Paper presented to Agriculture Water Conservation Conference, University of California, 1976.

Hunt, Robert C. and Hunt, Eva. "Canal Irrigation and Local Social Organization." Current Anthropology, XVII (3) 1976: pp. 389-411.

Hunt, R.C. "The Local Social Organization of Immigration System Policy--Implications of its Relationship to Production and Distribution." Brandeis University for US Agency for International Development, 1978.

The paper analyzes relationships between social, production and distributional organization of irrigation systems in a number of Asian country studies. Adjusting organizational and financial procedures may improve productivity and distribution of benefits and costs.

Huszar, Paul C., Radosevich, G.E.; Skogerboe, G.V., and Vlachos, E.C. "Consolidation of Irrigation Systems: Phase II Engineering, Economic, Legal, and Sociological Requirements." Washington, DC: US Department of the Interior, 1980.

Idrus, Rachmatiah, Ohorella, M.G.; Kristanto, K.; Wattimena, R.A.; Nazaruddin, L.; Ruru, F.H.; Lihawa, T.; Ukkas, M.Y.; and Linggojwo. Impact Evaluation of Bone-Bone Irrigation System in Luwu, South Sulawesi, Indonesia. Husanuddin University, 1981.

This study explored the impact of the rehabilitated Bone-Bone irrigation system on the production, productivity, income and employment of farmers affected by the system. The study examined a village before and after irrigation and then compared this same village to a non-irrigated village.

The authors found that the effects of irrigation create such an abundance in yield that a labor shortage results on the farms. Irrigation also generated many off-farm jobs but the labor shortage during harvest time prevented farmers from benefitting from these jobs. Human and animal labor, chemical inputs and land taxes increased faster than increased in gross farm income. As a result, farmers' incomes are distributed to a greater extent among village cooperative groups, hired labor, livestock owners and government revenue.

Based on these observations the author made five recommendations for more effective irrigation systems: 1) Relieve farmers from losses due to pests by reducing pesticide cost; 2) Reduce labor cost through uniform planting times; 3) create water user organizations to control water management; 4) Provide facilities for reducing post harvest losses; and 5) Provide selective mechanization in farming and increased animal labor.

Indonesia--Second, Third and Fourth Irrigation Rehabilitation Projects (Credits 195, 220 and 289-IND) Project Performance Audit Report, #3269. Prepared by Operations Evaluation Department. Washington, D.C.: The World Bank, December 31, 1980.

Instituto Nacional de Recursos Hidráulicos (INDRHI). "Analysis Tarifa de Agua del Año 1985." Santiago: INDRHI Irrigation District Files, 1983.

_____. "Cuadro Sinóptico de los Porcentajes de Inversión de las Zonas con Relación a los Distritos de Riego en el año 1984. Santo Domingo: INDRHI Central Files, 1985.

_____. "Determinación de factor de Pago por zona para Usuarios." Santo Domingo: INDRHI Central Files, 1985.

- _____. "Estadísticas de Distribución de Usuarios por Zonas." Santo Domingo: INDRHI Central Files, 1985.
- _____. "Recaudaciones por Concepto de Tarifas de Aguas Recibidas por los de Riego en al año 1984." Santo Domingo: INDRHI Central Files, 1985.
- _____. "Recaudaciones por Concepto de Usuarios en el Periodo 1966-84." Santo Domingo: INDRHI Central Files, 1985.
- _____. "Recaudaciones por zonas en 1980, 1981, 1982, 1983, 1984, and 1985." Santiago: INDRHI Irrigation District Files, 1985.
- _____. "Registro Asignaciones RD al Distrito/mes-1980-1985." Santiago: INDRHI Irrigation District Files, 1983.
- _____. "Relacion de los Deudos de los Usuarios de los Distritos y Zonas de Riego por Concepto del Uso de las Aguas Publicas." Santo Domingo: INDRHI Central Files, 1985.
- _____. "Resumen de Entrevistas Realizadas a Usuarios de Agua." (Mimeo results of a survey of Water User in Santiago Zone). Santo Domingo: INDRHI Central Files, 1985.
- _____. "Resumen Presupuesto 1984 por Objetos." Santiago, Dominican Republic: INDRHI Irrigation District Files, 1985. (Mimeo.)
- _____. "Resumen Proyecto de Presupuesto de operacion, mantenimiento y administracion para el año 1985." Santiago: INDRHI Irrigation District Files, 1983.
- Inter-American Development Bank. "Dominican Republic Reformulation of Loan 570/SF-DR." Mimeo Document PR-915-Z. Memo to Board of Directors from the Secretary. Washington, DC: Inter-American Development Bank, 26 July 1984.
- International Commission on Irrigation and Drainage. Specificities of the Moroccan Hydroagricultural Equipment. 30th Executive Council, May 1979.
- International Rice Research Institute. "Irrigation Policy and Management in Southeast Asia. Los Baños, Philippines: International Rice Research Institute, 1978.
- Institutional Framework for Improved On-Farm Water Management in Pakistan. Special Technical Report for the US Agency for International Development Mission to Pakistan. Fort Collins, Colorado: Colorado State University, January 1976.

The report defines some of the major irrigation water management problems in Pakistan and the technologies for correcting them, providing a strong basis for undertaking a program of improved on-farm water management even though there is still a need for additional field data to further identify and define problems. The most important components of a water management program for Pakistan are: 1) watercourse rehabilitation; 2) precision land leveling; 3) small tubewells; 4) effective agricultural and water management technical assistance and extension; and 5) development of local institutions to insure the effectiveness of the program. The more difficult problems are to define the appropriate processes for implementing such technologies.

One recommendation is to promote institutional development at three levels: 1) at the farm level by creating water user associations; 2) at the government agency level; and 3) at the legal regulatory level. Currently, Pakistan has no user associations and the first steps must be to introduce the concepts, use a bottom-up approach that will foster initiative among farmers, and provide them with incentives for improved water use by arranging for loans, giving technical assistance, etc. A Water Management Advisory Service is needed for liaison between farmer groups and government agencies, whose role must be to facilitate the development of associations by giving help in water allocation and management (especially in technical aspects), and by providing training.

Irrigation Assistance to Developing Countries Should Require Stronger Commitments to Operation and Maintenance. Washington, D.C.: US General Accounting Office, 1983.

The report outlines the rapid deterioration of many donor funded irrigation systems in Indonesia, Sri Lanka and Thailand, primarily because there is a shortage of funds for regular O and M (recurrent costs). This results in most developing country systems operating at less than 50 percent efficiency which reduces acreage and yields and enhances tension among farmers. Often early rehabilitation of systems becomes necessary and is done at tremendous expense. An example is the Luwu Project in Indonesia where routine maintenance was so poor that canals were eroded even though they were only constructed in 1979. The failure of each of the three countries to fully meet O and M funding expectations is detailed. In Indonesia, O and M needs greatly exceed government allocations and delivery of subsidies. Monitoring is also difficult because there are no consolidated figures for funds used in O and M. Eleven different government agencies are involved in funding and there is no single source of accountability.

The report recommends that AID: 1) require a recurrent cost plan that identifies operation and maintenance requirements and funding sources for each project; 2) adopt stronger project design and construction criteria to reduce recurrent costs; and 3) require that water user associations be established before financing on-farm construction.

Irrigation Policy and Management in Southeast Asia. Los Baños, Philippines: The International Rice Research Institute, 1978.

Irrigation Water Management: Report of a Planning Workshop. Los Baños, Philippines: The International Rice Research Institute, 1980.

Isles, Carlos and Collado, Manuel L. "Farmer Participation in Communal Irrigation Development: Lessons from Laur." MS prepared for publication in Philippine Agricultural Engineering Journal, nd.

Jayaraman, Pushpa and Jayaraman, Tiru K. "Attitudes of the Irrigation Bureaucracy in India to Scientific Water Management Tasks in Irrigated Agriculture: A Case Study from Gujarat State, India," Quarterly Journal of International Agriculture, XX (3) July - September, 1981: pp. 279-392.

