ORGANIZATIONAL STRUCTURE FOR RESOURCE MOBILIZATION IN HILL IRRIGATION SYSTEMS

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INTRODUCTION: HYPOTHESES

Farmer-managed irrigation systems exhibit a diversity of organizational structures and varying degrees of formality of structure. This paper analyzes factors that potentially influence the degree of formal structure of the organizations of farmer-managed irrigation systems in the hills of Nepal. The paper is based on one-and-a-half years of field research conducted by the authors in 1982-83 on eight farmer-managed systems. These systems are located in four villages in the mid-hills of the districts of Palpa, Gulmi, and Nawalparasi. Information from these eight intensively-studied systems was supplemented by rapid appraisals of an additional ten farmer-managed irrigation systems. Table 1 presents some basic information of the eight systems.

Tahle 1. Basic information on the eight irrigation systems studied.

System	Command Area (ha)	Irrigated Area (ha)	Percent Irrigated	Number of Members	Canal Length (km)
Thulo Kulo, Chherlung	41.7	34.8	83	105.	7.0
Raj Kulo, Argali	102.9	46.5	45	158	3.0
Tallo Kulo, Chherlung	23.9	17.9	75	61	6.5
Saili Kulo, Argali	14.9	14.9	100	51	2.5
Kanchi Kulo, Argali	14.2	10.7	75	28	2.0
Maili Kulo, Argali	15.8	15.8	100	72	2.7
Damgha Kulo, Majuwa	27.5	27.5	100	111	2.5
Tallo Kulo, Thambesi	50.0	22.6	45	55	0.2

It was expected that organizational structure would vary among $:>-stems, and one aim of the research was to understand, in broad terms, the factors causing the organizations to be structured differently. The hypothesis that guided the development of the study and selection of research sites was that the level of formal structure of the farmer irrigation organizations would be inversely correlated with the water supply relative to the area that could be irrigated. The effort and discipline needed to distribute efficiently and equitably a scarce water supply would require the organization to be structured with a higher degree of formality than if the water supply was abundant.

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There are other factors that may contribute to the level of formal organizational structure, and several additional hypotheses will also be investigated. It may be that the relationship of organizational structure to water supply is not an inverse relationship but rather an inverted U-shaped one, i.e., little formal structure at the extremes of water supply and more in the middle of the spectrum.

If a system is not irrigating the entire hydraulic command area, it may be that a stronger and more formal organization is needed to limit access to the water and prevent those on the periphery of the irrigated area from stealing water or pressing to require the organization to allow them access to water. Certainly the need for formal organizational structure is likely related to the size of the organization, at least when it reaches a certain threshold.

The ability of each of these factors individually to explain the observed difference in degree of formal organizational structure will be analyzed. Finally, the need to mobilize resources every year for the ongoing maintenance of the system will be argued to be the most significant factor influencing the level of formal organizational structure observed in farmer-managed irrigation systems in the hills of Nepal.

MEASURE OF THE DEGREE OF FORMAL ORGANIZATIONAL STRUCTURE

Before analyzing the possible determinants of organizational structure, it is necessary to rate the different irrigation management organizations according to the degree of formal structure. The formal structure of an organization can be described with reference to the following indicators: designated roles within the organization, its meetings, and the type of written records that it maintains.

Description of Organizations

The Thulo Kulo system of Chherlung exhibits the highest level of management intensity and organizational structure among the sample systems. There is significant differentiation of functions among the 105 members with an elected leader (mukhiya), secretary (sachiv), and management committee. The organization holds regularly scheduled meetings for conducting business and making decisions at which attendance is mandatory. Minutes are recorded of the meetings, and written records of members' water allocations and attendance at work, as well as accounts of the organization, are maintained. Fines are imposed for missing work.

The degree of formal organizational structure and management of the Raj Kulo of Argali is among the highest observed. The Raj Kulo organization has a written constitution and a number of elected functionaries. It maintains written records of the 158 members' attendance at work and their water allocations, the organization's accounts, and minutes of meetings which are signed by all members present. Sanctions for missing work or stealing water are set and enforced. Regular and extraordinary meetings of the organization are held to discuss plans, elect officers, present financial reports, and make policy decisions. Each year an audit committee is appointed to examine the accounts. Sometimes special committees are appointed to develop proposals for consideration or to carry out specific tasks.

The Tallo Kulo of Chherlung also exhibits a high degree of formal organizational structure with ten officers, a management committee, regular meetings, attendance records, minutes, accounts, and a sophisticated record of members' water allocation. Fines for absence from work, dirtying the main canal, and water atealing are imposed.

