ECONOMICS OF WATER PRODUCTIVITY AND INSTITUTIONAL CHANGES IN MAJOR IRRIGATION PROJECTS - CHALLENGES AND OPPORTUNITIES: A CONCEPTUAL FRAMEWORK

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Abstract

The paper focuses on understanding the dynamics of water management, challenges and opportunities for increasing water productivity and economic efficiency at the system level by focusing on on-farm water management in major irrigation projects. In the context of the ongoing irrigation management transfer to water users' association, the discussion tries to look at ways to achieve water savings in existing uses through increases in water use efficiency and water productivity in agriculture. This is perceived as the path to meeting future water demands while satisfying current needs. Understanding the concept of water productivity at various scales of the system helps to know the capacity and willingness of the small farmers to pay the increased water fees under new institutional arrangements.

The study looks at the institutional strategies with a focus on command area development authority, which is responsible for on farm development (OFD) which can increase the water use efficiency. The paper tries to identify problems and constraints in achieving OFD and the future role of recently formed water users' associations. There is a need to examine the interface between the apparently divergent processes of agriculture development and irrigation in the command and its implication on land use and water management practices both at farm and system level. The paper proposes the transaction cost approach as a conceptual framework for understanding the role of water institutions and stage based perspective to provide insights into the internal dynamics of ongoing water institutional change. This study proposes a conceptual framework to identify practically relevant principles for reform design and implementation.

1. INTRODUCTION

All forms of life on earth are threatened unless water of the right quality and quantity is available for their use. These are threats to the health and life of humans and other life forms in the ecosystem and translate into day-to-day threats to the security of individuals and nations in the form of diseases, food shortages, and chronic health problems. At the extreme end, they translate into hunger, conflicts and wars. Statistics on water from the World Resources Institute, the World Bank, IWMI, and IFPRI all lead to the same conclusion that water is getting scarcer due to excessive unsustainable use and water quality is deteriorating largely due to unsanitary human practices, intensive agriculture, or simply ignorance about proper water use at the farm, household, community and institutional levels.

Whenever there is a reference to water use, naturally the attention goes to agriculture, as agriculture sector is the largest consumer of water accounting at 72% of the total water worldwide and 87% in developing countries. With growing demand for water for non-agricultural uses (domestic, municipal, industrial and environmental), the share of agriculture is projected to decline to 62% worldwide and 73% in developing countries. In developing countries, the growth in water demand for industrial and municipal uses, in absolute terms is expected to exceed the growth in water demand for agriculture between 1995 and 2020 (Rosé grant, Ringler and Gerpacio, 1997).

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Water for agriculture covers a wide range of consumptive and non-consumptive water uses in all the agricultural sub-sectors and significant social, economic and environmental issues. It is a fact that agriculture produces the necessary food for the world’s population under both rain-fed and irrigated conditions (Appelgren and Klohn, 2001). Agriculture is thus not only the main consumer of water but also a critical factor shaping important terrestrial and freshwater biomes that form part of necessary life-supporting eco-system services. Agriculture has also become a source of water pollution that has upset the nutrition cycle in the watercourses and soil-water systems and rendered the water unsuitable or less valuable for other water uses.

Water use in agriculture is economically far less efficient than in other sectors (Barker, et al., 2003; Xie et al., 1993). Growing physical shortage of water on the one hand, and scarcity of economically accessible water owing to increasing cost of production and supply of the resource on the other, has preoccupied researchers with the fundamental question of increasing productivity of water use in agriculture in order to get maximum production or value from every unit of water used (Kijne, et al., 2003). Raising water productivity is the cornerstone of any demand management strategy (Molden, et al., 2001).

With high economic and environment cost of developing new water resources, improvements in the water use efficiency and productivity through better management strategies are crucial to mitigate the envisaged water crisis and meet both current and future demands.(Ximing Cai, et al., 2001; Molden and Fishermen, 2001; Seckler, 2003; Asian Productivity Organization, 2004). Sometimes, it is conceded that current efficiency is so low especially in major irrigation projects that most of the future water needs could be met by increased efficiency alone without development of new sources for supply of water (Seckler, et al., 2003). Thus, irrigated agriculture sector especially the farmers are increasingly feeling the pressure to both demonstrate and improve irrigation performance (Burt, et al., 1997).

Improving irrigation performance from the farmers point of view means raising crop yields per unit of water consumed, though with declining crop yield growth globally, the attention has shifted to potential offered by improved management of water resources (Kijne, et al., 2003 as cited in Dinesh Kumar, et al., 2005). It provides a means both to ease water scarcity and make more water available for other sectors. However, the key to understanding the ways to enhance water productivity is to understand what it means (Kijne, et al., 2003). Many researchers have argued that the scope for improving water productivity through water management, or efficiency improvement, is often over-estimated and reuse of water is underestimated (Seckler, et al., 2003).

Great opportunities exist for enhancing productivity of water use in agriculture in India (Dinesh Kumar, 2005). These include, irrigating the crops at the critical stages of growth, establishing greater control over timing and quantum of water delivery; providing appropriate quantum of other inputs to the crops; and growing certain crops in regions, where the ET requirements are lower and genetic potential of the crop can be realized. When water becomes scarce, the irrigation water allocation must be optimal to get positive marginal productivity. There are 2 major issues confronting water users, particularly farmers. First, amidst increasing water scarcity, there is an increasing competition for agriculture water for non-agriculture uses in major irrigation projects (IWMI, 2006). Second, are the ongoing institutional changes in irrigation sector especially irrigation management transfer to water users’ association in major irrigation projects. The supposition is that water is no longer a free good and every user must pay for water to increase efficiency of use. The review tries to look into the literature to understand how improvements in water productivity are possible and what are the institutional level issues and challenges that need to be addressed to improve water productivity.