The purpose of this paper is to analyze the attitudes of irrigation engineers in the Indian irrigation bureaucracy, and specifically these engineers' attitudes toward working in the area of water management/O and M versus working in the construction and designing wing of the irrigation department. In turn, the author looks at how these attitudes affect the current inadequacy in the discharge of water management functions. The study was based on two irrigation projects in Gujarat State involving 289 engineers.

In concluding that the engineers find work in the C and D wing of the irrigation bureaucracy to be far superior in both professional growth potential and in prestige than in the O and M wing, the authors argue that specific tasks must be undertaken to raise the status of O and M personnel and to engender in them a sense of self-esteem and commitment. One such specific task identified is to let O and M personnel see that problems encountered in O and M are challenging and interesting, and worthy of specialization and investigation. One problem mentioned is that of considering farmer participation in the O and M scheme.

Jayaraman, T.K. "A Case for Professionalization of Water Management in Irrigation Projects in India." Public Administration and Development, Vol. 1, 1981.

This paper addresses the lack of professionalism in the water management area of the Indian irrigation administration and the negative effects this has had on many irrigation projects, particularly in the delivery of water to farmers' lands in an adequate, timely, and reliable manner. The author suggests several ways that the self-esteem and sense of professionalism can be boosted among water management personnel.

Experimental rotational water supply (RWS) schemes have been welcomed by farmers. Irrigation and water management personnel have, in turn, responded positively to the farmers' reactions to RWS. This mutual confidence between irrigation personnel and farmers leads to an atmosphere that is favorable for the development of new institutions such as farmers' organizations designed to help regulate supplies below the outlets, to solve disputes among irrigators, and to monitor field channels and drains.

_____. "Farmers' Organizations in Surface Irrigation Projects: Two Empirical Studies for Gujarat." Economic and Political Weekly, XVI (89): pp. A89-A98.

Two empirical case studies from Gujarat state demonstrate the following conditions for successful farmer group-operated irrigation: certainties of water supply, relatively egalitarian community structure based on size of land holding and leadership by a person or group with proven ability, and a commitment to egalitarianism. The organizational form in both cases was a central committee of a small number of farmers with delegated authority for limited functions such as maintenance of water courses and community assets and liaison with the irrigation bureaucracy. In one case, the organization had the power to collect fees in lieu of labor, and in the second, the organization collected fees towards labor charges. The simple organizational form of the committees was adequate for the limited functions assigned, but more extensive functions such as water allocation and distribution and conflict resolution would require more formal organizational structures.

_____. "Irrigators' Organizations for Better Water Management: A Case Study of Attitudes of Irrigators from Gujarat State, India," Agricultural Administration, X (1982): pp. 289-212.

_____. "Water Use Efficiency and Rotational Water Supply at the Farm Level: Certain Results from an Experimental Pilot Project in Gujarat State, India." Water Supply and Management, V (6) 1981: pp. 391-399.

This paper assesses the water use efficiency at a 0.5 million acres irrigation project in Gujarat State, India, where rotational water supply at the farm level is used. One of the conclusions drawn by the author is that greater water use efficiency would

result if farmers came forward on their own to maintain the watercourses (earthen field channels), because this would increase the conveyance efficiency and reduce water losses in transmission. The author also asserts, however, that farmers will only come forward to do this if they can be assured of the availability of water supplies at scheduled intervals in adequate quantities in a reliable manner.

Karuanayake, M.M. "Farmer organizations and irrigation leadership in Sri Lanka: Retrospect and Prospect." Marga, VI (1) (1980): pp. 1-17.

The article examines the experience of farmer organizations in Sri Lanka in farm management and raises issues that have practical implications for policy information. Special reference is made to the role of cultivation committees and of irrigation agents. The Mahaweli model of farmer groups is also examined. Special attention is paid to the role of local irrigation management. It is suggested that priority be given to setting up higher level authority to deal with problems of water allocation in major irrigation systems and in the Mahaweli scheme.

Kathpalia, G.N. "Improved Irrigation Systems Management." Paper presented at the International Seminar on Field Research Methodologies for Improved Irrigation Systems Management. Coimbatore, India: Tamil Nadu Agricultural University, 1981.

Three types of irrigation system management for water delivery from the main headworks to the farm are contrasted for a selected group of irrigation systems in India. The first type emphasizes the control of water at the head of the minor canal such as those in the Punjab, Harjana, Uttar Pradesh, and parts of Madhya Pradesh. In this system, water drainage is computed from field to field and dependent on type of crop grown. The second type of management is where government controls water distribution up to the outlet (chak) and thus water charges are computed in terms of volume of water received and size of irrigated area. The third type, where the government regulates water flow up to the distributing head of the main or branch canal, assesses water charges on the basis of area irrigated and type of crop grown. A brief review of these approaches is presented and some organizational solutions are discussed.

Keller, Jack; Smith, Bryant; Aitken, Percy; LeBaron, Allen; Meyer, Ray; Walter, Michael; and Wolf, James. Peru: Irrigation Development Options and Investment Strategies for the 1980s. USAID Water Management Synthesis II Project, Report No. 14. Logan, Utah: Utah State University, 1984.

Keller, Jack; Clyma, Wayne; Drosdoff, Mathew; Lowdermilk, Max K.; and Seckler, David. Irrigation Development Options and Investment Strategies for the 1980's. USAID Water Management Synthesis Project. Logan, Utah: Utah State University, 1980.

This summary report reviews the status of irrigation projects in India prior to 1980, describing the extent of irrigated hectares, relative utilization, objectives of the Government of India and USAID in developing irrigation projects and the obstacles or constraints to efficient and effective utilization of current and potential projects. The authors conclude that the primary cause of underutilization is due to inefficient management and estimate that efficiency could increase 25 percent via improved on-farm delivery systems. They observe that the political objective to provide irrigation resources equitably to all sectors and regions of the country has resulted in thinly spread resources--too many new projects have been started with insufficient resources to complete and fully utilize available water resources. The effective range of irrigated water use varies from 10 percent to 100 percent with private wells achieving highest effective utilization and major and medium projects averaging 50 percent utilization. The disappointing record of the CADAs (Command Area Development Authorities) is noted with support given to reorganization of the government agencies overseeing irrigation projects to provide improved coordination.

The authors note that incomplete utilization of surface water does not necessarily represent a net loss. Seepage helps to develop ground water reservoirs and fill aquifers which provide long term benefits to farmers by establishing efficient reserves for dry seasons, ensuring availability of water in drought years and enabling higher distribution efficiency through private tube wells.

It was observed that AID's policy of limiting support of irrigation projects to areas greater than 40 ha often excluded smallholders who sometimes lacked the technical and organizational capacity to deliver water to their fields. Credit and technical support to fully develop irrigated potential was identified as a potential solution rather than a change in AID policy.

Keller, Andrew A. "Unit Command Area Response to Water Delivery by the Main System." PhD Thesis, Logan, Utah: Utah State University, May 1984.

Kemper, W.D.; M. Haq; and A. Saeed. Farm Water Management in Upland Areas of Baluchistan. Water Management Technical Report No. 51. Fort Collins, Colorado: Colorado State University, 1979.

Compared to the Punjabi Canal, water losses are less in Baluchistan due to topographic and physical differences (soil type) and to the policy of charging higher water fees leading to more efficient water use. In spite of these, farmers in Baluchistan have been observed to over irrigate due to lack of farm gate control. For farmers with tubewells, overapplication of water is also high because of inadequate management (extension) and to the fixed monthly charge on electricity rather than on a volumetric method. The authors suggest radical changes in the program and the encouragement of local participation in decision making.

Korten, Frances F. Building National Capacity to Develop Water Users' Associations: Experience from the Philippines. World Bank Staff Working Paper No. 528. Washington, D.C.: The World Bank, 1982.

Over a five-year period the National Irrigation Administration (NIA) of the Philippines has been building its capacity to develop water users' associations for small scale irrigation systems. The NIA approach is to develop a water users' association prior to construction of the physical system and then to involve association members fully in the planning and construction of the system. Implementing this participatory approach has required a wide variety of changes in the agency's policies, procedures, and personnel to become an enabler rather than simply a provider of services.

