

Options for Improving Water Distribution Regimes in the Dez and Moghan Irrigation Schemes in Iran

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Abstract—Despite the importance of efficient irrigation for sustainable food production in arid and semi-arid regions, poor water distribution regimes in the canal networks prevail. This has led to wide-ranging problems which necessitate measures to overcome crises in the future. The paper used field observations and surveys complemented by secondary data for analysis using the SPSS software. Results suggest the urgency for changing the status-quo situation by improving the maintenance of hydraulic structures and modifying water control structures. This view was shared by the agricultural extensionists who did neither consider purely technical nor purely non-technical interventions as adequate measures to change the status quo situation. Results show unanimous view for adopting an integrated water distribution model which could ensure the sustainability of crop production in command areas. A model, based on traditional Iranian Miraab system of Qanaat management would improve maintenance system, control structures needed for efficient and equitable distribution system. Results however, indicated a potential resistance principally by water agencies and upstream users. The resistance was reportedly linked to the farmers' inability to take up the new challenge the major challenge.

Keywords—integrated approach, Qanaat system, water distribution, water control structures, Miraab system

I. INTRODUCTION

RENEWABLE water resources are crucial for food production in arid and semi-arid regions like Iran where sparse and inadequate rainfall (250 mm) is far short of crop water requirements. This is exacerbated by high ET rate which can peak as high as 4500 mm annually in regions like Greater Dezful, one of major food silos in the Middle East where wide-ranging crops are grown throughout the year. The Dez and Moghan schemes are designed to provide a rigid rotation water scheduling regime to meet the water-requirements of crops mainly consist of cereals, fodders, sugar-beet, sugar cane, fruits and some cash crop vegetables grown in allotments of about 100 ha by the surface canal system [Hedayat 2005]. However, these croplands have undergone fundamental changes leading to re-distribution of a vast majority of integrated croplands among medium size co-operatives and small farmers with different cropping patterns after the revolution. These coupled with emerging land tenure system and new market mechanism has placed a new demand on water delivery system. The paper attempts to identify intervention options necessary to improve present delivery regime, evaluate most appropriate canal management models,

and highlight potential supports and resistance areas for the proposed change models.

II. MATERIALS AND METHODS

Both secondary and primary data sources were used. Primary data was obtained from survey and interviews of major stakeholders which were complemented by field observations. During visits to large schemes, symptoms of poor operational performance were observed, notably a failure to meet the demands of the new production regime adopted by the water users. More observations led to the selection of the Dez and Moghan irrigation and drainage schemes and their command areas as the case studies from which the primary data on various performance factors and environmentally-related components were generated for analyses. Initial workshops helped highlight alternative models of canal management that were conceptualized into “input-throughput-output” model of open-system theory around which data were collected from a survey and series on the command area interviews set in such a manner to cover both schemes equally on random basis. Data were analyzed and synthesized by the SPSS program.

III. RESULTS AND DISCUSSIONS

Results (tables I) show crucial importance of systematically routine maintenance of the hydraulic structures as a prerequisite to improve water distribution at the farm gates. This was not forthcoming because of poor management of the hardware and software. The reason for that was the ambiguity in the management structure. Results also linked the deficiencies in the conveyance and distribution system to what was observed to be irrational water charge system. Although higher charges were considered as a necessary condition for achieving more productive delivery system, better control structures, preferably downstream system was called upon. Such updating of the control structures in the conveyance and distribution canals could, from the perspective of a vast numbers of water users, lead to a more flexible delivery regime that is desperately sought for the cultivation of new crops that have emerged as serious alternatives to those that are economically-unviable to grow. Rationalizing water charge regime was recognized by the irrigation suppliers as a prerequisite for improving operational performance of hydraulic structure which research [Hedayat 2005] considers as being crucial. Despite admission by the water suppliers for a need to establish a better maintenance system [Shirin 2010, Sajedi 2010], they nonetheless made any improvement in the

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system conditional on the water users to pay the realistic water charges payment of real costs of water supply and distribution systems by water users. This was observed to be crucial, since research elsewhere[Mansoujian et al 2010] also highlight urgent measures to improve the state of hydraulic structures that are operationally deficient to function at design standards.