The objective of this review is to propose a conceptual frame work to understand the concept of water productivity and see how it can be improved in the context of ongoing institutional changes at field level with a focus on the interactions between scales of irrigation system, the trade offs between different uses of water (agriculture, fisheries, forests, livestock and field crops) and linkages between water productivity and farmer income. The conceptual framework can help in reforming design of ongoing institutional changes with prioritization like sequencing and packaging and implementation principles of minimizing transaction cost, creating favorable political environment and exploiting synergies within and outside water institutions.

2. WATER USE EFFICIENCY UNDER IRRIGATION

Water use efficiency in irrigation has various definitions. There are concepts of physical and economic efficiency. Whereas physical efficiency compares the volumes of water delivered and consumed, economic efficiency relates the value of output and the opportunity costs of water used in agricultural production to the value of water applied. Another definition compares the water applied to the biomass or yield output. The relationships between these measures of water use efficiency are not always clear and, although all of these efficiency concepts can be useful for irrigation water management, their perspectives can result in differing policy implications and strategies for investment in water management and irrigation.

2.1 Physical Irrigation Efficiency

In a review of technical and economic efficiency terms, Wichelns (1999) terms physical irrigation efficiency as the fraction of water beneficially used over water withdrawn. Classical irrigation efficiency (IEc) is defined as the ratio of water volume beneficially used by plants to the volume of water delivered through an irrigation system, adjusted for effective rainfall and changes in the water storage in the root zone (Burt et al. 1997):

$$IEc = \frac{\text{Crop - Evapotranspiration - Effective rainfall}}{\text{Volume of water delivered-Change in root zone storage}}$$

Irrigation efficiency at the project level is typically subdivided into distribution efficiency (water distribution in the main canal), conveyance efficiency (water distribution in secondary canals), and field application efficiency (water distribution in the crop fields). Keller and Keller (1995) and Keller et al., (1996) argue that although the classical or local irrigation efficiency concept is appropriate for irrigation system design and management, it could lead to erroneous conclusions and serious mismanagement of scarce water resources if it is used for water accounting at a larger scale. This is because the classical approach ignores the potential reuses of irrigation return flows. To overcome the limitations of the classical irrigation efficiency concept, they proposed a new concept, called effective efficiency (IEe), which takes into account the quantity of the water delivered from and returned to a basin's water supply

$$IEc= \frac{\text{Crop - Evapotranspiration - Effective rainfall}}{\text{Volume of water delivered- Change in root zone storage – Volume of water returned}}$$

2.2 Economic Efficiency

Economic efficiency of irrigation water use refers to the economic benefits and costs of water use in agricultural production. It includes the cost of water delivery, the opportunity cost of irrigation and drainage activities, and potential third-party effects or negative (and positive) externalities (Dinar, 1993). Economic efficiency can be expressed in various forms, for example, as total net benefit, as net benefit per unit of water, or per unit of crop area and its broader approach compared to physical efficiency allows an analysis of private and social costs and benefits. Economic efficiency is a criterion that describes the conditions that must be satisfied to guarantee that resources are being used to generate the largest possible net benefit (Wichelns, 1999).

3. WATER PRODUCTIVITY AND AGRICULTURE

There are two contradictory views on mechanisms to increase water productivity in agriculture. One view is that there is lot of scope to increase water use efficiency and productivity as only one third of available water is being used to produce food. Failure to include the potential for recycling or reuse of water diverted for irrigation in measurement of irrigation efficiency has led to the widely accepted view that public irrigation systems are poorly managed (Jensen, et al., 1990 and Molden, 1990). An opposing view focuses on the potential gains from improving agricultural water use efficiencies which may be minimal. Measured water use efficiencies gains are derived from individual farms or systems rather than from system/basin-wide assessments (Keller and Keller, 1995; Seckler, 1995). Unmeasured downstream recovery of drained water and recharge and extractions of groundwater can result in actual basin-wide efficiencies substantially greater than the nominal values for particular farms or systems. (Keller, 1995). This depends on alternative and previous uses and reuses of the water saved in the irrigation field, water quality, and location of the area within the basin.

Whether water management practices/technologies designed to increase water productivity and economic efficiency at the farm level translate into water productivity and economic efficiency gains at the system or basin level needs to be determined (Randolph Barker et al., 2003). Here, the problem lies in allocating the water among its multiple uses and users by irrigation agencies and the government.

Agriculture water use and management cross many scales like crops, fields, delivery systems, basins, nations and the globe. Water use efficiency is a scale dependent concept due to the recycling of return flows by downstream users (David Molden, et al., 2003). Opportunities to increase water productivity are diverse and occur at multiple scales viz. biological, environmental and management (Kassam, et al., 2007). Hydrology requires that potential productivity gains should be examined at farm, system and basin level. A problem may be observed within at one level but either the causes or its consequences might happen at another level or scales.

