WATER RESOURCES MANAGEMENT TECHNOLOGIES FOR BARANI AREAS OF PAKISTAN

Engr. Dr. Illahi B. Shaikh & Engr. Qazi Tallat Mahmood Siddiqui[1]

1. ABSTRACT

Pakistan with a Geographical area of 796,101 square kilometers possesses a large river like Indus, which alongwith its tributaries namely Chenab, Jhelum, Ravi, Kabul and Sutlej, forms one of the mightiest River System of the world. The River System comprises of 19 large river headworks, 45 independent irrigation Canal Systems measuring 64,000 kilometers, some 1.6 million kilometers of water courses and 94 large dams of height 15 meter and above including 3 super storage reservoirs. Water resources development (Surface & Groundwater Reservoir, Canal Network and Drainage System) plays a vital role in growing economy of the country. Agriculture, being the main source of crop production and necessity for the existence, directly depends upon the availability of appropriate quantity and quality of water in proper time. The fertility of land and production of crops is badly affected due to the unavailability of suitable water in arid area and standing of surplus water in the waterlogged area.

Barani agriculture contributes about 10% of the total agricultural production of Pakistan and depends on rainfall for its water. Most of the rainfall occurs during monsoon season from July to September. In the context of crop production, barani lands have often been underestimated. However, bumper crops especially wheat, sorgum and barley have been produced in these areas, which reveal a high potential for crop production. Water is the only limiting factor for agriculture development in these areas. The occurrence of rainfall in the rain-fed areas is erratic and its spatial and temporal variation is high. Due to the uncertainty of rainfall, farmers normally use less input to reduce the risk of loss in the event of drought. Nevertheless, there is high potential for the development and management of water resources and therefore, adopting proper water resource development and management practices could increase crop yield.

1- Chief Engineering Adviser/Chairman Federal Flood Commission, Ministry of Water and Power, Govt. of Pakistan/ Chairman PANCID &
Assistant Engineering Adviser (Civil), Ministry of Water and Power, Govt. of Pakistan/Member WG-YPF

Paper discusses in detail various water resources development and management technologies at length which are being practiced in Barani (rain-fed, arid /semi-arid) areas of Pakistan.

2. BACKGROUND INFORMATION

Only about 3 % of the world's total water resource is fresh (non saline) water, of which roughly one-third is inaccessible. The rest is unevenly distributed. In many areas, the existing water resources are increasingly contaminated with wastes and pollution from industrial, agricultural and domestic sources. Over the years, rising population, growing industrialization, and expanding agriculture have led to a rising demand for water.South Asia is one of the most densely populated regions of the world. It houses roughly one-fifth of the world's population, and this share is likely to increase to one-fourth of the total world population by the year 2025. The economies of the countries in the region are heavily dependent on agriculture.

Pakistan with a Geographical area of 796,101 square kilometers possesses a large river like Indus, which alongwith its tributaries namely Chenab, Jhelum, Ravi, Kabul and Sutlej, forms one of the mightiest River System of the world. The River System comprises of 19 large river headworks, 45 independent irrigation Canal Systems measuring 64,000 kilometers, some 1.6 million kilometers of water courses and 94 large dams of height 15 meter and above including 3 super storage reservoirs. Figure 2.1 and figure 2.2 show the Indus River Irrigation System map and Schematic Diagram respectively. In the case of Pakistan, water has played a very significant role in the economic development and will continue to be a driving force in its continued development into the future. Agriculture is the largest sector of the economy, with primary commodities accounting for 25% of GDP and 47% of total employment, and contributes more than 60% of foreign exchange earnings.

Pakistan is blessed with one of the largest integrated irrigation network in the world. The Indus Basin Irrigation System commands an area of 17 million hectares (42 million acres). The Indus River and its western tributaries on average bring about 175 BCM (142 MAF) of water annually and the average annual canal withdrawal is 128 BCM (104 MAF). The System has three major reservoirs, 19 barrages, 12 inter-river link canals, 45 independent irrigation canal systems and more than 1.6 million kms of water courses. The total length of the canal system is about 64,000 Km.