Based on data acquired from pilot projects involving farmers in the preconstruction and construction process, the lessons learned for developing user associations were the following: 1) farmers developed a sense of ownership in the system and concern for O and M after construction; 2) farmers could contribute knowledge that helped system design and layout; 3) the NIA as the implementing agency realized the difficulties of integrating social and technical dimensions because of the conflicting goals and approaches of engineers and community organizers and lack of awareness of their reciprocal needs.

In the O and M stage, user associations provided for water allocation and system maintenance by hiring full-time water tenders who were responsible for opening and closing outlets and mobilized members for routine maintenance. Tenders resolved conflicts at the sector level and collected fees immediately after the harvest. The fees accounted to \$25/ha/year (150 kg) of unhusked rice--half for amortization costs and half for association expenses. The involvement of farmers in the stages of preconstruction study and construction increased the probability of good O and M later.

Kosters, M. Price Control Policy in the Dominican Republic. Santo Domingo: US Agency for International Development, 1984.

- Kuhns, J., et al. "Pre-Investment Project-Feasibility Study and Final Designs of the Area of Influence of the Sabona Yegua Dam." Mimeo Document PK-855-A. Washington, DC: Inter-American Development Bank, 5 December 1977.
- Larson, D.W. "The Effect of Price and Credit Policies on Dominican Republic Agriculture." Consultant Report (Mimeo). Santo Domingo: US Agency for International Development. September 1984.
- Leindo Gil, Nancy. "Marco Historico-Económico del Aprovechamiento del Agua de la Agricultura del Valle Viejo de Tacna." MA Thesis, Lima, Peru: Universidad Particular Ricardo Palma, 1976.
- Levine, Gilbert. "Perspectives on Integrating Findings from Research on Irrigation Systems in Southeast Asia." Teaching and Research Forum, (26) (1982): pp. 9-15.
- _____. "The Relationship of Design, Operation and Management." In Irrigation and Agricultural Development in Asia. Edited by E.W. Coward, Jr. Ithaca, N.Y.: Cornell University Press, 1980. Pp. 51-62.
- Levine, Gilbert and Hart, Henry C. Mobilizing Local Resources for Irrigation. Interpretive Summary of a Seminar by the Agricultural Development Council, Colombo, Sri Lanka, August 11-15, 1980. ADB Report No. 22, N.Y.: Agricultural Development Council, 1981.
- The seminar had three objectives: 1) to provide an opportunity for comparative evaluation of South and Southeast Asian experience in the management of irrigation systems; 2) to identify common problems and their solutions; and 3) to suggest areas for research relevant to government programs. Theme papers and reactions from participants are summarized in this report.
- The major propositions are divided into: 1) types of resources used in irrigation, mainly labor vs. capital resources; 2) amount of resources needed; 3) approaches used for mobilizing resources, especially communal labor; 4) administration and operation of large-scale irrigation systems; and 5) strategies used in the formation of water user organizations.
- Lowdermilk, Max K.; Early, Alan C.; and Freeman, David M. Farm Irrigation Constraints and Farmers' Responses: Comprehensive Field Survey in Pakistan. Water Management Technical Report No. 48-A. Volume I. Fort Collins, Colorado: September, 1978.
- McCawley, Peter. "Survey of Recent Developments." Bulletin of Indonesian Economic Studies, April 1985.

Margolis, Julius. "Welfare Criteria, Pricing and Decentralization of a Public Service." Quarterly Journal of Economics. LXXI (August 1957): pp. 448-463.

Medagama, Jaliya. "Some Observations on Farmer Involvement in the Village Irrigation Rehabilitation Project in Sri Lanka." Paper presented at Workshop on Organization as a Strategic Resource in Irrigation Development. Manila, Philippines: Asian Institute of Management, November 15-19, 1982.

This paper describes the extent to which farmers in the project area participated in the planning, construction, and implementation of the rehabilitation project. The various government institutions and farmer organizations are examined, with emphasis on the potential for liaison and closer cooperation among them. The author indicates that the technical and construction agencies failed to adequately tap the vast experience and knowledge of the farmers concerning effective water management. The government depended heavily on their technical advisors who used mainly mathematical calculations, rather than consulting the farmers at the preliminary, pre-construction, construction and O and M stages to ascertain feasible methods of achieving maximum cost recovery and increased irrigation benefits.

Although the farmers were comfortable in forming liaisons with some government institutions, they felt that their expertise and practical knowledge could have been sought to a greater extent, thereby increasing the number of beneficiaries and avoiding misuse of precious financial and human resources, and time.

Merrey, Douglas J. Irrigation and Honor: Cultural Impediments to the Improvement of Local Level Water Management in Punjab, Pakistan. Water Management Research Project in Pakistan, Pakistan Report No. 9. Fort Collins, Colorado: Colorado State University, nd

This study explores the reasons why many villages in Pakistan cannot successfully organize water users in order to make effective improvements in farm water management and maintain these improved watercourses. The author identifies a cultural phenomena known as izzat (honor, reputation) as the major cause of local level water management failure and then proposes three ways in which officials and farmers can work within Pakistan's culture toward successful farm water management.

A water management improvement project was examined in a small village dominated by a few powerful brotherhoods or clans known as biraderis. The government provided the supplies and technicians for the improvement project while the farmers in the biraderis provided the labor and, after construction, maintained the system. The system deteriorated and became ineffective for three major reasons: 1) upon completion of the project, farmers

illegally cut into the main branch near the headwaters, thus shortchanging those near the tail; 2) powerful biraderis sabotaged efforts to irrigate farmers other than themselves in order to gain more izzat in the eyes of the community; and 3) these biraderis did not wish to organize and cooperate because small farmers would gain izzat and cause them to lose power and influence in the community.

Other problems concerning izzat included land disputes, pressure placed on engineers by powerful biraderis and the superior attitude of many Western officials toward the villagers in this type of extension project.

The author concludes that this village's inability to organize and cooperate typifies many villages in Pakistan. The most successful efforts occur among small shareholders near the tail of the watercourse. These farmers perform the labor and maintenance themselves, unlike the larger landholders.

The author suggests three ways in which the project can provide for more effective water management. The project needs to provide: 1) legal mechanisms which facilitate the existence of water user organizations; 2) sufficient on-going rewards which make it desirable to organize and cooperate even after project completion; and 3) effective sanctions applied by external authority from local communities. Izzat thus becomes a positive factor in encouraging organization and cooperation and discouraging factionalism.

Millar, Agustin A. Proyecto Piloto de Administración, Operación y Mantenimiento de un Proyecto de Riego Yoque del Norte. (Proposed convenio IICA/INDRH for Bid financing under loan 570/SF-DR). Santo Domingo: IICA, December 1984.

Ministry of Agriculture and Irrigation. "Irrigation Rates and Betterment Levy--A Critical Study." New Delhi, India: Directorate of Statistics, Central Water Commission, Ministry of Agriculture and Irrigation, 1975.

Mirza, Ashfaq Hussain. A Study of Village Organizational Factors Affecting Water Management Decision Making in Pakistan. Water Management Technical Report No. 34. Fort Collins, Colorado: Colorado State University, 1975.

Montalvo, Modesto A.M. and Lluen, Carlos A.Q. "Optimización del Recurso Hídrico en el Proyecto Especial de Irrigación Tinajones a Través de la Aplicación de Modelos Matemáticos." Tesis, Ingeniero Agrícola, Labayaque, Peru: Universidad Nacional Pedro Ruiz Gallo, 1984.

Moorti, T.V. "A Comparative Study of Well Irrigation in Aligarh District, India." Cornell International Agricultural Development Bulletin 19, May 1971.

Moore, M.P. Approaches to Improving Water Management on Large-Scale Irrigation Schemes in Sri Lanka. Colombo, Sri Lanka: Agrarian Research and Training Institute, 1980.