The Maili, Saili, and Kanchi Kulo organizations of Argali have similar management organizations. 'They all have elected officers; hold regular meetings; and maintain written minutes, records of merbers' attendance at, wcrk, and accounts. They establish and enforce sanctions for missing work. Maili and Saili Kulo systems are land-constrained, i.e., there is no additional area that could he irrigated and the area irrigated equals the hydraulic command area.

The Damgha Kulo system in Majuwa is land constrained, and the water supply relative to the hydraulic command area is abundant. The observed level of organizational structure was low, although there is more structure than in the Thambesi system. There are no elected officers in the organization. Functioning as a de facto leader is one of the members who has been awarded a contract for carrying out all of the maintenance on the main canal. Since members pay him according to their water allocations, he keeps a record of the allocation of each of the 111 members and of their payments. Other than this there are no written records. There are two regular meetings of the organization during the year.

In the Tallo Kulo system of Thambesi, the water supply is very scarce. necessitating intensive rotational distribution throughout the season. The organization, consisting of 55 farmers, has no designated officers or functionaries, holds no regularly scheduled meetings, does not have established sanctions for infractions, and maintains no written records except a list of members.

Methodology

The degree of organizational structure has been quantified by giving one point for the existence of each of the following: management committee, membership list, record of members' water allocations, written attendance record, written accounts, minutes of meetings, written constitution, regular meetings, and established sanctions (fines). Table 2 records the observation of the indicators for each system. To these was added the number of designated functionaries or officers of the organization. One could question whether this number should be added to the others, but the higher this number, the more role specialization there is, which is an indicator of organizational structure.

The sum of the organizational structure indicators is used to rank the level of organization in each system. The ranking shown in Table 2 fits quite well with the subjective "feel"that we developed for the relative degree of structure during the one-and-a-half years spent in the different communities. A different rank ordering of the systems is generated by each hypothesis that is tested. The ranking of the systems, according to relative degree of formal organizational structure, predicted by each hypothesis will be compared with that given in Table 2. The Spearman rank correlation coefficient will be used to test whether the two rank orderings are significantly different or not.

Organization as a Function of Relative Water Supply

It was expected that the management organization of systems with a scarce water supply would be more structured than that of systems in which the water supply was relatively abundant. A stronger organization with clearly defined rules and sanctions would be required to efficiently capture, convey, arid equitably distribute a scarce supply of water among the member farmers' fields lhan would be needed if the supply were abundant. Increased management intensity to manage scarce water more efficiently requires not only more control over water (physical control). but also increased control over human behavior (social control), resulting in the need for a more formal or structured organization. An organization distributing water by rotation requires a specified distribution plan and the ability to discipline its members to follow the rotatiun. If water is scarce, there will be more likelihood of water stealing and conflict; hence a method of managing conflicts, including a process for adjudicating complaints and applying and enforcing sanctions against offenders, is needed.

Table 2. Summary and rating of observed levels of organizational structure.

System	A	B	C	D	E	F	G	H	I	J	K	L	Rating
Thulo Kulo, Chherlung	11	1	1	1	1	1	1	1	0	1	19	1	V. High
Raj Kulo, Argali	10	0	1	1	1	1	1	1	1	1	18	2	V. High
Tallo Kulo, Chherlung	10	1	1	1	1	1	1	1	0	1	18	2	V. High
Saili Kulo, Argali	3	1	1	1	1	1	1	1	0	1	11	4	Medium
Kanchi Kulo, Argali	2	0	1	1	1	1	1	1	0	1	9	5	Medium
Maili Kulo, Argali	2	0	1	1	1	1	1	1	0	1	9	5	Medium
Damgha Kulo, Majuwa	1	0	1	1	1	0	1	0	0	0	5	7	Low
Tallo Kulo, Thambesi	0	0	0	1	0	0	0	0	0	0	1	8	V. Low

A - Number of officers
B - Management committee
C - Regular meetings
D - List of meetings
E - List of members' water allocation
F - Work attendance record
G - Accounts
H - Minutes
I - Constitution
J - Fines
K - Indicator (Sum A through J)
L - Observed rank order (1 equals highest)

Downing (1974) refers to this as the "excess scarcity hypothesis." The hypothesis is of the form "scarce water = more conflicts = more social control" (1974:119). He argues that it is not scarcity per se, hut scarcity relative to the crop's demand for water, i.e., a low relative water supply, that leads to more conflict necessitating more social control. He hypothesizes that "water scarcity during the (crop's) moisture-sensitive period forces some kind of rigid social organization to allocate water" (1974:121)

Observation of the technology and management practices used for distribution of water revealed that more intensive efforts were employed when the supply was relatively scarce than when it was abundant. The Damgha Kulo system of Majuwa, with the most abundant water supply, used several saachos (proportioning weirs) to distribute a measured allotment of water from the main canal into secondary canals. From below the secondary level, continuous-flow distribution without measuring devices was practiced.

