Comparing Indian Irrigation Institutions: What Determines Institutional Behaviour and Performance? Preliminary Empirical Observations

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"There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water badly – such that billions of people and the environment suffer." (World Water Vision 2000).

Introduction

The management of water resources is becoming increasingly challenging in India with accelerating growth and development. Scarcities are becoming frequent and managing the distribution across vast areas of the country, and amongst millions of users, in a way that is sustainable, is becoming a major problem. Irrigation is crucial for agriculture and rural incomes in India. The technical solutions to the difficulties are typically known and are often implemented, but the institutional issues of control, organization and management within the political economy of democracy and small farm agriculture are becoming exceedingly difficult and pose the most serious challenge.

This paper presents some preliminary results of recent field-based research supported by ACIAR which examines institutional issues in water resource management in India's agriculture. Among different approaches, it focuses on the new institutional economics framework for studying the subject. The effort is to draw lessons and suggest an effective institutional framework for improving water resource management institutions in India. The paper is based on primary data collected from a variety of settings in the states of Andhra Pradesh, Gujarat and Maharashtra.

Background of Water Resource Management in India

Water resource management is extremely important for India because of water scarcity, uneven distribution of rainfall, growing food demand, and because 60-70 percent of the population depends directly or indirectly on agriculture for income and employment. The distribution of rainfall across the country is very uneven. Only 8 per cent of the area receives very high/assured rainfall, and 20 per cent receives high rainfall. The remaining 72 per cent is in the low, dry or medium rainfall range. Over the year too, rainfall is highly concentrated. About 74 per cent of

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rainfall is received in the monsoon time-period of June-September. Thus, agriculture depends substantially on artificial methods of providing water.

The government has made large investments in the development of irrigation. Nearly 80 per cent of the investment is in major and medium sized irrigation schemes and 13 per cent in minor irrigation schemes. Figure 1 shows that there has been considerable growth in the irrigated area. The gross irrigated area is growing faster than net irrigated area indicating increasing irrigation intensity i.e. more cropping seasons under irrigation. However, in the late 1990s and early 2000s a slow down is apparent, suggesting the emergence of some difficulties in sustaining the preceding growth.

Figure 1: India: Irrigated Area

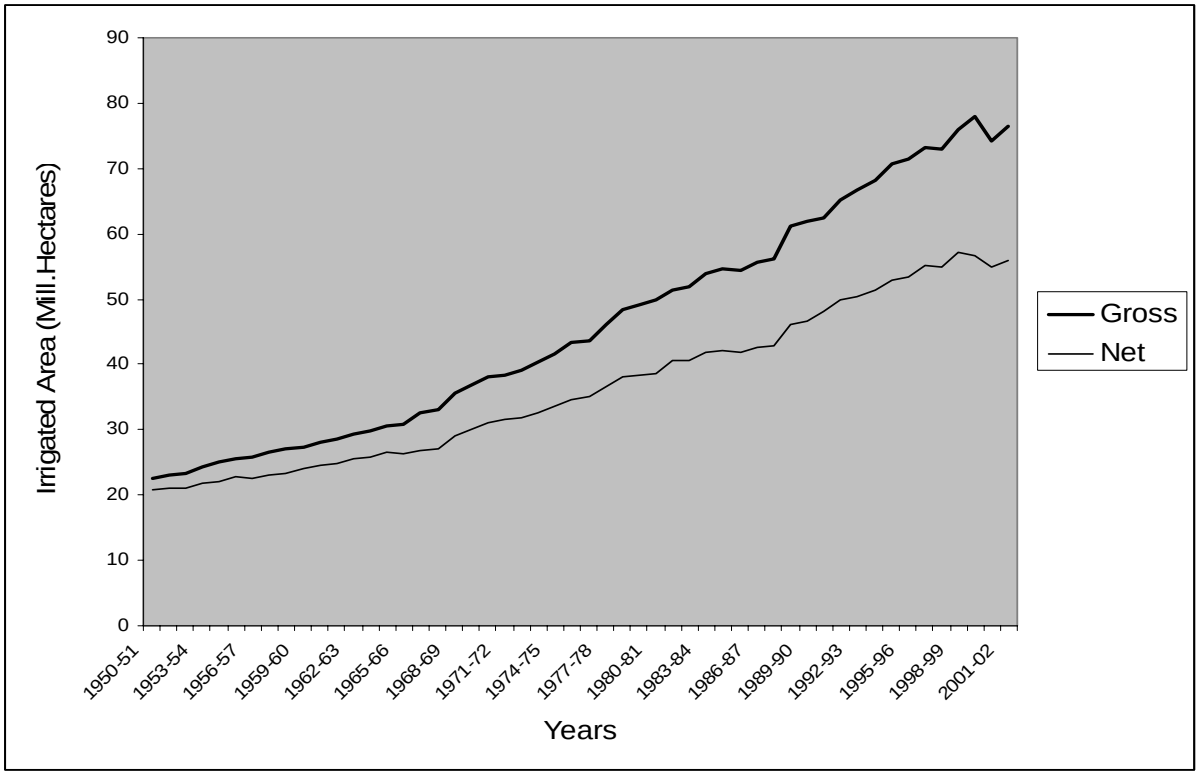
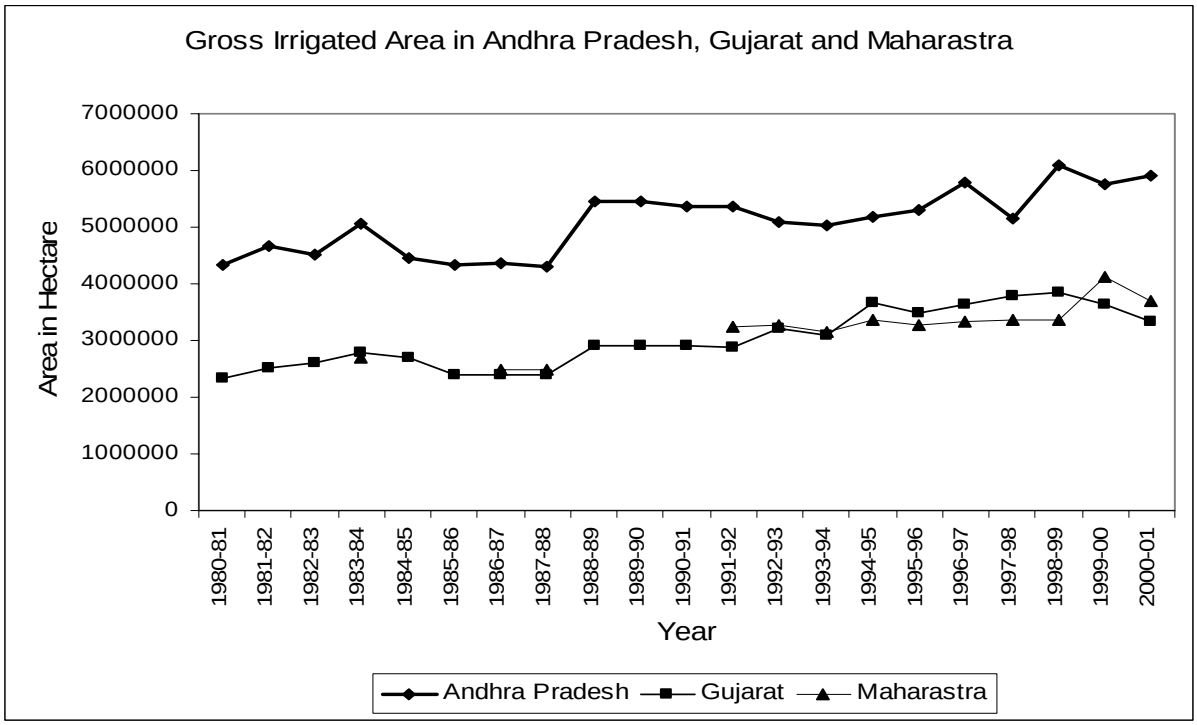