_____. "The Management of Irrigation Systems in Sri Lanka: A Study in Practical Sociology." Sri Lanka Journal of Social Sciences. 22 pages, nd.

Murthy, Y. R. "Experiences of O and M of Some of Our Irrigation Systems." Proceeding O and M of Canal Systems, Vol. 1, New Delhi, India: 1980.

The paper assesses the need to increase the use of water charges based on volume.

Neghassi, Habte Mariam and Seagraves, James A. "Efficiency in the Use of Water for Irrigation: The Role of Prices and Regulations." Natural Resources Forum 3 (1978): pp. 53-72.

Efficiency in the use of water for irrigation is normally defined in a physical sense - engineering and agronomic; and it is often assumed that higher efficiency is desirable. However, in an economic sense, there is an optimum range in the level of physical efficiency. Normally it can be said that as water prices increase, it becomes more rational to increase physical efficiency by selecting and adopting improved methods of controlling, measuring and applying water, and to design systems of pricing and regulations that will promote optimal allocation and efficient use. However, the value of water is often extremely low, in which case there may be little economic incentive to improve physical efficiency unless forced by physical factors that affect production and productivity such as soil characteristics, water-logging or nutrient leaching.

The combination of regulations and prices that are used to allocate irrigation water reflect the conflicting goals of redistribution of income in favor of agriculture and needs to encourage efficient use of water. Regulations and pricing systems also depend on the value of water, the dependability of supplies, systems of delivery and the extent to which flows can be regulated.

Using examples and case studies, this paper discusses physical and economic efficiencies and their interrelationships. It emphasizes the role of pricing and regulations and provides general guidelines.

Nelson, G. and Taleston F. "Why Irrigation Projects May Become Educing Monuments to Failure." Focus, 1977.

Much of the widespread failure of irrigation projects may be attributable to imposition of complex management and charging to previously traditional economies with limited experience in cash transactions.

Ng, Ronald and Lethem, Frances. Monitoring Systems and Irrigation Management: An Experience from the Philippines. Washington, D.C.: The World Bank, 1982.

The study is an evaluation of the Upper Pampanga River Integrated Irrigation Project (UPRIIS) whose goals were to improve rice yields in the project area based on efficient irrigation water supply through the rotational method. Since this method required cooperation between farmers and officials and among farmers themselves, the organization of irrigator groups was given priority by the National Irrigation Administration (NIA) which also made available water management technicians to ensure technical efficiency. In order to make the system self-financing for O and M, water charges were established at the rate of 125 kg of paddy/ha and 175 kg of paddy/ha of wet and dry season harvest respectively. Fees based on quantities of paddy have the advantage of protection against inflation and price fluctuations.

Evaluation after five years showed that though farmers have joined irrigation groups, their functional performance is rudimentary and they have not helped officials improve water discipline. The targeted water charge collection rate of 85 percent has not been achieved. For the future, continued production increases will depend on strategies to improve water discipline and collection rates. This must be based on improved understanding of farmer motivation and behavior that can be used to strengthen the irrigation rates. This must be based on improved understanding of farmer motivation and behavior that can be used to strengthen the irrigation associations, for farmers must feel as if they are partners in the development process. Some ground has been lost because getting farmers accustomed to payment for irrigation at an early stage is crucial. As time passes they come to expect irrigation as a right and hence become less willing to pay.

NIA Corporate Planning Staff. The Agricultural Input Loan: Irrigation Study. Manila, Philippines: National Irrigation Administration, November 1984.

Nickerson, J.E. Irrigation Management in China: A Review of the Literature. World Bank, Staff Working Paper No. 545, Washington, D.C.: The World Bank, 1982.

A review of organization and management of irrigation in China. Case studies are used to develop some generally applicable hypotheses about specific aspects of management. The desirability of volumetric charging for water must be weighed against the additional costs, and do not reduce the need for good organizational management.

Nyberg, Albert J. and Prabowo, Dibyo. Status and Performance of Irrigation in Indonesia and the Prospects to 1990 and 2000. Rice Policies in Southeast Asia Project, 1982.

In this comprehensive analysis of Indonesia's irrigation system, one central conclusion is that lack of attention given to O and M of existing irrigation structures has had an overall detrimental effect on the system. The O and M of the entire canal system has not developed well enough to assure that capital invested in the canals will return projected benefits, and greater emphasis should be placed on routine maintenance activities to avoid or delay the need for rehabilitation. The current need for rehabilitation of the canals is greater than it should be due to inadequate O and M and initial rehabilitation activities.

The authors conclude that although the economic benefits of appropriate O and M and the effects of water users associations on the O and M management infrastructure are difficult to measure, they nonetheless probably have higher economic payoffs than any other form of investment. In order to consolidate the gains from irrigation investment, it is imperative that water management, organization, operation and maintenance become effective.

Oficina Nacional de Estadísticas (ONE), VII Censo Nacional agropecuario 1981: Cifros Preliminaris. Santo Domingo: Oficina Nacional de Estadísticas, July 1983.

Ortiz, A. Incentives and Comparative Advantages to the Dominican Republic Dairy Industry. Published MS Thesis. Columbus, Ohio: Ohio State University, 1983.

Ongkingco, P.S. "Organization and Operation of 15 Communal Irrigation Systems in the Philippines." Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

Overseas Development Institute. "Introduction to Discussion of Water Rates." IMN Network Paper No. 10F, 001. London, England: Overseas Development Institute, 1984.

Discussion and comments on cost recovery in relation to water pricing and organizational structures.

_____. "Developing the Role of Farmers Associations in Sri Lanka and Northern Thailand." Case studies by Widaranpathirana, A.S., Jayawardere, J., and Kathpalia, G.N., IMN Network Paper No. 8, 001, London, England: Overseas Development Institute, 1983.

These case studies provide the basis for a discussion on the development of farmers groups and their effect on improving water management, O and M, and cost recovery. Where groups have operated successfully, benefits have accrued to both the irrigation system and community.

Ozal, Korkut. The Problem of Repayment. Ankara: Middle East Technical University, 1964.

Pant, Niranjana. Some Aspects of Irrigation Administration (A Case Study of Kosi Project). Calcutta, India: Arunima-Print Works, 1983.

_____. "Utilization of Canal Water Below Outlet in Kosi Irrigation Project: Administrative and Community-Level Solutions." Economic and Political Weekly. (September, 1981): pp. 78-88.

Pant, Niranjana and Verma, R.K. Farmers' Organization and Irrigation Management. New Delhi, India: Ashish Publishing House, 1983.

This article discusses the formation of cooperative user's irrigation societies, known as a chaks, and their effects in the Sone Command region of India. The authors examine the structure, characteristics, and composition of chak societies and analyze the role these societies play in the areas of local farmer participation, water distribution and repair and maintenance of irrigation infrastructure, conflict resolution, social justice, and interaction with the government and other institutions. They then evaluate the utility of these chak societies in terms of productivity and socioeconomic groupings of the beneficiaries. Three specific chak societies are used as case studies in this evaluation.

The authors explain that the ultimate goal of the chak is that it "...may be of help in the maximum utilization of irrigation potential..." Several purposes of the chak are identified: 1) to maintain common irrigation and drainage works; 2) to own or hire appliances, water pumps, and plants; 3) to maintain the irrigation structures; and 4) to regulate and supervise the supply of water and its fair distribution. The capital for the formation of these societies was raised by share payments made by the local landowners/farmers becoming members.

The authors conclude that chaks have been effective in irrigation management as well as in the areas of O and M, distribution of water and conflict resolution at the local level. The evaluation also finds increased productivity in terms of yield and intensity of cropping in chak areas as compared to areas outside of the chaks. The authors state that "...as regard(s) the utilization of these organizations in the effective implementation of various policy decisions, there is hardly any doubt about their ability." They also conclude that in two of the three chak societies examined, sections of the village also received some benefits, despite the fact that benefits resulting from the chak generally went to the dominant sections of the villages.