The four systems in Argali used saachos to apportion the water from main canal to secondary canals and from secondary canals to field canals. In some parts of the Raj Kulo, saachos were used to distribute water from field canals into individual farmers' fields. Systems with a scarcer supply were not able to distribute water continuously to the entire irrigated area. Both systems in Chherlung practiced rotational distribution below the secondary canals, beginning part way into the season. The Tallo Kulo system of Thambesi with the scarcest supply had to distribute water by rotation throughout the season.

The eight irrigation organizations will now be analyzed to test the hypothesis that the level of formal organizational structure is inversely correlated with the water supply. This comparison among systems analyzes how the Organizations are structured for irrigation management during the monsoon rice season. The primary purpose of all the systems is irrigation of the monsoon rice crop, and the organizations are structured for carrying out the activities necessary to successfully irrigate this crop. Some inter-seasonal comparison of management practices within a single system will also be included.

Relative water supply in this analysis is defined as the supply of irrigation water divided by the demand, where demand is evapotranspiration plus seepage and percolation, used to grow rice on the irrigated area. A further distinction of land area is made to define "gross relative water supply" (GRWS) and "net relative water supply" (NRWS). The GRWS is defined as the ratio of the available water supply to the water needed (water demand) to grow a crop on the potentially irrigable land area, i.e., the hydraulic command area.[2] The NRWS is defined as the ratio of the water supply to the water needed to grow a crop on the actually irrigated land area. The crop in the analysis is rice, and the demand is an average figure for the season, assuming that the soil is kept in a permanently saturated state without standing water on the surface.

Seepage and percolation rates measured in sample fields yielded an average demand over the season of approximately 4 liters/sec (approximate!:; 35 ha-mm/ha/day) in all sites. Compared to data from the Philippines (Valera and Wickham 1974) and Indonesia (Oad 19821, this demand is estremely high. However, farmers applied water at this rate and even higher, but no overland drainage was observed. The porous alluvial soils on the river terraces where the water table is far below the surface require very high rates of water application to maintain continuously ponded water in the fields.

The supply term of the GRWS and NRWS ratios is the total amount of irrigation supplied to the command area over a 98-day period from immediately after the seedlings were transplanted until the farmers dried their fields for the harvest.[3]

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[2]The available water supply used in this analysis is the discharge measured in the canal as it arrived at the command area. A more appropriate supply would actually be the flow in the stream at the diversion structure. It was not, however, possible to measure this on a daily basis because of the nature of the topography and stream discharge.

[3]Beginning the calculation after transplanting ignores the water needed for land preparation. This does not seriously affect the analysis because land preparation in these systems is accomplished in one day, using little water compared to the Philippines where the water utilized for land preparation may account for more than 30 percent of the seasonal requirement (Valera and Wickham 1974).

The expected ranking of systems was generated by 'the hypothesis that the degree of formal organizational structure would be inversely proportional to the GRWS. For example, a low GRWS would predict a high level of organizational structure, and a high GRWS, a low level of organizational structure. The hypothesis, thus, predicts that lhe Tallo Kulo of Thnmbesi, with the lowest GRWS would rank highest in degree of organizational formality and structure and Damgha Kulo of Majuwa with the highest GRWS, the lowest.

While the water supply may be scarce relative to the hydraulic command area, yielding a low gross relative water supply and a high expected level of formal organizational structure, the NRWS may not be low. This is because the area actually irrigated is often significantly less than the hydraulic command area. This can be seen in Table 1 where the hydraulic command area is compared with the area actually irrigated by the systems.

The Saili Kulo and Maili Kulo systems of Argali and Damgha Kulo system of Majuwa are land-constrained systems, i.e., the irrigated areas are bordered by other irrigation systems, major rivers, and drains which render irrigation of additional land unfeasible. The other systems are water-constrained, i.e., there is land in the hydraulic command area that is not being irrigated hut *to* which it would be feasible to deliver water. Table 3 presents both the GRWS and NRWS and compares the rank of the level of organizational structure predicted by each to the observed rank.