Table 1 below shows that the irrigated area stands at 54.7 million hectares or 38.8 per cent in net terms and 75.1 million hectares or 40.0 percent when measured in gross figures. There is a decrease in the growth rate of gross irrigated area from 2.61 percent in 1950-01 to 2.03 percent in 1990-01 indicating some reduction in growth.

Table 1: Trends in Overall Crop Area and Irrigated Area (in million ha.)								
Year	Net sown area	Gross sown area	Cropping intensity (%)	Net irrigated area	Gross irrigated area	Irrigation Intensity (%)	Percentage area irrigated	
							Net	Gross
1950-51	118.8	131.9	111.1	20.9	22.6	108.2	17.6	17.1
1960-61	133.2	152.8	114.7	24.7	28.0	113.5	18.5	18.3
1970-71	140.3	165.8	118.2	31.1	38.2	122.8	22.2	23.0
1980-81	140.0	173.1	123.6	38.7	49.8	128.6	27.7	28.8
1990-91	142.2	185.9	130.7	47.8	62.5	130.7	33.6	33.6
1998-99	142.6	193.0	135.4	56.5	77.6	137.4	39.6	40.2
1999-00	141.1	190.3	134.9	56.8	78.0	137.4	40.2	41.0
2000-01	141.1	187.9	133.2	54.7	75.1	137.4	38.8	40.0
Growth Rate								
1950-01	0.25	0.64	0.40	2.16	2.61	0.45	1.91	1.97
1990-01	-0.08	0.36	0.44	1.56	2.03	0.47	1.64	1.67
Source: India, Ministry of Agriculture (various issues).								

The figure below shows the trends of the gross irrigated area in the three sample states of Andhra Pradesh, Maharashtra and Gujarat. It indicates a rising trend but with substantial fluctuations, and a slow down in the late 1990s and early 2000s. Andhra Pradesh has the largest irrigated area.

Figure 2: Gross Irrigated Area



The Table 2 below gives the net and gross irrigated area in the three sample states. The table shows that in the latest year of 2000-01 Andhra Pradesh has the largest gross irrigated area of 5916.1 thousand hectares followed by Maharashtra at 3695.0 thousand hectares and Gujarat at 3342.0 thousand hectares. All the states are showing declines in the recent years from earlier peaks.

Table 2: Irrigated Area of the Sample States, '000 hectares

	Gujarat		Maharashtra		Andhra Pradesh	
Year	Net Irrigated Area	Gross Irrigated Area	Net Irrigated Area	Gross Irrigated Area	Net Irrigated Area	Gross Irrigated Area
1980-81	2002.6	2334.4			3462.7	4341.6
1990-91	2437.6	2910.5			4305.5	5369.7
1991-92	2511.6	2880.2	2713.3	3252.2	4350.8	5377.9
1998-99	3082.4	3840.0	2567.9	3362.3	4538.5	6092.7
1999-00	2979.0	3626.0	2972.0	4108.0	4384.1	5745.9
2000-01	2979.0	3342.0	2959.0	3695.0	4527.7	5916.1

Table 3 gives the distribution of the irrigation by source in the three sampled states as well as national data. These figures reveal considerable variation between states. Whereas canal irrigation is more important in Andhra Pradesh, well irrigation is substantially more important in Maharashtra and even more so in Gujarat. Tank irrigation is relatively more important in Andhra Pradesh.

Table 3: Source of Irrigation in the Selected States

(Percentage Share)

	Canal	Tanks	Wells	Other sources	Total	Net irri. Area ('000 ha.)
Andhra Pradesh	37.0	19.2	39.3	4.4	100	4395
Gujarat	20.2	1.0	78.4	0.5	100	3042
Maharashtra	21.0	14.4	61.2	3.5	100	2567
All India	31.5	6.1	55.9	6.6	100	55143

Source: India, Ministry of Agriculture 2000.

