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Implications of Government Policies on Water Resources Development and Management for Value Added Agriculture in Western Mountains of Pakistan

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ABSTRACT

This study was conducted to review the impact of government policies on water resources development and management in relation to value added irrigated agriculture in northern highlands of Balochistan, Pakistan. Water sector development in Balochistan had highly been policy motivated for boosting up agricultural economy. Groundwater mining by installing tubewells has actively been supported by government policies. Electric tubewells became highly popular during the period of 1973-74 to 1985-86 and gained annual increase of 12%. However, there was a sudden increase in diesel tubewells from 1985-86 to 1990-91. As a consequence, uncontrolled over exploitation of groundwater with a deficit recharge is extending serious threats to underground aquifers in most sub-basins. Meanwhile, the irrigated area by tubewells has increased @ 12% per annum. The compound growth rates per annum of area under food and cash crops are not only positive but have increased significantly during the period of 1985-86 to 1995-96. This paper suggests many technical recommendations to balance the recharge and discharge rates of natural aquifers for sustainable agricultural economy in western mountains.

Key Words: Government policies; Water resources; Development and management; Pakistan

INTRODUCTION

Hindu Kush Himalayan belt of Pakistan descends into northern Balochistan (Sulaiman mountains); whereas, Iranian plateau extends over the south western territory of mountainous Balochistan. Bhatti and Khan (1993) delineated Balochistan into five geomorphological categories including mountain ranges, piedmont plains, valley floors and basin plains, playas, rolling sand plains etc.

Water resources. A total watershed of 155 thousands km^2 is feeding 12 drainage basins and 24 sub-basins. Mean annual run-off from various major rivers and hill torrents has been estimated as 4.5 million acre feet and the flood water is little tapped by flood irrigation schemes (Anonymous, 1994). Minor base flows of few rivers are all captured and diverted through concrete lined irrigation channels to valley floors for irrigated agriculture. A general discharge is usually between 5 to 20 cusecs and the largest perennial base flow of 100 cusecs is in the Zhob river (Van Gils & Baig, 1992). There are about 73 major rivers and streams in the province. Groundwater is the most essential renewable natural resource in Balochistan. Important income generating activities like irrigated agriculture, pastoralism etc. and additionally domestic and industrial water supplies are largely linked to groundwater exploitation (Van Gils & Baig, 1992). Total exploitable groundwater potential of Balochistan is 1186 cusecs (1055.5 Mm^3/y). Until 1991, 400 cusecs or 356 Mm^3/y (34%) was being utilized by exploitation and remaining 786 cusecs or 699.5 Mm^3/y were available for exploitation (Bhatti & Khan, 1993).

Depth of water table may vary from basin to basin and may range between 1 to 100 m. Groundwater has been mined for orchard/agricultural purposes by open/dug well sand karezes. There used to be more or less 900 karezes in Balochistan (Anonymous, 1994). Advanced mining technology (tubewells etc.) has encouraged greater extraction of groundwater. It has been suspected that government policies have been encouraging over exploitation of groundwater resources with a little focus on tapping of surface water runoff and is presently being drained off through various drainage basins. Similarly heavy investment in the construction of delay action dams (DAD) for artificial groundwater recharge has become controversial. It is believed that subsidies concerning tubewell technology have motivated an influx of tubewells and is continuously causing depletion of groundwater with deficit recharge rate. This study analyses farmers' approach towards existing water resources in high altitudes and the impact of governmental policies on status of water development in mountainous region of Balochistan.

MATERIALS AND METHODS

Study area. It was the northern highlands of Balochistan representing irrigated agriculture. It covered districts of Kalat, Mastung, Quetta, Pishin, Qila Abdullah, Qila Saifullah, Zhob, Loralai and Ziarat.

Study approach. The farmers were randomly interviewed (field surveys using a pre-tested questionnaire) for assessing their water management skills influencing water use efficiency at farm level. The effectiveness of policy carriers (concerned public departments) was evaluated by discussions with representative individuals. An expanded vision of policy makers was intercepted at a technical meeting. An overview of the historical development of water resources in this region was extracted from available literature, and other secondary data sources.

Field surveys. National Aridland Development and Research Institute conducted formal field surveys in collaboration with Arid Zone Research Centre, Quetta, Department of Agriculture, Quetta and Irrigation and Power Department, Quetta during June and July, 1998. The district wise respondants are given in Table I.

