

STUDIES OF FARMER-MANAGED IRRIGATION SYSTEMS: TEN YEARS OF CUMULATIVE KNOWLEDGE AND CHANGING RESEARCH PRIORITIES

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BACKGROUND

Ten years of research in farmer-managed irrigation systems have corrected the myopic notion formerly held by many that irrigation systems were facilities that governments built, and irrigation development the domain of irrigation departments and international donor agencies. There is now wide-spread recognition that very frequently the total irrigation sector of a particular country involves a substantial portion of systems that were created and persist largely, though not entirely, outside the government sector.

Governments now are giving more attention to these farmer-managed systems than ever before. But in many countries there has been a long history of some form of government aid. Not infrequently, aid to these local systems has been channelled through some department other than irrigation-- Agriculture, Community Development, or Local Administration. This has also acted to isolate these farmer-managed facilities from the hydraulic works within the purview of the formal irrigation department.

But things are changing rapidly. Nearly everywhere, farmer-managed systems are being subsumed under the mandate of irrigation departments. And therein lies the problem. Worldwide, diverse policies are being fashioned, and varying procedures are being implemented with uneven results. Pressures to increase the involvement of government in farmer-managed systems arise from both government and water users. The significant increase in government involvement in farmer-managed systems has raised several important and interlocked concerns: concern for the increasing dependence of farmers on government-provided resources; concern for the imposition of inappropriate planning, design, and operational criteria; and increased concern for escalating costs of both construction and operation and maintenance (O&M).

These concerns, arising from the rapid acceleration of State¹ assistance to local systems and the increasingly central role of irrigation departments in planning and executing such assistance, have important implications for the nature of socially relevant studies of farmer-managed systems.

A major objective of this paper is to discuss these implications and suggest lines of study and inquiry appropriate for a research agenda on farmer-managed systems for the next ten years: a decade in which we expect the State will continue to be active in developing policies and implementing programs related to farmer-managed irrigation. The first part of this paper reviews past and current research, while the second suggests future research trends.

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REVIEWING PAST RESEARCH

Antecedents to Contemporary Work: Colonial Compilations

The historical literature of the West contains various references to farmer-managed systems that were recorded by agents of colonial governments as they went about their formal and informal inquiries. Three examples from different regions of the world, illustrate this early material. Christie (1914), discussing the farmer-managed systems of Ilocos Norte in the northern Philippines the now well-known *zanjeras* tried "to convey a general idea of the degree of development of native irrigation in Ilocos Norte." A unique item in the article is the full text of an agreement signed by a group of individuals joined into a *zanjera*. In some cases, Christie hinted at important aspects of *zanjera* organization though he did not elaborate on them. For example, he noted that the land irrigated in the *zanjeras* is divided into equal shares among the majority of the members, a point that Coward (1979) and Siy (1982) later elaborated as the "atar concept."

The point on which Christie ends is important: in cases where the government takes action to assist these *zanjeras*, it is important that the agents of change scrutinize "the original papers organizing the local irrigation societies" in order to be fair to these members. This must be one of the earliest calls for government assistance to farmer-managed systems that is sensitive to local history and existing arrangements.

Saunders (1980), in her report on irrigated agriculture among a Hausa group in southern Niger, used the materials of colonial agents to establish a long history of the area's irrigated agriculture. She refers to the writing of Brouin (1938), who reports that in the 18th century the local ruler:

...allegedly recruited some one thousand workers to build a small barrage, or simple dam, and a canal some three kilometers long and fifteen meters wide, to carry water from a natural pond to a nearby depression which flooded during the rains but lacked water during the rest of the year. Brouin reports that the system could still be seen in the 1930s (Saunders 1980:6).

She also refers to quotations from a German explorer who travelled in the area in the mid-19th century and reported an extensive district irrigated by springs that "ooze forth from the sandy downs." The bits and pieces that she is able to assemble from the colonial records give historical context to the contemporary system that she describes in detail.

In the early 20th century, the British Colonial Government operated a research institution called the "Board of Economic Inquiry, Punjab." This Board conducted studies of the rural sector in the State of Punjab an administrative unit that covered the present-day states of Punjab in both India and Pakistan, as well as additional areas now assigned to other states in both countries. One such study surveyed agricultural conditions in the Haripur and Margarh Tawgas subdistricts of the District of Kangra, and describes in some detail the organization and operation of a farmer-managed irrigation system, here called a *kuhl*, reported to irrigate more than 240 hectares (ha) and serving people of 9 hamlets (*tika*).

The description is a complimentary one, emphasizing the presence of different canal leaders. It also describes a sophisticated system of water allocation and distribution, including rotation and the means of mobilizing resources to operate and maintain the works. It ends with:

Notwithstanding all these difficulties, these kuhls are a remarkable instance of self-government and it is wonderful how well they are managed when we consider the many conflicting interests involved (Board of Economic Inquiry 1933).

Irrigation as a Means of Social Analysis: Anthropology Field Studies

A second information base on farmer-managed systems was produced by anthropological field workers whose research objectives were focused on some aspect of social organization or culture. They made observations on irrigation-related activities in the course of their field work. Thus they provide us with significant, though frequently incomplete, information about local systems of irrigation. There are numerous examples that illustrate this point.

In this genre of studies, the central nature of irrigation phenomena to the analysis varies. Sometimes, it is the major social activity that the analyst uses as a means for the study of some larger social process.² For example, Geertz (1967) uses the Balinese *subak* and Potter (1975) the *muang-fai* systems of northern Thailand as vehicles for understanding important principles of rural social organization; the Hunts (1974) employ irrigation to understand political power and processes in Mexico; Lewis (1971) examines irrigation groups in the northern Philippines to explore issues of habitat and social organization; Leach (1961) looks at irrigation in Sri Lanka while pursuing his basic interests in kinship and social organization; and Mitchell (1976) studies irrigation in Peru as part of his analysis of political and ritual life.

