POTENTIALS FOR IMPROVING WATER AND AGRICULTURE PRODUCTIVITY IN SINDH, PAKISTAN

BakhshalLashari[1] and Masood A Mahesar[2]

Professor, Institute of water resources engineering and management, Mehran University of Eng and Tech Jamshoro, Sindh Pakistan
[2] Chief Executive Research and Development Foundation, Hyderabad, Sindh Pakistan

ABSTRACT

Sindh is the second largest province of Pakistan. The total gross command area (GCA) is 5.76 MHa and its culturable command area is 2.27 MHa. Agriculture is the backbone of its economy. The major field crops sown in Sindh are wheat, cotton, rice, and sugarcane, which utilize 68 percent of the total cropped area. Sindh also produces horticulture crops: mangoes, bananas, dates, and chillies. To irrigate command area surface water is allocated 48.76 MAF which is provided through network of irrigation system; however, the availability is normally 10-12 less than this amount. Groundwater availability is 5 MAF which is unregulated and rain water is good potential but it is unexplored.

To operate and maintain the system, about 80% of O&M budget is used for administration and electricity and only 15-17% is used for maintenance of irrigation infrastructure. Due to lack of investment on the irrigation and drainage system, the irrigation water losses are 55-66 percent seepage losses and 30-40 percent application losses. Almost 50% of the cultuable command area does not have drainage facilities. Thus, total about 37.6 percent of the gross command area is under water logging and salinity which reduces production by 40 to 60 percent.

The yields of major crops for last 10 years (2000-2010) have shown that the average yields of wheat and rice crops were 3500 kg/ha while, yields of progressive farmers were 30-40 percent more then average yield. Comparing yields of wheat and rice crops with Egypt, again the average is 60 percent less then Egypt. Further, rainfed area is major source of agriculture which produces much less than average yield. The yield of wheat crop is varying from 700 kg/ha to 1700 kg/ha.

It is concluded that improving agriculture productivity is lying in promoting efficient and environmentally sound water management practices. Increasing water's productivity – gaining more crop yield and value per unit of water – is an effective means of intensifying agricultural production and reducing environmental degradation. The actions needed are: bringing the production levels of low-yield farmers up to 80% of what high-yield farmers get from comparable land by better water management. The greatest potential increases in yields are in rain-fed areas, where many of Pakistan's poor rural people live and where better water management is the key to such increases.

1. INTRODUCTION

Pakistan's irrigated agriculture through network of Indus Basin provides 90 percent of food and fiber requirements while "Barani" (rainfed) area contributes the remaining 10 percent. The Indus Basin System has 3 super dams, 19 river barrages, 12 inter-river link canals, 45 huge canal commands, and over 1.0 m tubewells, besides nearly 18,000 km of drainage network to dispose of agricultural effluent with one drain taking a sizeable part of the saline effluent right into the sea (LBOD). Unlike the contiguous irrigation network, the drainage network is not interconnected. Unfortunately this huge system of irrigated agriculture has not provided designed set objectives of poverty reduction. Consequently, the system has deteriorated with time due to the reasons: Separate management of various sectors (agriculture, irrigation system, environment and social), lack of coordination among various water related stakeholders and lack of systemic process of linkages between social, economic and environment; lack of implementation of modern technologies of water management; poor water policies, especially groundwater governance and adoption of decision support system tools; poor operation and maintenance of the system.

The economy of Sindh Province of Pakistan is also dependent on agriculture. The major field crops sown in Sindh are wheat, cotton, rice, and sugarcane, which utilize 68 percent of the total cropped area. Sindh also produces horticulture crops: mangoes, bananas, dates, and chillies. The total gross command area (GCA) is 5.76 MHa and it is estimated that about 37.6 percent of the gross command area of Sindh is under water logging and salinity problems which has reduced the production of major crops by 40 to 60 percent. However, net cropped area varies from year to year depending on surface water availability. The province contributes significantly towards overall national agriculture production in major crops as 42% in rice, 31% in sugarcane, 23% in cotton and 21% in wheat(Pakistan Statistical Year Book 2008).

Despite these phenomenal achievements in the water sector, population growth, rapid urbanization and industrialization, are imposing growing demands and pressures on water-resource. The expanding imbalance between supply and demand, has led to shortages and unhealthy competition amongst end-users besides causing environmental degradation in the form of persistent increase in water logging in certain areas, decline of

groundwater levels in other areas, intrusion of saline water into fresh groundwater reservoirs.

