Spate irrigation in Pakistan

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1 Introduction

Pakistan is an arid to semi-arid country, located between longitudes 61 West and 76 East, and latitudes 23 South to 37 North. Pakistan has a total area of over 79.61 million hectares, and a population of about 104 million, nearly 75 percent of it in the rural areas with an annual growth rate of over 3.0 percent. Administratively it is divided into four provinces: Punjab, Sind, NWFP and Baluchistan.

Agriculture is the main-stay of Pakistan's economy. It produces 35 percent of the Gross Domestic Product, nearly 59 percent of the total exports, and employs about 57 percent of the labour force. The area suitable for agriculture is estimated to be 35 million hectares. According to the 1985 Agricultural statistics, actual cultivated area is about 20.54 million hectares, of which 5.61 million are rainfed. Some is double cropped but nearly half lies fallow during one season.

2 Irrigation system

The canal irrigation system in Pakistan has been developed over more than a century and is now the largest integrated irrigation system in the world. It covers an area of 16 million hectares of which 88 percent is cultivatable. It has 48 principal canals, emerging from 20 river diversion structures. Fifteen have capacities of over 280 m^3/s. The cumulative operating capacity of these canals is 7 330 m^3/s (371 billion cubic meters per year). These canals traverse about 63 000 kilometers through 89 000 watercourses. Each watercourse serves, on average, 160 hectares. In addition, there are 12 link canals transferring bulk water supplies from the western to the eastern rivers. Three large dams Tarbela, Chashma and Manglas with a storage capacity of 18.6 billion m^3, have been built on the western rivers. These regulate seasonal river flow for irrigation during winter. It is estimated that more than 10 million hectares are presently irrigated by canals.

In addition to this grand canal system, there are about 232 697 private tubewells, with average capacity of 30 litres per second each, and 25 000 public tubewells of designed capacity of 50 to 120 litres per second. These tubewells pump about 41 billion m^3 of water and provide 30 percent of the total irrigation water. More than 3.6 million hectares are supplied exclusively by tubewells which also supplement some canal-fed areas.

3 Spate irrigation

There are two types of spate irrigation practised in Pakistan, riverian and hill torrent.

Spate irrigation, locally called *sailaba* irrigation, is practised in the riverian areas of Pakistan and in the sub-mountain plains of NWFP and Baluchistan. The rivers of Pakistan have a marked periodicity. They depend mostly on the rains in the mountain and snow melt from the glaciers. They are in high flood during summer, but run low during winter. When the rivers are in high spate the areas within the protective bunds are inundated. After the floods have receded, and the soil has been enriched by the river silt and moistened, crops like wheat and oil seeds are sown. Such irrigation is called *'Sailaba'*. It is the oldest form of irrigation, and in common practice in the Indus basin of Sind & Punjab. After the construction of Tarbela, Mangla and Chashma reservoirs, and the commissioning of a grand canal system, the riverian areas are not inundated every year; in the vicinity of rivers, tubewells are being installed to provide a perennial supply. The water diverted from the rivers has led to the controlled irrigation system.

In the sub-mountain areas of Baluchistan and the NWFP, the foothill lands are very fertile. But, due to the absence of a perennial supply of irrigation water, these have to depend on hill torrents; about 1.45 million ha come under this category.

3.1 Baluchistan

The total area of Baluchistan is 34.72 million hectares. It is equal to the area of the Punjab and NWFP combined. The population, however, is approximately a quarter of that of the Punjab.

One of the reasons for such a sparse population is that there are no major resources of surface water. The only reliable and perrenial source of irrigation water in some parts is the under ground water reservoir. The other source of water is hill torrents. The people of the area use ground water for drinking as well as for irrigation. The under ground water is withdrawn from natural springs, dug-wells or *Karezes*. The climate is dry and temperatures in winter normally drop below zero; sometimes snow falls on the mountains and high plateau. The rains, which usually come in summer, are scanty and erratic. Occasionally,

however, they fall with high intensity and flood the sub-plains. The soils, on the whole, are heavily eroded and almost infertile.

In summer the floods originate from the high mountain and flow over long distances to the sub-plains. These flows are, however, short and cannot be effectively impounded. Nevertheless, the local inhabitants construct levees, dykes and bunds in order to divert some of the flood water to their fields. The diverted water is immediately used on the cultivated land or stored in the ponds which are used as source of irrigation as well as for drinking. The water floods the land compartments, which are prepared in advance, sometimes to a depth of nearly 2 m. This flood water recharges the underground water reservoirs and the *karezes*. Advances in technology have brought many innovations to help use this scarce source of water. The soil and water conservation practices reduce soil erosion, increase the soil depth, raise a crop and recharge the ground water reservoirs. Delay action dams store the flood water for irrigation and recharge the under ground water reservoir.

3.2 Dera Ismail Khan Plain

Spate irrigation, locally called *Rodh Kohi*, irrigates a few million hectares of piedmont land in the Dera Ismail Khan and Dera Ghazi Khan districts.