For other analysts, irrigation was a more incidental topic. For example, Moerman's (1968) study of farmer decision making in northern Thailand makes only brief mention of irrigation activities, but that short discussion coupled with other information from northern Thailand gives an idea of farmer-managed irrigation in his study area. Or take the case of von Furer-Haimendirf's (1980) study of the Apa Tani in Arunachal Pradesh (northeastern India). The prose is sparse but highly suggestive in terms of what we know about small systems elsewhere:

Every one of the streams rising on the wooded heights that ring the Apa Tani country is utilized for irrigation purposes soon after it emerges from the forest and reaches a gully wide enough to accommodate a series of narrow terraces.... The channels have been cut deep into the soil and their dams are secured against the onrush of flood water by rows of wooden stakes sometimes reinforced by strong bamboo matting (von Furer-Haimendirf 1980).

Neither of these types of studies, in which irrigation phenomena are either incidental or central, sets out to understand irrigation systems per se. Rather, the analyst began

with some other "problem," usually one suggested by models and concepts developed within the analyst's discipline, and irrigation behavior and organization were examined because of their relevance to that disciplinary problem. These analysts examined irrigation activities not to understand how irrigation systems functioned, but to advance understanding of kinship processes, principles of social stratification, and so on. In fact, the best of these studies advances our understanding of both.

Irrigation Ethnographies

But there also were studies describing how existing farmer-managed systems operate. In these, the analysis may or may not be embedded in larger theoretical arguments. Three cases exemplify this line of research.³ Grader's (1960) study of Balinese subaks in the region of Jembrana is the first example. It is a straightforward description of the "ideal" organization of subaks in this region, touching on such topics as membership in the subak board, subak services and levies, subak religious activities, and subak regulations. In one case, Grader describes the creation of a new subak which began with the hiring of tunnel diggers by the traditional district government official responsible for coordinating subak affairs (*sedahan agung*). Only after the tunnel diggers were able to identify precisely the lands that would be irrigated, did the owners of those lands form themselves into a subak group.

Taillard's (1972) study of traditional irrigation systems in northern Laos is a preeminent example of irrigation ethnography. The report gives details of the geographical setting, the types of apparatus used to acquire and distribute water, and important features of the social organizational arrangements in place for handling such elementary tasks as system repair and water distribution.

Wilkinson's (1977) study of irrigation systems in Oman represents a third example of a careful irrigation ethnography. Unlike the Grader and Taillard examples which have irrigation descriptions as their end, Wilkinson's research purpose is to understand irrigation systems and settlement forms in the context of larger historical processes of political control. However, his means to this end is a careful discussion of the local irrigation systems of central Oman. Focusing on these farmer-managed systems, here called *falaj*, he states his intention as follows:

We will examine first, the layout of a falaj settlement, then the principles of water shareholding and the way in which finance and maintenance of the falaj are arranged, and finally the division of labor and responsibilities in the irrigation system (Wilkinson 1977:97).

Careful attention to detail in his field study allows him to reach important conclusions regarding the sociotechnical features of the falaj -- in particular, the means by which the architecture of the system is made congruent with the water rights of the users.

These irrigation ethnographies provide us with rich detail on the internal characteristics of the systems being studied often including information on both social organization

and the physical artifacts used to handle water. They have the characteristic that Geertz has called "thick description" allowing the reader to grasp much of the immediate context in which irrigation processes are operating. Irrigation ethnographies, based as they usually are on detailed field studies, typically uncover the considerable complexity of technical and institutional arrangements that develop in a farmer-managed system that has persisted over time. It is these complexities that are likely to remain unknown when less penetrating research procedures are employed.

Development-Oriented Irrigation Studies

Development-oriented irrigation studies are defined here as those studies in which the analyst is either examining a case of external involvement in farmer-managed systems or studying farmer-managed systems for the purpose of making development recommendations.

Some of the earliest of such studies was work done as part of the so-called Mekong Development Program. For example, Frutchev (1969) examined the activities of the people's irrigation systems in northern Thailand to better understand the institutional aspects of irrigation development that irrigation planners would face. Similarly, Coward's (1976) work in western Laos examined the implementation of a government irrigation development activity in a region where many farmer-managed systems existed. Irrigation development activities in Taiwan provided the setting for important development-oriented studies by Pasternack (1972) and VanderMeer (1968, 1971). VanderMeer's work, in particular, caught the transition from formerly independent farmer-managed systems to systems in which government was highly involved but farmers remained significant managers. Perhaps the most extensive effort by government to create new farmer-managed irrigation systems was the Thana Irrigation Program (TIP) of Bangladesh, launched in the early 1970s (Thomas 1976, Haq 1976, Hamid 1982). Much of the TIP's design was based on "experimental" work at Comilla in which the field staff designed and tested approaches for introducing tube wells and low lift pumps through village cooperative societies (Coward and Ahmed 1979, Howes 1983). The centrality of these farmer-managed pumps systems for agricultural change in Bangladesh has made them a subject for continuing study and research (Biswas and Mandal 1982, Hamid 1982, Howes 1982, Wood 1984).

One of the best examples of development-oriented studies is the work of de los Reyes and colleagues in the Philippines. This research has been done in close collaboration with the National Irrigation Administration (NIA) as that agency has endeavored to develop a more participatory style of government assistance to farmer-managed systems, called "communals" in the Philippines. Especially significant was their attempt early in the process to provide a broad-based understanding of the situation of the communal systems by conducting a nationwide study (de los Reyes 1980a and b). The study was based on a survey of a national sample of communals supplemented by detailed case studies of selected systems. Since then, other development-oriented work on farmer-managed systems has been done in the Philippines (Siy 1982; Angeles 1983, 1984; Illo et al. 1984; Illo and Volante 1984; de los Reyes 1984, 1985; Bagadion and Korten 1985).

While irrigation had been the subject of study in Indonesia for some time, an early development-oriented study of farmer-managed irrigation was made by Hafid and Hayami (1979) when they studied the outcome of the government's village subsidy program on two small systems, one in Java and one in Sulawesi. In the late 1970s, Cornell University began a series of field studies in Central Java that included farmer-managed systems. These studies were significant in that they attempted to observe both the engineering and the socioeconomic dimensions of the systems and their operations (Oad 1982, Duiwel 1985). Early in the 1980s, with assistance from the Ford Foundation, teams from Universitas Udayana in Bali, Universitas Sriwijaya in South Sumatra, and Universitas Andalas in West Sumatra began irrigation studies in each of their regions that included farmer-managed systems. Their work has yielded useful ethnographic information on the organization and operation of farmer-managed systems and is beginning to produce important information on the processes by which government is providing assistance to such systems (Sutawan et al. 1983, Universitas Sriwijaya 1983, Abuasir 1985). Also, there has been a set of studies examining a small-scale irrigation program called the "Sederhana Program." This program is being implemented by the Government of Indonesia with funding support from the United States Agency for International Development (USAID). Several other studies have been completed that give special attention to the farmer participation aspect of the program (Morfit and Poffenberger 1984, Robinson 1985a and b).