Improved agricultural practices allowed for substantial yield increases, as well as the value added agriculture through the development of water-resources, irrigation infrastructure and agro-based industries. Whilst these interventions have allowed Pakistan's food and fiber production to keep pace with demand, in other water related sectors, notably urban and rural water supply, the pace of development has not kept up with need, whereby significant proportions of the population remained deprived of the benefit of clean water supply and sanitation facilities, resulting in a large cost to the nation in terms of people's health.

Yields of major crops, though have been increased, are still low at national level. (although there is significant potential for further increase). The rainfed area which is almost neglected or less considered requires more attention that will significantly increase the production. The sustainability of irrigated agriculture is being threatened by a number of issues including: Growing need of water to meet requirements of rising population; lack of proper maintenance of the canal system leading to unsatisfactory service; waterlogging and salinization; over exploitation of groundwater resources, thus, rendering large areas out of reach of poor farmers and exhaustion of groundwater aquifers; lack of field drainage system which could timely dispose of drainage effluent; inadequate participation of consumers and proper pricing/valuation of water. Thus the urgent need is to optimize crop yield and production for which the focused areas are: efficient management and conservation of existing water resources, equitable water distribution in various areas and canal commands, effective drainage interventions to maximize crop production and institutional reforms to make the managing organizations more dynamic and responsive.

The reliable water distribution and supply from head to tail has failed, head people receive more water than tail water users. Consequently, the set targets of irrigated agriculture have not been achieved and therefore water and agriculture productivity is much less than should have been. Framers can play a major role to improve water and agriculture productivity if reforms in irrigation sector are implemented in latter and spirits. Poor function of irrigation system has been since 1960’s. This poor performance mainly due to water scarcity which resulted in unreliable supply, distribution and efficient use of it (Kijni, D.Murray-Rust and W. Snellen 2002; N.Bhutta and Vander 1992; Zaigum and M Kuper 1998; Strosser 1998 and Lashari B 2006).

2. METHODOLOGY

2.1 STUDY AREA

Sindh is the second largest province of Pakistan (Figure 1). The total gross command area (GCA) is 5.76 MHa and its culturable command area is 2.27 MHa. The

major field crops sown are: wheat, cotton, rice, and sugarcane, which utilize 68 percent of the total cropped area. Other crops grown are: horticulture crops like mangoes, bananas, dates, and chillies. To irrigate command area surface water is allocated 48.76 MAF which is provided through network of irrigation system; however, the availability is normally 10-12 percent less than this amount. Groundwater availability is 5 MAF which is unregulated and rain water is good potential but it is unexplored.

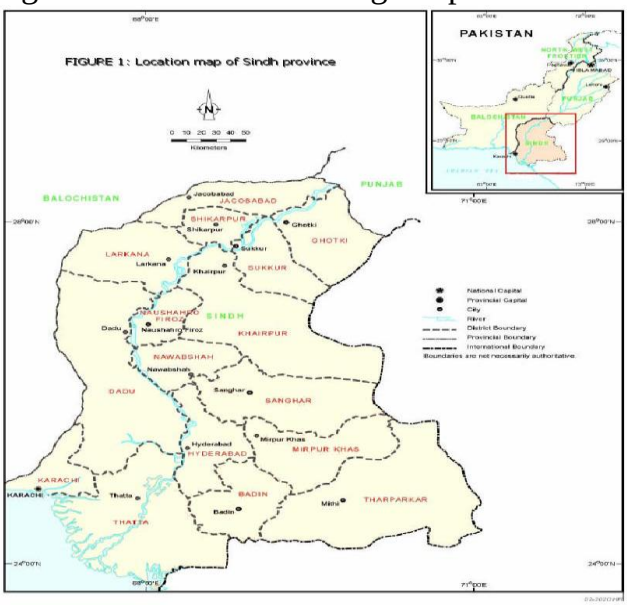


Figure 1. Map of Sindh Province of Pakistan

To achieve the research objectives of this work, the relevant information and data were gathered from various departments and organizations of Government of Sindh. The details are narrated below.