TABLE I

MEAN RANK SCORES ON MOST IMPORTANT INTERVENTIONS REQUIRED TO IMPROVE WATER DELIVERY (1 MOST IMPORTANT TO 5 LEAST IMPORTA

Intervention measuress	Farmers		Extensionists		Agency staff	
	Dez	Mogh	Dez	Mogh	Dez	Mogh
Changing to flexible delivery regime	2.76	2.67	3.19	3.18	2.94	3.12
Changing to downstream control system	3.35	2.67	3.06	3.54	3.56	3.19
Increasing water charges	2.29	3.24	2.22	1.79	1.31	1.73
Improving O&P	1.59	1.41	1.59	1.57	2.19	1.96

The findings manifestly substantiate those obtained by Hedayat [2005] who also show an urgent need to improve the maintenance of hydraulic structures and changing the present rigid upstream water control system. These notwithstanding, there was a view that singled-out rationalization of water charges as crucial for removing the observed operational deficiencies. By contrast, poor water delivery arise from what water users regard as deficient control and conveyance structures which as the agency’s critics stress , and observations also confirm, are linked to inadequate maintenance.Results (table II-III) suggest that purely technical or purely non-technical interventions would not be sufficient to make the system adequately responsive to meet on-farm techno-engineering challenges as well as off-the-farm economic realities. These have to be fulfilled for sustainable crop production in both command areas [Hedayat 2005]. It can be deducted from the observations and research that proposed integrated model based on the Iranian Miraab system of Qanaat management with a sound sustainability and productivity track record would be appropriate for modern canal management. Provided that it is established and operated by the Shaarebin without government interventions, it would have highest chance in addressing challenges than the least-favoured purely technical one which has not succeeded in the past.

It was found(table 3.4) that the integrated model would initially improve maintenance quality than upgrading the conveyance and application efficiencies in Moghan, an attitude which was the opposite in the Dez. The interpretation being that farmers make much better use of water available to them and where on-farm application efficiency is lower than design standard, it might be attributed to poor conveyance and distribution- a process that is beyond their control. It can also indicate that poor conveyance is embedded in

TABLE II
MEAN RANK SCORES ON THE LIKELY SUCCESS OF EACH CANAL MANAGEMENT MODEL

Likelihood of the models in improving water delivery	Farmers		Extensionists		Water agencies	
	Dez	Mogh	Dez	Mogh	Dez	Mogh
Purely technical change	%	%	%	%	%	%
Very likely	0	0	0	0	11	0
Likely	0	8	6	7	33	35
Neither likely nor unlikely	39	32	44	33	33	15
Unlikely	61	60	50	60	23	50
Very unlikely	0	0	0	0	0	0
Purely non-technical Change	%	%	%	%	%	%
Very likely	0	0	11	7	0	0
Likely	6	28	16	13	78	43
Neither likely nor unlikely	55	44	50	46	22	50
Unlikely	39	28	23	34	0	7
Very unlikely	0	0	0	0	0	0
Integrated change	%	%	%	%	%	%
Very likely	78	52	72	66	56	43
Likely	22	44	17	27	44	43
Neither likely nor unlikely	0	4	11	7	0	14
Unlikely and Very unlikely	0	0	0	0	0	0

TABLE III

MEAN RANK SCORES ON APPROPRIATENESS OF ALTERNATIVE CANAL MANAGEMENT MODELS

Appropriateness of each canal management model.	Farmers		Extensionists		Water agencies	
	Dez	Mogh	Dez	Mogh	Dez	Mogh
Purely technical change	2.61	2.62	2.58	2.57	2.39	2.50
Purely institutional Change	2.39	2.24	2.28	2.37	2.22	2.04
Integrated change model	1.00	1.14	1.14	1.07	1.39	1.46