Background on Institutions in Water Resource Development

Historically, before government investment in irrigation started in India, many emperors and local chiefs invested in ways of storing water in ponds and tanks, (Singh 1991). Some excavated inundation canals and "anicuts" to draw water from rivers. The responsibility for maintenance and distribution of water often remained with the farmers and some of these bear testimony to the potential of farmers for organised human efforts. Following large government investment, the unsatisfactory management of irrigation, particularly the delivery and utilisation of water at the farm level attracted the attention of government planners and administrators. Starting in 1973, a coordinated approach to the development of irrigated agriculture was sought and this was to be implemented through Command Area Development Authorities

(CADA). The major objective was to upgrade the outlet command with suitable on-farm development works to lead to better distribution and utilization of water over the entire irrigation command (Singh 1991). Water in India is a state subject under the constitution and most states created multi-departmental project organisations headed by senior officers of government to implement the CADA programme. On the whole, CADA continued to be seen as a government programme imposed from the top. Farmers did not adopt CADA and seldom perceived that the programme was meant for them and required their support. Faced with this reality, some project administrators argued that programme implementation and water utilisation could probably be improved if farmers were given the responsibility for irrigation management. In many states, farmers receiving water from an outlet point were consulted and water users cooperatives/ associations were formed. However, most of these did not function well or became defunct.

Institutional problems in water resource management represent a very serious challenge for sustainable agricultural development in India (Gandhi 1998; 2003). Standard neo-classical theory has often little to offer in terms of practical and durable solutions in this context. Determining the right price for the water hardly solves the problem since the major problem lies in invoking the price and cost recovery. Reddy (1998) examined institutional imperatives for large irrigation systems in India and finds that pricing and other market mechanisms are hardly a panacea for the ills of irrigation systems. The study finds that the farmers are willing to pay 2-3 times the current price for water provided government supplies water in sufficient quantity and in a timely fashion. Singh and Tewari (1998) examination of institutional issues with respect to ground water found that even though institutions exist, there was often little control over the extent of private investment. The number of private tube wells increased by about 200 to 300 percent in all the regions of the UP state between 1979/80 and 1992/93, and even government tube wells increased substantially. The water balance in all regions was negative and worsening. Apart from lowering the water table this was reducing tubewell discharge and increasing the cost of irrigation. Similarly, Dhanasekaran's (1998) scrutiny of the distribution of irrigation water in Periyar Vaigai project found that the performance of such large scale surface irrigation projects is unsatisfactory since organisational aspects are neglected. The tail reach in particular suffers inadequacy in deficit years and untimely supply during normal years.

Saleth (1996) indicates that India is heading for a water crisis unless policies and institutions are radically transformed and reoriented. Moreover, Saleth and Dinar (1999) suggest that an integrated approach which covers institutional change to modernize and strengthen the legal policy and administrative arrangements governing water sector as a whole, is required. Svendsen and Gulati (1995) indicate that given the sub-optimal functioning of the irrigation network of major and medium irrigation schemes in India, attention needs to be focused on the development of institutions or organizations that can function independently on a long-term basis. Brewer et al. (1999) also reviewed the problems of water users associations and found that even though there was major concern among the government officials, no

evidence was found to indicate that water distribution becomes more inequitable after management was transferred to water user associations. Vaidyanathan (1999) indicates that evolving appropriate institutional arrangements is fundamental to solving the water resource management problem. He writes that privatisation of water, and market allocation of this is neither feasible nor desirable in India, and therefore the government must play a major role. However, this represents a major departure from the current arrangements. Shah (1993) studying ground water markets contends that a new set of policy instruments are required to manage ground water development. Moreover, he argues that supplying and charging of power has a very important impact in this context. Svendsen and Rosegrant (1994) studying irrigation development in Southeast Asia indicate that three basic shifts are required: The first requires that water/ irrigation should be viewed as an economic good rather than a social good. The second shift is of viewing irrigation development not simply as constructing irrigation facilities, but as providing irrigation water to the farmers. The third transformation requires the conceptualization of irrigation systems as providing irrigation services to the farmers. Meinzen-Dick and Mendoza (1996) indicate that growing water scarcity problems and competition between uses and users of water pose a serious policy challenge to policy makers in India. Property rights for water are important for group action to provide the necessary authority for allocation.

Livingston (1993) indicates that in the case of water resources many of the assumptions under which markets yield accurate incentives and foster efficient resource use, are violated. This is because water is fugitive, lumpy and rife with externalities. Besides, it is non-rival, entails substantial transaction costs and suffers from information deficiencies. Thus institutional control is essential. Designing institutions to deal with the physical peculiarities of water in a way that establishes sensible incentives and enables efficient resource use is however not easy. Ostrom (1992) indicates that control and use of water, a constantly moving, flowing resource, is an endlessly challenging task. Crafting institutions for irrigation systems is challenging and requires skill in understanding how rules, combine with particular physical, economic and cultural environment to produce incentives and outcomes.

New Institutional Economics Approach

The recent revival of interest in institutions and their role in economic development has led to the emergence of new institutional economic thought. The school is lead by the work of economists and economic historians such as Douglass North, Robert W. Fogel, Ronald Coase and Oliver E. Williamson amongst others. The contributions cover transaction costs, property rights (including agency theory), political economy, public choice, quantitative economic history, cognition, ideology and the role of path dependence (Rutherford 1994). It is now being widely accepted that apart from inputs and technological change, institutions clearly are major determinants of the outcome of growth and development. Thus, the study of issues such as institutional forms, institutional arrangements, institutional design, institutional constraints and how institutions change has assumed great importance.

Olson and Kahkonen (2000) and Picciotto (1995) support the usefulness of the institutional economics approach. In the context of water markets and water institutions, Crase, Dollery and Lockwood (2002) and Herath (2002) indicate the usefulness of the new institutional economics approach.