Water Resources: This information which includes daily flows, water distribution, losses, asset management, drainage and water logging and salinity were collected from Irrigation and power department Government of Sindh and Sindh Irrigation and Drainage Authority (SIDA).

Crop and land management: The Agriculture department, Government of Sindh is mainly responsible for agriculture and on farm water management. The relevant information and data such as cropping pattern, cropping intensity, crop production and crop yields were collected from the agriculture department. Analyzing the data, following findings were determined. Based on results the way forward for optimizing the system is suggested.

3. RESULTS AND DISCUSSION

Water availability: Sindh relies almost entirely on the water of the River Indus because groundwater is 80% saline only it provides 5 million acre foot (MAF) water. As per Water Accord 1991, Sindh's share is 48.76 MAF. Figure 2 indicates that the availability of water is

normally 10-12 percent less than the allocated share of water. Thus the reliable water supply and water distribution to the water users, especially tail-enders have always been issue.

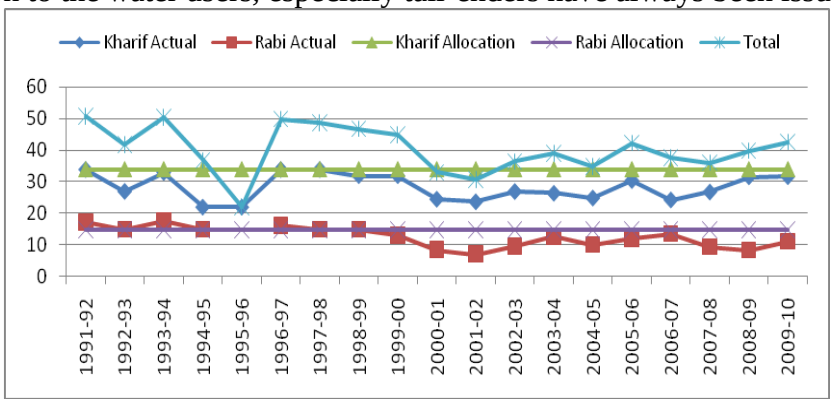


Figure 2. Surface Water Availability in Sindh

It is further evaluated that this inequitable distribution of water, unreliable supply of irrigation water, water losses (seepage 55-66 and application 30-40 percent), lack of coordination among irrigated agriculture stakeholders and lack of investment on the irrigation system are major obstacles in conserving and efficiently managing water resources in Sindh.

Asset management: Assets of Provincial Irrigation Department are managed by the department. Figure 3 shows that the major portion of the amount of the budget is used for the administration and electricity used for groundwater extraction through tube wells. For example: in year 2009 total allocation for O&M was Rs 7531 million from which Rs 2991 million (40%) used in administration cost, Rs 1309 million (17%) used for maintenance of canals and flood protection embankments and Rs. 3231 million (43%) used in electricity charges for FGW tubewells (SCARP Tubewells), while, the return from the irrigation system as water delivery services is very less. For example in year 2003 total expenditure was Rs 4500 m and revenue collection was about Rs 600 m which is about 87% less than the expenditure.

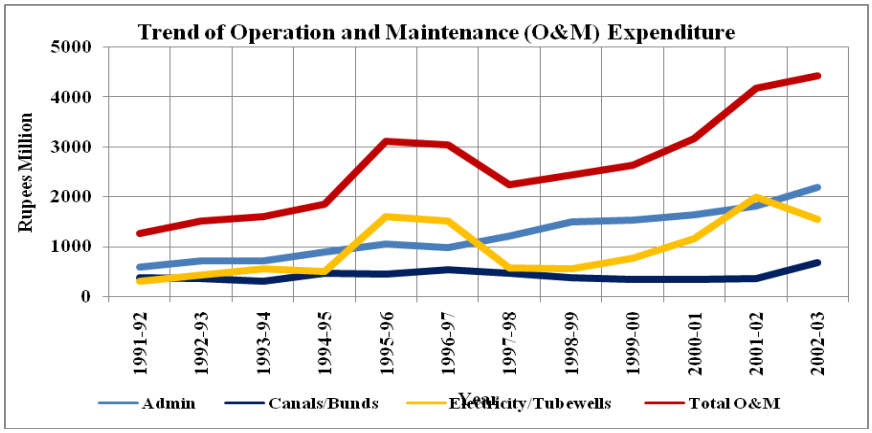


Figure 3. Operation and Maintenance Budget and its Distribution

Drainage, water logging and salinity: Water logging and salinity are the most pronounced problems in Sindh, which pose a major threat to sustainability of irrigated

