"AN ANALYTICAL ASSESSMENT ABOUT CONJUNCTIVE USE OF SURFACE AND GROUND WATER RESOURCES: A CASE STUDY IN THE LOWER INDUS REGION"

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ABSTRACT

It is apparent that groundwater which is a substantial resource for providing additional water is a potential source to meet the growing demands of agriculture. It is also regarded as a potential source to improve water use efficiency. In particular, the integrated management of both groundwater and surface supplies (i.e. Conjunctive Use) can be one of the few options to improve the performance of irrigation systems in Pakistan.

Incidences of corruption are very common in irrigation management, however, very limited research has been carried out to report it and relate it with the under-performance of Irrigation System Management (ISM) in general and Conjunctive Use Irrigation System (CUIS) in particular. The field survey revealed large-scale malpractice involving both the irrigators and agencies that substantially affect the reliable distribution of surface water. The practice provides a disproportionate share of irrigation supplies to head-middle reach farmers at the cost of tail reach farmers. There are substantially higher water losses at the head reaches with nearly no irrigation supplies at the middle-tail reaches of the sample distributory. As a result, farmers in canal water scarce areas in the command areas have shifted to exploit groundwater resources so that unreliable and inadequate canal supplies can be accommodated.

Key words: Conjunctive Use of Surface Irrigation and Groundwater; Irrigation System Management; Tubewell Irrigation System; Water Use Efficiency; Participating and Non-Participating Farmers; Equity; and Irrigation Reliability.

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INTRODUCTION

The expansion of acreage over the last thirty years was directly dependent upon either an increase in the existing irrigation supplies or improvements in water use efficiency. It is evident that Pakistan's crop production per hectare remains one of the worlds lowest [2]. It is now apparent that future agricultural growth will mainly depend on improving water-use efficiency because future increase in availability of irrigation has reached to its limits. The distribution of surface irrigation supplies has become highly inequitable, variable and unreliable and that has further undermined the efficient use of irrigation supplies.

The majority of farmers naturally wish to crop as much of their land as possible and none are readily satisfied with the 54:27 per cent Rabi : Kharif split in the original design [3]. However, as a result of widespread corruption in distributing canal supplies not all farmers on sample distributory are fortunate enough to receive even their allocated irrigation supplies during the year. Farmers in the tail areas of the distributory are the most deprived group in terms of receiving adequate canal supplies. Whereas, at the head and middle reaches, deviation from the written down rules in the shape of informal arrangements between the farmers and the irrigation agency allows the farmers to receive irrigation well beyond their official allocations. This paper emphasizes that corruption in the canal irrigation system is one of the major factors towards successful promotion of CUIS[4] in the area. The paper is based on the research findings in the area of the SCARP Transition, North Rohri Pilot Project, Sindh. One of the 14 distributaries of *Sakrand* unit, 'Jamal Shah distributory' was selected for this

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[2] For instance, wheat productivity is 55 percent less than that in Mexico; rice 63 percent that of Egypt; maize 65 percent that of Turkey, cotton, 20 percent that of Turkey; and sugarcane 37 percent that of India.

[3] The present copping intensities are much higher than the design. CI In Kharif 1995 was 57 percent and in Rabi 75 percent with 141 percent as annual Cropping Intensity with canal use only.

[4] According to Vincent and Dempsey 1991, p 3, a CUIS is considered to be a "combined and integrated management of surface and groundwater for optimal productive and allocative efficiency".

research study. The paper is divided into three major parts. The first presents details about the study area and sampling methods. The second reviews the concepts of corruption especially in the context of irrigation management. Part three presents survey results, provides the explanation of these results and conclusions.

REVIEW OF THE CONCEPT

"Just as fish moving under water can not possibly be found out either as drinking or not drinking water, so government servants employed in the government work can not be found out while taking money for themselves" (Wade, 1982).

Khan 1996, mentioned that it is difficult to provide a definition of corruption that is independent of the moral or normative judgments of the observer. As a result, most definitions in social science discussions are in terms of deviation from objectively legal norms without questioning the morality or legitimacy of these norms.