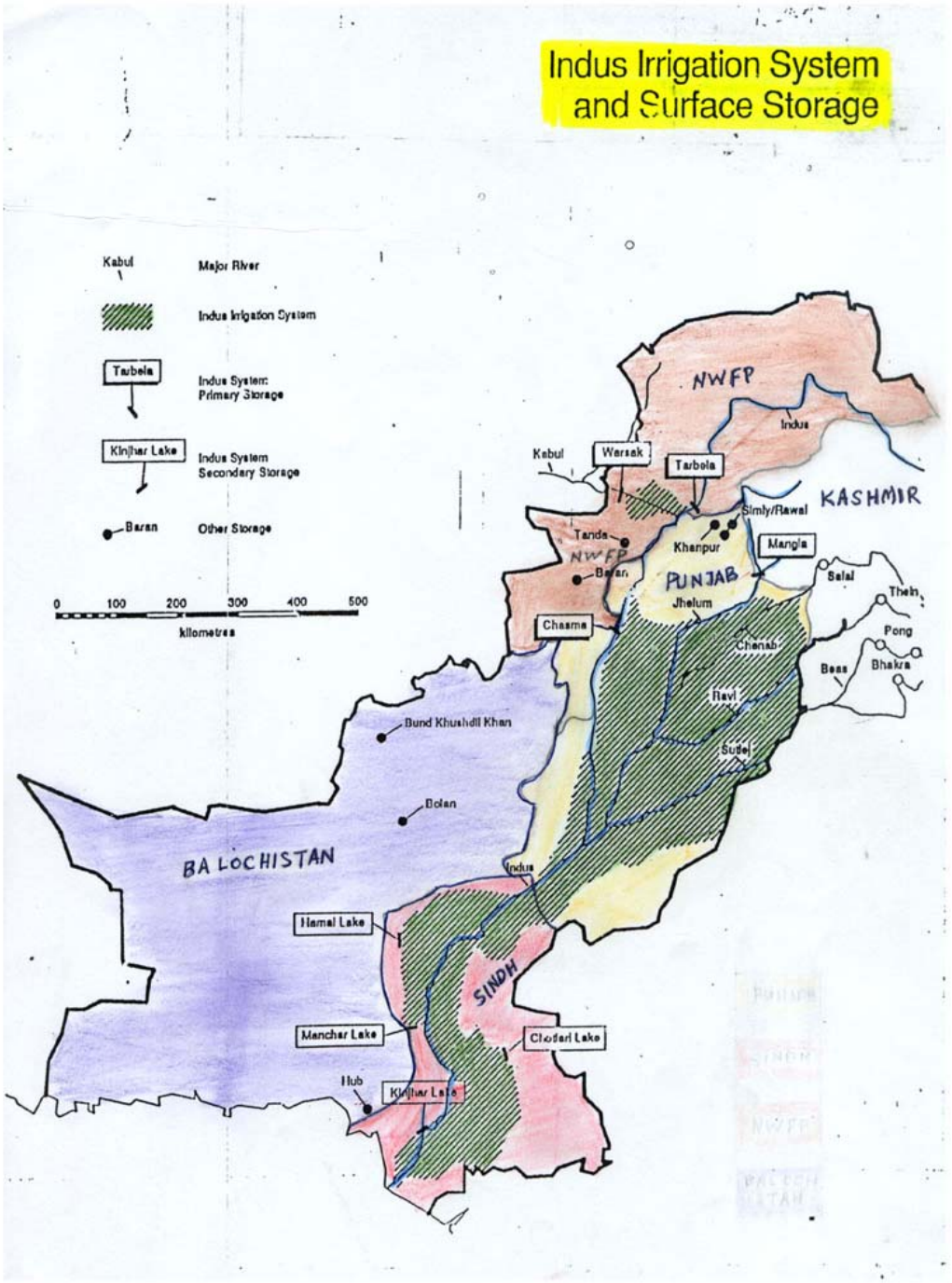
Indus Irrigation System and Surface Storage
Kabul
Major River
Indus Irrigation System
Tarbela
Indus System: Primary Storage
Kinjhar Lake
Indus System Secondary Storage
Baran
Other Storage
0 100 200 300 400 500
kilometres
NWFP
Indus
Kabul
Warsak
Tarbela
KASHMIR
Simly/Rawal
Tanda
Khanpur
Mangla
NWFP
Baran
PUNJAB
Jhelum
Salal
Thein
Chasma
Chenab
Pong
Beas
Bhakra
Ravi
Bund Khushdil Khan
Sutlej
Bolan
BALOCHISTAN
Indus
Hamal Lake
SINDH
Manchar Lake
Clofarl Lake
Hub
Kinjhar Lake