Since the GRWS in the Raj Kulo of Argali is low, the expected level of organizational structure is high. The GRWS and expected level of organizational structure of Argali's Kanchi Kulo are medium. However, the NRWS in these two irrigation systems is high and the expected level of organizational structure is low. In both of these systems there is additional area that could be irrigated, and the conclusion one would draw is that since the organization is using a large amount of water on a limited area it is weak and ineffective, and the organization of users is not using the scarce water resource efficiently.

Table 3. Predicted organizational structure determined by the GRWS and the NRWS compared to the observed rank.

Organization	GRWS	NRWS	Predicted Rank[a] GRWS	Predicted Rank[a] NRWS	Observed Rank
Thulo Kulo, Chherlung	0.82	0.99	4	3	1
Raj Kulo, Argali	0.60	1.34	2	6	2
Tallo Kulo, Chherlung	0.67	0.90	3	2	2
Saili Kulo, Argali	1.26	1.26	7	5	4
Kanchi Kulo, Argali	1.02	1.35	5	7	5
Maili Kulo, Argali	1.18	1.18	6	4	5
Damgha Kulo, Majuwa	1.70	1.75	8	8	7
Tallo Kulo, Thambesi	0.28	0.61	1	1	8

[a]Predicted rank of level of organizational structure (1 = highest).

It is true that the organization does not appear to hr using the water efficiently.[4] But this is not because the organizations are loosely structured or ineffective. On the contrary, both are highly structured and effective.

It is not ineffectiveness of the organizations which accounts for the high water supply relative to the area actually irrigated Rather the organizations are able, through the established tradition of water rights, to effectively restrict access to water from the system. Thus, only a portion of the hydraulic command area receives irrigation for monsoon rice, even though there is sufficient water to irrigate a larger area if a more intensive form of management of distribution were adopted.

ALTERNATIVE HYPOTHESES

The above discussion has examined the hypothesis that the level of formal organizational structure is inversely correlated with the relative water supply and found that it does not hold for **a** number of the systems that were studied. These results forced us to look for other explanations for the organizational structure.

Weak at the Extremes, Strong in the Middle

Since the level of formal organization in Damgha Kulo in Majuwa with a very high GRWS and **NRWS** and that of Tallo Kulo **in** Thambesi with a very low GRWS and NRWS were similar, we hypothesized that the relationship of management intensity and formal organizational structure to the relative water supply is described by an inverted U-shaped function as in Figure 1.

Figure 1. Organizational structure vs. water supply: an alternative hypothesis.

[4]It is important to introduce a caveat here. The use of water was only measured during one year in these systems. It may be that in some years with less rainfall the organization must work very hard to irrigate the area that we observed and that water-use efficiency would be much higher. From comparison of annual rainfall data from a meteorological station nearby, the rainfall in the year we observed was about average.

At the extremes where water is either very scarce or extremely abundant, increased management efforts through a stronger organization are either unproductive or unnecessary. The maximum returns to, and thus, incentives for organized group activity may be in cases of intermediate water supplies. This type of community response function was suggested by Uphoff, Wickramasinghe, and Wijayaratna (1981) in analyzing incentives for farmers' participation in irrigation system management.

By this hypothesis it would be expected that the Tallo Kulo system in Thambesi and the Damgha Kulo system in Majuwa would both have very low levels of organizational structure, as they do. The rank order predicted by this hypothesis is presented in Table 4 together with the observed rank from Table 2.

Table 4. Rank order of levels of organizational structure predicted by inverted-U hypothesis and compared to the observed rank.

System	Distance from Mean NRWS[a]	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	-.19	5	1
Raj Kulo, Argali	.16	3	2
Tallo Kulo, Chherlung	-.28	6	2
Saili Kulo, Argali	.08	2	4
Kanchi Kulo, Argali	.17	4	5
Maili Kulo, Argali	.00	1	5
Damgha Kulo, Majuwa	.57	7	7
Tallo Kulo, Thambesi	-.57	7	8

[a]Observed NRWS of the system minus mean NRWS of all eight systems.

The organizations which the hypothesis significantly misranked are the Maili Kulo of Argali and the two organizations in Chherlung. It could be that the midpoint between the two extremes of Majuwa and Thambesi does not really define the point at which the maximum incentives for strong organization are to be found. The maximum of the inverted U may be closer to the NRWS of the Thulo Kulo organization in Chherlung than to that of the Maili Kulo of Argali, which happened to be the midpoint between the observed extremes.

