IMPACT OF CHASHMA RIGHT BANK CANAL (CRBC) ON AGRICULTURAL PRODUCTION OF DISTRICT D.I. KHAN: AN EX POST EVALUATION

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Abstract: This paper attempts to explore the impact of Chashma Right Bank Canal (CRBC) on the agricultural production of D.I. Khan district. In this study focus has been made on the ex post impact evaluation. CRBC is 272km long canal and commands 250,000ha, out of which 61\% lies in D.I. Khan district. Work on the CRBC was started in 1984 and was completed in three stages during 2003. Data were collected both from primary and secondary sources. In order to achieve the mandated task, analysis was carried out both at macro (district) and micro (village) level. The analysis revealed that there has been substantial increase in the agricultural production after the inception of CRBC. High agricultural production was largely confined to the CRBC command area. In D.I. Khan district, the agricultural production of almost all the Rabi and Kharif crops was enhanced as a result of CRBC. The increase in agricultural production was recorded in rice, sugarcane, wheat, cotton, maize, pulses and orchard, whereas negative change in agricultural production occurred in millet, barley, sorghum and oilseed.

Key Words: CRBC, agricultural production, command area.

Introduction

Water is an essential agricultural input for high crop yield (Ahmad, 1993). Irrigation has played a key role where climatic condition doesn’t fulfil the crop water requirements (Cantor, 1967; Chaudry, 1993; Atta-ur-Rahman, 2010). In 1800, the world's irrigated land was mere 8 million ha which was increased to 220 million ha in 1990 (Jensen et al. 1990). Presently, about three-quarters of the irrigated land are in the developing countries. Globally, irrigated agriculture has been providing 40\% of the world's food, from only 20\% cultivated area (Atta-ur-Rahman et al. 2012). It is irrigation which has boost-up the food production over the past hundred years. In Asia, more than 70\% of the developed freshwater resources are used for irrigation purposes, whereas more than 80\% of the total irrigation water is used for rice production (Guerra et al. 1998). In many agricultural regions, farmers and agriculturalists have been asked to enhance production and satisfy increasing demand for food. However, some organizations are calling upon the farmers to enhance environmental quality by reducing the
negative impact of agricultural practices (Carruthers et al. 1997).

Irrigation farming gives much greater crop yields than dry land farming (Cantor, 1967; Garg, 1987). In developing countries, irrigation improves economic returns and can boost agriculture production. Khan and Ali (1998) found that areas close to the head or middle reach of the main canal have high agricultural production, whereas areas located at the tail reaches, lag behind in yield. Improved irrigation is recognized as an important factor in achieving maximum food production and may enhance the farmer’s income (Dumagay, 1984).

Impact evaluation is a process to analyse the achievements and results of the completed project (Hussain, 1991). Evaluation actually measures the effects of the outcome against the specified goal of a project. Hence, evaluation pinpoints all the weaknesses of the project. The main purpose of evaluation is improvement in the inherent policies and programmes (Atta-ur-Rahman and Khan, 2012). The evaluation process should not only focus on the negative checks but also positive and constructive factors as well.

Pakistan has a huge potential to increase agricultural production due to its relatively level terrain, heavy soils, sunny days, appropriate climatic conditions and abundant supply of farm labour (Khan et al. 2006). Unfortunately, inadequate supply of irrigation water at critical times of crop growth, lack of drainage, saline soil, low-quality seed and antiquated farm implements, imbalances in farm input, unsatisfactory agriculture and irrigation practices are major constraints limiting crop production in Pakistan (Khan, 1996; Atta-ur-Rahman, 2010). Since the introduction of canal irrigation, waterlogging and soil salinity have become the major problems impeding agricultural growth and development (Ahmad, 1993).

The Chashma Right Bank Canal (CRBC) is a large irrigation system spread over the Khyber Pakhtunkhwa and Punjab. The Chashma Barrage has diverted Indus water via canal called as CRBC. It commands 250,000ha, out of which 61% lies in Khyber Pakhtunkhwa and 39% in Punjab (WAPDA, 2002). The purpose of implementing Chashma Right Bank Irrigation Project (CRBIP) was to increase agricultural production and improve socio-economic condition of rural population (ADB, 1987). The annual incremental production of crop yield will further enhance and this would be achieved by increasing cropping intensity (WAPDA, 2002).

The analysis revealed that there has been substantial increase in the agricultural production after the inception of CRBC. High agricultural production was largely confined to the CRBC command area. In D.I. Khan district, the agricultural production of almost all the Rabi and Kharif crops was enhanced as a result of CRBC. The increase in agricultural production was recorded in rice, sugarcane, wheat, cotton, maize, pulses and orchard, whereas negative change in agricultural production occurred in millet, barley, sorghum and oilseed. Similarly, after the advent of canal irrigation in the form of CRBC the yield in kg per ha of all the crops have been improved. It is due to this, the present study was undertaken to find out the ex post impact evaluation of CRBC on the agricultural production of D.I. Khan district.