Table I. District wise sample respondents in northern Balochistan

Districts	Sample	% of Respondent
Kalat	18	12
Mastung	16	11
Quetta	20	13
Pishin	15	10
Qila Saifullah	25	17
Zhob	20	13
Loralai	21	14
Ziarat	15	10
Total	150	100

RESULTS AND DISCUSSION

Water resources development. Water sector development in Balochistan had highly been policy motivated for boosting up agricultural economy. Within agriculture sector, water development targeted precisely on growth of high value orchard economy. Other civic development was linked to water development for agricultural production. In mid 1970's, the province was connected with National Grid System and the electrification process in basins with high water potential was impetuous by Water and Power Development Authority (WAPDA). Installation of electric tubewells was encouraged by speedy electricity connections. While taking advantage of this situation, most public water supply schemes in urban and rural areas by Public Health Engineering Department (PHED), Water and Sanitation Authority (WASA), Quetta, Rural Water Supply and Sanitation projects, Balochistan Area Development Projects and Rural Water Supply projects assisted by foreign donors like United Nations International Children's Emergency Fund (UNICEF) have resorted to installation of electric tubewells.

A. Groundwater extraction. Groundwater mining by installing tubewells has actively been supported by government policies and has been considered as the key to Balochistan's agricultural prosperity (Verheijen, 1998). Wells were installed free of cost, pumping equipment was subsidized and interest free loans for purchase of tubewells equipment were offered by the Agricultural Development Bank of Pakistan. Diesel operated motorized wells were initially introduced for groundwater development and were sooner joined by tubewells. At the end of 1960's, there were more than 2442 tubewells in Balochistan (Verheijen, 1998), whereas there were 3717 tubewells (both diesel and electric) in 1973-74, however, number of diesel tubewells was more than double of electric. Within 12 years (by 1985-86), total number of tubewells increased to 8167 @ 6.8% per annum. A maximum influx of tubewells occurred during 1985-86 to 1990-91 and the number of tubewells was almost doubled i.e. 15148 @ 13.2% annually. The pace of tubewells installation had sharply slowed down during first half of 1990's (until 1995-96). The annual increase was @ 3.7%. This decline may be attributed to certain measures adopted by the provincial government to stop sharp depletion of aquifers in most basins.

It was interesting to observe that electric tubewells became highly popular during the period of 1973-74 to 1985-86 and gained annual increase of 12.2% as compared to 2.5% of other category. It explicits the supportive impact of government policies on electrified tubewells. However, there was a sudden increase in diesel tubewells from 1985-86 to 1990-91 (6992 @ 15.4% per annum) coupled with a decline in annual growth rate of electric tubewells. Study area possessed 66% of total tubewells of province and had followed similar pattern of tubewells development as mentioned above. Field survey of this study concluded following reasons of a continued decline in tubewells installation.

- An uncontrolled over-extraction of groundwater in Quetta and Mangocher areas had drawn down the water table of aquifers to considerably deeper depth and as a

consequence, tubewells operating at relatively shallow depths were abandoned.

- The government became sensitive to rapid depletion of aquifers, therefore, reduced subsidies on tubewell development. As a consequence, water mining at deeper depths asked for heavy investment by local farmers.
- In case of diesel tubewells, increases in diesel prices have increased the operation and maintenance costs, however, agricultural returns due to various marketing constraints and higher costs of other supportive inputs are becoming meagre.
- Daily load shedding of 10 to 12 hours and fluctuating electricity supply cause frequent damages to electric motors of tubewells. All these factors are increasing operational and maintenance costs and thus private users are getting discouraged.
- The geophysical features of the area limit scope of expansion in irrigated fields.

Groundwater issues. Although groundwater is a renewable resource, its sustainability is endangered under the current scenario of uncontrolled over-exploitation. Worst affected localities are Pishin, Quetta, Mastung and Mangocher valleys. Total discharge of all four sub basins is 255 cusecs as compared to total recharge of 208 cusecs. There were reports of 4 m minimum depletion of water table in Pishin and maximum 15 m in Mangocher (Anonmous, 1994). Bureau of Water Resources (BWR, 1996) concluded maximum recharge deficit of 55.5 cusecs in Pishin sub-basin and a minimum recharge deficit of 10 cusecs in Mastung area. Conclusively, water mining by modern technology like drilling rigs, turbine and sub-mersible pumps has enabled local inhabitants to explore deeper wells. Electrification coupled with flat rate operation had adversely affected underground water table. Majority of electrified tubewells are found in Pishin, Quetta, Mastung and Kalat districts and are extending serious threats to underground aquifers in these sub-basins.

B. Surface Water Development. Presently, less than one third of surface water is taped by sailaba and khushkaba cultivation, and by many small water reservoirs called DADs. Majority of DADs were constructed for artificial recharge with no irrigation facility.