In addition to research in Bangladesh mentioned above, some important and useful development-oriented research in South Asia has been reported and is currently underway. In Nepal, Martin (1986) and Yoder (1986) have completed detailed field studies of farmer-managed systems in the hill areas. That line of research is being continued through the joint activities of the International Irrigation Management Institute (IIMI) and the Government of Nepal.

In Sri Lanka, Abeyratne and Perera (1984) and Begum (1985) have recently completed field studies of village tanks and village *anicuts* (weirs), and of government assistance provided through the World Bank-financed Village Irrigation Rehabilitation Program (VIRP) (Medagama 1982).

In Pakistan, most irrigation studies have focused on the large public canal systems of Punjab and Sind. However, there has been limited work on the smaller farmer-managed systems in selected hill areas of the country. For example, Bhatti (1979) has reported on the organization and operation of a *gul* system in the North-West Frontier Province. Some work has also been done on the well-known *karez* systems of Baluchistan (Kemper et al. 1979) which are presently being rehabilitated through various government programs.

Minor irrigation systems are an important part of the irrigation sector in India. A large number of these minor systems are tube wells, some of which are individually owned and operated. Many, though not all, of the minor systems both groundwater and surface water works -- are farmer-managed. Thus far, there have been relatively few studies, development-oriented or otherwise, of these small farmer-managed facilities. Pant (1984) has written about pump groups in eastern Uttar Pradesh and made suggestions for future public intervention. Small systems are numerous in the Himalayan region, but there have been

few studies of these systems in India. As part of a project planning exercise, Shingi (1984) has reported on such systems in Himachal Pradesh. Also, Joshi and Seckler (1982) have written about an innovative project to introduce a farmer-managed irrigation system in the Sivalik hills near Chandigarh. Some development-oriented studies have also been completed in South India. For example, Patil and Kulkarni (1984) have written about the farmer-managed *phad* systems found in Maharashtra which are being affected by government assistance. But the most extensive research has been done on the tank systems of Tamil Nadu, which are now the subject of a major "modernization" program (Saktivadivel 1982) as well as the tanks of other states in South India (von Oppen and Rao 1980a and b, Doherty 1982). Palanisami and Easter (1983a and b) have written extensively on the tanks of Tamil Nadu, some of which are farmer-managed while others are jointly managed (see also Meinzen-Dick 1984). Most recently, tank studies have been undertaken by Saktivadivel et al. (1986) at the Centre for Water Resources at Anna University.

Information on farmer-managed systems in northeast Asia is conspicuously lacking -- including development-oriented studies. Nearly all of the research on irrigation in Taiwan has focused on systems that are jointly managed by government and farmers. While much has been written about irrigation in Japan, including farmer-managed systems, most of the information is available only in Japanese (Kelly 1982). Small farmer-managed systems are extensive in Korea. However, with the exception of the study by Oh (1978), little research has been done on these systems and on related issues of public intervention. Wade's (1982) report, which does have a development thrust, deals only with the larger, bureaucratically managed systems. Finally, there is a complete absence of information on this topic from China. However, the recent shift in government policies to the so-called "responsibility system" could have important implications for farmer-managed systems.

There is some literature on development-oriented research into farmer-managed systems in Africa. In Morocco, for example, several useful studies are available. Moroccan researchers have done work on "irrigation petit" and the changing policies of government toward such systems (Bourdebala et al. 1984). Government involvement in the development of farmer-managed perimeters along the Senegal River has been the subject of several recent studies (Diemer and van der Laan 1983, Patterson 1984, van der Laan 1984, Miller 1985, Horst 1986). Two very useful studies have recently been completed in Kenya. Ssenyonga (1983) has carefully analyzed traditional furrow systems in a region of the Rift Valley and discussed their relevance to regional development. Fleuret (1985) has reported on farmer-managed systems in the Taita Hills region of southern Kenya. These systems are currently experiencing high levels of disorganization as a consequence of government land titling programs. The Food and Agriculture Organization (FAO) has been especially active in promoting irrigation development strategies in Africa that favor farmer-managed systems (Underhill 1984).

Farmer-managed systems in the Andean region are also experiencing continuing government intervention and some researchers have been analyzing these processes. Recent work by Lynch (1986) has reported on government intervention in the Sierra region of Peru through the project called "Plan Meris."

Finally, we note some development-oriented research on farmer-managed systems in North and Central America. Small systems are widespread in certain regions of Mexico. The Government of Mexico, sometimes with assistance from international agencies, has been providing public assistance for "improving" these systems for some time. Government strategies toward farmer-managed systems have been studied by Lees (1974) and more recently by Goldring (1985) and Hunt (1986).

Less well studied is the process of government assistance to farmer-managed systems in the United States, especially in states such as New Mexico, Colorado, and Utah. That such assistance is still being planned and implemented is demonstrated in the following quotation describing a proposed Bureau of Reclamation Project to improve several acequia systems in northern New Mexico.

The project is located on the Rio Grande in Rio Arriba County, New Mexico. There are presently nine diversion barriers and approximately 27 miles of diversion canals serving approximately 1,800 acres. The principal features of the project consist of improvements such as the installation of more permanent diversion structures, headgates, wasteways, arroyo siphons, and concrete lining of ditches to improve irrigation efficiency, conserve water and reduce operation and maintenance costs (US Bureau of Reclamation).

In their 1978 book, Maass and Anderson provide some details on such systems in Colorado and Utah as part of their analysis of irrigation organization and performance. Thompson (1984) is presently undertaking a research project to understand the various forms of financial assistance provided to farmer-managed systems in the western United States.

People's Irrigation in Northern Thailand.

While the above discussion sets out to disaggregate and categorize the various studies of farmer-managed irrigation systems, it is also instructive to examine the mosaic of such studies that have been completed in a given region. The case of the muang-fai in northern Thailand is an interesting example of the diverse sources of information available, the changing and continuing interests of researchers over time, and the cumulative evidence that has been developed regarding these systems.