Organization to Restrict Access to the Water Resource

The high degree of formal organizational structure of both the Raj Kulo and Kanchi Kulo systems might be due to the fact that they are irrigating less than the entire command area, yet operating at a relatively high NRWS. An argument could be made that systems with a relatively high NRWS and a low GRWS will need to have a strong organization to be able to' restrict access to the water since there is additional land that could be irrigated. According to this hypothesis, systems which irrigate a low proportion of the hydraulic command area would exhibit a high degree of formal organizational structure and vice versa. Table 5 presents the ranking of the systems given by this hypothesis.

Table 5. Rank order of organizational structure predicted by the hypothesis that organizations are strong to restrict access to water.

System	Percent Irrigated	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	83	5	1
Raj Kulo, Argali	45	1	2
Tallo Kulo, Chherlung	75	3	2
Saili Kulo, Argali	100	6	4
Kanchi Kulo, Argali	75	3	5
Maili Kulo, Argali	100	6	5
Damgha Kulo, Majuwa	100	6	I
Tallo Kulo, Thambesi	45	1	8

One would think that since water is such a valuable resource, farmers whose fields are located so that they could be irrigated would be clamoring to force organizations like the Raj Kulo and Kanchi Kulo to allow them access to the water for irrigating monsoon rice. Surprisingly, very little of this type of sentiment was encountered. Several factors could explain this. First, the systems are very old, and the principle of water rights is so well established that people do not think of questioning it. Second, the information obtained concerning the development of these systems suggests that the relatively abundant supply may be a recent phenomenon. At least in the case of' the Raj Kulo, improvements in the system over the past two to three decades are said to have greatly increased the volume and reliability of the supply.

Pressure to allow greater access to the water may yet develop as farmers without a water allocation realize over a period of time that there is excess water in the system. Finally, the fact that all farmers with fields in the command area are permitted to use the system to irrigate wheat and maize in the winter and spring may remove some of the pressure to allow wider access to the water in the monsoon season.

Organizational Structure as a Function of Size

Size, especially the number of members, would seem to be an important variable explaining the level of organizational structure. Organizational theory says that, in general, an organization with a large number of members will be more formally structured than one with fewer members. While this may contribute to the level of formal organizational structure, it does not explain much of the variation observed among the systems. The Damgha Kulo organization with 111 members is the second largest organization, yet has a low level of organizational structure. The Kanchi Kulo organization of Argali with only 28 members is considerably smaller than all the other organizations. However, it has a considerably higher degree of formal structure than the Tallo Kulo of Thambesi, with 55 members, and the Damgha Kulo organization. The number of members in each organization and the ranking of the relative levels of organizational structure predicted by this hypothesis arc. given in Table 6.

Table 6. Number of organization members and rank order of organizational structure predicted by organization size.

System	Members	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	105	3	1
Raj Kulo, Argali	158	1	2
Tallo Kulo, Chherlung	61	5	2
Saili Kulo, Argali	51	7	4
Kanchi Kulo, Argali	28	a	5
Maili Kulo, Argali	72	4	5
Damgha Kulo, Majuwa	111	2	7
Tallo Kulo, Thambesi	55	6	8

ORGANIZATION TO MOBILIZE RESOURCES FOR SYSTEM MAINTENANCE - A TENTATIVE HYPOTHESIS

Implicit in the hypothesis that the level of organizational structure is inversely correlated with the water supply is the assumption that the organization is structured primarily for distribution of water. 'This may be true of farmer organizations within large irrigation systems which are jointly managed by an irrigation agency and farmer organizations. The agency may carry out all activities required to deliver water to a certain level within the system where it becomes the responsibility of the farmers' water-user organization to distribute it among the fields.

Rut there are other activities required for the operation of an irrigation system, and in different environments different ones may be more determinative of the organizational structure. After doing a rapid appraisal of irrigation systems in Iihairini in Gulmi District, we developed .an alternative hypothesis that better explains the organizational structure of farmer-managed irrigation systems in the hills of Nepal.

There are several irrigation organizations in Khairini, and all have an extremely abundant water supply. The organizations have almost no formal structure, much like the Tallo Kulo system in Thambesi which, however, has a scarce water supply. One of the Khairini organizations, however, did have a list of the members. Several years prior to our visit, this canal had been badly damaged by a flood. A list of the members had been compiled and attendance taken during the repair work. In thinking about this and reflecting on our observations of the other systems' organizations, we concluded that the mobilization of labor for maintenance of the system was a key activity in this environment and the factor which was most influential in determining the nature of the organizational structure. The greater the amount of labor that must be mobilized to maintain the headworks and main canal to capture and convey water to the command area, the more highly structured and formal is the organization. This was found to be true irrespective of the amount of supply available. In this environment of monsoon flood streams and unstable hill slopes, organization to maintain the system for water acquisition is more important than for water distribution.