agriculture on about 30 percent of irrigated lands. This situation is aggravated by the low irrigation efficiency (30-35 percent), old irrigation practices, and lack of drainage facilities and due to the flat gradient. It is an estimate that the water logging and salinity has reduced the production of major crops by 40 to 60 percent (IUCN 2007). In 1999, the waterlogged area, with water table depth 0 to 1.6 meters (0-5 ft), was 2.2 million ha, which however drastically reduced to about 0.26 million ha due to drought conditions from 1998-2001. In 2003, more than 2.7 m ha area was affected due to water logging situation. From 2004 to 2009 water table has again risen and continuously rising (Figure 4).

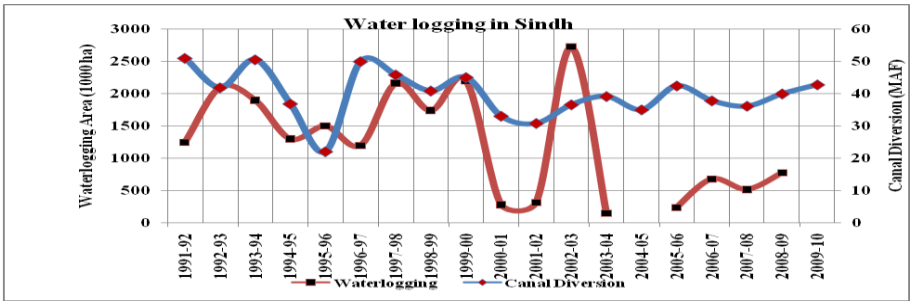


Figure 4. Water logging in Sindh.

Soil salinity in Sindh has been increasing with the expansion of irrigated area. In saline ground water (SGW) areas salinity remains at a very high level of 3,900 – 4,000 ppm while in fresh ground water (FGW) areas, salinity has remained between 900 ppm and 940 ppm. The extent of saline area in Sindh is shown in Table 1.

Table 1. Irrigated Areas Affected by Salinisation

Description	Areas (MHa)
Cultivated Land	
Non-saline land	3.67
Slightly saline land	0.33
Saline sodic and saline Gypsiferous Land	0.12
Saline sodic land	0.10
Sub-Total:	4.12
Uncultivated Land	
Saline with sparse vegetation	0.86
Saline- barren	0.11
Sub-Total:	0.97
Total Command Area:	5.1

Data analyses have shown that almost 50% of the Culturable Command Area (2.4 million ha) does not have drainage facilities. The present surface drainage density is usually not more than 3-7 m /ha which leaves much of the land without a drainage system (Azad 2003), therefore water logging permanently exists however the scale varies as shown in Figure 4.

Cropping Pattern and Yield of major Crops: Table 2 explains cropping pattern of major crops such as wheat, cotton, rice and sugarcane from last 12 years (2001-2009) has been gradually increased. For example: wheat in 2001 was about 811,000 ha and in 2009-10 was 1031,000 ha (22% increase), cotton in 2001 was 523,000 ha and in 2009 was 651,000 ha (20% increase), rice in 2001 was 540,000 ha and in 2009 was 733,000 ha (26% increase) and sugarcane in 2001 was 239,000 ha and in 2009 was 263,000 ha (10% increase)