Increasing the water productivity is a shared responsibility as farmers and managers of water systems determine the levels of technical and allocative efficiency of the water resource and their decisions are influenced by the policy and regulatory instruments and complementary interventions (Simon Cook, et al., 2006). All these producers and managers have multiple objectives like productivity, profitability, diversity and stability based on which they assess the performance of their production systems (McConnell and Dillon, 1997). The definition of water productivity is found useful by people depending on scale at which they are working (Molden, et al., 2003).

4. ON-FARM WATER MANAGEMENT

On-farm (system) water management in major irrigation projects consists irrigation systems including the engineering and managerial tools, which maximize yields and farm incomes; the drainage system relating to the tools preventing water logging; salinity on the crops; labor and social system dealing with the impacts of irrigation on the welfare of farmers, workers, and the environmental system related to the impacts of the irrigation on environment (ICID, 1997).

Still on-farm irrigation faces an old problem, on the one hand, engineers considered the farm as a matter for the agronomists and farmers, and devoted their attention to off farm systems, on the other hand agronomists paid attention to the plant, the crop, and the crop responses to water stress, limiting their attention to define when to irrigate. The gap between the traditional engineering and agronomist disciplines was left to the farmer (Luis Pereira, ICID, 1997). Even though efforts have been made to fill these gaps, these measures mattered only to large farmers and relatively few developments concern the small farmers.

The studies addressing problems related to efficient use and management of water for irrigation have highlighted 2 critical parameters, namely the absence of scientific land development in irrigation commands and lack of discipline among stakeholders regarding development, distribution and management of water. Agricultural use of water for irrigation is itself contingent on land resources (J. Dillon, FAO, 2004). Given the importance of on-farm development (OFD) and on-farm water management (OFWM) in the efficient performance of irrigation systems, there have been commendable efforts to examine the economics of OFD as well as the dynamics of water management practices in canal commands. It is found that the low progress of OFD and non implementation of land consolidation program by Command Area Development Authority(CADA) have led to low productivity (Reddy, 1991 and Vishwanath, 2001) in major irrigation projects in Karnataka and Kerala respectively

5. ECONOMICS OF WATER USE

With an international consensus (Dublin Statement, 1992), water management is considered in relation to issues of economic efficiency, environmental protection, sustainability and the needs of marginalized and poor people (Kerry Turner, et al., FAO, 2004). Accordingly, the value of water is increasingly seen in terms of economic, social and environmental requirements (Hussain, et al., 2007). The popular productivity indicators based on crop output do not capture the full range of benefits and costs associated with agricultural water use. The value of agricultural water may not be as low as it is generally perceived when all major uses, both direct and indirect, at various levels, are properly accounted for. As of now, water productivity at farm scale leaves out the multiple uses of water but at basin level the water productivity takes into consideration the beneficial depletion for multiple uses of water (Palanisami, et al., 2006). The value of water varies across time and space and scales in the system endorsing the view of Molden, et al., (2003).

For irrigation, on-farm performance is typically a physical case in terms of application efficiency and distribution uniformity (Luis Periera, ICID, 1997). There is a need to further develop and use other innovative approaches to analyse on-farm irrigation performance with regard to economic return of water use, the labour requirements, the welfare provided by improvements in irrigation. There are questions about trade offs between higher water productivity of desired outputs, the agronomic or economic gain of high water productivity, and the cost and efforts of concurrent investments to obtain this productivity (Dirk Zoebl, 2006). Working out water productivity within agriculture, water use by fisheries, forests, livestock and field crops is very important and analyzing each water use independently often leads to false conclusions because of the interactions among these components (Molden, et al., 2003). Considering these dimensions, it may be appropriate to represent on-farm system as composed of irrigation system, the drainage system, the labour and social system and environmental system (ICID, 1997). Empirical work on broad application of economics of small water systems can be a starting point. (Leon Hermons, 2004; Bandopadhyay, 2007)

6. INSTITUTIONAL CHANGE

With regard to water scarcity there are two predominant views, on one hand there are researchers who believe that scarcity of water is due to lack of available water resources, a phenomenon which is aggravated by pollution problems and climate change (Van Koppen, 2003; Madulu, 2003, etc.). On the other hand there are those who argue that the problem of water scarcity is economic in nature, caused by the lack of proper institutional framework and lack of incentives to adequately develop and manage scarce water resources (Dinar, 2000; Tushar Shah, 2005; Denoso and Melo, 2005).

Water productivity improvements in large scale irrigation are possible, but require major programmes of modernization, a combination of institutional change and investment in system improvement (World Bank, 2006). The most significant change in institutional arrangements in recent years has been the participatory irrigation management (PIM) and the development of water users associations (WUAs), which is more of a purposive reform program than the normal process of institutional evolution. The dominant water sector concerns no longer revolve around water development and water quantity but around water allocation and water quality (Saleth and Dinar,1999). This development paradigm enhancing the influence of economic forces and participation of stakeholders in decision making is irreversible.

The underlying rationale for participation in irrigation management is that users have a direct interest in the efficiency and flexibility of water delivery and are more willing to pay for the costs if they have an influence over operations (World Bank, 2006). The success of these water users' institutions (WUAs) will only be possible if the economic productivity of water for irrigated agriculture generates sufficient returns. From an economic perspective, it is tempting to reduce the study to a benefit-cost analysis of water use before and after institutional change, but the analysis requires more (Livingston, 2005).