Williamson (2000) classifies the institutions into a “macro” and “micro” levels. The macro level institutions deal with the rules of the game or the humanly devised constraints that structure political, economic and social interactions: the informal constraints – sanctions, taboos, customs, traditions and codes of conduct, and formal rules – constitutions, laws, property rights (North 1990). The micro level deals with institutions of governance – market, quasi-market and hierarchical modes of contracting, or of managing transactions and seeing activities such as economic activities through. Many formal and informal local institutions/organizations in rural India would be in the micro category. According to the new institutional economics foundations (North 1997), two of the major challenges are to evolve an institutional framework in which:

1. The transaction costs are minimised
2. The incentives favour a co-operative solution, in which cumulative experiences and collective learning are best utilised.

A fundamental reason why institutional design matters is the existence of two different kinds of costs: (1) Transformation costs and (2) Transaction costs. Typically, organizations take account only of transformation costs. They fail to see transaction costs. These are costs associated with arriving at the necessary interdependent decisions, arrangements and agreements, one-time and on-going, which are essential for the success of most large activities. Experiences show that these costs are large, and further, are determined substantially by the institutional setup. Reducing transaction costs should be a major objective of institutional design.

Examination based on the new institutional economics fundamentals has led to hypotheses and findings regarding features related to successful institutions. Pagan (2003) offers a fivefold typology, which is briefly described below:

1. Clear Objectives: Good institutions have clear objectives and show a clarity of purpose. They also demonstrate a transparency in the decision-making processes towards achieving the objectives, and this helps in transmission and sharing of the clarity of purpose and in reduction of transaction conflict.
2. Good Interaction: Another important feature of outstanding institutions is good internal interaction. Good internal interaction becomes very important in reducing transaction costs. Good interaction also helps the achievement of cooperative solutions to the problems and situations faced by the institution. Successful institutions are also show good interaction with other institutions.
3. Adaptiveness: Successful institutions also demonstrate adaptiveness. This is important for achieving success in varied settings, and sustaining it over a changing environment. This is particularly important for institutions related to

water resource management since they deal with complex natural systems with a substantial variation, and also social and political differences. The institutions also have to deal with both public and private preferences, and their success often depends substantially on their ability to take both into account.

4. Appropriateness of Scale: Good institutions have appropriateness of scale with respect to their size and scope, particularly spatial and administrative scale. Institutions which are too large become too heavy on transaction costs. On the other hand, institutions which are too small have too little control and excessive dependence on others for their success. For some resources/ activities multi-level organizations may be required.
5. Compliance Ability: Good institutions also have the required compliance ability. This is necessary to bring the orderly behaviour that is required for attaining overall goals at the institutional level and fairness at the individual level. The compliance capacity is required for effective monitoring, controlling violations, and enforcement of the contractual terms. The compliance mechanisms in good institutions depend not only on external controls or third-party enforcement, but also internal controls/ discipline or self-control.

Another set of fundamentals emerge from the management theory on organizational design and governance (see, for instance, Ackroyd 2002, Groth 1999, Nystrom and Starbuck 1981). It indicates that a good organization/ institution must deliver on at least three kinds of rationalities to be able to provide good governance. These rationalities are described below.

1. Technical Rationality: This addresses the production technology, the basic workflow, and the means to accomplish ends. The main emphasize of this rationality is on efficiency. It deals with issues such as maximizing the output-input ratio - how to derive the most output from the input. This kind of governance is traditionally the most emphasized and has dominated management thinking in the past. However, overriding emphasis on the technical aspects and technical efficiency often leads to severe organizational limitations.
2. Organizational Rationality: The organizational rationality addresses the question of how to organize so that coordinated efforts occur. Since the organization's objective is not the highest technical efficiency of the sub-units, but maximizing the achievement of the overall organizational objectives, coordination becomes critical to effectiveness and efficiency of the organization. Unless the sub-units dove-tail their work with each other, the overall organizational achievements cannot be maximized.
3. Political Rationality: This higher level rationality deals with concerns of justice and maintenance of regimes. For organizations to work well, a sense of fairness and general support becomes important. Political rationality deals with decisions that influence consensual support for management and acceptance of its decisions. It deals with ability of individuals to determine salient goals and the autonomy felt by the individuals.

In order to understand the institutional issues and problems in India's water resource management, a study was undertaken with support from ACIAR, in which a survey was conducted to collect data from the field. The survey was designed for the given context largely on the basis of the conceptual frameworks discussed above. The objective was to see if the institutional behaviour and performance are indeed related to the issues raised by the framework, and then draw lessons for improving the institutions and the institutional performance. This paper examines part of the data.

Data

The study draws data from the states of Gujarat, Maharashtra and Andhra Pradesh in India. All these states face water scarcity conditions and have attempted to address the situation through various means, including different institutional innovations and efforts. The study samples a variety of local institutions involved in water resource management across these states. In the state of Gujarat, these include tube-well based co-operatives, tube-well based partnerships and check-dam groups. The tube-well co-operatives and partnerships have sought to address the problem of high investment requirements and operational costs of deep tube-wells, as ground water recedes, in addition to the distribution of the scarce available water amongst the participating farmers. The check-dam groups have sought to achieve better rain water harvesting and recharge of wells through the creation of a set of check-dams around the village. In Maharashtra there has been a history of development of irrigation co-operatives to better manage the distribution of canal water by the farmers on their own, and some of lifting waters from rivers. In Andhra Pradesh there has been a large government initiative to form water user associations in the rural areas across the state to manage the distribution of canal and village tank or pond water to the farmers.