Both the relative water supply and the need to mobilize resources for maintenance are, at least conceptually, important factors determining the structure of the management organizations of faimer-managed irrigation systems. The effect of scarcity of supply on the structure of the farmer-managed irrigation organizations has already been analyzed, and we have seen that, for the systems studied in the hills of Nepal, the relative water supply does not have the expected impact on the structure of the irrigation management organizations. The influence of the need to mobilize resources for water acquisition, particularly labor, on the level of formal organizational structure, will now be analyzed.

Analysis of Resource Mobilization and Organizational Structure

The critical organizational activity in many of the systems in the hill region of Nepal is resource mobilization for maintenance of the intake and main canal for water acquisition, and the structure of the organization reflects this. Many organizations do major annual maintenance in June prior to transplanting the monsoon rice crop. During the monsoon season, one or two men patrol the main canal every day to repair small leaks in the intake and canal and to alert other members if major damage, such as a landslide, has occurred, requiring emergency maintenance work by all members of the system.

If members of an irrigation organization have to invest a significant amount of labor, and sometimes cash, in order to acquire water, they will want to be sure that everyone who benefits contributes his fair share. Hence, in organizations that must mobilize a large amount of resources, written attendance records, sanctions for missing work, and audited accounts were found. The organizations' rules and minutes of meetings tend to focus on the issues surrounding the mobilization of resources, e.g., how much labor and cash members must contribute, the fines for not attending work, and circumstances under which one is excused from work. The main functions of the elected officers of the organizations are to organize and supervise the maintenance work on the system, keep accurate records of members' contributions, and enforce sanctions for failure to contribute as required. This is the case in Argali and Chherlung where the canals are from two to six kiiometers long, requiring many man-days of labor for maintenance prior *to* and during the monsoon season.

On the other hand, the system in Thambesi has a main canal that is less than 200 meters long and can be cleaned in one day with only a few members working. This has resulted in an organization that is less concerned that an accurate record of members' contributions be maintained and proportional contribution by all members enforced. The Tallo Kulo organization in Thambesi does not keep records of members' attendance at work, imposes no sanctions for being absent, maintains no written rules nor minutes of meetings, and keeps no accounts. The organization has no officers or designated functionaries.

All of the organizations in Chherlung and Argali have, in recent years, assessed cash contributions from their members to make improvements to their intakes and main canals. Keeping account of these contributions and the expenditures also requires a more formal organizational structure. The Damgha

Kulo system in Majuwa has the same need to record accounts since the maintenance is given out on contract. Contracts have also been given out several times for tunnel construction on the main canal of the Damgha Kulo system. The Tallo Kulo organization in Thambesi has not raised any cash from its members.

The records maintained by the organizations in Argali and Chherlung proved to be a good source of data concerning resource mobilization, particularly labor, over the years. No written records of labor mobilization were maintained by the Tallo Kulo system of Thambesi and Damgha Kulo system of Majuwa. An estimate of the total labor mobilized in Thambesi was made by taking the average number of days that the sample farmers reported they had worked on the system and extrapolating for the total membership. Maintenance of the Damgha Kulo is done on contract by several members. The value of the contract was divided by the daily wage rate to estimate the amount of labor mobilized.

Table 7 relates the amount of resources (man-days of labor) mobilized to the predicted and actual degree of formal organizational structure. According to Table 7, the level of formal organizational structure is highly correlated with the total amount of labor that must be mobilized annually in a system to acquire water, i.e., to maintain the intake and conveyance canal so that water can be delivered to the command area.

Table 7. Annual labor mobilization and rank of organizational structure predicted by resource mobilization compared to the observed rank.

Organization	Years of Labor Records	Total Annual Days of Labor Mobilized	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	3	2440	1	I
Raj Kulo, Argali	18	1909	3	2
Tallo Kulo, Chherlung	7	1979	2	2
Saili Kulo, Argali	4	1208	4	4
Kanchi Kulo, Argali	5	608	6	3
Maili Kulo, Argali	11	827	5	5
Damgha Kulo, Majuwa	a	440	7	7
Tallo Kulo, Thambesi	b	370	8	8

[a]Estimated by dividing the value of the maintenance contract. by the daily wage rate.
[b]Estimated by extrapolating from sample farmers' responses to a question about how many days they worked on the system.

It would seem that one could control for the scale of activity relative to command area. The amount of labor per hectare and labor per member are thus, other variables that should be examined, Table 8 presents an analysis of the predicted ranking of Organizational structure based on the labor required per hectare and per member.

