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Impact of small dams on agriculture and groundwater development: A case study from Pakistan

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ABSTRACT

Water resources development and management is imperative for sustainable agriculture in water scarce areas. In Pakistan, the state of Punjab has constructed 32 small dams, in the Pothwar region, to store and conserve water for agricultural production. However, little information is available on the impact of these small dams on agriculture and socio-economic conditions of the area. This study was undertaken to evaluate the impact of three small dams, Jawa, Kasala and Dhok Sanday Mar, on agriculture and groundwater development in the area and to provide guidelines for the effective utilization and sustainable management of small dams in Pakistan. Data related to on-farm practices were collected during personal interviews using a pre-tested questionnaire. Water-table depth was measured from the open wells in the area with a water-table recorder. Secondary data such as inflow, outflow, rainfall, water charges and land use were collected from small dams organization.

After the construction of these dams and irrigation canals, cropping intensity and crop yield have increased. Due to availability of irrigation water there has been a shift of cropping pattern from wheat and forage crops to vegetable crops. Farmers are earning up to $2433 per ha per year. An analysis of inflow–outflow of the dams shows that, if properly managed, the storage is sufficient to irrigate all the crop lands within the command area. The depth to the water table has also decreased since the dams were constructed. The water table varies from 6 to 15 m in the irrigated areas served by the Khasala dam as compared to 7–39 m before the dam was constructed. The water table depths for the areas served by the Jawa dam ranged from 7 to 39 m before the dam was constructed to 9–25 m after construction. The shallower water table has made the groundwater accessible and as a result the number of wells has increased. This has reduced drudgery on the local inhabitants particularly for women who had to fetch water from far away for their domestic uses.

The area has potential for expanding both land use and cropping intensities, if innovative irrigation and agronomic practices are adopted. Moreover, mobilizing local water user associations, proper maintenance of irrigation infrastructure and technical support of the agricultural and extension services can enhance the productivity in the area.

1. Introduction

Pakistan's economy depends on agriculture, which contributes 24% of gross domestic product (GDP). Apart from producing food for the population, it provides raw material for agro-based industry. Out of about 22.16 million hectares (Mha) of country's total culturable land, 17 Mha is irrigated, giving about 90% of total agricultural production (MINFAL, 2004).

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About 17% of the cultivated area depends on rainfall for crop production. Rainfed areas are concentrated in the Pothwar plateau, the northern mountains and Northeastern plains of the country forming the largest contiguous block of dry-land farming in Pakistan. The rainfed area contributes only 10% of the total agricultural production. These areas are characterized by limited availability of water, which is the most important input for agriculture development. The occurrence of rainfall in these areas is highly erratic both in space and time with most of the rainfall occurring during monsoon (July to September). The Pothwar plateau spreads over 2.2 Mha, and the total cultivated area of the Pothwar plateau is around 1.0 Mha. About 4.2×10^9 m^3 of water is lost as surface runoff annually (Bhutta, 1999). Moreover, due to the uncertainty of rainfall, farmers normally minimize inputs to reduce the risk of loss in the event of drought and mainly depend on off-farm incomes for their sustenance. Agriculture in this area is therefore, just at subsistence level, primarily due to acute shortage of assured irrigation supplies. Other factors contributing to meagre agriculture in the area include small land holdings, obsolete methods of farming, and lack of institutional and infrastructure facilities. The present average land holding is generally less than 1.0 ha. The trend of division of land holdings and migration has disrupted the social balance in the Pothwar plateau and is hindering further economic development (Bhutta, 1999).

There could be two possible approaches to increase the agricultural production: either bringing more area under cultivation, or increasing the crop yield per hectare. Water is the most limiting factor affecting crop yield (Ashraf et al., 1999). Since 1961, the Government of Punjab through the Small Dams Organization (SDO) has constructed 32 small dams in Pothwar plateau and 19 more dams are under construction. These dams are designed to irrigate over 1420 ha. However, only 40% of the anticipated command area has been developed (NESPAK, 1991; Bhutta, 1999; Iqbal and Shahid, 1992). On average, 69% of the water in the reservoirs is being released and used for irrigation (Bhutta, 1999).