Nye 1967; and Leff 1970, defined corruption as a behavior which deviates from the formal rules of conduct governing the actions of someone in a position of public authority because of private-regarding motives such as wealth, power or status.

Kantidey 1989, reported that corruption was an act undertaken with the deliberate intent of deriving or extracting benefits by encouraging or convincing illegal activities.

According to Wade 1982, p289, there were two major types of corruption: a) political and b) administrative. Elaborating both types of corruption, he mentioned, "there is a *distinction between political and administrative corruption*". Administrative corruption refers to the mis-allocation of public resources for private gains, and political corruption involves sabotage of political process for private gains, such as manipulation of electoral process by open sheltered bribery.

Bottrall 1981, p122, mentioned, *"there are at least two dimensions to water distribution. First is the technical aspect related to the*

appropriateness of the water distribution methods. Second is the social and political dimension, which concerns the ability and willingness of irrigation officials to allocate water equitably and to resist powerful pressure to misallocate water. An efficient distribution of water thus requires not only a high order of technical skill but also a management system to deny extra water to the more powerful and better located". Patil 1987, p4, reported, *"most of the public systems are operated and managed by the bureaucracy right from the head-works up to the farm gate. The bureaucracy establishes a clientele relationship with each farmer, and the experience shows that this method of managing irrigation systems has proved to be inefficient and prone to corrupt practices".*

Easter and Welsch 1986, explained that excessive water use by the upstream farmers deprives downstream farmers of water. Only the irrigation officials may see the potential for re-distributing the water while the individual farmers can only see their own direct loss or gain. In other words, the inefficiency in delivering the responsibilities of the irrigation agency leads to inequitable delivery of service, which is the major critical issue faced by the irrigation systems. It is widely recognized that one of the major causes of in-efficient allocation (inequitable distribution) of water resources by the irrigation department has been the corruption factor.

SURVEY FINDINGS: INEQUALITIES IN SURFACE SUPPLIES

Almost all sample farmers on the distributory, reported that the un-reliable canal supplies were not chiefly because of the distributory was running with shortage of supply from its parent canal. It was largely the mismanagement problem, sample farmers narrated that they paid bribes to officials so they not only maintained their share under *'warabandi'*, but also disproportionately gained control over surface supplies.

The survey data shows that tubewell development in the research area has largely concentrated in tail reaches[5] as a response

[5] The pattern of all tubewells developed in the area shows that only 9 (6 percent) were located at the head and owned by 8 farmers. Similarly, 49 (34 percent) tubewells were owned by 45 farmers at the middle of the distributory and the remaining 83 (59 percent) were reported at the tail reach and were installed by 78 farmers.

to unreliable surface supplies (Table 1). It may also be argued that historically, there had been no irrigation system called 'Tubewell Irrigation System (TWIS)' in the area, as farmers before the SCARP transition project either relied on integrated surface and groundwater management or only canal supplies in the area. The private tubewell development since the closure of SCARP tubewells in the area has primarily emerged in response to highly unreliable and inefficient canal supplies in the area. All farmers in TWIS reported that the practice of relying on TWIS was adopted since they could not receive reliable supplies to cultivate even traditional crops let alone cash crops. Thus, it is argued that TWIS and CUIS are responses to the same problem of inefficient canal management in the area. They are separated only by a distinction i.e. farmers who rely on only tubewell irrigation since they did not receive adequate canal supplies, and farmers who used partial canal supplies with emphasis on tubewell irrigation since these partial supplies could not be relied upon for crop cultivation. The survey data suggest that rules regarding bribe rates and distribution of extra[6] canal water between the irrigation officials and participating farmers[7] at the watercourse level are well established and understood by both. For example, participating farmers reported that they knew how much they would have to pay (extra) during a season for receiving adequate canal supplies. They explained that the rates are fixed by officials' well in advance before the start of receiving supplies for the crop season. A flat rate of Rs. 200 is charged per acre per season by the officials as the cost of supplying adequate canal irrigation in the research area.

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[6] It is extra water for those who bribed the irrigation officials. However, it in real terms was the share of downstream farmers who were deprived off their share due to bribes at head middle reaches.

[7] The term participating farmers is used to identify all those sample farmers who managed to receive extra irrigation supplies by bribes.