Figure 2.1

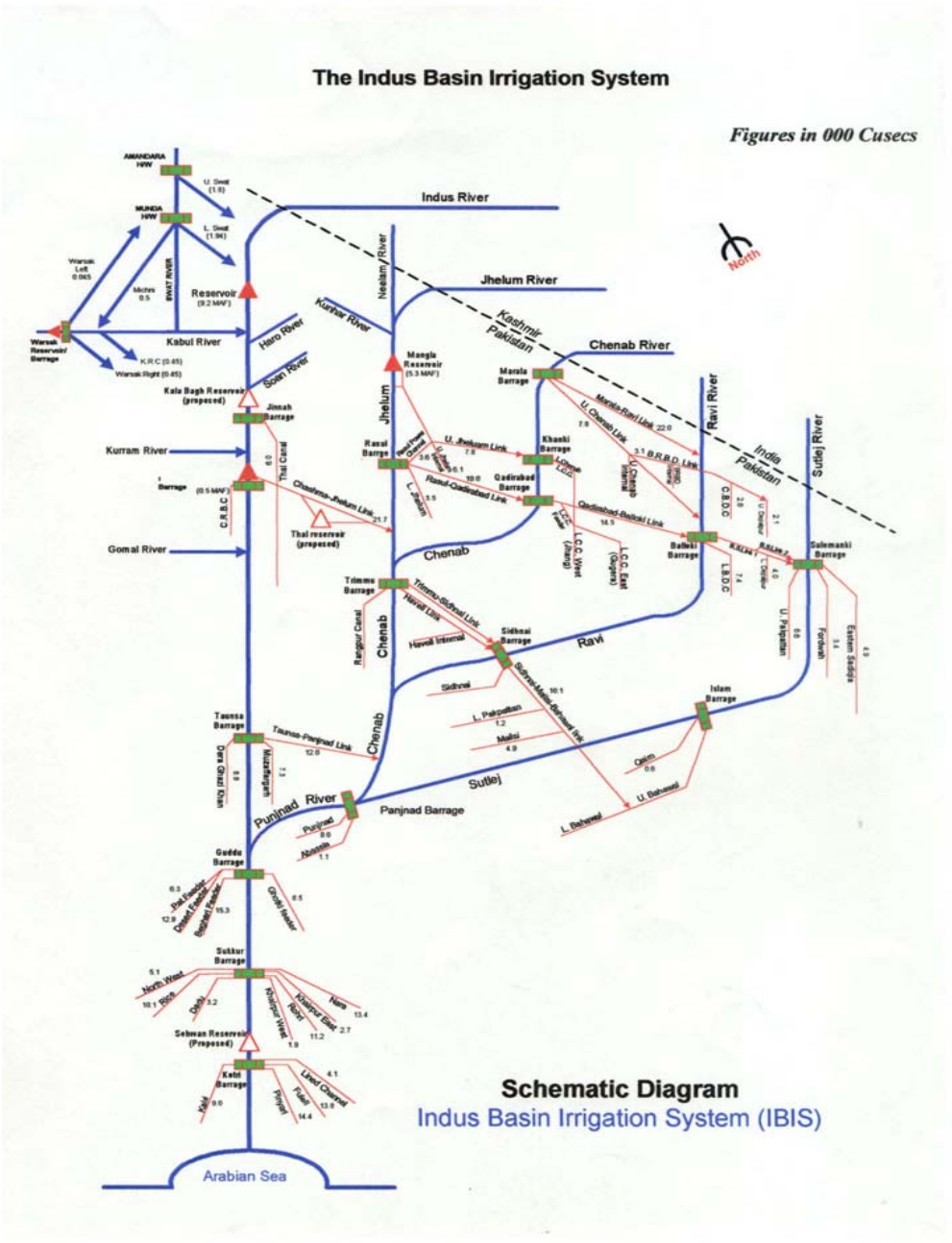

Figure 2.2

Pakistan is a country of over 141milion people, which is expected to grow about 221 million by the year 2025. The most pressing need over the next quarter century in Pakistan will be the management of the rapidly increasing population and provision of basic amenities. The increasing population will have a major impact on food and fiber requirements. Irrigation is the single largest sector of Pakistan's economy. The principle crops include wheat, rice, cotton, sugarcane, oilseeds, fruits, vegetables, pulses. The overall yield per hectare of most crops is far below their demonstrated potential.