Based on information available from the government and academic institutions in each state, a set of diverse local water institutions were selected in each state for study. The institutions were covered through detailed institutional questionnaires for the institutions as well as household questionnaires for the beneficiaries of these institutions. In the state of Gujarat, which has largest diversity of water institutions, 16 such institutions were covered. At these locations, 240 beneficiary farm households were sampled. The distribution across types of institutions is given in Table 4. In the state of Maharashtra 5 canal or river-lift co-operatives were covered, and 100 beneficiaries were sampled for questionnaire survey across them. In the state of Andhra Pradesh 5 water user associations across major, medium and minor irrigation projects were investigated and a sample of 100 beneficiaries surveyed. The results reported here are based on part of the data.

Table 4: Sampling Plan: Number of sample households					
Sl. No.	Kind of Local Water Institution	Gujarat	Maharashtra	Andhra Pradesh	Total
1	Canal co-operatives	50	100	0	150
2	Water users associations	0	0	100	100
3	Tube-well co-operatives	40	0	0	40
4	Tube-well partnerships	50	0	0	50
5	Check-dam groups[1]	100	0	0	100
	Total	240	100	100	440
[1] This sample is not included in the analysis					

The household survey covered a variety of questions related to the respondent profile, landholding, village setting, institutional association and activities, institutional performance, and a variety of questions related to institutional structure and function based on the frameworks based on new institutional economics, discussed above. This paper analyzes part of the data. The survey pertains to the 2004-2005 cropping year.

Results

Sample Profile

Table 5 below gives the summary of the land holding profile of the respondent households. It indicates that the average land holding of the respondents is 2.10 ha. This shows the small sizes of the farms and matches with the national land holding pattern. A small number of households were engaged in leasing-in and leasing-out of land, and this gives an average operational holding of the land of 2.13 ha. for the households. The average irrigated area comes to 1.98 ha, higher than the national figure but reflective of the focus of this study.

The next table - Table 6 below, gives the family size distribution of the sample households. It indicates that the modal families fall in the range of 5-10 family members, even though the maximum may be about 20 given the existence of joint families.

Table 5: Land Holding Pattern (hectares)					
	N	Min	Max	Mean	Std. Dev
Owned	340.00	0.00	40.00	2.10	2.91
Leased in	30.00	0.10	4.80	1.26	1.07
Leased Out	4.00	2.00	3.20	2.68	0.54
Operated	340.00	0.10	40.00	2.13	2.79
Irrigated Operated Area	323.00	0.10	40.00	1.98	2.75

Table 6: Family Size Distribution	
Family Size	Number (includes joint families)
0-5	92
5-10	189
10-15	49
15-20	8
Above 20	2
Total	340

Association with the Water Institution

Table 7 below gives the association of the respondent households with the water institutions. It indicates that 310 out of the 340 respondents are members of the institutions. Moreover, 18 households within the sample comprise managing committee members, 5 are chairmen, and 1 is vice-chairman. The sample also includes 2 secretaries, 1 staff, 1 director and 2 non-members. Over 90 percent of the sample is constituted by ordinary member households.

Table 8 shows that the majority of respondents indicate active participation in the institution, with 31 reporting very active involvement. Some 127 respondents indicated a passive association. Table 9 below indicates that the reliance of the households on the institutions is very high with 92 indicating very substantial reliance, and 173 substantial reliance. A small number, however, indicate very little to no reliance. Table 10 below indicates that a little less than half of the respondents are in the middle of the command area, whereas 86 are at the head reach, and 109 are at the tail end. This indicates a fairly even representation across the reach in the sample.

Table 7: Position of respondent in the institution	
Membership Type	Number
Non-member	2
Member	310
Managing committee member	18
Chairman	5
Vice-chairman	1
Secretary	2
Staff	1
Director	1
Total	340

Table 8: Level of participation in activities/ decision-making of institution	
Participation	Number
Very active	31
Active	182
Passive	127
None	0
Total	340

Table 9: Reliance of the respondent household on the institution	
Reliance	Number
Very substantial	92
Substantial	173
Some	21
Very little	26
None	28
Total	340

Table 10: Relative location in the command area	
Location	No. of farmers
Head end	86
Middle	145
Tail end	109

Water Situation and Topography

Table 11 below indicates that the source of canal water is available to 177 of the households, but a large number of 101 depend on tube-wells. Other sources of water include open wells, tanks, lifting from tanks, rivers and rain water use. Some households had access to multiple sources of water. Table 12 indicates that 176 respondents have farm lands in lowland areas, whereas 154 report farm lands in upland areas. The majority of farmers have flat topography of farm land, but some report uneven and somewhat hilly lands.

Table 11: Reported sources of irrigation water	
Sources	No. of Farmers
River	20
Open well	21
Tube well	101
Canal	177
Tank	3
Rain water use	16
Lift from Tank	2

Table 12: Agro-ecology and land topography	
Overall agro-ecological characteristic	No. of Farmers
Lowland –Wet	176
Upland – Dry	154
Total	340 (10 both)
Topography	
Flat	269
Uneven	41
Some What Hilly	16
Hilly	1
Total	340 (13 both 2,3)

Table 13 below indicates that 131 respondents report no scarcity or excess water. However, 124 report scarcity or acute scarcity, and 85 report occasional scarcity. Table 14 below indicates that 189 respondents report no change in the water availability, 148 report decline or sharp decline. Table 15 below describes the change in the water quality. 238 households report no change, but 102 households report deterioration or sharp deterioration.

Table 13: General water scarcity situation on the farm	
Situation	No. of Farmers
Excess water	12
No scarcity	119
Occasional scarcity	85
Scarcity	97
Acute scarcity	27

Table 14: Change in the availability of water over the years	
Change	No. of Farmers
Increase	3
No change	189
Decline	129
Sharp decline	19

Table 15: Change in water quality over the years	
Current Situation	No. of Farmers
Improvement	0
No change	238
Deterioration	96
Sharp deterioration	6

Cohesion, Institutional Management and Success

Table 16 below gives the household response on the cohesion in their community. Most of the households report good cohesion, but a small number indicate either excellent cohesion or some conflict. No household reported severe conflicts in the village.