Table 8. Labor per hectare and labor per member used to predict the level of organizational structure.

Organization	Man-days/ Ha	Predicted Rank	Man-days/ Member	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	70	3	23	3	1
Raj Kulo, Argali	41	6	12	5	2
Tallo Kulo, Chherlung	111	1	32	1	2
Saili Kulo, Argali	81	2	24	2	4
Kanchi Kulo, Argali	54	4	22	4	5
Maili Kulo, Argali	52	5	11	6	5
Damgha Kulo, Majuwa	16	8	4	8	7
Tallo Kulo, Thambesi	16	7	7	7	8

Neither man-days of labor per hectare nor man-days of labor per member proved to be as good as total labor for predicting the level of formal organizational structure in these systems, although both are better than the other variables which were tested.

STATISTICAL TEST OF THE RANKING OF ORGANIZATIONAL STRUCTURE BY DIFFERENT HYPOTHESES

A statistical procedure which can be used to compare the rankings of the organizations according to the predicted levels of formal organizational structure with the levels actually observed is the Spearman rank-correlation coefficient. It is a well-known non-parametric statistical method used to compare two rankings of a variable to determine whether they are statistically different (Snedecor and Cochran 1967:194). This statistic was calculated for the rankings predicted by each hypothesis, comparing the actually observed ranking of the levels of organizational structure from Table 2 with the predicted rankings. Table 9 reviews the rankings and presents the Spearman rank-correlation statistic for the ranking given by each hypothesis.

The ranking according to the total amount of labor mobilized for maintenance of the system is the one most similar to the actually observed ranking. The null hypothesis that they are uncorrelated is rejected at the 1% level. Annual maintenance labor per member is significant at the 5% level, and labor per hectare is the next best predictor. The two relative water supply variables are the poorest predictors for this sample of systems.

Inter-seasonal Comparison

All of the discussion and analysis above has been based on the organizations' activities and structure for the monsoon rice season. A comparison of organizations in this season with their activities and structure in the winter season supports the above conclusions. The Raj Kulo of Argali is a particularly striking case. In the winter, the water supply in the stream is much less than during the monsoon, yet the area that is irrigated is over 100 hectares compared to 47 hectares in the monsoon season. Farmers who do not have access to water for irrigating rice are permitted to irrigate wheat in the winter. This can be done because irrigation of wheat requires much less water than irrigation of rice.

Table 9. Ranking of systems according to **predicted** level of organizational structure.

System	Ranking Variable or Hypothesis								
	A	B	C	D	E	F	C	H	I
Thulo Kulo, Chherlung	1	4	3	5	5	3	1	3	3
Raj Kulo, Argali	2.5	2	6	3	1	1	3	6	5
Tallo Kulo, Chherlung	2.5	3	2	6	3	5	2	1	1
Saili Kulo, Argali	4	7	5	2	7	7	4	2	2
Kanchi Kulo, Argali	5.5	5	7	4	4	8	6	4	4
Maili Kulo, Argali	5.5	6	4	1	7	4	5	5	6
Damgha Kulo, Majuwa	7	8	8	7.5	7	2	7	8	8
Tallo Kulo, Thambesi	8	1	1	7.5	2	6	8	7	7
Rank correlation coefficient	-	.18	.14	.34	.19	.30	.98[b]	.68	.75[c]

A - Observed level of organizational structure
B - GRWS
C - NRWS
D - Inverted U-shape (weak at extremes, strong in middle)
E - Percent of command area irrigated
F - Number of members in organization
G - Total maintenance labor per year
H - Maintenance labor per hectare
I - Maintenance labor per member per

[b] significant at 1% level
[c] significant at 5% level

The intensity of management and the level of formal orqanizational structure is much lower in the Raj Kulo system during the winter than in the monsoon season. There is no systematic procedure for coordinating water distribution among all the farmers. Farmers meet at a designated place on the main canal on the day they want to irrigate, and those who are there that day decide among themselves the order of distribution. In the winter almost no maintenance is required to keep the water flowing. There is very little rainfall during this season; hence, the intake is seldom destroyed by floods, and landslides which damage the canal rarely occur. Thus, the organizational mechanisms for resource mobilization are not observed in the winter.