Irrigated agriculture yields can be increased through use of improved technology and better management of the highly complex agricultural management system.

As the population continues to grow, Pakistan is now essentially at the limit of its water resources and is becoming a water scarce country. There is a strong and growing need to manage this precious resource more carefully and efficiently to ensure water for all on a sustainable basis. In order to effectively use water to meet the future demands for food and rural development, there is need to evolve strategies for development of water resources, management and conservation. A good proportion of the water which will supply the additional needs of the future must come from conservation, the food needs of the future could only be met through combined efforts in water conservation, additional storages and most importantly through increases in crop yields.

Pakistan falls in arid to semi-arid region of the world. The rainfall is neither sufficient nor regular, to meet the growing needs of agriculture. About 70 per cent of the annual rainfall occurs in the months, of July to September. The topography of the area forms mainly Indus Basin, Cholistan and Thar Deserts and small basins of Balochistan. The major source of irrigation is surface water mainly consisting of flows of the Indus River and its tributaries. The months of peak-flow are July to September during the monsoon rains. There are mainly two crop seasons. The flows during the Kharif (summer) are 84 % and during Rabi (winter) season are 16%. The alluvial plains of Pakistan are blessed with extensive unconfined aquifer, with a potential of over 62 BCM (50 MAF), which is being exploited to an extent of about 47 BCM (38 MAF) through private and pubic tubewells.

Barani agriculture contributes about 10% of the total agricultural production of Pakistan and depends on rainfall for its water. Most of the rainfall occurs during monsoon season from July to September. In the context of crop production, barani lands have often been underestimated. However, bumper crops especially wheat, sorgum and barley have been produced in these areas, which reveal a high potential for crop production. Water is the only limiting factor for agriculture development in these areas. The occurrence of rainfall in the rain-fed areas is erratic and its spatial and temporal variation is high. Due to the uncertainty of rainfall, farmers normally use less input to reduce the risk of loss in the event of drought. Nevertheless, there is high potential for the development and management of water resources and therefore, adopting proper water resource development and management practices could increase crop yield.

3. TECHNOLOGIES FOR BARANI AREAS OF PAKISTAN

3.1. SMALL /MINI DAMS:

It has been estimated that about 11 BCM (9MAF) of water is lost annually as surface runoff from the Barani regions. If 50 % of this could be retained in small/mini dams, water equivalent to more than half the capacity of the Tarbela dam reservoirs could be stored. There are many potential sites for the construction of small/mini dams in northern areas of the country as well as in Pothowar region. The government of the Punjab has constructed 31 small dams in the regions.

Besides supplying water for irrigation, these dams have many indirect benefits. They help recharge the groundwater, provide water for domestic and municipal purposes, control soil erosion, control floods in hilly and plain tracts, help to develop fish culture and also provide recreational activities.

However, there are several issues relating to these dams which still need to be addressed, such as development of command area, low water conveyance and application efficiencies, reduction in reservoir capacity due to sediment deposition and vegetation growth, evaporation and seepage losses. Reports compiled by International Water Management Institute (IWMI) and National Engineering Services of Pakistan (NESPAK) reveal that presently only 23% of the stored water is being utilized with a cropping intensity of 60% against projected figure of 130%. With no salinity and groundwater problems, good climate for production of high value crops and proximity to markets, this area should increase its share in agriculture production using high efficiency trickle or bubbler systems. It is interesting to note that small/mini dams are being constructed by many progressive farmers in the Pothowar Region and they have proved to be successful in generating income comparable to that of farmers in the canal irrigated areas.

3.2: DUG WELLS

Large scale water resource development through mini and small dams involves large capital investments. Moreover, these reservoirs need special attention in terms of operation and maintenance. Since these dams are mostly public owned, disputes over water rights and sharing maintenance cost also arise. Small- scale on farm water resources development and management activities however, can play an important role in increasing the income of the farmers. The individual farmers or a micro community owns these systems, therefore they make best use of the water resources available and the problems of disputes over water are also eliminated.