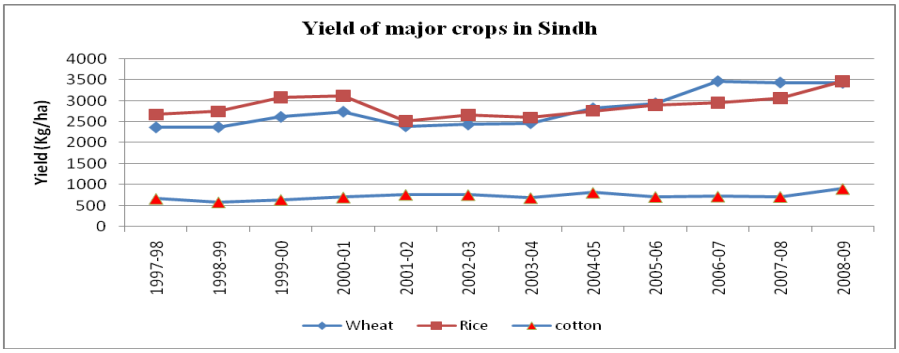


Figure 5. Yields of Major Crops in Sindh

The yield of major crops such as wheat, rice and cotton has gradually increased from last 5-6 years. The wheat yield in irrigated areas in 2009 was 3500 kg/ha and rice yield was also about 3500 kg/ha (Figure 5). However, it is also observed thru data that some of the districts were getting wheat yield around 4000 kg/ha. Also it was learnt during field visits and meeting with stakeholders that maximum yield of some progressive farmers go up to 6000 kg/ha.

Table 2. Area and Production of Major crops in Sindh Province of Pakistan

Crops/Year	Wheat		Rice		Sugarcane		Cotton	
Year	W-Area (000 ha)	W Prod 1000 Ton	R-Area (000 ha)	R-Prod 1000 Ton	S-Area (000 ha)	S-Prod 1000 Ton	C-Area (000 ha)	C-Prod 1000 bales
1997-98	1120.2	2659.4	689.3	1840.9	261.6	15999.6	600.3	2335.5
1998-99	1123.7	2675.1	704.1	1930.3	270.8	17050.7	630.2	2134.1
1999-00	1144.2	3001.3	690.4	2123	230.6	14290.8	633.5	2377.4
2000-01	810.7	2226.5	540.1	1682.3	238.8	12049.7	523.6	2141.1
2001-02	875.2	2101.0	461.1	1159.1	240.7	11416.3	547.4	2443.2
2002-03	863.7	2109.2	488.3	1299.7	258.6	13797.6	542.6	2411.8
2003-04	878.2	2172.2	551.2	1432.8	259.9	14611.8	561.4	2242.8
2004-05	887.4	2508.6	543.9	1499.6	214.9	9357.4	635.1	3016.7
2005-06	933.2	2750.4	593.2	1721	183.2	11243.4	637.1	2648
2006-07	982.2	3409.1	598.1	1761.8	214.7	12529.2	570.1	2398.2
2007-08	989.9	3411.4	594	1817.7	308.8	18793.9	607.4	2536.2
2008-09	1031.4	3540.2	733.5	2537.1	263.9	13304.3	651.5	2978.3

Figures 6 and 7. Comparing the yield of wheat and rice crops with world, data shows that the average yield of wheat in Sindh is 3500 kg/ha whereas, in germany and UK is more than 8000 kg/ha. Similarly, yield of rice crop in Sindh is 3500 kg/ha and in Egypt it is more than 9000 kg/ha and in USA is about 8000 kg/ha.