The opportunity and transaction costs of institutional changes in the water sector are strongly influenced by forces external to the water sector. These water users' associations created to improve the functioning of water economy critically depend on the level of formalization of water economies (Tushar Shah, 2005), which in turn depend upon the overall economic evolution of that country. It is therefore crucial to exploit the political economy and organizational context to gain momentum for accelerated reforms in the water institutions. The institutional change can emerge both from the endogenous structure as well as from the exogenous environment of institutions.

Saleth and Dinar (2004) advocate using the performance and transaction cost impacts of institutional linkages as a framework to interpret the way different factors affect the change process. Like all institutions, water institutions are also subjective[2], path dependent[3] and hierarchically embedded within the cultural, social, economic and political context. This suggests the perception of individuals as a source of change, nature of the change process, the scope for scale economies in transaction costs and the powerful role of contextual factors in institutional change.

The ongoing irrigation management transfer to water users cooperatives in irrigation projects across developing countries including India suppose that irrigation water has to be priced on volumetric basis as decides by the irrigation agencies, and farmers will have to pay for the cost of water supply and related services, by forming water users' associations. When zealously implemented, especially in the informal segments of the water economy with large number of users, water permits and water prices hit poor people in remote rural areas hard (IWMI, 2007).

Gulati, et al., (2005) observe that most water user organizations failed in India because they were focused areas of concern to the government but not necessarily to the farmers. They recommend that user organizations receive the authority to levy water fees, conduct maintenance, and represent farmers' interests to government agencies. This demonstrates potential but successful irrigation management transfer requires much greater policy and institutional changes. Even where formal conditions seem to be in place, as in Andhra Pradesh, there is considerable evidence that there is unwillingness of government organizations to delegate or share power with user organizations (Ratna Reddy and Prudvikar, 2005). This raises a fundamental issue: while governments may be willing to transfer the hard work and expense of local water management to users, they are rarely willing to restructure their bureaucracies or to make the other legal and structural changes needed to achieve a new balance of political power favoring users (Wade 1982).

From an aggregate perspective, if the objectives of the politically prevailing interest group does not coincide with greater economic efficiency, researchers especially economists will have to identify opportunities to change water institutions in a way that could increase economic efficiency integrating every section of the water users including non elites (tail enders, small and marginal farmers, socially, economically and politically backward users). As a guiding principle, the concept economic efficiency is powerful, but limited. While institutional change is likely to increase or decrease the aggregate net beneûts accruing to a society, it will definitely change the distribution of those benefits and costs. Therefore, equity must also be a central element of the evaluation methodology.

There is unanimity that WUAs work better where the irrigation system is central to a dynamic, high-performing agriculture; the average farm size is large enough for a typical farmer to operate. The reform also supposes that supply of water resources is just sufficient to meet the demand requirements in the given command. The farm producers are linked with global input and output markets. The costs of self-managed irrigation are a insignificant part of the gross value of the product of farming (Tushar Shah, 2005a). But command areas in India have a large proportion of small and marginal farmers growing mostly low-value cereal crops. The informal nature of irrigation economy reduces the farmers' stake in improving the public irrigation system. This informality increase the transaction cost of community management. Relatively low value of produce and the fact that reforms often come with higher irrigation fee and greater management responsibilities reduce the potential pay-offs of farmers.

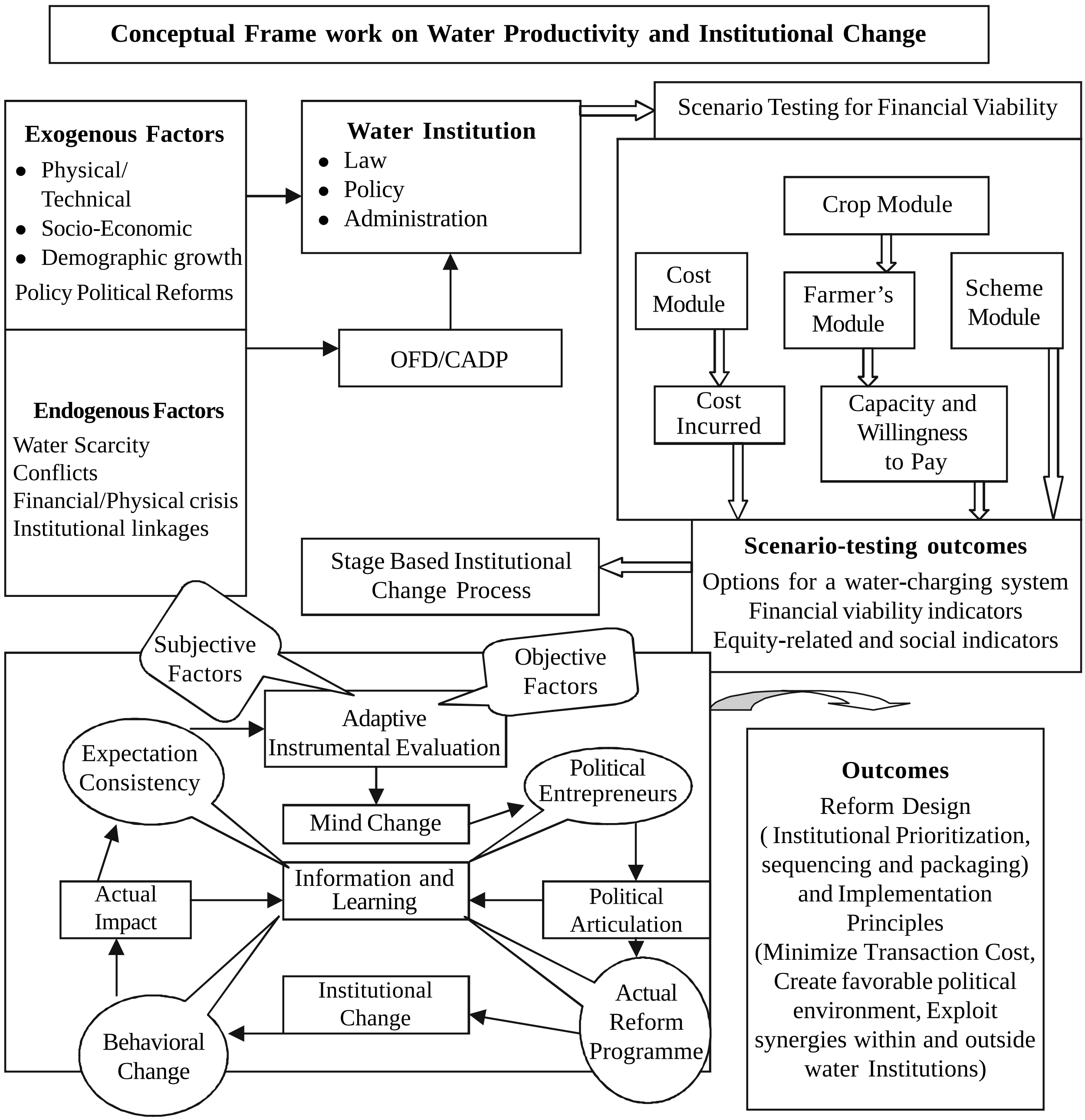
[2] Institutions are subjective in origin and operation but objective in manifestation and impact. Their subjective nature is recognized as the belief system, behavioral habits, or the subjective model of individuals (North, 1990)