Pazos, I. and Reynoso, G. "Situación del Riego en Republica Dominicana." Documents B-5 presented at VII Seminario Latinoamericano de Irrigación, Santiago de Chile, 28 November-2 December 1983.

Peterson, Dean F. "Systems and Technology for Improved Irrigation Water Management." Adapted from a paper prepared for Agricultural and Rural Development Training Workshop, Washington, D.C., June 18-22, 1984.

This paper is concerned with the goals and objectives of irrigation water management. The author identifies human well-being as the overriding goal, and then incorporates this generalized goal into the discipline of irrigation management by stating that the one purpose uniquely served by an irrigation system is to increase production by enhancing the water available for crops.

The author then proceeds to analyze the irrigation water management systems, in part by addressing what he identifies as five "system management considerations": 1) the total system; 2) the farmer as the ultimate manager; 3) the type of system; 4) design and development limitations; and 5) improving management on constrained systems. He views the farmer as the ultimate manager because the farmer, and not the salaried bureaucrat, makes the ultimate production decisions and takes the risks. The author asserts that all functions of the irrigation system should be focused toward the objective of improving the farmer's production environment. Means of improvement include the need for reliable irrigation supplies, enhancement of the farmer's technical and economic information base, and addressing the farmers' perceptions of their production environment.

Peterson, Dean F.; Walker, James L.; and Coward, E. Walter.
Evaluation of the On-Farm Water Management Research Project.
Prepared for US Agency for International Development. Fort Collins, Colorado: Colorado State University, September, 1979.

This report is focused on the improvements in water management of existing irrigation systems in Pakistan and evaluating the success of the 10+ year Colorado State University (CSU) irrigation project in Pakistan in comparison to other centrally-funded research projects.

The authors conclude that the major project achievement was maintenance of project focus over a ten year period and the success of the interdisciplinary approach employed by the project team. They attribute these successes to: the essential design of the project and the focus on on-farm water management; the emphasis on field work together with a flexible work plan which allowed the project to respond to real world problems rather than rely on pre-planned work plan; the conceptualization of the water course as a dynamic unit; the interdisciplinary approach employed by the CSU team; and the recruitment of staff who possessed not only excellent technical skills, but also the requisite attitudinal and interpersonal skills to successfully integrate the various project goals.

The team determined that full farmer participation was essential to project success, with farmers willing to contribute not only labor, but also some financing. Although the project was not focused on institutional and human resource development, training and development of institutional capacities were essential parts of each step in the process. The multiple-contact strategy employed, which required the team to interact with various government ministries and organizations, was deemed to be a success in that it: maintained an active overall strategy, avoiding the usual lulls; eliminated dependence on the project team by individual institutions; and allowed for more facets of irrigation management problems to regularly appear as agenda items on the various institutions involved.

Modification of current Pakistani law was suggested if water user associations were to be granted meaningful legal rights. Little action has been taken on this front with the result of less formal irrigation user groups. The authors suggested that more attention should have been given to traditional user groups, especially in Baluchistan and the Northwest Frontier Province, where peculiar ecological and cultural settings exist, in order to suggest new social organizations and provide actual examples for policy-makers of the possibilities of local-level organizations. Case studies of local irrigation organizations would have been useful supplements to the general discussion. Real world experiments provide a useful source of data.

Pomaredo, Carlos. "Some Considerations for Agricultural Price Policy in Peru." Lima, Peru: INIFA, June 25, 1984.

"Project Presentation. Kaliprogo Irrigation Project--Phase 2. Sermo Dam. Upper Areas and Basin Planning." Department Pekerjaan Umum, Direktorat Jenderal Pengairan Directorate Irigasi II. Project Irigasi Kaliprogo. Yogyakarta, Indonesia: nd

Quenemoen, M.E. "Price Policy Implications for Small Farms in Kafr El Sheikh Governorate." Water Use and Management Project. Vol. IV: Appendix C: Technical Articles by Egyptian and American Teams. Cairo and Fort Collins, Colorado: Colorado State University, September, 1980.

Radosevich, George E. Water User Organizations for Improving Irrigated Agriculture: Applicability to Pakistan. Water Management Technical Report No. 44. Fort Collins, Colorado: Colorado State University, 1975.

The water laws of Pakistan, although providing no impediment to water user associations, do not encourage cooperative efforts among water users at the farm level, and Pakistan has no formalized pattern of local associations designed to promote the effective distribution and use of water. Such local associations should be developed, for they would support improved irrigation, increased employment, and greater agricultural productivity. Such organizations could involve farmers in local decision-making, resolve disputes, and constitute a legal contact point between the government and water users. The organizations would need to be simply structured and tailored to the religious, social, political, economic, and legal systems of Pakistan. Such organizations function well in other countries studies. The Tribunal of Waters in Valencia, Spain, is a good model of the type of organization that would be effective in Pakistan, especially since it has some Islamic roots. The authors offer 28 recommendations concerning the proposed functions of water user associations in the Indus Basin and means of developing it. These deal with a charter, bylaws, objectives, functions, formulation of rules and regulations, assessments, sanctions, jurisdictions, separation from politics, member representation, member obligations and rights, cost sharing, water course maintenance, extension and training activities, interfaces with government, and other aspects of such organizations.

Rao, P. K. "Comments on Cost Recovery and Irrigation Water Pricing." IMN Network Paper No. 10F, London, England: Overseas Development Institute, 1984.

Operational difficulties in cost recovery include inflated cost estimates and wasteful O and M where farmers are not involved in the work programme. More consideration needs to be given to the overall pricing and subsidy issue.

Rao, T.H. Analysis of Water Rates. Lift and Flow Irrigation Schemes in Anihra Pradesh, India. Hyderabad, India: Andhra Pradesh State Irrigation Development Corporation Ltd., 1979.

Lift schemes are financially more beneficial to the Government, but high water rates relative to those for flow schemes are discouraging development. Despite this there is a large hidden subsidy as charges do not increase with costs.

Ray, A.; Bruce, C., and Hotes, F.L. Cost Recovery Policies for Irrigation Projects. Informal Guidelines. World Bank Staff Paper. Washington, D.C.: The World Bank, 1976.

Cost recovery is assessed in terms of economic efficiency, income distribution and public savings. There is a useful discussion on cost recovery and economic rent. A range of rent recovery indices are recommended to distinguish between different income classes. The procedures for, and extent of cost recovery will vary, with projects directed to low income areas accepting a low cost recovery. The recovery in relation to O and M may be a poor measure of the adequacy of water charges and benefit terms.

Recharte, Jorge. "Ethnography of Irrigations in Peru with Special Reference to the Coast," 1983.

Reidinger, Richard B. Institutional Rationing of Canal Water in North India. Davis, California: University of California, Department of Agricultural Economics, 1971.

Based on the premise that institutional rules rather than market forces determine canal water rationing, the author defines three levels of rationing: water release into the canal system at the administrative unit level, rotation among channels within administrative units and the farm level where there are turns among farmers (warabundi). The uncertainties of the system increase farmer risk causing low utilization and poor system performance. Problems include lack of supply flexibility and control by farmers and operators, predetermined schedules for water delivery, shares of water based on amount of land ownership, a fixed water levy per irrigated acre unrelated to the quantity of water applied or its marginal value, and high seepage losses from unlined canals. The difference in rotations between the warabundi and the channel enhances farmer uncertainty. Farmers are certain of receiving water twice a month but they never know when during the month they will receive it, which makes precise crop and water management difficult and restricts adoption of new crop varieties. Farmers expressed a desire to supplement available irrigation with tube wells. Recommendations for improved rationing include putting the levy on a volumetric basis, allocating more water to small farmers in the interest of equity,

replacement of the warabundi system with a more flexible one that allows water trading, and the development of water user associations that give greater control to farmers.

Robinson, David M. "Farmer Participation in the High Performance Sederhana Irrigation Systems Project in Indonesia." Jakarta: US Agency for International Development, December 1984.