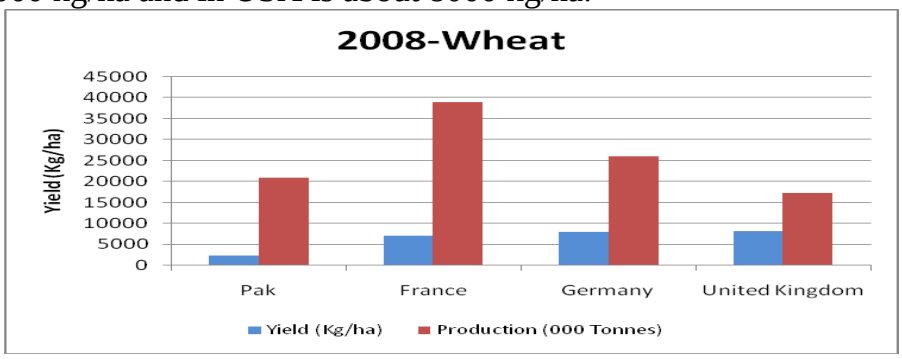


Figure 6. Production and Yield of Wheat Crop in the World

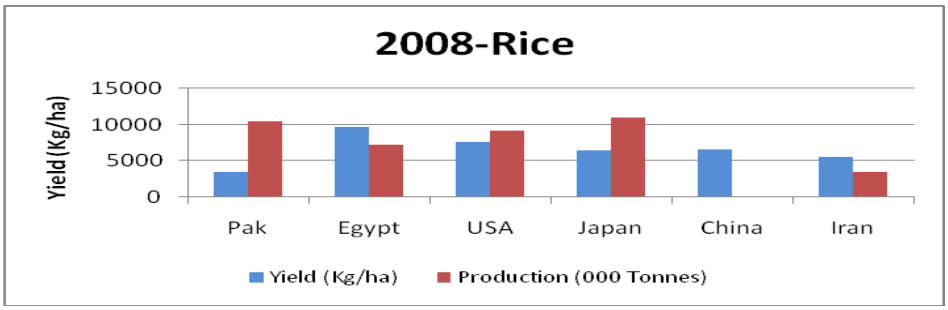
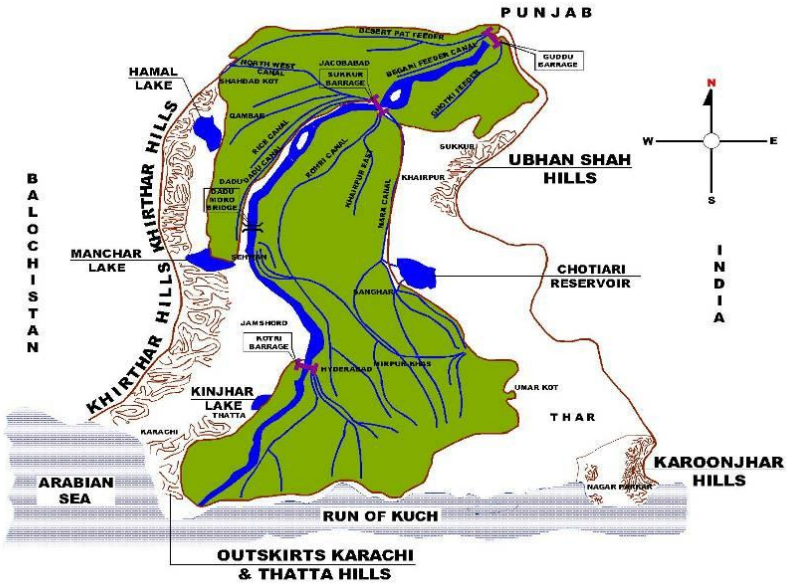


Figure 7. Production and Yield of Rice Crop in the World

Non Irrigated Area (Rainfed): In Sindh there are three potential areas where rainwater harvesting can be done. These are Khirthar Hills, Khirthar Hills and Ubhan Shah Hills as shown in Figure 8 below.



The small dams organization has been established in July 2007 for the main purpose of construction of small dams, delay action dams and retention weirs to provide water for agriculture and drinking purpose. So far, 9 small storage dams and 26 retention weirs have been constructed/are being constructed and new proposed medium dams are 7, small dams are 57 and weirs are 68. This indicates that Government of Sindh is taking steps to conserve rainwater which has huge potential to increase crop productivity. However there is no command management plan to utilize stored water for better yield of the crops. Presently, the production and yield have been compared and are shown in Figures 9 and 10.