[3] Path dependency means that the present status and future direction of institutions cannot be divorced from their earlier course and past history (North, 1990). Here the institutional linkages in temporal sense and hierarchical means institutional linkages in a structure sense.

As evident from the literature reviewed, the ongoing institutional reforms will be able to succeed only if there is an understanding on transaction cost for the institutional changes, scope for increasing water productivity at different levels and constraints in on-farm water management.

7. CONCEPTUAL FRAMEWORK

Consistent with the institutional economics literature (North, 1990; Ostrom,1992), water institutions are conceived in a much broader sense than mere organization. Water institutions set the rules and thereby define the action for both individual and collective decision-making in the realm of water resource development, allocation, use, and management. Since these rules are often formalized in terms of three inter-related aspects, i.e., legal framework, policy environment, and administrative arrangement, water institutions can be conceptualized



as an entity defined interactively by these three concepts. Factors that lead to changes in these three components have diverse origin and varying level of impact. For analytical convenience, these factors can be grouped into endogenous factors that are internal to water sector and exogenous factors that are outside the strict confines of both water institution and water sector. The endogenous factors include water scarcity, water conflicts, financial and physical deterioration of water infrastructure, and operational inefficiency of water institutions. Exogenous factors include general legal system, economic development, demographic growth, technical progress, economic policies, political reforms, international commitments, changing social values and ethos, and natural calamities including floods and droughts. The exogenous factors, define the general environment within which water-institution interaction occurs while the endogenous factors capture the dynamics of such interaction.

Each of the institutional components can also be decomposed further to highlight some of the key institutional aspects. These aspects will be used as an analytical framework for organizing a comparative review of existing structure and ongoing changes in the water institutions vis-à-vis the institutional needs of the reform.

A major feature of the stage-based perspective of institutional change is that the change process is not entirely evolutionary or autonomous. Deliberate and purposive policies can substantially alter or reinforce the course of institutional change. Various policy options and reform strategies are implicit not only in the institutional features but also in the very mechanics of the stage-based process of institutional change itself (Saleth and Dinar, 2004). This framework can be used as a basis for developing strategies and tactics for altering the change process in terms of a few reform design and implementation principle. The focus will be around the following key aspects depending upon context and information availability.

- Review the progress, key issues, and constraints in achieving on-farm development and water-related targets at the project and state levels.
- Review changes, trends, and patterns in the water sector.
- Review key features of existing structure and ongoing changes in the institutional arrangements governing the water sector of select developing countries.
- Assess how conducive or favourable the conditions in water sector and the structure and changes in water institutions are for achieving the water-related targets at the project and regional level.

7.1 Scenario Testing

The analysis of water productivity in the irrigation command where irrigation management has been transferred to WUAs involves scenario-testing for the capacity and willingness of farmers to pay the costs incurred by the scheme and participate in the charging system to be set up. They must also understand the impact of certain measures or decisions, or certain farmers' strategies on the financial viability of the scheme. The approach must include a sustained and multi-disciplinary partnership during scenario development and discussion between farmers and transfer operators (NGOs, irrigation agency). Such an approach has huge potential for information and decision-making support towards transfer operators, for training, and for farmers' participation.

There are costs incurred by supplying water and water-related services to farmers, and hence financial viability must be pursued at scheme level (involving partial or total cost recovery). In the irrigation management transfer context, this means that 1) The management entity (WUA) provides irrigation water and related services to farmers, 2) Such services incur costs (capital, maintenance, operation and personnel-related), 3) The management entity charges the farmers based on the system to be established, and 4) The farmers tap into their monetary resources (generated by irrigated or rain-fed cropping systems, by off-farm income) to pay these water service fees. However, one should understand that smallholders' agricultural and resource-management systems face a quickly changing economic, legal and social environment.