Table 16: Social/ economic cohesion in the village community	
Social/ economic cohesion	No. of Farmers
Excellent cohesion	9
Good cohesion	326
Some conflict	5
Several conflicts	0
Total	340

Table 17 below gives the response on the role and involvement of different groups in the running of the water institutions. 173 respondents indicate that the general body is very active, and 95 report that it is very active. With respect of the chairman, 120 report that the chairman is very active, and 79 report that he is active. In the case of the managing committee 101 report that it is active, and 94 report that

it is very active. The members also seem to be playing an active role with 205 reporting that they are active, and 54 reporting that they are very active. With respect to government officials, village government and village head man, most indicate that they have no role in the water institutions.

Table 17: Role of the following in the running of the institution				
Role of	Very Active	Active	Passive	No/ None
1. General Body of the institution	95	173	25	47
2. Chairman	120	79	32	109
3. Managing Committee	94	101	36	109
4. Members	54	205	35	46
5. Non-members	19	52	49	220
6. Secretary	84	92	24	140
7. Other staff	60	103	30	147
8. Government Officials	0	10	60	270
9. Panchayat – Village Govt.	0	13	48	279
10. Sarpanch – Village Headman	0	16	29	295

A large number of other responses were sought and covered in the survey – all are not covered here. Finally, the households have rated the success of the water institutions they are associated with – and the results are given in Table 18 below. A majority of 195 indicate that the institution performance is just satisfactory. This indicates a substantial scope for improvement. 56 report that the performance is poor. On the other hand, 70 indicate that the institution is successful, and 19 indicate that it is very successful.

Table 18: Respondent assessment of the success of the institution	
Success	No. of farmers
Very successful	19
Successful	70
Satisfactory	195
Poor	56
Total	340

Results of the Analysis of the Success of Institutions

The tables in this section provide some preliminary results on the analysis of the success/ performance of institutions, as well as of some other features. The success rating is taken as an indicator of performance and is found to be closely related with performance indicators. The ratings are statistically analyzed using the F-statistic test for difference in means and the statistical significance examined at the 95 percent level.

Table 19 below analyses the differences across the institution types: tube-well cooperatives, tube-well partnerships, canal co-operatives and water user associations. The results indicate a statistically significant difference of the performance across these institution types. The institution showing the best performance is the canal co-operative, and the institution showing the poorest performance is the water user association. The results indicate that even though the tube-well co-operatives show a higher mean than the tube-well partnerships, the difference between them is not statistically significant. Thus, there is difference in success across institution type evident within these data.

Table 19: Results of analysis of success rating across institution type

	Tube-well Co-opera-tives	Tube-well Partner-ships	Canal Co-opera-tives	Water User Associations	F-Statistic
Mean Values	**2.25**	**2.18**	**2.58**	**1.46**	**72.69*** **
Tube-well Co-operative	-	ns	***	***	
Tube-well Partnership	ns	-	***	***	
Canal Co-operative	***	***	-	***	
Water User Association	***	***	***	-	
***=Difference in means significant at 95 percent level, ns=not significant					

4	3	2	1
Very Successful	Successful	Satisfactory	Poor

Table 20 below analyses the difference in the institutional performance across the states of Gujarat, Maharashtra and Andhra Pradesh. Results indicate a statistically significant difference in the institutional performance across the states. The institutions of Maharashtra show the best performance, and the institutions of Andhra Pradesh show the poorest performance. Even though the mean for Maharashtra is higher than that of Gujarat, the difference is not statistically significant. There are a number of plausible explanations for these results although discussion on these this is beyond the scope of this paper.

Table 20: Results of analysis of success rating across States

	Gujarat	Maharashtra	Andhra Pradesh	F-Statistic
Mean Values	**2.39**	**2.51**	**1.46**	**93.60 *** **
Gujarat	-	ns	***	
Maharashtra	ns	-	***	
Andhra Pradesh	***	***	-	

Table 21 below analyses the differences in performance between surface water institutions and ground water institutions. The results indicate that even though the surface water institutions show a somewhat higher mean, the difference between the two is not statistically significant. The results indicate that water institutions can be successful or unsuccessful irrespective of the source of the water – surface or

ground. There is no systematic association between performance and the water source evident within these data.

Table 21: Results of analysis of success rating across surface and ground water			
	Canal (Surface)	Ground	F-Statistic
Mean Values	**2.21**	**2.13**	**0.65 ns**
Canal (Surface)	-	ns	
Ground	ns	-	

Table 22 below analyses the participation levels across the sample states. The results indicate that the difference across states is statistically significant. Gujarat shows the highest participation level of the members in their institutions, followed by Andhra Pradesh. The participation levels are the lowest in Maharashtra. The results indicate that the differences are statistically significant across each of the states showing a notable difference in the participation levels.

Table 22: Results of analysis of participation level across States				
	Gujarat	Maharashtra	Andhra Pradesh	F-Statistic
Mean Values	**2.94**	**2.44**	**2.69**	**20.90*** **
Gujarat	-	***	***	
Maharashtra	***	-	***	
Andhra Pradesh	***	***	-	

4	3	2	1
Very Active	Active	Passive	None

Table 23 below gives the results of difference in participation levels by institution type. The results indicate that the differences are statistically significant. Tube-well partnerships show the highest level of participation. These are small groups with substantial member involvement, therefore, resulting in strong participation. This is followed by water user associations, tube-well co-operatives and canal co-operatives. The results indicate that the differences between tube-well co-operatives and canal co-operatives, and water user associations and canal co-operatives are not statistically significant.