Environmental Setting of the Study Area

D.I. Khan is the southernmost district of Khyber Pakhtunkhwa and stretches between 31°
15° to 32° 32' North latitude and 70° 11' to 71° 20' East longitude (Figure 1). The district is bounded on the north by Marwat, Bhittani and Shirani hills, while Suliman Mountain lies in its west. The Indus River and Vehowa stream form the natural boundary to the East and South, respectively. D.I. Khan district has a total reported area of 730,575 hectare (ha), out of which 236,371 ha was cultivated, 3,908 ha under forest, 132,487 ha uncultivated and large share of about 357,809 ha was cultivable waste during 2003-2004 (Figure 2a; 2b). According to Population Census Organization, in 1998 the total population of D.I. Khan district was 853,000 (GoP, 1999). It grew at an average annual rate of 3.26%, during 1981-98 (GoP, 1983; GoP, 1999). Since the inception of Pakistan, the population of D.I. Khan is growing faster than the national average.

Physically, D.I. Khan district has been divided into seven broad regions namely, active floodplain, meander floodplain, rolling sand plain, alluvial plain, piedmont plain and mountains (Said, 1971; ADB, 1987; Atta-ur-Rahman, 2010). Active floodplain forms a narrow strip of about 1 to 8 km wide on the right bank of river Indus. Meander floodplain occupies a compact block in the north eastern parts of the district D.I. Khan. It is characterized by numerous bars, meander scars, levees and oxbow lakes. Rolling sand plain occupies the drainage basins of several seasonal streams at the foot of the Marwat-Bhittini range (Said, 1971). Alluvial fans occupy the foot of the mountains, where rivers and streams enter the plain. The slope of the piedmont plain is from west to east, towards the Indus River. It occurs in the central parts of the district, between the alluvial fans and the active floodplain of the Indus River. Exposed bedrock consists of the Khisor, Marwat and the Bhittinni ranges.

The climate of D.I. Khan is characterized by long hot and dry summer and short cool

winter. During summer (April-September), the mean daily maximum temperature is usually above 33°C for seven months, while 37°C and above is recorded from June to July. June is the hottest month with mean maximum temperature above 41°C (GoP, 1999; WAPDA, 2002). Winter is short and fairly cold with severe frost and temperature touching the freezing point. January is the coldest month and records a mean minimum temperature of 4°C and maximum 20°C. In D.I. Khan, rainfall is received in two well-marked seasons. Approximately 45% of the annual rainfall received from summer monsoon during July and August, while the western disturbances are responsible for 30% of the annual rainfall mainly received in winter. The average annual precipitation is 268 mm. The amount of rainfall is not sufficient for the agricultural production.
Canal irrigation, inundation, lift and Rod Kohi (Figure 3a; b). Canal-irrigation is available only in a narrow belt in the eastern part of district in D.I. Khan. The perennial streams are known as Zam, which are restricted to the western and northwestern parts of the district. This type of irrigation is potentially better than Rod Kohi because of more reliable supply of water. Summer floods in the Indus are the principal means of irrigation in the active floodplain of the Indus River. Narrow eastern fringe of the active floodplain have good quality of groundwater and suitable for lift irrigation. Due to scanty and erratic rainfall, rainfed cultivation is not practicable in most parts of D.I. Khan district.

**Materials and Method**

To achieve the mandated task extensive primary and secondary data sources were consulted. Similarly, data were obtained from both inside and outside the CRBC command area. Initially, a series of reconnaissance visits were made to grasp the impact of CRBC on the agricultural production. For collection of primary data, four different types of questionnaires were designed i.e. questionnaire for individual household, questionnaire for the whole village (Focus Group Discussions), questionnaire for the line agencies and questionnaire for the mouza patwari. Questionnaire for the individual households were administered in all the sample villages. Similarly, for every sample village two to...
three questionnaires for the whole village were administered during Focused Group Discussions (FGD’s) with the community leaders and elderly people. Questionnaire for the line agencies were filled-up by interviewing officials of the concerned line agencies.