One can begin with an interesting irrigation ethnography that deals with irrigation in an area geographically outside the political borders of northern Thailand but in a proximate zone and with a culturally similar group. In 1949, Han-Seng published a report on land systems in southern China which included a description of local irrigation organizations among an ethnic Tai group⁴ in a part of the ancient kingdom of Sip Song Pan Naa. From this report we learn of various rules and roles for operating and maintaining the irrigation systems. We also discover an important point regarding the function of the local nobles (*chao*) in developing rice lands by which they extracted surplus from the peasants. Various writings, categorized above as social science studies using irrigation as a means for understanding social processes, were produced in the 1960s and 70s (Wijeyewardene 1965, 1973; Potter 1975). Several irrigation ethnographies also have been written

(Bruneau 1968; Tanabe 1981; Sirivongs 1982; Lando 1983; and, as previously discussed, for related areas in Laos, Taillard 1972). Also beginning in the mid-1970s and continuing to the present, several histories of local areas have highlighted the development of people's irrigation systems (Calavan 1974, Cohen 1981, Ganjanapan 1984). Finally, more recently, several researchers have undertaken field studies with an explicit focus on change and development in people's systems (Frutchey 1969, Sektheera and Thodey 1975, Suraroek et al. 1980, Sirivongs 1982, Tan-Kim-Yong 1983).

From Wijeyewardene's 1973 paper, we first learn about the impact of government irrigation development activities on the affairs of people's irrigation systems. That theme, in its contemporary manifestations, is again repeated in the writings of Suraroek et al. (1980), and especially in the detailed field studies conducted by Sirivongs (1982) and Tan-Kim-Yong (1983). Moreover, the contemporary involvements of the state can be placed in historical perspective, since the writing of Calavan (1974), Cohen (1981), and Ganjanapan (1984) detail the manner in which earlier political figures frequently played a large role in stimulating the creation of particular people's systems or significantly modifying systems that already existed. External intervention in these systems is shown not to be a new process -- though there may be unique features of the present government involvement.

Finally, we should note that in recent years, there has been growing interest on the part of the government in developing farmer-managed irrigation systems in the northeast region of Thailand. As a complement to this policy, researchers at Khon Kaen University have been involved in innovative programs for delivering external assistance to existing, and new, farmer-managed systems in that region (Mayson 1984).

Characteristics of the Completed Research

The above review of completed research on farmer-managed systems, while not exhaustive, serves to demonstrate the considerable literature that exists. Although a large portion of the research deals with Asia, significant work from other regions of the world is also available -- and perhaps is not out of proportion to the extent of existing systems in the various regions. With the above literature in mind, we suggest the following six generalizations regarding the relevance of this body of completed research for improving the policies and programs of public intervention in farmer-managed irrigation systems.

1. The completed research is very heavily social science-oriented, and is primarily concerned with the institutions and organizations by which farmers create, operate, and reproduce their systems. While many of the reports refer to various physical components of the hydraulic works and the agronomic dimensions of the irrigated crop(s), in many cases, these dimensions are presented as mere background, and the discussion fails to provide a discussion of processes through which organization and apparatus are articulated. There have been relatively few solid engineering contributions to this literature, important exceptions being von Oppen and Rao (1980a and b), Worboys (1981), Horst (1983), Angeles (1983), Wensley (1984), Engelhardt (1984), Wensley and Walter (1985), and Yoder (1986). While a number of studies have approached the field with a socio-technical orientation that has made the researcher sensitive to the interplay between the physical apparatus

and the institutional rules and organizational arrangements, the latter typically receive more attention than the former.⁵

2. Nearly all of the completed studies have been descriptive; very few have been analytical. The studies are excellent in answering the question: What is going on in this location? Such information has been absolutely critical for correcting many of the stereotypes and inaccurate assumptions that policy makers held about farmer-managed systems. The body of completed research has been essential for creating a more informed picture of the informal component of the irrigation sector in many countries, and has encouraged a rethinking of the future of such systems. But there is a need to go beyond these various descriptions to provide analytical concepts and models that help explain the systemic features of these systems and the regular patterns associated with their reactions to external assistance. One line of work in this area is the "property concept" discussed by Coward (1983, 1985a and b). Other approaches are needed.

3. Nearly all of the completed studies have focused on the internal dynamics of the systems under investigation. Most studies have not placed these systems in the larger regional contexts in which they operate, and thus have not been able to inquire about the possible impact of external environmental, social, economic, or political changes on these critical internal happenings. The exceptions to this pattern are those studies that have examined the impact of external government assistance. However, without an understanding of the other external forces that may be at work, we may fail to understand why government assistance is being requested, being provided, or resulting in the observed consequences.

4. Nearly all the studies that have been concerned with the impact of government assistance on farmer-managed systems have examined short-term effects only. The studies have been undertaken immediately following or within a year or two of completion of the intervention. Given that external interventions to any system tend to have at least short-term disorienting effects, and that new irrigation structures or procedures may always require a "shakedown" period for learning and adjustment, it may not be surprising that our studies tend to identify long lists of intervention problems. Extending the impact period may modify our findings.

5. The studies of farmer-managed systems, nearly without exception, fail to discuss the bureaucratic characteristics and processes of the assisting agency (an exception is Goldring 1985). If one assumes that the consequences of public intervention minimally result from actions of both irrigators and agency staff, this failure to discuss the bureaucracies that plan and implement programs of public intervention is devastating to any research program intended to provide suggestions for improving such interventions.

6. The completed research has not included a clearly articulated concept of the role of the State and its bureaucracies in national development. Some researchers seem to assume that the role of the government is to integrate the various competing forces of society, and to play a role in allocating society's scarce resources in some fair manner. Other analysts may assume that the function of government is to represent the interests

of the ruling classes and to direct resources in ways that protect and enhance the favored position of those with power and influence. Still others may view the State as having a large degree of autonomy; thus being relatively independent of either society as a whole or of the ruling classes. The consequence of not having a theory of the State's role is that its various actions in relation to farmer-managed systems are presented in an anecdotal and atheoretical manner. One result is that the undesirable effects of public intervention tend to be blamed on inadequately trained staff, insufficient resources, or greedy public servants.