System Performance

There is a relationship between the need to mobilize resources to acquire water and the effectiveness of distribution of the water. Lewis (1971) compared two systems in the hills of Illocos Norte in the Philippines. The one required much maintenance (40 to 60 work days per member annually). It enforced fines for absence from work, and repeat. offenders were denied water. However, in the year that he observed, there were few absences, and all fines were paid. The members were satisfied that they were receiving the water to which they were entitled. In the other system, much less maintenance labor was required, but "some members regularly failed to appear for labor, and fines against them are often impossible to collect" (Lewis 1971:165). Members in the tail area of this system complained of inequitable distribution, and several who were most commonly not. served dropped out of the organiaation.

Similar results were seen in the systems studied in Nepal. In systems requiring the mobilization of large amounts of resources for maintenance, the distrihution of water more nearly coincided with the allocation of entitlements to the water than in systems that require little effort in water acquisition. In the Tallo Kulo of Thamhesi, which requires little labor for maintenance, the fields at the tail of the system suffered much more moisture stress than those at the head, even though their allocation of water was said to be the same. This was not true of systems in which much labor had to he invested to keep the supply flowing. In these the actual distribution of water matched the allocation of water remarkably well. Yoder's (1986) analysis of water distribution and stress in the Kanchi Kulo of Argali and the Thulo Kulo of Chherlung demonstrates this.

The organizations in Argali and Chherlung required the resources of all the members to acquire the water. The farmers at the head of the system could not take all the water they wanted, denying the tailend farmers their share, because they were dependent for their supply on the assistance of those at the tail in maintaining the system. This interdependence among the farmers in systems requiring a high level of resource mobilization is a key factor affecting their equitable and efficient operation. Where few resources are needed to keep the supply flowing, the farmers at the head do not have to be concerned with keeping the tailend farmers satisfied that they are receiving their fair share of the water so that they will continue assisting in the acquisition of water.

It appears that it is more difficult to maintain an effective organization in a system where water distribution is the primary activity than in one where water acquisition is the key activity. Farmers in a system all face the same incentives for water acquisition but not for distribution. When water is scarce, the farmers at the head have an incentive to break the rules and take more than their allotted share of the water. Without the interdependence resulting from the need to mobilize much labor for maintenance, it is more difficult to enforce an equitable distribution of water.

CONCLUSION

An irrigation organization has a number of different tasks which it must accomplish to make effective use of the water resource in agricultural production. Different environments render different activities more or less important, and the nature of the activity and its relative importance will determine, to some degree, the organizational requirements of a system. These in turn, will have an impact on the structure of the organization.

The physical activities directly related to water in an irrigation system are: acquisition, distribution, and drainage. In the extremely well-drained soils of the river terraces in Nepal where the systems studied are located, drainage is not a significant concern of the organizations. Both acquisition and distribution are important. A more intensive technology and management to achieve a greater degree of control over the distribution of water were observed where the water supply was scarce relative to tho area irrigated. Organizations installed technology (saachos) or adopted management practices (rotational distribution or distribution by contract) which enabled them to distribute scarce water more efficiently and equitably. However, this activity did not have nearly as great an impact on the structure of the organizations as did the activity of water acquisition.

Organizations which must mobilize large amounts of resources, particularly labor, to maintain the system for acquisition of water, irrespective of the amount of water delivered, exhibited a higher degree of formal structure than those which require relatively few resources to keep the water flowing. The water supply relative to area irrigated (NRWS) and the amount of resources that must be mobilized for water acquisition certainly affect the nature of the organization, but the organizational requirements for mobilizing resources to acquire water dominate the structure of the organizations in this environment,.

The labor requirement for rotational distribution can be considerable although, with the exception of the Tallo Kulo in Thambesi, it does not exceed the labor needed for water acquisition. Even though a significant amount of labor may be required for water distribution, it does not have the same effect on the organization as the labor for acquiring the water. This is, at least in part, because labor for distribution is essentially an individual affair.[5] The organization as a whole does not suffer if an individual is absent when it is his turn to receive water--only he does. However, if failure to participate in maintaining the system results in less water delivery, everyone will suffer to some extent from a shortage of water.

Systems that required the mobilization of large amounts of resources for maintenance had better performance as measured by the comparison of actual water distribution to the water allocation. Where the organizations were strong, requiring resources from all members to acquire the water, farmers at the head of the system could not take all the water they wanted, denying the tailend farmers their share. Farmers at the head were dependent for their supply on the assistance of all users in maintaining the system. This interdependence among the farmers in systems requiring a high level of resource mobilization was found to be an important factor affecting the equitable and efficient operation of systems.

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[5]There are examples, though not observed in the systems studied, of a group of farmers working together for distribution. When it is time for the group's part of the system to receive water, some of them police the canal while others in the group irrigate.

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