7.1.1 Implementation features

The approach involves 3 phases: 1) Information on the scheme at household level, 2) Information analysis and information-system development, which requires a typology[4] of farmers, and 3) Running the model on a scenario-testing basis, evaluating the impact of certain measures or decisions, or certain farmers' strategies on agricultural and production features, land allocation, costs and cost recovery, and sustainability-related indicators. Different farmers strategies and practices co-exist within a scheme. Grouping irrigation farmers into several types helps representing this reality,

7.1.2 Analysis of the situation

The model's conceptual framework (S. R. Perret, 2002) takes into consideration the economic and financial aspects of scheme's management, and addresses some technical indicators in order to check out whether the scenarios are realistic (example: water resource availability). 5 input modules form the basis of the information system, as interfaces for data capturing by the user.

7.1.2.1 Cost Module

Each cost-generating item is listed in the "cost" module. This module generates output variables that reckon the costs incurred by the scheme and its management (i.e., capital costs, maintenance costs, operation costs, personnel costs). Such information answers the question on how much does it cost to operate the scheme in a sustainable manner, regardless of who is going to pay for it.

7.1.2.2 Crop Module

In the "crop" module, each irrigated crop is listed with its technical and economic features (example: management style, cropping calendar, water demand, yield, production costs). This module generates micro-economic output variables (example: gross and net margins) that allow comparative evaluation of crops in terms of profitability, land productivity, and water productivity.

7.1.2.3 Farmer Module

A "farmer" module captures different types of farmers, with their cropping systems (combination of crops that have been documented in the crop module), average farm size, scheme's size (percentage), willingness to pay for irrigation water services. This module generates type-related output variables (example: aggregated income per type, crop calendar) and scheme-related output variables (example: number of farmers, aggregated water demand) when combined with the "scheme" module.

7.1.2.4 Scheme Module

A "scheme" module lists the scheme's characteristics (example: size, rainfall and resource-availability patterns, tariff structure). This module is combined with the "farmer" and "cost" modules, and generates output variables on water pricing, tariff, cost recovery rate, contribution per type. The capacity and willingness of farmers to pay can be assessed by amalgamating crop and cost module and using them in water charging system and generated output variables on cost recovery rate. This answers question such as who may pay, and how much, for what water services. It also generates some social and equity-related indicators farmers, crop type, area per type, gross margin per type and gross margin per type at scheme level, total water consumed), and resource-related indicators (example: total number of farmers, area per type, number of farmers per type, type net income, scheme total net income, total water consumption, overall weekly water balance).

Additional scenarios may be tested through the capture of non-real/prospective data, especially when the given scheme has not yet been rehabilitated or transferred (example: alternative crops and cropping systems, emerging farmers' types, changes in scheme's management patterns, options for a charging system, new infrastructures, and so on). Based on the scenario testing of the ground realities in the command on going institutional change in the command will be studied by stage based conception of institutional change approach.

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[4] Developing a farmers' typology is a prerequisite, as one can neither address all farmers individually nor consider them all similar.

7.2 Water Institutional Change: A Stage-based Perspective

While the institutional transaction cost approach explains the logic of institutional change, it has an analytical limitation in explaining the process of change, as the interesting dynamics are subsumed within the beneût–cost calculus. There are other theories such as those based on market approach. As water scarcity becomes acute, the social costs of inefficient institutions tend to rise. These costs are relatively high in the early stages of reform, but tend to decline as institutions mature, with the articulation of stronger institutional linkages to facilitate upstream and downstream changes. For instance, with transferable water rights, prospects for conûict resolution and water markets become brighter owing to transaction cost linkages within these aspects. Scale economies in transaction costs are also possible when water reforms become a part of the larger economic and political reforms. Intentional institutional design, induced institutional innovation, rent-seeking and political bargaining also have limitations as they capture only a part but not the entire process of institu-tional change. However, a combination of relevant theories can be logically linked to capture the whole dynamics of the change process.

The stage-based perspective of institutional change proposed by Saleth and Dinar (2004) can be a general framework for linking different theories to provide a simple but relatively more complete description of the change process. This framework depicts the stage-based perspective characterized by four main stages of institutional change. These stages progress as a circular process that is subject to constant subjective and objective feedback, learning and adaptation. In different stages, the change process is mediated by mechanisms such as instrumental (or reference point-based) subjective evaluation, information ûow and learning externalities, political lobbying and bargaining, organizational power and politics, and behavioral changes and performance expectations.

Of the 4 stages, the First stage involving mind change is significant. Mind change and perceptive convergence occur among individuals not only from their adaptive and instru-mental evaluation of subjective and objective factors but also from the information feedback and learning experience they gain from existing institutions and ongoing changes. Since perceptive convergence means an implicit demand for institutional change, political entrepreneurs with an eye on electoral payoffs articulate such demand with their campaigns and lobbying.

In the second stage, political agreement about the need for change does not mean agreement about the details of change. Whether political entrepreneurs take these initiatives (a form of public goods) depends on their ex-ante perception of a tangible political benefit for them or for their political parties (Knight and Sened, 1995 as cited in Saleth and Dinar, 2005). Owing to the potential for divergence in the transaction cost of different social and political groups, there will be an intense debate, bargaining and even, counter-campaigns. The reform program that would emerge from this process is an outcome of the relative bargaining power of different groups.