These small reservoirs are subject to high evaporation losses due to the high surface area to volume ratio. On average, small reservoirs can lose 50% of their impoundments to evaporation in arid and semi-arid areas (Sakthivadivel et al., 1997). The small dams in Pothwar are also subject to high evaporation losses. On average these dams lose about 1.74 m/year, which is about 20% of their storage capacity. The seepage and percolation losses in small reservoirs can be about 20% of reservoir volume against 5% in large dams (Keller et al., 2000). The cost per unit of water in small dams is also relatively high. The cost per 1000 m^3 of water ranges from $1 to 32 (1 US$ = Rs. 60) for large reservoirs, whereas it is from $7 to 110 for medium and small dams ((NESPAK, 1991; Keller et al., 2000). These small dams; however, act as buffer during dry season and dry years and should be managed properly (Mugabe et al., 2003). Since the evaporation losses and unit cost of water storage in small dams are relatively high, it becomes imperative that the stored water be used judiciously and efficiently.

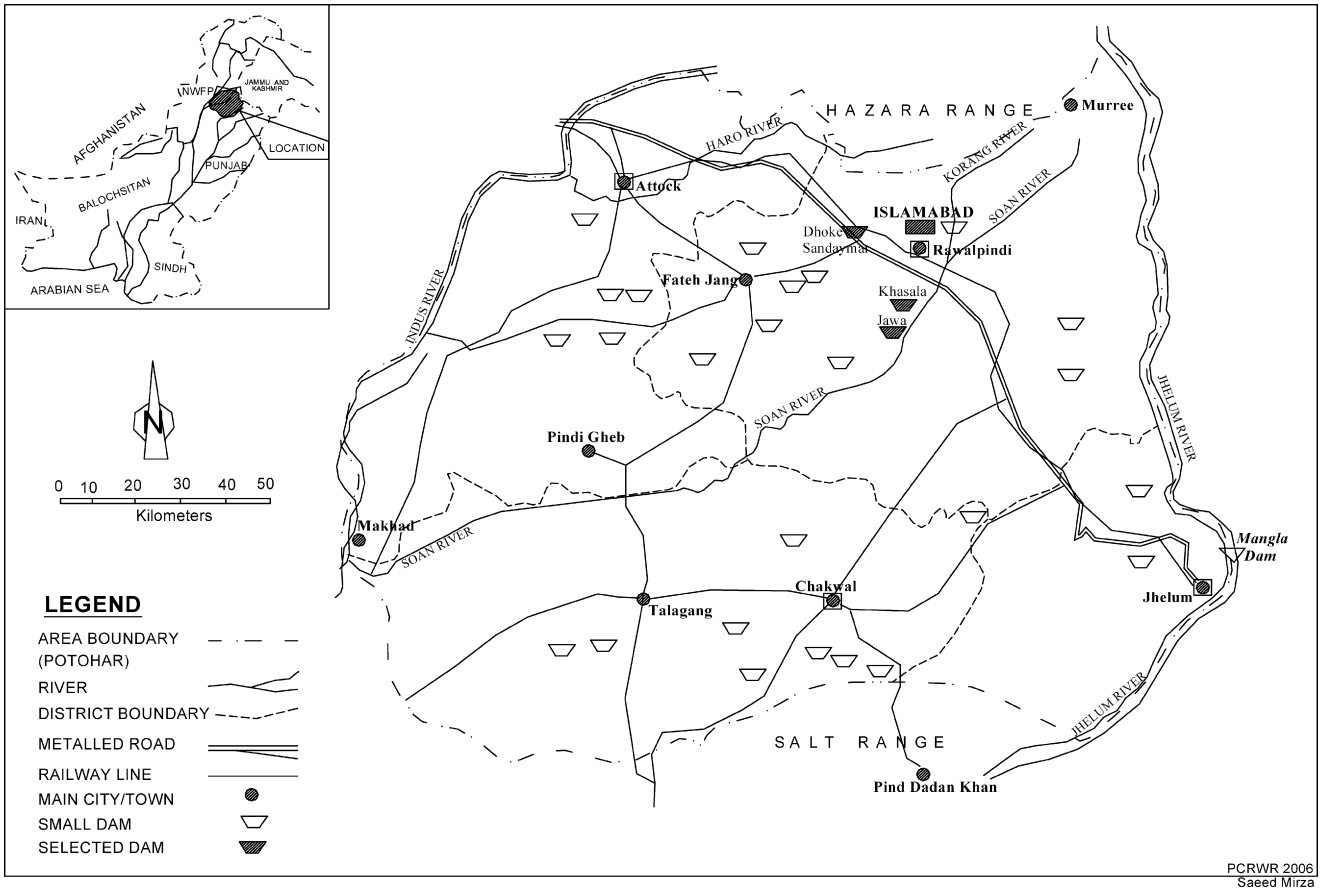

Fig. 1 – Location of the selected dams.