Table 1 Irrigation Turns[8] Received by Location on the Distributory:

Rabi 1995-96	Mean No.of Turns	Std	D.F	Mean difference	t-value	p Value
Head Reach	10.07	2.97	112	1.154	1.97	.05*
Middle Reach	8.91	2.97				
Kharif 1995						
Head Reach	8.18	2.66	112	1.025	1.99	.049*
Middle Reach	7.15	2.68				
Annual Turns						
Head	18.25	5.5	121	4.009	3.16	.002*
Middle	14.24	7.3				
Rabi 1995-96						
Head	10.06	2.968	135	1.896	3.08	.003*
Tail	8.172	3.534				
Kharif 1995						
Head	8.182	2.661	135	2.106	4.02	.000*
Tail	6.075	2.957				
Annual Turns						
Head	18.25	5.516	158	6.8276	5.18	.000*
Tail	11.42	8.04				

Source: Survey Data,

*** = Significant al .05 level**

It was revealed that the arrangement between the officials and the participating farmers works on similar principles to that of the *warabandi* system. For example, if a farmer owned 50 acres

[8] Under Warabandi System.

of land he had to pay a total of Rs.10000[9] in each season. Supposedly, the farmer decided to plough only 30 acres of land during the season he still had to pay for the entire land he owned, i.e. 50 acres on the watercourse. However, as in the case of *warabandi system*, choice of cropping pattern and area to be planted was solely farmer's own decision.

The participating farmers reported that as in the case of the *'warabandi system'*, extra payments to officials does not guarantee to cultivate 100 percent of area in a particular season. This mainly ensures that they would receive reliable supplies, which assists them to decide about the acreage to be ploughed and type of crops to be cultivated.

IMPACT ON CANAL SUPPLIES

Comely 1990, pointed out that groundwater alone is rarely sufficient for intensive irrigated agriculture. Surface irrigation will recharge the aquifer. Thus, adequate and reliable control over surface supplies by the farmers is the key factor towards successful integrated management of surface and groundwater resources. Contradictory to this, survey data clearly indicated a significant variation in number of turns received by the farmers by their location on the sample distribuory. The data suggested a positive relationship between the bribes (i.e., extra payments to officials) and mean irrigation supplies received by the farmers. From a social perspective, it is argued that the cost to the society in this situation is substantially very high. For example, 59 percent of participating farmers raised their mean irrigation supplies at the cost of the remaining 41 percent of farmers who received significantly very limited canal supplies[10] throughout the year.

[9] That is 50 acres * Rs 200 per season.

[10] t-values of 5.71, 5.61, and 10.5 for Rabi 1995-96, Kharif 1995, and year respectively confirm the significant variation in the mean irrigation turns between participating and non-participating farmers in the area.

Table 2 Annual Irrigation Turns by Participating and Non-Participating:

Location	No. of Farmers	Mean Turns	Min. Turns	Max. Turns	Stdev	Measuring Inequity in Annual turns Coefficient of Variation
Participating Farmers						
Head	18	21	14	23	1.7	8.09
Middle	25	17	11	23	2	11.76
Tail	16	19.8	10	22	2.3	12.23
All	59	18.29	10	23	3.6	18.66
Non-Participating Farmers						
Head	--	--	--	--	--	
Middle	10	6.4	--	17	5.4	84.37
Tail	31	5.3	--	13	4	75.47
All	41	5.6	--	17	4.4	78.57

Source: Survey Data

Table 2 shows annual mean irrigation turns received by farmers who paid bribes and those who did not. It also highlights percent of total irrigation supplies received by the participating farmers[11], which shows that overall 83 percent of all irrigation turns in during the year were received by the participating farmers. Out of all irrigation turns reported by the sample farmers 18 percent of farmers, located at the head received 29 percent of all supplies. Similarly, 24 percent of all sample farmers at the middle who participated received approximately 39 percent of all supplies. Moreover, 12 percent of all participating farmers located at tail reach received 23 percent of total canal supplies. In comparison, 41 percent of all non-participant farmers received only 17 percent of all canal supplies.