Water resources conservation. Underground water exploitation was rarely linked with the renewal of aquifers by maximizing infiltration. Surface water conservation measures were largely inadequate to minimize soil erosion in drainage areas of reservoirs through watershed rehabilitation by biological or structural means.

Delay action dams. The concept of DAD is to restore the reduced flow in karezes and upgrade water table level especially in open wells by collecting and having stored runoff water in a big reservoir created by constructing a huge embankment with modern technology. DAD is constructed just within hills where a river or creak with its flood water enters into a gravely fan. The provincial government picked up this concept during early 1960's. Few DADs were constructed during 1970's. The Irrigation and Power Department promoted mainly DAD technology during 1980's and 1990's as major artificial groundwater recharge measure. At present, 110 DADs have been completed or are under construction and construction of 500 more DADs have been proposed. DADs were considered as an urgent remedy for the problem of insufficient groundwater recharge in Balochistan. Unfortunately, biological watershed management in runoff areas was not given due priority and as a consequence of degrading vegetal cover, silting up phenomenon of these reservoirs had been rapid.

Value added irrigated agriculture. In Balochistan, 0.842 million ha or 50% of total cultivated area are perennially irrigated. Main sources for perennial irrigation are major canal systems in the east of the province irrigating 0.494 million ha or 58.6% of the total perennially irrigated area, whereas water from tubewells and karezes was irrigating 0.235 million hectares (28%) and 0.10 million ha (12%), respectively. The irrigated area by tubewells increased @ 12% per annum during 1974-96. Tubewells are main source of water for perennial irrigation in northern Balochistan and are irrigating 0.168 million ha or 81% of the total irrigated area in northern highlands. The most salient development at province level was an enormous expansion of area irrigated by tubewells from 96.6 thousands ha in 1985-86 to 0.235 million ha in 1995-96, showing an annual growth rate of 12%; whereas, in northern Balochistan it increased from 78.6 thousands ha to 0.17 million ha during the same period.

Cropping pattern. Northern Balochistan had a total cropped area of 0.28 million ha in 1995-96, of which 0.165 million ha (59%) was cropped during the winter season and 0.115 million ha (41%) cropped during the summer season. Wheat is the most important crop during winter season, followed by barley, fodders and white cumin. Fruits and summer vegetables including onion and potatoes are dominant crops during the summer season with 66 thousands ha (63% of total

summer crops) and 22.6 thousands ha (21%), respectively; whereas, fodders and melons are other important summer crops.

Growth rates. Growth in agriculture output has mainly been achieved by investment in the development of irrigation infrastructure. Impact of public sector policies resulted in (i) increase in area under crops, (ii) increase in productivity of crops with the adoption of improved practices, and (iii) changes in cropping patterns from low value to high value crops. The compound growth rates per annum of area under food and cash crops are not only positive but increasing significantly during the period from 1985-86 to 1995-96. Water resources development and management, improvement in technology and stabilized prices as well as assured market of these commodities motivated local farmers to bring more and more area under these crops.

Farmers' perceptions of government policies. Farmers' perceptions regarding water resources development and management in northern Balochistan are presented in Table II. Survey results conclude that development of water resources was encouraged due to high returns from orchards and other high value crops (100% of respondents), better control over water supply (85% of respondents), subsidy on tubewells installation for agricultural development (40% of respondents), and to meet the food requirements of growing population (30% of respondents). Electrification of water potential basins on priority also encouraged installation of tubewells for agricultural development in surveyed areas. Farmers also reported that construction of DADs had positive effect on maintaining and improving underground water table.

Marketing of fruits and vegetables. Balochistan is major exporter of fruits and vegetables to other parts of the country. Marketing process in Balochistan can be delineated into five distinct stages and levels, namely, rural markets (feeder markets), primary markets (assembly stage), wholesale markets (main markets), weekly markets, and urban retail markets. Agricultural produce reaches final consumers, (households, processors, and exporters) successively through all these channels, or by-passing one or two channels, depending upon the nature and size of a commodity. In all these markets, commodities are sold and are purchased at negotiated price, commensurate with the prevalent market price, except for wholesale markets, where the produce is auctioned through licensed commission agents. Markets can also be differentiated into grain (including oilseeds) markets, fruit and vegetable markets, and livestock markets.