In D.I. Khan district, there were a total of 384 mouza (smallest revenue unit). Data about the cropping pattern before and after CRBC of all these mouza were collected, to get clear picture of CRBC impacts on the agricultural production of D.I. Khan district. Ideally, the entire mouza should have been surveyed for in-depth study. However, for detail and intensive study, out of 194 CRBC command mouza, four were randomly selected for micro-level study namely: Jarra, Gomal, Buchari and Chera, which make 2.4% of the CRBC command mouza. Likewise, one mouza that is Khudaka was also randomly selected outside the CRBC command area. The sample mouza were selected from all the three stages of CRBC i.e. from stage I, Jarra (middle reach), stage II Gomal (head reach) and stage III Buchari and Chera (tail reach). In the sample villages, there were a total of 1,102

Fig. 3. (a) spatial distribution of pre CRBC (1979-80) irrigation system (b) post CRBC (2003-04) irrigation system
Results and Discussion

Agricultural (crop) production is directly related to yield per hectare that gives the productivity of the land. It is followed by a fact that higher the yield, higher would be the production and consequently increase in the gross value of crop production would occur. As such, average yield is an important indicator of the production process. The aim of this analytical discussion is to explore the impacts of CRBC on the agricultural households, making a household size of 7.8 people. Out of total households, 300 were surveyed, which makes a sample of 27.22% of the total household. Likewise, for each and every sample village, two to three questionnaires were filled during Focused Group Discussions. Group discussion with the community leaders, local organizations and farmers etc. were the landmark feature for cross checking the individual data. Questionnaire for the line agencies were designed and filled-in by interviewing thirty officials of different line agencies.

The secondary data was obtained from the related departments, organizations. The collected data were analysed and presented the data in the form of maps, tables, statistical diagrams and description. Finally, the information was interpreted in the light of existing socio-economic and physio-ecological environment of the study area.

In order to get clear picture of pre and post CRBC changes in the agricultural production, analysis has been made at two levels; macro and micro. In macro level analysis the entire district has been covered, whereas at micro level five sample villages were studied in detail.

In the following section analytical discussion has been made on the ex post impact of CRBC on the agricultural production (from 1970 to 2005). It was also discussed with special reference to irrigated and un-irrigated areas. The production value for all the (pre and post CRBC) crops were calculated at market price 2006 level. The discussion is based on two broad categories i.e. Kharif (summer crops) and Rabi (winter crops).

Macro Level Analysis (Kharif Production)

It was found that after the inception of CRBC, the production of almost all the Kharif crops have been improved (Table 1). The increase in agricultural production has been recorded in rice, sugarcane, cotton, maize and pulses, whereas negative change in agricultural production has occurred in millet, sorghum and oilseed. The analysis revealed that after CRBC yield in kg per ha of all the Kharif crops has been increased. The production value of Kharif crops was estimated at market price 2006. The comparison of pre and post CRBC market value shows positive change for rice, sugarcane, cotton, maize, pulses and fruit, whereas negative production value has been registered for millet, sorghum and oilseed. The positive changes in sugarcane and rice production is mainly due to the farmer’s trends towards the high return crops after CRBC.
Table 1. CRBC D.I. Khan district, pre and post kharif production

<table>
<thead>
<tr>
<th>Period</th>
<th>Indicators</th>
<th>Rice</th>
<th>Sugarcane</th>
<th>Cotton</th>
<th>Maize</th>
<th>Millet</th>
<th>Sorghum</th>
<th>Pulse</th>
<th>Oilseed</th>
<th>K.Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre CRBC</td>
<td>Yield in Kg/ha</td>
<td>1,495</td>
<td>29,871</td>
<td>1,243</td>
<td>988</td>
<td>349</td>
<td>308</td>
<td>457</td>
<td>230</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Production in tones</td>
<td>2,800</td>
<td>95,500</td>
<td>2,676</td>
<td>1,600</td>
<td>2,900</td>
<td>4,300</td>
<td>54</td>
<td>56</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Value in million rupees</td>
<td>112</td>
<td>200.5</td>
<td>107</td>
<td>16</td>
<td>29</td>
<td>43</td>
<td>1.6</td>
<td>1.7</td>
<td>57</td>
</tr>
<tr>
<td>Post CRBC</td>
<td>Yield in Kg/ha</td>
<td>2,815</td>
<td>42,440</td>
<td>2,519</td>
<td>1,847</td>
<td>635</td>
<td>616</td>
<td>647</td>
<td>333</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Production in tones</td>
<td>18,374</td>
<td>490,819</td>
<td>5,143</td>
<td>2,197</td>
<td>924</td>
<td>1,798</td>
<td>2,734</td>
<td>0.4</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Value in million rupees</td>
<td>734.9</td>
<td>1030.8</td>
<td>205.7</td>
<td>22</td>
<td>9.3</td>
<td>18</td>
<td>82</td>
<td>0.01</td>
<td>1971</td>
</tr>
<tr>
<td>Change</td>
<td>Change in value (in million rupees)</td>
<td>622.9</td>
<td>830.3</td>
<td>98.7</td>
<td>6</td>
<td>-19.7</td>
<td>-25</td>
<td>80.4</td>
<td>-1.69</td>
<td>1914</td>
</tr>
</tbody>
</table>