_____. "Making an Irrigation Association a Vehicle for Development: Preliminary Observations on a Group of Philippine Rice Farmers." Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

A study of the establishment of an irrigation association in the Catanduanes province, Philippines, and the effects of a project to improve production and promote land reform, revealed several factors which demanded attention. The association's president played too large a role in the association's funding and daily operations, which served to delay the irrigation systems' smooth functioning at times (since he alone knew O and M, repair and key financial matters) and also distanced him from the other members (he was accused of favoritism and too much control, while he claimed he did all the work and used his own money for things the association should have financed). Irrigation fees indeed were insufficient, due to low production, faulty collection techniques and lack of strong identification with the association.

Land tenure and land reform became a major focus. The project made credit, technical and other assistance contingent upon a 70/30 arrangement between tenants and owners in distribution of harvest proceeds, rather than the traditional 50/50 arrangement. A questionnaire was distributed, the results of which were to convince the landowners of the profitability of the new arrangement. The questionnaire served to calculate a net break-even point (i.e., minimum yield required so that landowners would receive the same share of proceeds under the new arrangement as under the previous) and a gross break-even point (i.e., yield required to entirely repay production loans and to have savings for costs of the succeeding crop). Complicating factors were that tenants were often relatives of owners, and may have had difficulty voicing complaints. Also, mortgaging and re-mortgaging of lots made it difficult to discern the usufructuary.

The president agreed to more equally distribute functions of the association, and by-laws, constitution and financial records were made more readily available. The paper was written only one season after the project was implemented, and yields were not yet up to expectations. However, the provincial governor tentatively agreed to start a similar program in another area. It was hoped

that success in irrigation cooperation would spur farmers to cooperate in other areas, such as fertilizer purchase, marketing and conflict resolution between tenants and landlords.

Rydzewski, J.R. "Determination of the Operation and Maintenance Costs of Irrigation Projects." ICID Bulletin, January, 1984.

The paper reviews the nature and extent of O and M costs in irrigation. A methodology for collecting recurrent costs is proposed for use in policy and project management.

Sagardoy, J.A. "The Role of Water Pricing and Metering in Promoting Efficient Irrigation Water Use." Seminar on Economic Instruments for National Utilization of Water Resources. Water/Sem/7R9. Geneva, Switzerland: United Nations, E.C.E., 1973.

_____. Water Charges for Agriculture in Some Selected Countries." Rome, Italy: Food and Agriculture Organization, 1973.

In Mexico, recovery of irrigation costs through water pricing is based on farmers' ability to pay. The result is a highly subsidized system with complex management.

Sagardoy, J.A.; Bottrall, A.F.; and Uittinlogaard, G.O. Organization, Operation and Maintenance of Irrigation Schemes. Irrigation and Drainage Paper No. 40. Rome, Italy: Food and Agriculture Organization, 1982.

A study of organizational and management issues in irrigation, with a discussion of the usefulness of a range of alternative procedures for operation and charging for water.

Sallam, Mohamed; Knop, Edward; and Knop, Sheila. "Egyptian Farmer's Perception of Alternative Extension Strategies and Tactics in Irrigated Agricultural Development." Water Use and Management Project. Vol. IV, Appendix C: Technical Articles by Egyptian and American Teams. Cairo and Fort Collins, Colorado: Colorado State University, September, 1980.

Sanchez Velez, Roger. "Resumen del Informe de Peru." Santiago, Chile: Document prepared for VII Seminario Latinoamericano de Irrigacion, 1983.

Sarria Remy, Carlos. Análisis de los Mecanismos Institucionales y Económicos Para Optimizar el Uso de Agua Agrícola. Lima, Peru: Grupo de Análisis de Política Agraria (GAPA), 1984.

_____. "Documento Base Para el Análisis de Políticas de Aguas e Irrigaciones." Lima, Peru: Inter-American Development Bank, June 1984.

Seagraves, J.A. "Using the Residual Method to Estimate Values of Irrigation Water and Land." Draft of Paper.

The author provides a means of organizing data and estimating the values of each resource for purposes of investment decisions on water and land use. Net income per hectare is separated into estimated values of land and water, and ratios of water to land are used to help decide which of these resources would have the most elastic supply. A marginal supply price is then budgeted for that input and the residual income is attributed to the other fixed resource.

The article also notes that prices charged for water use cannot always be an accurate indicator of value or estimated value, because irrigation water is often a loosely-defined water right that is purchased along with the land, and the water fees are not high enough to ration the limited quantity of water among potential buyers. However, where water rights are transferred apart from the land (within canal user associations or cooperatives, for example) some studies contend that within such cooperatives effective allocation of water to its highest-valued use does take place.

Seagraves, James A. and Easter, K. William. "Pricing Irrigation Water in Developing Countries." Water Resources Bulletin XIX (4) (August, 1983): pp. 663-672.

Alternative combinations of water pricing and regulations are possible in allocating irrigation water. The best combination will depend on the value of water, ability to control deliveries, desire to subsidize agriculture, ownership traditions, crops grown, return flows, drainage problems, staff training, ability to collect fees, the number of farmers involved, etc. Marginal cost pricing is just one possible alternative and it is more a way of thinking about prices rather than a set system. The possibilities for achieving an equitable and efficient distribution of water are improved if some form of marginal cost pricing is included in the system of water charges.

Secretaría del Estado de Agropecuario. Costos de Producción por Entrevista. Santo Domingo: Secretaría del Estado de Agropecuario. Departamento de Estadísticas y la Departamento de Planificación, 1980.

The Sederhana Assessment Study. Bogor: P.T. Exsa, March 1985.

Sensuar, B., Green D., and Roe, T. "An Analysis of Foodgrain and Nature Policy in the Dominican Republic." Report under University of Minnesota/USDA, Office of International Crops and Development Research Agreement, No. 58-319R-1-220 (Mimeo). Santo Domingo: University of Minnesota/USDA, October 1982.

Siy, Jr., Robert Y. Irrigation and Water Management Policies in the Philippines. Manila, Philippines: Asian Institute of Management, 1983.

Small, Leslie. "Investment Decisions for the Development and Utilization of Irrigation Resources in Southeast Asia." Teaching and Research Forum 26 (1982): pp. 1-9.

Steinberg, David I. Irrigation and AID's Experience: A Consideration Based on Evaluations. Draft. Washington, D.C.: US Agency for International Development, March, 1983.

Steinberg, David I.; Caton, Douglas; Holloran, Susan; and Hobgood, Thomas. Philippine Small-Scale Irrigation. AID Project Impact Evaluation No. 4. Washington, D.C.: US Agency for International Development, 1980.

Summary of Ex-Post Evaluations of Small- and Medium-Scale Irrigation Projects Partially Financed with IDB Loans. Prepared by Operations Evaluation Office, Washington, D.C.: Inter-American Development Bank, May, 1982.

Svedsen, Mark. Irrigator Collective Behavior in Three Philippine Irrigation Systems. Presented at "Investment Decisions to Further Develop and Make Use of Southeast Asia's Irrigation Resources." Bangkok, Thailand: Agricultural Development Council, August 7-21, 1981.

Svedsen, Mark; Merrey, Douglas; and Fitzgerald, Worth. "Meeting the Challenge for Better Irrigation Management." Horizons, March, 1983, pp. 17-25.

After noting the massive investments in irrigation over the last decades, the continued investment and attention to irrigated agriculture, and the shifting focus from building new systems to improving the performance of existing systems--the authors review the major requirement to increase food production via irrigated agriculture: improved irrigation management. Improved water management, or irrigation management, is defined as a complex set of factors going beyond the purely technical system and reaching to issues of long-term sustainability, as well as management of people, funds, equipment, information, and political relationships. They note that, without an interdisciplinary approach or without examining all levels of the irrigation system and subsystems, symptoms tend to be confused with causes and technological fixes are proposed which cure only the symptoms of a larger problem.