AN ILLUSTRATIVE AGENDA FOR FUTURE RESEARCH

Over the past 10 years, studies of farmer-managed irrigation systems, and of public interventions to assist them, have multiplied vastly. During this decade, we have seen growing recognition of the importance of farmer-managed systems on the part of national governments and international donors. No longer are farmer-managed systems merely of academic interest; they are the object of many public programs in irrigation development, and are now within the purview of most mainline irrigation agencies. Moreover, it is not just a matter of irrigation departments forcing their assistance on farmer-managed systems; in many instances, the request for help from the farmer group is strong and persistent. Thus, there are both supply and demand forces at work, which has profound implications for a relevant research agenda for the next decade.

In our judgement, two of the dominant trends in present public intervention programs must be modified: 1) transforming highly autonomous farmer-managed irrigation units into systems that are overly dependent on State actions, resources, and staff; and 2) forcing a standard efficiency logic of operations, and the accompanying hardware to operationalize that logic, on these farmer-managed systems, many of which have multiple objectives and whose logic may or may not emphasize the efficient use of water.

These are endemic problems in the public intervention programs aimed at improving farmer-managed systems. A research agenda focused on these systems should address these problems explicitly. We believe that an agenda, organized to address the following four questions, but not limited to them, is a step towards that objective

- * What are the forces leading to government intervention?
- * What are the factors leading to dependence?
- * What are appropriate planning, design, and operational criteria?
- * What are the effects and implications of extended involvement of government in farmer-managed irrigation systems?

What are the Forces Leading to Government Intervention?

It can be hypothesized that these forces derive from factors internal to the particular irrigation system, the local community of which it is a part, and the context in which both operate, and other factors that are associated with the State and its environment. These factors lead to several specific research issues.

Labor dynamics and farmer-managed systems. Most studies of farmer-managed irrigation systems have shown that their O&M processes are labor-intensive and that their reproduction is highly dependent on the ability to mobilize labor supplies. There often has been the assumption that in the developing country situations in which we are working, labor is abundant rather than scarce. However, new work on labor dynamics in rural areas has shown that as rural households become integrated into wage labor and commodity markets, they often experience complex and contradictory pressures on their labor supply. Collins (1986) states the arguments as follows:

Labor availability in contemporary communities cannot be understood apart from the processes of semiproletarianization that are affecting rural households. Family members may be involved in subsistence production one month, petty commerce another, and seasonal migration to use their labor power during the dry season. The need to participate in these diverse activities is frequently related to a diminishing land base, or to declining terms of trade. This dynamic may lead to problems of labor scarcity.

Labor scarcity may in turn lead to patterns of poor resource management. Thus a vicious circle of impoverishment is created (Collins 1986:26).

This perspective of labor dynamics could be highly relevant to the farmer-managed irrigation systems that we are studying. It could partially explain the interest on the part of local groups in external assistance that they hope will ameliorate labor constraints. Faced with the difficulty of mobilizing sufficient manpower for system repairs and operation, farmer groups may turn, however reluctantly, to the State to take over system operation and maintenance. Note also that many State intervention programs assume that the irrigation group will implement the necessary operation and maintenance activities following the State's intervention. Frequently, this does not occur. Again, part of the explanation may lie with the changing labor dynamics of the irrigation households and not just with perverse ideas about government being responsible for what it builds.

In brief, whether or not changing labor dynamics are altering the ability of an irrigation group to mobilize needed manpower, is an empirical question. Labor dynamics may be a factor in explaining key processes, such as system operation, calls for external assistance, and reaction to public interventions.

Collins (*ibid.*) makes several points regarding research strategies for the study of labor dynamics that have direct relevance to farmer-managed systems. First, she argues the need to determine labor availability or scarcity in specific regional and temporal contexts. We could add to that: in specific system contexts. The suggestion here is not to assume that labor scarcity is a problem in all farmer-managed systems, but rather to make labor dynamics a specific part of the inquiry regarding system management.

Second, she argues the need to "...be able to recognize communities stressed by the growing need to sell off-farm activities, and land that is poorly managed as a result of strategies to meet short-term needs" (*ibid.*).

Modifying this for our situation, one could propose that we need to be able to recognize farmer-managed systems that are being stressed due to changing labor dynamics with the result that system management is poor or deteriorating. Collecting information on the percentage of income derived from off-farm sources or the percentage of income derived from non-irrigated agricultural activities or both could alert the researcher to a possible labor-stress situation. Moreover, identifying such stressed systems would be a first step in developing public intervention policies that are sensitive to this condition, rather than exacerbating it. One can expect that public investments in labor-stressed systems are unlikely to result in desirable consequences unless the intervention directly confronts that labor problem.

Farmer-managed systems in a regional context. A concern with labor dynamics is one facet of a more comprehensive perspective that views individual farmer-managed systems as part of a larger regional political economy, a network of relationships by which the local system and its users are connected to the State and its bureaucratic apparatus as well as to an external economy, often a world economic system.

It is easy to overstate the historical autonomy of farmer-managed systems -- to assume that they were once unconnected to any larger economy or polity -- and thus to misunderstand the significance of present State involvements with them. Important recent scholarship has called into question, many of these prior assumptions regarding historical connections (Roberts 1967; Calavan 1974; Ludden 1978, 1979). We have learned that many, perhaps even most, locations were within the spheres of influence of some regional realm, and that patterns of trade were remarkably far-reaching. Ganjanapan's (1984) discussion of the development and change of the people's irrigation systems in a district of Chiang Mai province at the turn of the century illustrates this point. In this period, the Bangkok-based kingdom of Siam extended political control over the Chiang Mai-based kingdom of Lan Na and, simultaneously, the construction of a railroad linked the Chiang Mai region with the world rice market. Both of these processes created significant incentives for the regional elite to invest in the development of local irrigation facilities.

The understanding of these historical connections suggests that many of the systems that we now see as indigenous and independent may in fact have origins associated either with general policies of some earlier State or with direct past actions of the State. That is, the State has been an important part of the environment in many farmer-managed systems, historically as well as in the contemporary period. The same can be said regarding trade.

This view can be important to conceptualize the research problem dealing with public intervention in farmer-managed systems. By hypothesizing an extended period of State involvement rather than merely a recent one, the researcher is led to several novel questions. What was the nature of State intervention in the earlier period? What of those earlier forms of intervention has persisted, and what has been modified? What factors have contributed to continuity and to change in State assistance to farmer-managed systems?