Estimating the levels of inequality in irrigation supplies across the distributory between participating and non participating farmers, analysis of the coefficient of variation shows that there

[11] The term is used here to indicate farmers who could pay bribes to irrigation officials.

are large inequalities in the distribution of canal supplies among the farmers. This is evident from the data with coefficient of variation of 78.57 with non-participant farmers compared to 18.67 for participant farmers.

The inequitable and unreliable distribution of canal supplies across the distributory as a result of mismanagement by the irrigation agency simply to earn illegal amounts largely explains not only the reasons for concentration of tube well development in the middle-tail reaches of the distributory. It also substantially explains one of the key factors that have undermined the likely benefits of CUIS in the area. For instance, out of all 92 farmers using CUIS, 51 farmers (55 percent) belonged to all those farmers who did not participate in bribing irrigation officials. The preceding data reveals that crop production and income of those non-participating farmers was markedly low compared to those who used CUIS and paid extra to officials.

ANNUAL CROP CULTIVATION AND CROP YIELDS

The survey data reveals that reliability in irrigation supply through bribes under CUIS improved the performance of farmers to that of non-participating farmers. These differences are substantial even when performance is compared with those who did not participate irrespective of method of irrigation they adopted for cultivation. This is evident from the data (Table 3) indicating significantly higher mean annual cash crop and mean area under crops by the farmers in CUIS who paid bribes. The survey data also revealed that crop yields of the major crops of the participating farmers in CUIS were significantly higher. Table 5 shows these differences.

Table 3 Impact of Bribes on Annual Crop Cultivation- Weighted Means.

Annual Cash Crop	Mean % CCA	Std	D.F	Mean difference	t-value	2-tail sig
CUIS Farmers with Bribes	.44	.37				
			53	.23	2.41	.019*
All Farmers without Bribes	.21	.29				
Annual Crop						
CUIS Farmers with Bribes	2.0	1.3				
			138	1.16	7.42	.000*
All Farmers without Bribes	.84	.63				

Source: Survey Data, 1995-96
*** = Significant at .05 Level**

Table 4 Impact of Bribes on Average Per Acre Crop Yield

ISM	Mean Per Acre Crop Yield					
	Cotton	Wheat	Sugar Cane	Kharif Fodder	Rabi Fodder	Rice
	Maunds /Acre	Maunds /Acre	Maunds /Acre	Maunds /Acre	Maunds /Acre	Maunds /Acre
CUIS with Bribes	9*	32*	576*	426*	577*	30
All others without Bribes	7.7	28	521	380	507	26

Source: Survey Data
Note: * = Significantly different at .05 Level

NET CROP INCOMES AND BRIBES

The survey data showed that the farmers who participated in bribes reported significantly[12] higher gross and net incomes compared to those who did not. In order to evaluate the performance of participating farmers in CUIS, the gross and net crop incomes of all non-participating farmers (i.e. a total of 99 farmers) irrespective of ISM were compared with the participating farmers under CUIS.

Table 5 Gross and Net Income in CUIS With and Without Payment of Bribes

Gross Income	Mean Rs/Acre	D.F	Mean difference	t-value	p Value
CUIS Farmers with Bribes	3591				
		604	512	3.60	.000*
All Farmers without Bribes	3079				
Net Crop Income					
CUIS Farmer with Bribes	3010				
		604	600	4.24	.000*
All Farmers without Bribes	2409				

Source: Survey Data

*** = Significant at .05 Level**

CONCLUSION

The paper emphasized that due to limited availability of irrigation supplies in future, it was necessary to explore other options such CUIS so that future demand food and fiber can be substantiated. However, successful policy towards promoting CUIS largely depends on the adequate and reliable surface irrigation supplies. Corruption in distributing surface irrigation across the command areas was highlighted as one of the key factors explaining relatively poor performance of the CUIS in the research area. As data indicated that both in Rabi and Kharif seasons farmers at head reaches received a significantly higher number of surface irrigation turns compared to farmers located at middle and tail reaches. This significantly affected the

[12] Differences in gross and net crop incomes were significant at .05 level.

performance in terms of higher yields, productivity and incomes of farmers located at water sparse areas of the sample distributory.

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