The authors note that USAID has responded well to these issues over the last decade. Water Management Synthesis II, a joint project of the Asia and Science and Technology Bureaus, is designed to develop the knowledge necessary to overcome these

problems and transfer the lessons learned to the appropriate government institutions in developing countries, which are responsible for the planning, design, implementation, operation, maintenance, monitoring and evaluation of irrigation institutions. This institution-strengthening strategy focuses on management, farmer participation, an interdisciplinary approach, and two-way communication between irrigation subsystems. It is the focus of USAID irrigation efforts in the '80s.

Tagarino, R.N. Economic and Financial Policy Issues in Philippine Irrigation Systems. Los Baños, Philippines: University of the Philippines at Los Baños Continuing Education Center, 1976.

The irrigation pricing policies of the Philippine government are evaluated in this paper with respect to income distribution, water use efficiency, and economic growth. The major conclusion of the paper is that water charges must be based on both benefits and costs of the project and their implications to farmers' income and government revenue.

Tagarino, R.N. and Torres, R.D. "The Pricing of Irrigation Water: A Case Study of the Philippines Upper Pampanga River Project." In Irrigation Policy and the Management of Irrigation Systems in South East Asia. Edited by Taylor, D.C. and Wickham, T.M., Bangkok: ADC, 1979.

The irrigation water rates policy resulted in a fee which was too high in relation to incomes and too low to cover O and M costs. Alternatives for charging should consider change in production, and prices received by farmers. Benefits to non-project participants, competing objectives for efficient water use, revenue generation and income distribution must all be taken into account to determine appropriate charges.

Takase, K. "NIA-ADB Water Management Project." Farm Water Management Seminar, Manila. Rome, Italy: Food and Agriculture Organization, 1972.

Taylor, Donald C. "Agricultural Development Through Group Action to Improve the Distribution of Water in Asian Gravity-Flow Irrigation Systems." Teaching and Research Forum. No. 1, The Agricultural Development Council, Inc. Singapore: Singapore University Press, 1976.

_____. "Financing Irrigation Services in the Pekalen Sampean Irrigation Project, East Java, Indonesia." Irrigation Policy and Management in Southeast Asia. Los Baños, Philippines: The International Rice Research Institute, 1978. pp. 111-22.

Farmers are already paying more for irrigation water than the amount being spent on O and M in the project. With substantial external benefits to Government, agro-industry and consumers caution is required in approaching the possibility of increased charges. A number of methods for cost recovery are evaluated.

Taylor, Donald C. and Wickham, Thomas H. eds. Irrigation Policy and the Management of Irrigation Systems in Southeast Asia. Bangkok: The Agricultural Development Council, Inc., 1979.

Torres, R.D. "Pricing Irrigation Water." Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

United Nations. Efficiency and Distributional Equity in the Use and Treatment of Water: Guidelines for Pricing and Regulations. Natural Resources/Water Series No. 8. New York: United Nations, 1980.

Unson, Delia Cecelia Ochoa. Social Development and the Communal Irrigation System in Laur, Nueva Ecija: Baseline and Selected Interim Monitoring Results, Final Report. Quezon City: Institute of Philippine Culture, 1978.

Uphoff, Norman. "Contrasting Legal and Organizational Approaches to Water Management Development in Sri Lanka." Ithaca, N.Y.: Department of Government, Cornell University, 1982.

UPRIIS, Operation and Maintenance Manual. Cabanatuan City: UPRIIS, 1985.

_____. Organization and Development of Farmers Irrigators Associations (Zone Team Approach) Completion Report. Cabanatuan City: UPRIIS, January, 1985.

US Agency for International Development. Approaches to the Policy Dialogue. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1982.

_____. Food and Agriculture Development. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1982.

_____. Institutional Development. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1983.

Irrigation Development Options and Investment Strategies
for the 1980's. WMS-II Project Report No. 14. Logan, Utah: Utah
State University, 1984.

The report urges USAID to concentrate on development of small scale community irrigation in the Sierras with the emphasis on maximizing social benefits per unit of capital input. This should be supported by incentive policies for agricultural development.

The prevailing system of water allocation is based on cropping patterns. Water ownership rights are held by the state and farmers are required to submit to the irrigation district a cultivation plan for the season projecting anticipated irrigated crops and areas. Based on these submissions the district allocates water. Water distribution is enforced at the farm level by sectoristas who are government personnel. Shortage of funds and personnel results in sectoristas being appointed only for management and control of systems where conflicts are common as a result of water scarcity. The system's weakness is its emphasis on determining allocation rather than enforcing distribution.

User participation in irrigation is relatively high in Peru and the organizational structure is defined by law. The primary motivating force in participation is the need for regulation in order to protect individual interests. Organizations are particularly active where conflicts are common but there are shortcomings in that the presidents of the user organizations cannot handle allocation abuses and therefore equity suffers. The possibility for establishing successful user organizations in the Sierras is great because of the Indian population which tends to be communally organized.

By law, Peruvian irrigation users are required to pay a tariff and a quota. The purpose is threefold: to recover capital costs; to recover O and M costs; and to increase efficiency of water use. The current tariff varies from district to district and is based on farmer ability to pay. It is collected by the government for the public fund. The quota is collected by user groups for their own use. The rates of the tariff and quotas are, however, so low as to be almost inconsequential. Collection costs are sometimes higher than generated revenues.

Prescriptions to use pricing as a means for getting farmers to use water more efficiently will not work where water is scarce because it may aggravate an already difficult situation. Although some studies have suggested that there is considerable wastage of water, pricing may not be the solution for inefficient use. Other factors may be involved, such as inefficiencies in the main system which are related to the local system, and over which users have no control and cannot effect by improved management. In setting fees, it is important to take into consideration that a variety of objectives may be involved and it is necessary to relate the tariffs to the paramount objective.

Cost recovery and management issues in Peru are greatly affected by macroeconomic conditions. A clear relation was found in this study between good on-farm water management and cases where farmers were faced with strong market prices, whether real or subsidized. In these cases, a minimum of governmental support was needed.

- _____. Local Organizations in Development. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1984.
- _____. The On-Farm Water Management Project in Pakistan. AID Project Impact Evaluation Report No. 35. Washington, D.C.: US Agency for International Development, June 1982.
- _____. Pricing, Subsidies, and Related Policies in Food and Agriculture. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1982.
- _____. Project Paper: Agricultural Policy Analysis. Prepared by University of Minnesota in Dominican Republic. Washington, D.C.: US Agency for International Development, 1984.
- _____. Project Paper: Dominican Republic Rural Savings Mobilization. AID/LAC/P-163; Loan #517-0179. Washington, D.C.: US Agency for International Development, August 18, 1983.
- _____. Project Paper: India - Hill Areas Land and Water Development. No. (386-0489), New Delhi: USAID/India, July 27, 1984.
- _____. Project Paper: India - Maharashtra Minor Irrigation. No. (386-0490), New Delhi: USAID/India, May 1984.
- _____. Recurrent Costs--Problems in Less Developed Countries. AID Policy Paper. Prepared by Bureau for Program and Policy Coordination. Washington, D.C.: US Agency for International Development, 1982.
- _____. Sederhana: Indonesia Small-Scale Irrigation. AID Project Impact Evaluation Report No. 29. February 1982.
- _____. Study of Recurrent Cost Problems in Irrigation Systems. Colombo, Sri Lanka: Engineering Consultants Limited, 1984.
- Veeman, Terence S. "Water Policy and Water Institutions in Northern India: The Case of Groundwater Rights." Natural Resources Journal VIII (3): pp. 569-88.

The need for predictable and reliable water supplies to maximize the effectiveness of using the new high yielding varieties (HYVs) has resulted in groundwater problems for northern India. Water supply problems are viewed in this paper as intrinsically related to existing groundwater rights and the lack of institutions for regulating such rights. The "Correlative rights doctrine" is used in analyzing the economic value of having groundwater rights and groundwater regulations.

Venugopal, K.; Kumar, P.N.; Pal, S.P.; and Agarwal, S.C.
Techno-Economic Study of the Recovery of Water Related Charges in the World Bank Assisted Haryana Irrigation Project. India: National Council of Applied Economic Research, 1982.