The simple paradigm that identifies local systems in an earlier non-intervention period in contrast to current farmer-managed systems in which intervention is occurring may apply in relatively few situations. More likely, we would be observing cases in which there is a long history of State involvement in the local system and the nature of this intervention may have changed little, or dramatically, over time. These changes may be producing sociotechnical results rather unlike the results of the prior era. Adopting a paradigm that explicitly assumes some prior form of State intervention until otherwise empirically determined, would alert the researcher to search for continuity and change in State actions. It would also prompt an analysis of the extent to which the positive or negative outcomes of the intervention might result from a misfit between the present regional situation and changes or consistencies in the form of State intervention.

Studying the irrigation bureaucracies. A large factor determining the outcome of public intervention in farmer-managed systems is the implementing bureaucracy. However, most studies focus only on the outcomes of public interventions -- a pump installed, a division box mislocated -- not on the agency processes that led to that result. Thus, to a very large extent, the processes and procedures of public intervention remain a black box. There are some exceptions. In the context of the participatory approach to communal irrigation development in the Philippines, attention was given to understanding how the technical agency and its staff were organized (Alfonso 1981). In addition, through the use of a research technique called "participant observation" (de los Reyes 1984), researchers were able to collect information on agency decisions and interactions with local groups more or less as they occurred.

However, in general, our understanding of what occurs within the farmer-managed systems (and, to some extent, why) is now superior to our understanding of what occurs within agencies planning and implementing public assistance for such systems. Without understanding the latter, we are unlikely to understand the limits to agency actions or the forms of assistance most readily supplied by the State apparatus. There seems to be little likelihood that we can make progress in improving public intervention without a significant increase in our understanding of the relevant bureaucracies.

The research strategies and techniques for studying irrigation bureaucracies will both parallel and differ from those we use to study irrigation communities. While irrigation bureaucracies that implement programs for farmer-managed systems are practically unstudied, bureaucracies in general are a focus of many social inquiries, including some work on irrigation bureaucracies concerned with administering large-scale systems (Moore 1980, Lees 1984). Work on this topic should begin with a review of current theory and research in formal organizations.

Two important parallels should be followed. First, the dominant research design should be "field studies;" that is, the study of agencies in context doing their normal tasks. Researchers should be participant observers within these contexts -- attending meetings, accompanying staff as they go about their routines, "hanging around" during tea breaks, and so forth. In effect, for the agency analyst, the office (and, by extension, the field in which the staff operate) becomes the "village."

Second, studies should be done with the interdisciplinary perspective that has informed much of our study of farmer-managed systems. An irrigation agency is not just a formal organization, it is a formal organization with specific irrigation-related functions that have high engineering content and, frequently, high economic content. Many of the processes and procedures used in the agency will be justified with regard to some engineering or economic "need." Thus studies of such organizations, and explanations of staff behavior, are likely to be unsatisfactory if based only on a single disciplinary viewpoint, such as sociology or public administration.

While the above parallels are important, a potentially important difference must be considered: the matter of access. Gaining access to farmer-managed systems, while not always simple, usually can be achieved because there are many such systems; if access is difficult in one, an alternative can be approached. Moreover, since the researcher is often seen to be in a superior social position to the villagers in a farmer-managed system, access often is tolerated. None of this is meant to minimize the important issues of establishing rapport between the researchers and local people, even in a location where access has been provided.

But irrigation agencies clearly are very different social entities. In dealing with them, the researcher may not be operating from a position of perceived social superiority. Moreover, there may not be several irrigation agencies to choose from; being turned down by one may preclude the ability to conduct the research (unless one is in a position to move between countries or perhaps between distant regions in a large country). Thus, the matter of access is not inconsequential.

One approach to this access problem is what might be called the "management consulting approach." The researchers work closely with the agency to understand its processes and procedures, consulting with the agency regarding desirable changes and improvements. Disadvantages of this approach might include the need for the analyst to make the study results confidential and not available to the general research community. Such confidentiality would severely limit the ability to draw contrasts and comparisons across agencies and thus to begin processes of generalization and model-building.

An alternative approach would be to enter the agency setting in a more traditional research role with support from and accountability to someone other than the agency staff -- perhaps to a superordinate agency, such as a planning ministry. In this case, more effort would probably be required in developing researcher-staff rapport, but the study results could be more widely available for reporting and debate.

No doubt, different irrigation agencies will be differently disposed to permit research on themselves. In some cases, it will be necessary, perhaps even desirable, to begin with the management consulting approach. In others, an agency may have enough self-confidence to allow the traditional research approach to be employed. Researchers should be prepared to proceed using whatever approach is initially acceptable to the agency, while constantly seeking opportunities to move study results into the public arena for discussion and debate, and thus contributing to our cumulative knowledge of agency processes.

What are the Factors Leading to Dependence?

Increasing dependence can be a result of persistent or extraordinary lack of fundamental resources on the part of the irrigators, of governmental policies which indirectly disadvantage these farmers, of intervention practices which reduce the effectiveness of small group action, or of deliberate governmental policies and practices designed to decrease independence for political objectives. This view of the potential causes of dependence suggests an additional set of research issues.

Studying farmer-managed systems that do not function -- the "autopsy approach." Some critics of the existing research on farmer-managed systems have noted that most studies have focused on systems that are functioning well. The result is that farmer-managed systems are all depicted as operating smoothly, while it is clear to many observers that there are numerous examples of local systems that have fallen into disrepair and disuse. No doubt there has been a tendency for researchers to search for sites where things are operating well because in these systems there is an opportunity to see the various social processes of irrigation occurring and to obtain details on rules and roles that are functional. Research sites with these characteristics were required precisely because the research was concerned with understanding how farmer-managed systems operated and why. Thus, non- or poorly functioning systems represented unsatisfactory sites for the research purposes at hand.

Now, however, in attempting to understand public intervention strategies and outcomes, and in the light of the considerable body of available information regarding the processes occurring in functioning systems, the importance of studying farmer-managed systems that are not operating well increases.

For one thing, such systems will often be the target of public intervention. Farmers in such systems may be the ones agitating for public assistance. And the State's perception of the problems of these "poor" systems will be the basis of policy formulation and program planning. Consequently, there is a definite need for research that examines the factors related to the unsatisfactory operation of these systems. Why have systems fallen into disuse? Why are systems that once operated effectively no longer able to do so?