Table 23: Results of analysis of participation level across institution type					
	Tube-well Co-opera-tives	Tube-well Partner-ships	Canal Co-operatives	Water User Associat-ions	F-Statistic
Mean Values	**2.65**	**3.12**	**2.62**	**2.69**	**7.69*** **
Tube-well Co-operative	-	***	***	ns	
Tube-well Partnership	***	-	***	***	
Canal Co-operative	ns	***	-	ns	
Water User Association	ns	***	ns	-	

Table 24 provides the results of member reliance on their institutions across the states. The differences across the states are statistically significant. Gujarat shows the highest reliance of members on their institutions, indicating a high dependence on the institutions. This is followed by Maharahstra and then Andhra Pradesh. The differences are statistically significant between each of the states in the sample.

Table 24: Results of analysis of Reliance level across States				
	Gujarat	Maharashtra	Andhra Pradesh	F-Statistic
Mean Values	**4.32**	**3.91**	**2.99**	**50.24*** **
Gujarat	-	***	***	
Maharashtra	***	-	***	
Andhra Pradesh	***	***	-	

5	4	3	2	1
Very Substantial	Substantial	Some	Very Little	None

Table 25 provides the results on the reliance on institutions across institution type. The results indicate that the differences are statistically significant across the institution types. The highest reliance is shown by tube-well partnerships, followed by tube-well co-operatives. The lowest reliance is shown by water user associations. The results indicate that the differences between tube-well co-operatives and tube-well partnerships are not statistically significant, and the difference between tube-well co-operatives and canal co-operatives is also not statistically significant. Thus, the data support the view that tube-well partnerships and tube-well co-operatives show the highest reliance on them by members.

Table 25: Results of Reliance Level across institution type					
	Tube-well Cooperatives	Tube-well Partnerships	Canal Co-operatives	Water User Associations	F-Statistic
Mean Values	**4.30**	**4.40**	**4.03**	**2.99**	**31.93*** **
Tube-well Co-operative	-	ns	ns	***	
Tube-well Partnership	ns	-	***	***	
Canal Co-operative	ns	***	-	***	
Water User Association	***	***	***	-	

5	4	3	2	1
Very Substantial	Substantial	Some	Very Little	None

Table 26 examines the relationships of the success of the institutions on the water situation at their locations. The results indicate a statistically significant relationship between the water situation and the success of the institution. The highest success is shown by institutions where there is excess water, and the lowest success is shown by institutions in acute scarcity. Amongst the others those under scarcity show a somewhat better performance. Thus institutional success is strongly related to the water situation at each locale.

Table 26: Results of success of institutions across General Water Situation						
	Excess Water	No Scarcity	Occasional Scarcity	Scarcity	Acute Scarcity	F-Statistic
Mean Values	**3.45**	**2.13**	**2.21**	**2.24**	**1.26**	**24.62*** **

4	3	2	1
Very Successful	Successful	Satisfactory	Poor

Table 27 examines the relationship between change in water availability and the success of institutions. The results indicate a statistically significant association. Success is associated with increase in the water availability, which may be partly due to the institution itself. Where there is a sharp decline, the institutions show a poor performance. Thus, both the water situation and the change in the water situations are closely associated with the success of the institutions. Questions of causation and interdependence arise but they are not explored here.

Table 27: Results of analysis of success across change in water availability					
	Increase	No Change	Decline	Sharp Decline	F-Statistic
Mean Values	**4.00**	**2.18**	**2.21**	**1.26**	**17.09*** **

Table 28 examines the association between cohesion and institutional performance. The results do not indicate a statistically significant association (significant at 90 percent). But communities reporting excellent cohesion show the highest mean, whereas those with conflict show a lower mean.

Table 28: Results of analysis of success across social/ economic cohesion						
	Excellent Cohesion	Good Cohesion	Some Conflict	Several Conflicts	Severe Conflict	F-Statistic
Mean Values	**2.67**	**2.15**	**1.80**	**-**	**-**	**2.64 ns**

Table 29 reports on the association between the location of the household in the command area – head, middle or tail, and their success rating of the institutions.

The results indicate that there is significant difference (at 95 percent but not at 99 percent). The head location households show the highest means but the difference in the means is not large.

Table 29: Location as an Explaining Factor of Success Response				
	Head	Middle	Tail	F-Statistic
Mean Values	**2.24**	**2.23**	**1.99**	**4.06 *****

Table 30 examines the association of the success of the institution to the involvement level of the general body in the running of the institutions. The results indicate a statistically significant association between the two where the general body is actively or very actively involved, the success of the institution is significantly greater. A passive or non-involved general body leads to poor success. Note that the mean value doubles, indicating the association/ importance of political rationality.

Table 30: General Body Role					
	None	Passive	Active	Very Active	F-Statistic
Mean Values	**1.26**	**1.48**	**2.26**	**2.58**	**60.96 *****

Table 31 examines the importance of the chairman's role in the success of the institution. Results indicate that there is a statistically significant association, and where the chairman is very active, the success of the institution is much greater. Table 32 similarly examines the association with the managing committee's involvement. It finds that there is a statistically significant association, and the data support the view that an active or very active managing committee results in a more successful institution. This may be associated with organizational rationality.

Table 31: Chairman's Role					
	None	Passive	Active	Very Active	F-Statistic
Mean Values	**1.83**	**1.47**	**2.28**	**2.56**	**36.25*****

Table 32: Managing Committee's Role					
	None	Passive	Active	Very active	F-Statistic
Mean Values	**1.83**	**1.50**	**2.44**	**2.48**	**33.10*****

Table 33 examines the impact of member involvement in the success of the institutions. It finds a statistically significant association. Active or very active involvement of the members in the running of the institution is significantly associated with the successful institution. Table 34 examines the secretary's role

and once again finds a statistically significant association. An active or very active secretary appears very important to the success of the institution. This may be associated with technical rationality.