The third stage is crucial as it is found where institutional supply occurs with reform implementation. However, there is a vast scope for slippage between reform implementation and actual changes in view of many financial, organizational and bureaucratic constraints. Often, imple-mentation proceeds with ceremonial and procedural changes (example: policy declarations and renaming or merging of organizations) and ends up only with euphoria rather than with actual change. But even these cosmetic changes are useful both in realigning political groups and creating a pro-reform atmosphere conducive for undertaking substantive changes (example: legal reforms, devolution, privatization and water rights). Even with substantive institutional changes, reform benefits may not be immediate and perceptible, as the direct outcome of institutional change is only a process of behavioral changes and its outcome depends on the impact of these behavioral changes on actual resource allocation, use and management. While institutional change is a slow and continuous process, it is neither linear nor unidirectional, as the change process can proceed to the next stage, stay in the same stage, or revert to previous ones as dictated by the interplay of factors in different stages. The stage-based perspective can be used as a framework to identify and link relevant theories. The reform implementation principles can be used to decide how and when to initiate and deepen the reform efforts. Although reform design aspects themselves have a major bearing on these decisions, what is more important are the strategic and tactical opportunities for reform imple-mentation provided by the exogenous factors. For instance, the political economy contexts provided by changes in the overall institutional environment (example: fiscal crisis, political reforms, international agreements and donor pressures) can be exploited with appropriate timing, dose and scale of reform implementation. Thus, fiscal crisis provides a favorable context for implementing even a radical program with the least political opposition. Similarly, when the water sector reform forms part of larger political or economic reforms, its implementation becomes easier owing to synergic effects and scale economy benefits from the larger program to stages of the change process.

8. CONCLUSION

Proposed ways in which water is to be owned, distributed and managed imply fundamental changes. An understanding of how the water economy really works is very important in order to intervene in a promising and workable way. Even though the essential elements of effective institutions and policies are applicable in all the locations and at all scales they are contingent, context specific and non-linear and therefore outcomes are uncertain. In India, reforms are implemented without understanding how India's water economy really functions.

Based on this review and in the light of on going irrigation management transfer to water users' associations in most of the irrigation systems; based on past experiences with these reforms; and little or no knowledge of the actual and potential of economics of water use owing to small size of land holdings, the following inference can be made

1. It appears there is lot of scope for farmers to increase water productivity and economic efficiency with the existing cropping system and other water use practices in the system as a whole. However, it is not certain whether increased productivity addresses the issue of equity and poverty.

2. In the context of proposed reforms, if there is increased income from increased water productivity, small farmers will also be willing to pay higher water charges. However, it is not clear how does the size of the production system influence the changes.

3. There is need to understand what water productivity and economic efficiency mean at various levels of field, farm, distributary and system.

4. Even though it clear that there are trade offs in increasing system level water productivity between upstream and down stream use, agriculture and environment (production versus conservation), cropping and livestock/fisheries/forestry, there is no clarity or consensus on how to manage these trade offs.

5. There is a need to understand the form/structure of the local water users' institutions that have been emerging and how they are similar or different from the existing formal and informal institutions.

6. The question that remains unanswered is what are the contextual factors that determine the success of new institutions and how they are influencing the ongoing institutional change process.

REFEREANCES

Asian Productivity Organization (2004), Linking Main System Management for Improved Irrigation Management, In: Wijayaratna (Eds.), Report of the APO Seminar, Sri Lanka, 3-8 June, 2002

Bandopadhyaya (2007), Water Systems Management in South Asia. Need for a Research Framework. Economic and Political Weekly, March 10,2007 pp 863-873

Batchelor, C. (1999), Improving water use efficiency as part of integrated catchment management. *Agricultural Water Management* 40(2): 249-263.

Dinar, A. (1993), Economic Factors and opportunities as determinants of Water Use Efficiency in Agriculture, Irrigation Science 14(2): 47-52

Dinesh Kumar, M.; Singh, O.P.; Madar Samad; Chaitali Purohit and Malkit Singh Didyala (2004), Water Productivity of Irrigated Agriculture in India: Potential Areas for Improvement, International Water Management Institute Colombo, Srilanka.

Dirk Zoebl (2006), Is Water Productivity a Useful Concept in Agricultural Water Management?, *Agricultural Water Management*, 84 (2006),265-273.

Dublin Statement on Water and Sustainable Development(1992), Conference on Water and the Environment (ICWE) in Dublin, Ireland, on 26-31 January 1992.

IPTRID (2003), The Irrigation Challenge: Increasing Irrigation Contribution to Food Security through Higher Water Productivity from Canal Irrigation Systems. Issue Paper 4, FAO, Rome.

IWMI (2006), IWRM Challenges in Developing Countries Policy Brief No., International Water Management Institute, 2006.

Intizar Hussain; Hugh Turral; D. Molden and Mobin-ud-Din Ahmad (2007), Measuring and enhancing the value of agricultural water in irrigated river basins, In : Water productivity: science and practice, *Irrigation Science*

Jenson Marvin (2007), Beyond Irrigation Efficiency, In: Water productivity: science and practice; *Irrigation Science*, Feb. 2007.

Kassam, H.; Molden, D.; Fereres, E., Doorenbos, J. (2007), Water productivity: science and practice, introduction, Irrigation Science, 2007.