One might call this the "autopsy approach." We presume that a satisfactory study of these nonfunctional systems will require an interdisciplinary approach because the causes of system decline may lie in any of several different domains: changes in hydrologic conditions, changes in prices or public policies, changes in land ownership, unmanageable social conflicts, and so on. Sorting superficial from deep causes would be important. Likewise, trying to determine which causes, if any, could be ameliorated through public intervention should be given priority.

Work on nonfunctioning systems and the identification of factors related to system decline, combined with existing research on the social processes occurring in performing systems, should yield better insights regarding the most appropriate forms for public intervention in particular regions and areas. For example, some public intervention programs

are working on the premise that problems lie below the point of diversion within the command area of the farmer-managed systems, and thus their interventions are targeted at hardware and software intended to improve the management of water at that level. Other public agencies are minimizing their involvement at that level of the system and focusing their attention on improving regulation of the hydraulic flow above the point of water diversion or capture by the various farmer-managed systems. Choices between these approaches, and others to be identified, should be derived from a broader database that is built on studies of both "good" and "bad" farmer-managed systems.

Hazard research and understanding public interventions. Recent writing in ecological anthropology suggests that researchers concerned with the interplay between habitat and social organization begin by identifying the hazards that individuals face in their environments. They then proceed to examine the various responses, individual and collective, that people develop for dealing with these hazards (see Vayda and McCay 1975). Lees (1980) has extended this line of thought to the analysis of development projects. She argues that examination of development projects should include attention to the following questions:

- a) What are the hazards that exist in the pre-project situation and how are local people organized to respond to these hazards?
- b) What new hazards may be embedded in the project's solutions for resolving the pre-project hazards -- including the likely attrition of pre-project hazard response patterns and institutions developed locally?

This general approach could be useful in examining public intervention to assist farmer-managed irrigation systems. The analysis would begin with attention to the risks and hazards that are involved in the operation and use of the pre-project irrigation system. Answers would be sought to the broad question of who in the pre-project system responds in what ways to what hazards. The next logical question would deal with the actions taken by the State: Whose ability to respond to which hazard and by which means has been improved or reduced? Finally, the analysis would pursue the question: Will the State's actions create any new hazards and, if so, who is expected to respond in what way to these?

Examining cases of State intervention in farmer-managed systems within this inquiry frame could serve to highlight several important matters. First, it facilitates identification of the sociotechnical processes by which irrigators, individually and/or collectively, respond to threats and perturbations in their environment, in the hydraulic works, and in the derived water supplies. Second, it helps clarify the degree of conformity in perceptions of system problems as held by the irrigators, on the one hand, and the State's agents, on the other. Third, it highlights the State's actions and tests them in terms of their likelihood to constitute a novel hazard for the local group or to attenuate existing response patterns. And finally, assuming that the State's actions may introduce some new hazard(s), it allows the analyst to identify the presence or absence of expected response capability on the part of the users. Solid research and analysis and the development of improved policies and guidelines can be expected to follow from the application of this perspective.

What are Appropriate Planning, Design, and Operational Criteria?

The identification of appropriate criteria on which to base changes in farmer-managed systems is relatively difficult. This is partly due to conflicting views of the current performance of these systems and to differing perspectives regarding system objectives. This suggests the following research issues for consideration:

Improving the conceptualization and measurement of system performance. Most irrigation improvement activities are explicitly intended to increase the performance of some existing irrigation system -- yet system performance remains one of our most elusive concepts. Only two of the numerous studies of farmer-managed systems are explicit about the meaning of good system performance or incorporate empirical measures of system performance. The first is Oh's (1978) study of small tank systems in Korea in which he attempts to evaluate the "customary rules of reservoir management" being used in a sample of 64 systems from which data was collected. There are more than 15,000 small reservoirs (command area of less than 50 ha each) in Korea, operated by farmer groups coordinated by local government authorities. One important aspect of the study is Oh's explicit conceptualization of system performance. He notes, for example, that:

The practical goal of management policy should be to provide the minimum security guarantees (of water rights) to induce cooperation of all irrigators in system maintenance and water resource conservation (ibid.: 105).

In some ways, this represents a rather straightforward conceptualization of good management: A well-managed system is one that delivers water with a degree of certainty that motivates the users to cooperate in maintaining the system and allocating water effectively. These concepts would undoubtedly be difficult to operationalize in a field setting. While Oh's research methodology is overly dependent on a questionnaire approach, his work is to be commended for the unambiguous concern with understanding management performance and the role of institutional arrangements, especially the hypothesized effect of secure water rights, in contributing to good performance.

A second study that gives direct attention to conceptualizing and measuring performance is Vermillion's (1986) study of two farmer-managed systems in northern Sulawesi, Indonesia. He tackles the difficult issue of assessing the impact of various forms of informal behavior among the irrigators (water borrowing, negotiating special deliveries of water, etc.) on the actual "efficiency and equity of water allocation" (1986:254). To achieve this goal, Vermillion required measures of water supplies across space and time. This he did by collecting field measures of concepts such as relative water supply, field water depth, and relative water adequacy. With these measures of system performance in hand, he was able to reach conclusions such as the following:

So the observed prevalence of interpersonal water allocating in these systems had not meant disorder or a basic misallocation of water by any apparent criterion. On the contrary, such practices generally are adaptations which roughly serve to counteract the effects of the physical inequalities among irrigated plots (ibid).

If we are to make progress in analyzing the impact of public intervention on the performance of farmer-managed irrigation systems, we need to have clear procedures for assessing performance -- ideally, before and after the intervention. This area of research overlaps with research on government-managed systems in which performance is also a key concept without conceptual precision or associated operational measures.