malfunctioning of hydraulic structures that in turn is attributed to inadequate maintenance. In other words, poor crop yield and quality is linked to low irrigation application which in turn, is attributed to deficient conveyance systems. This was however, different under the Dez command area where its lined conveyance canals were operationally and technically much better than those in Moghan. Based on these, there is an urgent need for establishing maintenance on tertiary and quaternary canals by the water users. This would throw the ball in the water users' court, which have to take the management responsibilities and be denied to make the irrigation suppliers as escape goat for deficiencies that they now would have to be accountable. This was supported by the field observations which although confirm the prevailing shortcomings, would nonetheless, dispute the "all is the fault of suppliers" argument. It is for this reason it is argued that when the Shaarebin are obliged to implement and sustain an integrated canal management model, they would be able to utilize the scarce water resources as did their Miraab predecessor [Hedayat 2005]. A more positive view by the stakeholders in Moghan was observed on the suitability of integrated model for improving maintenance and environment than their Dez counterparts. Qualitative analyses suggest that water suppliers are not manifestly keen to appreciate the importance of systematic maintenance as catalysts to achieve efficient delivery. Despite the now-and-then acknowledgement by water supplies of recurring operational problems stemming from deficient control and conveyance structures, their root causes are nonetheless, traced to inadequate maintenance of tertiary structures. It is on such basis that successful implementation of the integrated model is more likely to overcome. Field observations, while supporting this, calls for a holistic approach to ensure management continuity and operational sustainability [Hedayat2005].

TABLE IV
MEAN RANK SCORES OF THE PERCEPTIONS OF THE EFFECTS OF INTEGRATED CANAL MANAGEMENT MODEL.

Appropriateness of each canal management model.	Farmers		Extensionists		Water agencies	
	Dez	Moghan	Dez	Moghan	Dez	Moghan
Purely technical change	2.61	2.62	2.58	2.57	2.9	2.50
Purely institutional Change	2.39	2.24	2.28	2.37	2.2	2.04
Integrated change model	1.00	1.14	1.14	1.07	1.4	1.46

Results (table 3.5) further suggest a variation of views as expressed by the stakeholders on support for the proposed model. Each group regarded itself as strongest supporter, which is expected to change the power-relation [12] between those involved in the "water supply" and "water use" chain. From observations made, it was found that implementation of new model would lead to a better water delivery system. This is because present maintenance system is bound to undergo improvement with the consequences of much improved control structures necessary for more efficient conveyance and distribution system-factors which have been shortcoming in the past. There were reservations, though not so explicit on the manner in which the proposed model is to be implemented. Water suppliers were rather pessimistic about the willingness of agricultural extensionists to help and support the water users in implementing the model, although did not go so far as to call them "resisting forces". They further raised their doubts as to whether the new model would successfully be implemented because, the agricultural extensionists in their view, have failed in preparing the farmers to take the new challenge. The majority view held by the stakeholders was that government has much at stake and, as such, would willingly support the integrated model. The reason is embedded in its potential to enhance the productivity of farming system and environmental integrity in both schemes.

IV. DISCUSSIONS

The majority view called for rationalized water charges as a pre-requisite for improving maintenance of the hydraulic structures which in turn would be crucial to improve water delivery. Farmers accentuated the importance of improving water control structures which would mean changing from present upstream to downstream control system. There was

TABLE V
MEAN RANK SCORES ON SUPPORT FOR THE INTEGRATED CANAL MANAGEMENT MODEL

Appropriateness of each canal management model.	Farmers		Extensionists		Water agencies	
	Dez	Moghan	Dez	Moghan	Dez	Moghan
Purely technical change	2.61	2.62	2.58	2.57	2.39	2.50
Purely institutional Change	2.39	2.24	2.28	2.37	2.22	2.04
Integrated change model	1.00	1.14	1.14	1.07	1.39	1.46

also an urgency to shift from rigid rotation to a more flexible scheduling system that would meet the crop-water-requirements at the frequencies rates and durations which they