Keller (1995), Effective Efficiency: A water Use Efficiency Concept for Allocating Freshwater Resources, Centre for Economic Policy Studies, Winrock International, USA

Kerry Turner; Stavros Georgiou; Rebecca Clark; Roy Brouwer (2004), Economics of Valuating Water in Agriculture, From the Sectoral to Functional Perspective of Natural Management, Water Reports-27, FAO, Rome

Leon Hermans; Gerardo van Halsema; Reuben Kadigi; Charles Sokile; Henry Mahoo (2004), Supporting local IWRM in Mkoji Sub-Catchment, United Republic of Tanzania – some lessons on water valuation and institutional development. Sokoine University of Agriculture, Soil Water Management Research Group, Morogoro, Tanzania

Luis Pereira (1997), On Farm Systems: A Discussion on ICID Strategies, International Council for Irrigation and Drainage(ICID)

Madulu,N.F. (2003), Linking poverty levels to water resources use and conflicts in Rural Tanzania. Physics and Chemistry of the Earth.28: 911-917

Marie L. Livingston (2004), Evaluating Changes in Water Institutions: Methodological Issues at the Micro and Meso levels. *Water Policy* 7(2005) 21-34

Martha Otero; Rubiano, J. and Johnson N (2003), Integrating Scales of Analysis and Scales of Action in Water Resources Management, Editorial, Workshop of Scales and Integration held during baseline conference on International Program on Water and Food(CPWF) of CGIAR in Nairobi, Kenya.

McCollen, D.J. and Dillon,D. (1997), Farm Management in Asia: A system Approach, FAO Farm Systems Management Series13. FAO, Rome.

Molden, D. and F. Rijsbermen, (2001), Assuring water for Food and Environmental Security. Paper presented at the CGIAR Mid Term Meeting2001 in Durban, South Africa.

Molden, D., H. Murray-Rust, R. Sakthivadivel and I. Makin (2003), A water productivity framework for understanding and action. In J. W. Kijne; R. Barker and D.Molden (Eds.), Water Productivity in Agriculture: Limits and Opportunities for improvement, CAB International. Pp 1-18.

North, D. C. (1990), Institutions, Institutional Change and Economic Performance, Cambridge University Press, Cambridge.

Palanisami, S; Senthilvel; C. R. Ranganathan and T. Ramesh (2006), Water Productivity at different scales under Canal, Tank and Well Irrigation Systems, Centre for Agricultural and Rural Development Studies, TNAU, Coimbatore.

Randolph Barker, David Dawe, and Arlene Inocencio (2003) Economics of Water Productivity in Managing Water for Agriculture. International Water Management Institute, Colombo, Sri Lanka, International Rice Research Institute, Manila, Philippines.

Reddy, M. V. (1991), Command Area Development Programmes. PhD Dissertation Submitted to the University of Mysore, Mysore, India.

Rogers, Peter.; R. Bhatia and A. Huber (1997), Water as a Social and Economic good: how to put the principle into practice. Paper presented for the meeting of the TAC of the Global Water Partnership.

Saleth, M.and A. Dinar (1999), Water Challenge and Institutional Response: A Cross-Country Perspective The World Bank, Washington, D.C., USA.

Saleth and Dinar (2005), Water Institutional Reforms: Theory and Practice. Water Policy 7 (2005) 1-19.

Seckler, D.; D. Molden and R. Sakthivadivel (2003), The Concept of Efficiency in Water Resources Management and Policy. In Kijne. J. W.; R. Barker and D. Molden (Eds), Water Productivity in Agriculture: Limits and Opportunities for Improvement. CABI Publishing. UK. Pp -37-53.

Shah, T. (2005a.), The New Institutional Economics of India's Water Policy. International Workshop on African Water Laws, Plural Legislative Frameworks for Rural Water Management in Africa,26-28 January 2005, Johannesburg, South Africa.

Shah, T (2005b.), Water Management in Informal Economics: Experiences from India, interviewed by Chris Morger and A. Kolff for Info Resources.

Simon Cook; Francis Gichuki and Hugh Turral (2006), Agricultural Water Productivity: Issues, Concepts and Approaches, Basin Focal Project Working Paper #1, CGIAR Challenge Programme on Water and Food.

Theodore C. Hsiao; Pasquale Steduto and Elias Fereres (2007), A systematic and quantitative approach to improve water use efficiency in agriculture; In: Water productivity: science and practice Irrigation Science

Van Koppen (2003), Water Reform in Sub Saharan Africa. What is the difference? Physics and Chemistry of the Earth.28: 1047-1053.

Vishwanathan, P.K. (2001), Economics of On-Farm Development: A study of Major Irrigation Projects in Kerala. PhD thesis, ISEC Bangalore, India.

Wallace and Batchelor (1997), Managing Water Resources for Crop Production. Philosophical Transactions of the Royal Society London, B 352,937-947.

Ximing Cai and M.W.Rodegrant (2003), World water productivity. Current Situation and Future Options. In Kijne.J.W., R.Barker and D.Molden (Eds.) Water Productivity in Agriculture: Limits and Opportunities for Improvement. CABI Publishing. UK. Pp -163-178.

Ximing Cai; Claudia Ringler and M. W. Rodegrant (2001), Does Efficient Water Management Matter? Physical and Economic Efficiency of Water use in the River Basin, Environment and Production Technology Division, IFPRI, Washington, D.C.

World Bank (2006), Reengaging in Agricultural Water Management, Challenges and Options, Directions in Development, World Bank, Washington.