Visaya, Benito P. "The PRMP and the Zanjerias." Paper Presented at Asian Conference on Organization as Strategic Resource in Irrigation Development. Manila, Philippines: Asian Institute of Management, November 15-19, 1982.

The experience of the National Irrigation Administration (NIA) of Philippines' with irrigation design and implementation led to a greater respect for and inclusion of existing traditional structures of farmer organization (called zanjeras), in terms of farmer participation in planning and implementation as well as optimal utilization of existing irrigation networks. The zanjera is a communal irrigation system operated by a very cohesive group with values of fair and equal distribution of labor, money and other resources. In its initial stages, the Palsiguan River Multi-Purpose Project (PRMP) did not utilize the zanjeras' existing system of canals. Also, farmers were suspicious of NIA's motives as well as resistant to signing right-of-way waivers and paying irrigation fees. A re-assessment of the project led to a strategy which involved farmers from the beginning in planning for the project, after taking zanjeras leaders on a field trip to observe the benefits of a similar project. A survey of the zanjeras canals showed that 85 percent of the existing canals could be utilized in the project. The remaining canals and ditches to be constructed were jointly planned by the zanjeras and NIA. NIA also provided opportunities for strengthening the zanjeras through federations, registering them with the Securities and Exchange Commission, and providing training in O and M. Thus, the zanjeras could assume full responsibility for the new system. The authors concluded that project success is highly dependent on farmer participation in the project at the planning stages and throughout the construction and turnover process.

Wade, Robert. "Collective Responsibility in Construction and Management of Irrigation Canals: Case of Italy." Economic and Political Weekly, December, 1979, pp. 155-160.

. "The Social Response to Irrigation: An Indian Case Study," Journal of Development Studies XVI (1) (1979): pp. 3-26.

This article treats the subject of canal irrigation and the management thereof in a case study of the southern Indian district of Andhra Pradesh. Specific attention focuses on the relationship between the degree of corporate organization and the scarcity and uncertainty of water supply. In India an estimated 40-50 percent of food grain production comes from irrigated areas; of this area, one-half is supplied by canals. The functioning of these canals at the local level has not attracted the appropriate attention of social scientists, in that the specific district studied exemplifies a system with a low degree of organization where the land owner is the primary manager of the land. The comparison is made to a village with a higher degree of organization which contains committees designed to settle irrigation and cultivation questions and which nominates the members on an annual basis. Among the functions of the committee are: 1) appointment of water guards; 2) establishment of harvesting dates for sorghum; and 3) collection and management of village funds. The author therefore asserts that to employ common irrigators is of sociological significance in that the establishment of common irrigators results in cultivators relinquishing management of irrigated land and their individual claim to control water usage. A corporate approach to irrigation as a response to water scarcity is evident in nearly all cases studied. Where water is problematic for virtually all irrigators, users tend to form a corporate body to deal with problems of users' rights, allocation, fees, and equitable distribution of the resource. These pressures, then, are likely to be institutionalized in the formation of an association or committee concerned with management problems. Finally, as described in the Indian villages studied, which lack a formalized management structure, the organizational response is likely to be most strongly shaped by the immediate environmental pressures such as water scarcity and its impact on water regulation.

. "Water to the Fields: Institutional Innovation in India's CAD Programme." South Asian Review VIII (1975): pp. 301-321.

The article examines the impact of the Command Area Development (CAD) Programme in terms of improving the efficiency of water use, increasing crop yields, and maintaining land fertility levels on a large scale. The use of such methods as land consolidation, realignment of field boundaries and reallocation of lands to farmers is evaluated with respect to their effects on decreasing conflicts in water use and increasing collection of water fees. Wade examines further the effects of the CAD on the institutional design for water sharing at the farm level and suggests that socioeconomic research is needed in evaluating the long-term impact of such projects.

_____. "The System of Administrative and Political Corruption: Canal Irrigation in South India." Journal of Development Studies XVIII (3) (1982): pp. 288-327.

Wade, Robert and Chambers, Robert. Managing the Main System: Canal Irrigation's Blind Spot. Brighton, England: Institute of Development Studies, University of Sussex, 1980.

The authors argue that current evaluation and professional writing concerning canal irrigation systems is severely biased by ignoring or screening out a set of causes for inefficient irrigation management. They identify the following three implicit false assumptions prevailing current discussion: 1) problems are 'technical' rather than 'institutional' in nature; 2) problems are 'below' rather than 'above' the outlet, i.e., at the farm and village level; and 3) inasmuch as problems are institutional in nature, they are problems with farmer institutions.

Effective and efficient management of the main system, or even realization of problems with the main systems, are hampered by several 'blind spots': 1) village level and on-farm management deficiencies are more visible than system distribution problems; 2) no professional discipline exists to identify and provide solutions for main system management as exists for the physical, economic, social and agronomic elements of the systems; 3) prejudicial blame is given to farmers as ignorant and therefore of water as a scarce resource in the analysis of problems and potential solutions; 4) solutions are treated as zero-sum games when in fact benefits can accrue to all participants in the system by improved management of the main system; and 5) little incentive exists for canal operators to allocate water efficiently, rather allocation is to minimize conflict to the operator.

The authors propose that changes in both cognitive and diagnostic procedures are needed to overcome these problems. Increased focus must be paid to main system management, especially to overcome the bias and blind spots identified.

Water Management in Bank-Supported Irrigation Project Systems: An Analysis of Past Experience. Prepared by Operations Evaluation Department. Washington, D.C.: The World Bank, April 1981.

Watson, William D.; Nuckton, Carole Frank; and Howitt, Richard E. Crop Production and Water Supply Characteristics of Kern County. Davis, California: University of California, 1980.

Wattanavitukul, Somluckrat and Cruz, Concepcion. Irrigation Water Management at the Village Level in Selected Asian Countries. Draft. Honolulu, Hawaii: East-West Center, 1982.

The majority of case studies of Asian irrigation systems at the village level were done on relatively isolated systems with minimal government inputs. A review of some studies done on village irrigation systems located within large-scale projects is presented in this paper. Two major types of organizational arrangements are identified: 1) direct state management where no village organization exists; and 2) state coordination with existing local, village administration.

Wells, John Craig and Norman, William Ray. Sahelian Irrigated Agriculture: A Review of French Literature Sources. Water Management Synthesis II Project. Ithaca, New York: Cornell University.

Wickham, Gekee Y. "Farmer Attitudes Towards Irrigation and Farmer Potential for Cooperation." Water Management in Philippine Irrigation Systems: Research and Operations. Los Baños, Philippines: The International Rice Research Institute, 1973.

In this study, the author finds that farmers in areas of assured water adequacy tend to be less cooperative with water management personnel because they already have free access to water, whereas farmers in water-short areas exhibit a greater degree of cooperation in hope that it will improve their water supply. Cooperation between farmers themselves also seemed to be preferred on an informal basis rather than through formal means such as irrigators associations. In addition, farmers were generally interested in working individually rather than as a group, pump use being the only preferred group activity recognized by a majority of the farmers in the study group.

One traditional notion of noncooperation in the area of water fee payments is challenged by the author. The traditional explanation of inadequacy of water resulting in non-payment is not born out in this study, nonpayment remains a problem despite 71 percent of the farmers in the study group acknowledging they have at least adequate water supply.

The study also notes that farmers generally have good relations and communication with the government-employed ditch tender. This relationship was mostly social, however, so irrigation was seldom the topic of discussion. The author therefore advocates the need for either increased communication between higher-level irrigation personnel and the farmers or an upgrading of the ditch tenders' responsibilities, in the areas of water distribution or collection of fees for example.

Wickham, T.H. Water Management in the Humid Tropics: A Farm Level Analysis. PhD Dissertation. Ithaca: Cornell University, 1971.

Young, Robert A. Notes on the Allocation, Pricing and Valuation of Irrigation Water. Paper prepared for seminar on "Economics of Water Uses for Irrigation in Egypt." Cairo, Egypt: Department of Hydraulic Engineering Cairo University, and Water Research Center, Ministry of Irrigation, December 6, 1983.