are demanded. This clearly suggests an implicit agreement among the majority of stakeholders that all is not well with the services provided at the farm gates. What they did not agree upon however, was the courses of action required to shift the status-quo situation. Farmers were observed to seek ways of alleviating the present technical deficiencies that the agricultural extensionists and water suppliers did not agree. Although they acknowledged that these would only improve by reforming the present water charges. The author agrees with the analysis advanced by [13], whose research in Malaysia pin points the much-needed maintenance on systematic basis as a pre-requisite for efficient water control and delivery regimes. However, the author has reasons to disagree with the arguments advanced by the water suppliers who stress that the operational deficiencies in the system are the consequences imposed inadequate water charges. However, the farmers would be unrealistic in expecting to receive flexible, reliable and equitable water delivery at their farm gates without being prepared to pay the full costs of water supply. The fact that the farmers in many of the command areas are still allowed to indulge in applying cheap or under-priced irrigation water in their croplands (merely paying 30% of the O&M costs) is the major cause for concerns among critics who do not realistically consider this to be a sustainable policy. Although it was pointed out by some observers that changing from upstream to downstream water control system would be a capital-intensive intervention which they stress would be hard to justify particularly under present economic austerity. The author however, sees a good scope for such change and maintains that the Dez and Moghan schemes would not necessarily incur unjustifiable costs because of such technical modernization. In fact he has a clear conviction that what is regarded as the additional costs of modernizing the control system over its conventional counterpart would not represent anything more than a small percentage of the total costs, not mentioning its potential savings in construction costs, requiring less freeboard and smaller canal capacities to serve the same cropping pattern. This could materialize provided that overall efficiency is increased from present 30 % (Moghan) to 50% after interventions [19]. The author argues that incorporation of buffer reservoirs can enhance irrigation water flow into croplands but maintains that its success should not necessarily be linked to its physical nature. It would rather depend on social institution (cohesive organization) of the water users to store nightly flow (when irrigation is difficult) as a means of augmenting day flow. It would be based on such requirements that buffer reservoirs, as has successfully been used in Oman [1], would lead to optimum use of water resources.

A. Alternative canal management models

Despite water suppliers' pessimism about the responsiveness of the integrated model, most farmers challenged the isolationist managerial approach of water suppliers. The latter in their view, do not demonstrate a faith

in the farmers' potentials to establish a pragmatic socio-physical package, as has been reportedly implemented by the Indian farmers [5]. Field observations also suggest that crop producers of the Greater Dezful region, under the Dez command area could, if conditions allow them to implement the model. This would allow them to ensure sustainable water delivery system based on "service principles". Mollinga's [2001] observations elsewhere echo the above findings, by expressing his reservations on effectiveness of "one-sided approach" to canal management. The existing arrangements in many schemes, as Mollinga observes, is not adequate to meet the future challenges. The latter, as Ragab [2002], [11] and Hedayat [2005] point out, are likely to be mitigated by a holistic approach to water resource management. Results further suggest more inclination by farmer and agricultural extensionists to adopt an integrated model than is expected by water agencies. This echoes a view expressed by [15], whose observations suggest that efficient water delivery requires high technical skills as well as a competent management to support and maintain it. It also calls for an approach, which as research by [12], [11] and Hedayat[2005] suggest, calls for a simultaneous application of hardware and software aspects (i.e. an interdisciplinary approach). Although purely technical modernisation has had relative success in Gillian (Iran), Jaiba project (Brazil), and northwestern Mexico [Plusquellec et al 1994], this narrow approach could not be used as a panacea for other projects. The reason lies in differing socio-economic, climatic and agronomic conditions that might take an specific approach in one particular scheme but not the others. Farming system in the Dez and Moghan, involves totally different techno-engineering and cultural features, requiring a unique delivery regime which in certain cases could be exclusive to its requirements and appears to be a totally different cattle of fish all together. It is probably for this reason that [6] are critical of those water suppliers whose tendency is to cling to what they refer as the outdated design standards for solution of complicated canal management challenges. Burt and Styles show their concerns over the propensity of water suppliers to resist potentially- constructive options that are initiated by the outsiders. The agency's unwillingness to take an integrated approach to canal management would, as [2]point out, bypass the contributions of outsiders whose valuable indigenous agronomic and hydraulic practical knowledge could help manage the system. In line with this analysis, [14] report the achievement of the holistic change program in the Saidyia canal system of Nile Delta in Egypt , which they point out, has enabled the water suppliers to provide continuous flow and reliable irrigation water to their clients. The proposed integrated approach, as Beadle et al [1988] view it, would help the operators to establish a better system's performance by enhancing the capacity of distribution network . This would be a pre-condition for establishing optimal match between supply and demand, based on "service concept" rather than a policy that primarily considers the convenience of suppliers. The integrated approach considers systematic and routine maintenance as the vital ingredient for establishing efficient