Rodh Kohi irrigation collects rain water coming from the mountains. It operates in the same manner as in Baluchistan. However, in Baluchistan it covers the submountain area, whereas in Dera Ismail Khan and Dera Ghazi Khan districts, temporary earth weirs are constructed to irrigate fields on both sides of the streams. It covers mostly plains and gently sloping land.

Districts adjacent to the hill and mountain ranges, are fed by the hill torrents. The local inhabitants have developed a network of *Rodh Kohi* irrigation which still contains certain drawbacks. The earthen bunds/embankments are not properly built up and sudden breaches take place during heavy floods because the weak embankments of the fields can not hold the excess water. This results in soil erosion and a reduced fertility level. Standing crops are also washed off and repair is expensive. After flooding the fields, the water is allowed to stand to penetrate the deeper soil stratas.

Rodh Kohi irrigation used to be considered of great value and importance as a long established appropriate technology. The farming community in the past was close knit with strong social bonds. However, the age of machinery has brought changes.

Traditionally, farmers in *Rodh Kohi* areas used to repair the embankments collectively. They used to come out with their bullocks and ploughs, at the call of their elders, and even make financial contributions so that the earthen bunds (weir) could be constructed or repaired before the flood season. But now, after the introduction of individually owned heavy machinery like bulldozers, the subsidy provided by the government, individualism has replaced cooperative enterprise.

The agricultural economy of the areas commanded by spate irrigation is not strong; the time and quantity of the rains is uncertain while soil reclamation and essential repairs are expensive, so *Rodh Kohi* irrigation is protected by law. A set of rules determines the sites on which earthen weirs are to be constructed, indicates the groups of areas *(Chaks)* to be irrigated by each hill torrent *(Nullah)*, and records the *warabandies* of each *chak* by village. All villages and *chaks* on both banks of the stream have certain rights of water utilization. At times, when the flow is less and villages located at the tail end need water for drinking, the head land owners are bound to leave some water to meet their requirements.

3.3 Tribal areas

The belt along the Pakistan and Afghanistan border stretches from Baluchistan to Chitral. It has a population of 7.5 million. This belt mostly consists of hilly areas. Small patches of land are cultivated in the valleys using a centuries old irrigation system. Cultivatable land is very scarce in the tribal areas attached to NWFP and is usually devoid of any source of water except from the hill torrents. The agriculture depends exclusively on spate and spring irrigation, and seasonal flood water from the mountaineous catchment areas is diverted to the agricultural fields for irrigation.

The monsoon rains, from July until September, brings heavy floods. Due to the nature of the terrain, flood water flows at a very high velocity, causing soil erosion and creating gullies which develop into big and wide creeks filled with gravel, sand and big rocks or stones, and no soil is available. However, water is diverted from the main stream through specially designed inlets. These are so formed that they are not washed away. Water is impounded in the compartments and allowed to stand for 24 hours, allowing the heavy silt to settle out. The clear water is then drained out leaving a layer of fertile soil on top of the gravelly formation.

This reclamation process continues for the virgin land while dykes are made along the drainage way on both sides of the creek which form the sides of the compartment. The inlet on the flood side of the creek is made of wood or stones bounded with steel wires. Blocks of 1.5 m x 0.9 m x 0.6 m are used to protect the levees from the rushing water.

Farmers have informal associations for using the flood water. These associations observe age-old traditions. When there is no shortage of water every land holder can have water the same day. Each land holder is responsible to make the bund strong enough to hold water along his holding. The land holders association visit the protective bund twice a year to look for weak points. A committee is constituted to which the inspection team reports about the condition of the protective bund.

The head reach structure of the protective bund is made jointly by all the land holders. It takes the full force of the flood water. If any breach occurs at this point the whole cultivated area is covered with silt, stones, rocks and gravel and it becomes barren again. The Government subsidises the construction of dykes on which the welfare of whole communities depends.

4. Recommendations

1. Appropriate, economical measures are possible to collect rain water. The system could be redesigned

for improved spate irrigation.

2. The force of flash floods is too much for the dykes and levees constructed by local people. These dykes and levees should be constructed on the basis of any preliminary survey regarding the volume and velocity of waters and its contents, if they are to hold the flood.
3. Proper engineering design is not available to the people. They depend on their own experience which fails them because there is no consistency or permanency in the water supply.
4. The government support is limited to subsidies only. No technical input or guidance what-so-ever is provided as in the irrigated areas.
5. It would be advisable to conduct a survey of the catchment areas, in order to reduce silt load and to avoid erosion in the mountains and hills.
6. To save the soils, forests and collect flood water, it is necessary to provide small dams, delay action dams and reservoirs.
7. The administration should be responsible for ensuring an equitable supply of water to all the affected farmers.
8. Technical advice is also required by the farmers to prepare fields so that even the smallest quantity of water could be made available. This will cover more area and contribute to better agriculture. Ultimately it will improve the welfare of the people.