Table II. Farmers' perception on water resources development and management in Northern Balochistan

Parameters	+ve	-ve	?
Factors affecting tubewell installation			
• Subsidy on tubewell (%)*	40	-	60
• High returns on cash crops (%)	100	-	-
• Population increase	30	-	70
• Better control over water supply (%)	85	-	15
Construction of DAD effect			
• On underground water table	100	-	-
• Sustaining spring/karez system	74	-	26
• Reduction in water supply fluctuations	40	-	60
Flat electricity tariff effect			
• On underground water table (%)	-	76	24
• On operational cost(electric motors burn)	-	10 0	-

Improvement in water use efficiency	Subsidy (%)	% expansion in irrigated area
• By land levelling	30 to 100	18
• By pucca water tank	75 to 100	27
• By pucca water channel	75 to 100	22
Improvement in yield		
• By better control on water supply		15%
• By improved practices**		42%

+ive= Positive impact or encourage farmers in adoption of the technology/facility; -ive= Negative impact or discourage farmers in adoption of the technology/facility; ?= Do not know; *Subsidy on tubewell installation was Rs.20,000 to 30,000/-; **Improved practices means high yielding varieties, timely pruning and pesticide spray, etc.

A breakdown of gross margin showed that net margin (profits) retained by intermediaries after adjusting for marketing and handling costs constituted more than 50% of the gross margin. A further examination of its analysis revealed that bulk of the profit is earned by pre-harvest contractors and retailers. Profit margins were higher when the produce was marketed outside the province. Marketing mechanism that linked farm production to ultimate consumer continued to impose one of the major constraints to improved agriculture performance. Price variability of fruits and vegetables discouraged farmers from taking necessary risk to adopt new technologies.

Management implications

• Under arid and semi-arid conditions, water resources in Balochistan are extremely scarce. The surface water resources are about 4.5 MAF and are little tapped. Groundwater is the most essential renewable natural resource. As estimated, total available groundwater potential was 1186 cusec and about 400 cusec were being utilized. Most important income

generating activity is agriculture and depends mainly on groundwater exploitation which is being encouraged by the government. Most of the flood water schemes do not survive longer than three to five years due to siltation problems. An integrated approach for conserving or developing water resources has been lacking.

- Tubewells have emerged as major source of irrigation (51.3%) and are followed by spring irrigation (30%). Farmers concluded during survey (1998) that tubewells allowed them better control over time and quantum of water to be used. It may be concluded that most of the tubewells are installed on relatively large farms (farm size >10 ha), however, community irrigation schemes (springs and karezes) are very important source of irrigation for small farms in general.
- Although groundwater is a renewable resource, its sustainability is endangered under the current scenario of uncontrolled over-exploitation. Electrification and flat electricity charges have adversely affected underground water table.
- There had been little effort to tap surface water (seasonal flood water) on the lines of huge reservoirs like Tarbela and Mangla dams. DADs were constructed with an objective of artificial groundwater recharge, however, success is little because of heavy sedimentation load. Watershed management through bio-technological means has had little ranking for effective natural recharge.
- More than 86% farmers practice border irrigation and over irrigation of cultivated field is a common practice. Water losses are consequently considerable.
- The community based water developments and irrigation systems being sustainable since centuries, however, have become endangered by the promotion of indivisible water source developments (tubewells etc).
- Although small farms make-up more than 60% of all farms, however, maximum farm area falls under the category of medium farm sizes ranging between 5.1 ha to 20 ha. It may be concluded that a shift towards orchard economy due to improved water developments is clearly visible whereas on average, 45% of total irrigated area is under orchards.

Recommendations

- Watershed management through biological measures must be ranked as top priority. All incentives and subsidies to private sector should be diverted towards plant communities rehabilitation.
- Seabuckthorn (*Hippophae rhamnoides*), a native multipurpose plant species and a magical tool for conserving mountainous habitat, should be promoted in northern Balochistan. Special and attractive packages may be offered to local communities and farmers for undertaking large scale plantations. This plant species would positively slow down degradation process within five to eight years, since it reduces runoff even on steeper slopes by 95% and it controls soil erosion by 99%. The Chinese success models of seabuckthorn may successfully be replicated in Balochistan.
- All DADs may be handed over to neighbouring communities linking with packages of revegetation in DAD watershed areas and desiltation of actual reservoirs.
- Farmers supported subsidy on land levelling (30 to 100%), cemented water reservoirs (75 to 100%) and cemented water channels (75 to 100%). They also argued that 18% irrigated area of individual farm may be expanded by precise land levelling, 27% may be expanded by cemented water tanks and 22% may increase by cemented water channels.

Farmers perceived that 15% of farm yields could simply be improved by having a better control on water supply and 42% improvement may be achieved by improved practices like scheduled and scientific pruning of orchards, pesticide sprays, high yielding varieties etc. Farmers' training on conservation of water resources and efficient use of water at farm level may also be regarded as high priority. The training and education programmes on all aspects of farm management for improving farm yields should target school children and youth at college level.

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