Table 33: Member's Role					
	None	Passive	Active	Very active	F-Statistic
Mean Values	**1.35**	**1.60**	**2.37**	**2.41**	**33.10*** **

Table 34: Secretary's Role					
	None	Passive	Active	Very active	F-Statistic
Mean Values	**1.77**	**1.78**	**2.71**	**2.29**	**45.44*** **

Table 35 examines the relationship between the success of the institution and the role of the government in creating it. The results indicate a statistically significant association. The estimates show that where the government has been heavily involved in the creation of the institution, the success is notably lower. The best success is shown by organizations where the government has played some role in the creation, but the beneficiaries have also taken the initiative. Where the government has played no role, the success is higher than where the government has played a strong role. Again, this has important implications, although a comprehensive treatment of this issue is not attempted here.

Table 35: Organization Created by Government						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**2.36**	**2.52**	**2.80**	**1.67**	**1.47**	**48.69*** **

Table 36 provides results on the association of the success with government supervision of the organization. The results indicate that the association is statistically significant. The greatest institutional success is shown by organizations where there is partial supervision and partial self-governance. Where the supervision is extremely strong, the success is notably lower.

Table 36: Government supervises the working of organization						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**2.11**	**2.35**	**2.40**	**1.67**	**1.76**	**7.53*** **

The tables that follow are based on the new institutional economic fundamentals discussed about and examine the association of factors which lower the transaction costs and promote co-operative solutions to the institutional performance. Table 37 examines the association of institutional performance with setting of clear objectives and purpose within the institution. The results indicate a statistically significant association the organizations which set clear objectives have a significantly greater chance of success. Where the purpose is not clear, success appears to be remote.

Table 37: The organization has a clear set of objectives / purpose						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.23**	**1.33**	**1.50**	**2.31**	**2.22**	**24.98*****

It is not sufficient to have clear objectives – it is very important then to make and pursue plans to achieve these objectives. Table 38 below examines the association between this aspect and the success of the institution. It finds that there is a statistically significant association. The institutions which are seen to make and pursue plans are more successful are shown by the high success mean levels.

Table 38: Institution makes and pursue the plan						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.91**	**1.58**	**1.87**	**2.65**	**2.60**	**27.39*****

Apart from objectives and plans, good interaction is essential to reduce transaction costs. Table 39 examines the relationship between members-institution interaction and institutional performance. The association is found to be statistically significant. Institutions which have good interaction show significantly greater success levels as compared to those in which this is weak.

Table 39: There is good interaction between members and institutions						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.00**	**1.59**	**1.67**	**2.22**	**2.31**	**10.42*****

In order to promote good interaction, an active institution would help members settle disputes, thereby actively helping to reduce the transaction costs. Table 40 below examines the association of this factor to institutional success. The association is found to be statistically significant. There is, however, a bi-model result with institutions where this is strong as well as partial showing equally high performance. However, where this is absent, the performance is substantially lower.

Table 40: Organization helps members to settle the dispute						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.89**	**2.00**	**2.53**	**2.10**	**2.53**	**13.91*****

Another major feature indicated by new institutional economics is the adaptability of the institution to changing and varying situations and environment. An adaptable institution lowers transaction costs, and improves reach. Table 41 below provides the results on the association of this factor with institutional success. The results clearly show that institutions where such processes are seen to exist have a substantially higher success level where institutions where such processes are not to be found. This indicates that rigid institutions are not the ones which are the most successful.

Table 41: Organization has clear mechanism for changing the rule if need arises						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.41**	**1.67**	**1.93**	**2.43**	**2.50**	**41.19*****

Table 42 similarly examines the association with the presence of process for changing the rules to the success of the institution. It indicates that where there is a clear mechanism for changing rules as the need arises, the institutional success is significantly improved.

Table 42: There is a process for adapting rules of the system						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.29**	**1.69**	**1.87**	**2.45**	**2.90**	**47.38*****

An institution which has too large a scale will usually have excessively high transaction costs, ultimately leading to less success. On the other hand, an institution which has a small scale may have difficulty in retaining viability, effectiveness and relevance. Table 43 examines the association between this factor

and the success of institutions. The results indicate a statistically significant association. Institutions which are of the 'right' scale and size are significantly more successful as compared to others.

Table 43: The scale of the institution is appropriate for efficient management						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.19**	**1.50**	**1.65**	**2.39**	**2.27**	**32.64*****

Another important issue is the capacity or power of the institution to bring compliance to the rules of the institution. Table 44 below examines the association of this with the performance of the institution. The results indicate a statistically significant association. Clearly, where the institution does not use its powers to bring compliance the success is lower. However, excessively strong use of power may also lower success on the other side. The highest success is shown by institutions where there is partial agreement on this. It perhaps indicates that discretion in the use of power is very important to the success of the institutions. Non-use as well as excessive use appears to lead to poorer institutional performance.

Table 44: Institutions uses its power to bring compliance						
	Strongly Disagree	Disagree	Partially Agree/ Disagree	Agree	Strongly Agree	F-Statistic
Mean Values	**1.38**	**2.25**	**2.47**	**2.37**	**2.03**	**38.46*****

Conclusions

The management of water resources is becoming increasingly challenging in India with growth and development. The institutional issues of control, organization and management pose the most serious problem. This paper presents preliminary results of recent field-based research which examines institutional issues and performance in water resource management in India. It uses the new institutional economics framework for studying the subject and covers institutions in the states of Andhra Pradesh, Gujarat and Maharashtra. The results indicate substantial scope and need for improving institutions. Institutional performance is found to vary significantly by institution type and state but not by resource base of surface or ground water. Method of initiation and control emerge as important determinants of institutional success. The new institutional economics based fundamentals such as clarity of objectives, good interaction and adaptability are found to substantially explain the success or failure of institutions. Issues of

governance such as active involvement of the general body, managing committee and staff relating to political, organizational and technical rationality also emerge as significant determinants. These preliminary results indicate substantial scope for drawing lessons for improving water resource management institutions in India. Future work aimed at unbundling these associations should assist policy makers to refine and promote irrigation reform.

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