The growing importance of water rights. Completed research has demonstrated the importance of secure water rights for the successful operation and continuity of farmer-managed irrigation systems (Martin 1986, Cruz 1986). This research is consistent with theoretical ideas from economics and sociology on the role of property rights in creating incentives for individual and group actions (Hollowell 1982, Macpherson 1978). In the past, given the low intensity of irrigated agriculture in many of the regions where farmer-managed systems are located, such systems have been able to guarantee rights to their members. Now as competition from other users increases, including competition from the irrigation department, more and more farmer-managed systems are faced with insecure conditions for their water rights (Korten 1985). The continued development of irrigated agriculture in a region, particularly when the State is one of the development agents, can have the effect of eroding or eradicating the legitimate rights of existing water users. It appears that one effect of public intervention in farmer-managed systems is to disrupt the security of water rights held by traditional users (Pradhan 1984). In effect, the State often trades "improvements" for control, but usually not guarantees, of water rights. This increase in uncertainty can have negative impacts on the legitimacy of the irrigation organization involved in operating a farmer-managed system. An ambiguous situation of water rights also can lead to undesirable policies and actions by the agency because there is no clear limit to acceptable action on their part.

What Korten (ibid.) has noted for Southeast Asia may apply more widely. Few countries now have an "operational program" for allocating and enforcing water rights to groups and individuals in society. However, it may be that this is one of the more important functions that the State can perform in support of irrigation development. Clearly, it is a State function and not one that can be performed by the local groups themselves. Second, without secure water rights, the incentives for existing farmer-managed systems to continue, or for new ones to form, will be reduced.

Cognitive studies of farmer-managed systems. Earlier, we noted the common tendency in public intervention programs to impose a logic of water efficiency on farmer-managed systems -- a logic that many analysts either carry with them from particular settings in which water is scarce or which they carry as part of their socialization in a professional discipline (especially the disciplines of engineering and economics). But not all farmer-managed systems operate either in a setting of water scarcity or in settings in which water efficiency is given primary utility. In a recent survey of literature on local irrigation systems, we concluded that a fundamental principle of the systems studied was equity, operationalized through a fair allocation and distribution of water (Levine and Coward 1986).

The argument here is not that a logic of equity characterizes all farmer-managed systems, but rather that there is a need to study systems to determine empirically the

underlying logic and fundamental values on which operational choices and decision are based. That is, there is a need to study these systems to determine the ideas that are used to give meaning and order to them. This "cultural analysis approach" to irrigation is illustrated in the work in Morocco of Geertz et al. (1979). Vermillion (1986) in his fieldwork in northern Sulawesi has also applied this approach in attempting to ascertain local concepts and meaning of crucial behavior, such as "water borrowing." A number of researchers in the Andean region have focused on ritual activities in farmer-managed irrigation systems as a means to understanding the structural principles and underlying values that energize these systems (Isbell 1978, Sherbondy 1986).

A fuller understanding of this cultural dimension of farmer-managed systems is needed for very practical reasons. First, these cultural ideas are often central to the everyday behavior we observe in system operation (water sharing, mobilizing labor for needed repairs, etc.), and give meaning to these activities beyond the material consequences. Second, they are the least visible elements of the local scene, and therefore the least likely to be understood and considered in planning and executing a program of public intervention. And finally, they are likely to be in strong contrast with the implicit cultural ideas of the technocratic irrigation department. For this reason, our understanding of the outcome of public interventions of farmer-managed systems may be enhanced if we operate from a sound cultural analysis of the farmer-managed systems (as well as of the implementing agencies) and anticipate project outcomes that reflect local cultural accommodations.

What are the Effects and Implications of Extended Involvement of Government in Farmer-Managed Irrigation Systems?

Providing answers to this broad question depends on our broadening the scope of inquiry regarding effects and implications. In particular, we suggest the following issue: Analyzing long-term public intervention in farmer-managed systems.

As noted previously, State intervention in farmer-managed irrigation systems is not a new phenomenon. In areas such as Bali (Indonesia), Ilocos Norte (Philippines), and Chiang Mai (Thailand), public programs that intervened in farmer-managed systems began early in the 20th century. However, to our knowledge, there have been no studies that examined the impact of this long-term government involvement. Such work would be compromised by the lack of pre-project data. Most studies of public intervention have focused only on very recent State activities. For example current research on public interventions in the Balinese subaks is primarily concerned with contemporary interventions, although there were significant State involvements in some subaks during the earlier Dutch colonial period (Sutawan et al. 1983).

Looking only at current State actions and only very soon after they have been completed, may distort our understanding of the processes and outcomes of public intervention. Following any public intervention, there is perhaps a period of disorganization during which learning about and adjustment to the new hardware or software will occur. If this is the case, and if most of our studies are conducted during that transition period, the result could be an overly pessimistic assessment of the impact of public intervention on these

systems. To avoid this possible bias in research findings, several research designs could be utilized:

1. research sites in which a longer time has elapsed between the period of intervention and the period of study should be included in the analysis; or

2. a longitudinal research design could be employed that would follow particular sites in which intervention has occurred for a longer post-intervention period to ensure that observations were being made beyond the initial period of confusion and disorganization; or

3. research sites in which initial public intervention occurred much earlier -- several decades or more -- could be investigated to understand long-term effects better.

Any or all of these alternatives would complement our present work and add depth to our understanding of public intervention processes and outcomes. Such studies may be more difficult to fund because they are not as directly related to immediate agency problems and concerns. However, it may be that some ingenious research project designs could incorporate a few such sites along with the more conventional sites, thus providing useful comparisons while allowing the researchers to provide immediate feedback to the sponsoring agency.

Conclusion

This agenda for future research on public intervention in farmer-managed irrigation systems is intended to be suggestive rather than definitive and illustrative rather than comprehensive. However, we think it identifies major breaches in present understanding and gaps critical to the formulation of improved public policies. Nevertheless, contributions to its refinement or perhaps to its complete reformulation are welcome.

NOTES

¹*Editor's Note:* the authors' use of "State" and "government" has been retained.

²All the examples in this section deal with studies of contemporary as compared to ancient irrigation situations. However, it should be noted that there is a considerable body of archeological literature concerned with irrigation and sometimes specifically with the interaction between State and locality in irrigation matters.

³Three other remarkably detailed ethnographies are Gray (1963), Eldblom (1968), and Hart (1976).

⁴*Editor's note:* A group of languages spoken in southeast Asia, including Thai, Lao, and Shan.

⁵An interesting example of this point arises in the context of the Muang-Fai systems of northern Thailand. Many of these systems use a technique of constructing twin weirs at the point of water diversion from the stream. While several social scientists have noted such structures, there has not, as yet, been a careful study of their purpose and function from an engineering point of view.

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