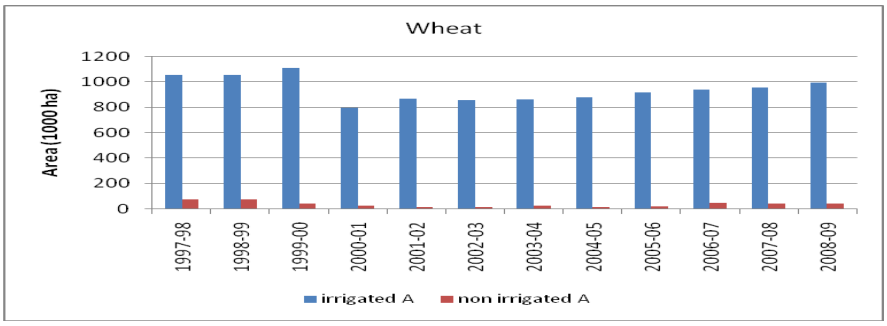


Figure 9. Area irrigated in canal command and rainfed

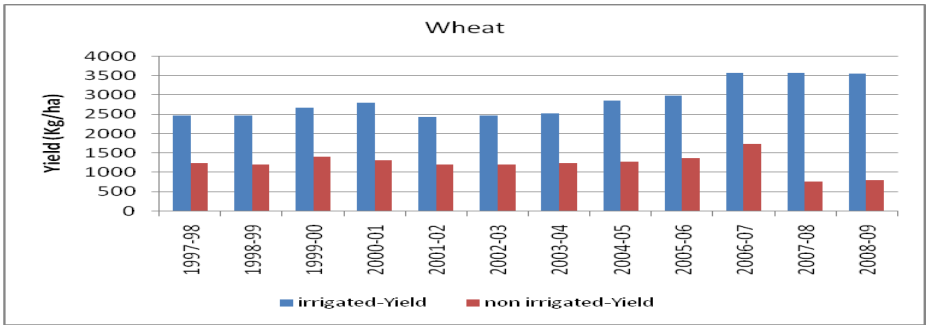


Figure 10. Yield in canal command and rainfed areas.

The wheat yield in rainfed area is much less than the canal command area. In rainfed area the yeild has been varying from 700 kg/ha to 1700 kg/ha from year 1997 to 2008-09. The poor yield in Barani area is obviously due to unavailability of water from crop sowing to its maturity. There is lot of potentials to increase yield in rainfed areas if water conservation techniques are adopted and water made available from sowing to harvesting

4. WAYFORWARD TO INCREASE AGRICULTURE AND WATER PRODUCTIVITY

The study has suggested that the following three areas be given focus to improve productivity of water and agriculture. The actions required are suggested in Tables 3-5

Indus Basin Irrigation System: Support on-farm water management programs, Reform governance of irrigation sector, Improve O&M of irrigation canal system, promote efficient and conservative use of groundwater, however, more focus on: governance reforms, efficient use of groundwater, drainage of agriculture lands and control of soil salinity.

Barani Areas: Continue to support construction of small and mini dams for water storage and for better watershed management. Emphasis on command area development

High Productivity Irrigation System: On a pilot basis PIDA to bid out management of one main canal and its service area to private sector

Table 3: Action suggested for the Irrigated Areas of Sindh

Desired Outcome	Suggested Interventions
Efficient on-farm water management	▪ Watercourse improvement ▪ Precision land-levelling ▪ Sprinkler and drip irrigation
Reformed governance of canal irrigation system	▪ Resource conservation technologies ▪ Fully implement 1997 Act to convert Irrigation Department to Irrigation and Drainage Authority, ▪ Transfer main canals to SIDA management at regular intervals, ▪ Continue to promote and strengthen FOs and WUAs ▪ Promote FOs-private sector links for input supply
Improved canal operation and maintenance	▪ Restructure AWBs, which is a weak link. ▪ Urgently reform the abiyana issue, ▪ Price canal water more realistically, in comparison to groundwater ▪ Let abiyana collections be used for maintenance of the tertiary systems, ▪ Formulate an asset management plan and put it to practice. ▪ Measure and report water flows to insure all canals receive their fair share ▪ Encourage FOs to employ some technical staff for proper O&M. ▪ Improved canal water delivery service should furhter reduce groundwater use, ▪ Assist farmers in getting energy-efficient motors and pumps.

Table 4. Action suggested for Barani Areas of Sindh

Desired Outcome	Suggested Interventions
Improved conservation of water resources and Improved watersheds	▪ Assist farmers in building mini dams ▪ Assist farmer in building dug wells ▪ Assist farmers with lift irrigation schemes ▪ Promote beter on-farm water management and the use of other inputs.
Improved water conservation and storage	▪ Construct small dams to store stream runoff and provide supplemental irrigation, ▪ Promote efficient on-farm water management and use of inputs through command area development programs.

Table 5: Action suggested for High-Productivity Agriculture in Sindh

Desired Outcome	Long-List Interventions
High agricultural productivity Modernized, demand-based irrigation system	▪ Let SIDA and FOs decide the amount of service fees or the abiyana, ▪ Let the abiyana be used to pay for the system operation and mangement. ▪ Rehabilitate and modernize the canal system including: Flow measurement and reporting Use of decision support systems Proper flow regulation structures

5. CONCLUSION

Finally, it is concluded that there is huge potentail in both irrigated and rainfed areas to increase crop productity and yield if proper water conservation and management is made and suggested actions are well taken. These actions not only provide food security but also develop good environment and reduce poverty in the province as general and country as whole.

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