The Barani Master Plan reports that there is considerable potential for development of open wells in the cultivable lands of the Pothowar Plateau. The aquifers in the Plateau are generally in sandstone formations with low transmissivity values. It is considered that dug wells up to 20 m (66 feet) deep can safely yield 3-6 liters/second (lps) water to irrigate small fields besides meeting domestic requirements. However, the design of such well needs to be based on aquifer transmissivity and recharge characteristics of the aquifer. The development of a typical dug well can provide water for about 2 ha (5 acres) of flood irrigated 4 ha (10.0 acres) of sprinkler irrigated or 6 ha (15.0 acres) land with low-pressure drip, typically for high value orchards.

3.3 PRESSURIZED IRRIGATION SYSTEMS

Due to the scarcity of water, merely 25% of total rain-fed area is under cultivation. The farmers use obsolete methods of irrigation resulting in poor application and distribution efficiencies. In most of the area, the land is highly undulated and precision land leveling is therefore, not a feasible economically justified option. Under the prevalent topographic conditions, gravity irrigation is also not possible in these areas. Therefore, it is of utmost importance that the scarce water resources in the region are utilized most aptly and efficiently with minimum losses.

3.4 SOIL AND WATER CONSERVATION PRACTICES

These technologies include contouring, strip cropping, terracing, improved tillage practices and construction of soil and water conservation structures. A brief description of each follows.

a). Contouring:

In contouring, tillage operations are carried out as nearly as practical on contours. On gentle sloping lands, contouring reduces the velocity of overland flow. If ridge cultivation is practiced, the storage capacity of furrows is increased, permitting the storage of large volume of water. It has been shown that contour cultivation of a good piece of land with grass can reduce watershed runoff by 75 to 80% at the beginning of the season.

b). Strip Cropping:

Strip cropping consists of a series of alternate strips of various type of crops laid out so that all tillage and management practices are performed across the slope or on the contours. Strip cropping is not a single practice. Rather it is a combination of several good farming practices such as crop rotation, contour cultivation, proper tillage operations and stubble mulching.

c). Terracing:

The cultivated lands of Pothowar tract are undulating. Land leveling is not only costly but also puts the soil at the risk of erosion. Terracing involves constructing broad channels across the slope of rolling land. The function of terracing is to decrease the length of hillside slope, thereby reducing sheet and rill erosion, and preventing the formation of gullies. Terraces not only check erosion but also increase retention of rainwater in the soil for next crop.

d). Good Management Practice:

Where erosion can be controlled by stubble, vegetation or other means practices that reduce surface runoff, diminish erosion and improve moisture reserves in the soil are proper bunding, leveling and deep ploughing. Deep ploughing helps hold water so that most of the water infiltrates into the soil, while leveling ensures the equal distribution of moisture over the whole field. Each millimeter of saved water could increase yield of wheat by an average of about 10 kg/ha. The adoption of these conservation practices for a kharif season increased crop yields by 14%. However, for light-textured and sandy soil, Rain-Water harvesting technique can increase surface runoff and collect it at appropriate places to meet domestic, livestock and agricultural needs.

4.0 CONCLUSIONS

There is high potential for the development and management of water resources in the Barani (rain fed/arid) areas of Pakistan. These areas have a strong legacy of ancient water application and conservation techniques which have now been blended with modern trends. Adopting proper water resources development and management practices could considerably increase the crop yield in these areas.

5.0 REFERENCES & BIBLIOGRAPHY

1. Ahmed, Nazir (1993). Water Resources of Pakistan, Shahzad Nazir Publications, Lahore, Pakistan
2. Kahlown, M-A-(2004). Pakistan Water Resources Development and Management. PCRWR, Islamabad, Pakistan
3. NESPAK (1991). Evaluation of Small Dams in Punjab and NWFP Vol. II Part-A-C, Planning and Development Division, Islamabad, Pakistan
4. Shaikh, I.B (2005) Research Thesis on Water Resources Management of Pakistan and Analysis for Future Strategy, Preston University, Pakistan