water control and conveyance in the main, secondary, and tertiary canals. The establishment of these would in turn, improve flexibility, reliability and equity in supplies; minimize group conflicts over water scheduling and adverse environmental impact. It is based on these and field observations that establishment of integrated approach would lead to a more legitimate change. By fostering an environment for the water users' ownership of integrated model, much of the deficiencies in the canal operations system would be mitigated. In other words, the O&M criterion should be assessed on the whole constellation of technical, social, economical, cultural and environmental factors. This has implication for the water suppliers simply because their failure to establish systematic maintenance would affect the efficiency by which the water is conveyed in the canals and applied at the farm level. The integrated model according to the water agencies though might improve maintenance in primary and secondary canals would not necessarily make any difference in the operational performance of the tertiaries. Implicit in their arguments is that integrated model could do little to improve the operation and maintenance in their domain of responsibility- primary and secondary canals. What they think it might do however, is the possibility of improving those deficiencies in water management chain which traditionally fall under the responsibilities and duties of the farmers and extensionists- a proposition which the latter categorically refutes. This suggests that each group tends to make others as scapegoat for malfunctioning of water delivery system. The view of present paper is that the Dez and Moghan presently lack adequate maintenance system, typified by dilapidated state of hydraulic structures, poor conveyance and distribution regimes but does not necessarily point at one particular aspect or one group as the cause. He regards instead the "one-sided" approach as one of the major causes of poor scheme management and as such, would consider the integrated approach as a sound framework because it considers both technical and non-technical aspects into canal management equation. The proposed model would therefore, be instrumental in encouraging active farmers' involvement (through the Miraab groups or Shaarebin), while relieving the hitherto water suppliers from routine tasks. This would enable them to focus on provision of better support services. Success in these would depend on the commitment and support of the stakeholders. Their support would signal their willingness to co-operate with the change process, which as Nepal [5] have observed, increases the legitimacy of outcomes. The Miraab groups, as representatives of farmers would, as observations show, take care of and serve one hydraulic unit in line with the model adopted by their Qanat's Miraab predecessors. The holistic nature of the integrated model would make change acceptable to their constituent members (water users). By shifting the canal management from coercive to co-operative approach, it would be possible for Miraabs (as experiences in Qanats suggest) to eradicate or at least minimize prevailing "them and us" mentality. The Miraabs (as cohesive groups) like their Nepal counterparts, might think of

"our canals" rather than "the government-owned-and-managed canals" [Beadle et al 1988:90]. Based on such findings, it would be plausible to point out that the institutionalization of a cooperative work setting, would enable the Miraabs (on behalf of their constituent members) to operate and maintain the systems without allowing any interference in the functioning of water conveyance, control and distribution systems by unauthorized individuals. The water users of both command area, as Baland and Platteau [1996] point out, would have the ability and willingness to devise appropriate institutions needed to manage their water resources on an agronomical, economically and environmentally-sustainable basis.

V. CONCLUSIONS AND IMPLICATIONS

The governments, whose principal objectives in agricultural sector are achievement of economic regeneration and development in crop-producing command areas, have a crucial role to play for implementing the model. This is important, as the crop-producing command areas in question support the production systems that contribute to national food basket and GDP on one hand while being instrumental in enhancing rural employment and regeneration on the other. The government should therefore actively support the stakeholders in both command areas by encouraging the competing service agencies to help these production units at hardware and software levels. They should do so by supporting them to take the stewardship of water abstraction, conveyance and distribution systems as integral to production process. The government should throw its active support behind institutionalization of such workable socio-political mechanisms required to achieve what Hedayat [2005] refers to as "Nazaameh Toolideh Paydaar" or sustainable farming regime. The latter, unlike past practices, ensures the integrity of croplands linked with environmental sustainability in arid and semi-arid regions like Greater Dezful in Khuzestan and Paarsabaad in Moghan.

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