Source: GoNWFP, 1975; 1980; and 2005. Value is estimated at market price, 2006

The analysis further reveals that there has been constant increase in the rice production after CRBC. Prior to the inception of CRBC, total rice production was 2,800 tonnes in 1970, which after CRBC increased to 18,374 tonnes in 2005 (Table 1). It is pertinent to note that rice production is only reported from the irrigated areas, as rice requires plenty of water. It was found during field survey that two important varieties are very common among the farmers i.e. IRRI and KS-282. The data further reveals that after CRBC, a positive change in production value has occurred. The increase in production and yield per hectare is attributed to the introduction of canal irrigation in the form of CRBC.

The data further indicate that in D.I. Khan district, there has been gradual increase in the sugarcane production. Prior to CRBC, sugarcane production was 95,500 tonnes in 1970, which gradually increased to 490,819 tonnes after CRBC in 2005 (Table 1). As sugarcane is a water-loving crop, therefore it is predominantly reported from the irrigated areas. The analysis further reveals that the increasing production is predominantly reported from the CRBC command area. In D.I. Khan district, before CRBC yield in Kg per ha was 29,871 during 1970, whereas after CRBC in 2005 it marked the figure of 42,440. This indicates a positive change in production value has occurred.

The analysis reveals that after CRBC the production of cotton has been increased in the last twenty years. Prior to CRBC, cotton production was 2,676 tonnes in the year 1985, which was increased to 5,143 tonnes after CRBC in 2005.
However, the cotton production was found maximum over the irrigated areas as against un-irrigated areas. Similarly, a positive change in production value has been occurred. Likewise, there has been an increase in the yield after commissioning of CRBC. On average before CRBC, the yield in Kg per ha was 1,243 in 1985, which after CRBC has been increased more than two fold (2,519 kg/ha) in 2005. This increase is attributed to the enhancement in the area under canal irrigation.

The analysis reveals that the production of maize has gradually increased during the study period. The table 1 shows that after CRBC in 2005, the total production was 2,197 tonnes as against 1,600 tonnes before CRBC in 1970. The analysis further elaborates that the maize production does best over the irrigated land. Therefore prior to CRBC yield in kg per ha was 988 (1970), which was doubled and marked the figure of 1,847 after CRBC in 2005. This indicates that the introduction of canal irrigation system has accelerated the yield per ha and a positive change in production value of maize has been recorded.

In D.I. Khan district, millet is predominantly a crop of un-irrigated area. However, it is also grown over irrigated area. The analysis reveals that area under millet has been gradually reducing. Before CRBC, millet production was 2,900 tonnes, which after inception of CRBC has gradually reduced to 924 tonnes in 2005. The decrease in production is mainly due to the reduction in area under millet. As a result more area came under canal irrigated area and was allocated to more rewarding crops as compared to millet. The table 1 indicates that yield in Kg per ha is gradually increasing both over irrigated as well as on un-irrigated land. Before CRBC, in 1970 yield in Kg per ha was 349, whereas, after CRBC the yield has increased to 635 kg/ha. The data reveals that a negative change in production value of millet has been recorded.

The Table 1 elaborates that there has been constant decrease in the production under sorghum, whereas yield per ha is encouraging. Before CRBC, in 1970 total production of sorghum was 4,300 tonnes, but after CRBC in 2005, the production was reduced to 1,798 tonnes. The reduction in sorghum production is mainly due to the allocation of land to other high return crops. It was found that a negative change in production value has been recorded. However, the yield in kg per ha is improving (Table 1). Before CRBC, in 1970, the yield in Kg per ha was 308, which after CRBC has increased to 616 kg per ha in 2005. The analysis reveals that yield in Kg per ha is encouraging over the irrigated areas as against un-irrigated land. This is mainly due to the advent of canal irrigation.

In Khari pulses, mung bean is the major pulse grown in D.I. Khan district. The table 1 indicates that after CRBC both production and yield of Kharif pulses has been increased. Before CRBC, production of Kharif pulses was 54 tonnes, which has been rapidly enhanced to 2,734 tonnes after CRBC. The increase in the pulses production is attributed to the increasing acreage as a result of CRBC. The statistics reveals that after CRBC a positive change in production value has been recorded. As far as yield per ha is concerned, it is also improving. Before CRBC, yield in Kg per ha was 457 as against 647 after CRBC. The increase in production and yield per ha is because of canal irrigation.

In D.I. Khan district, important Kharif fruits are watermelon, muskmelon, dates, apple and mango. The table 1 indicates that there has been
consistent increase in the production and yield per hectare of Kharif fruits particularly after CRBC. Similarly, with increasing production, the yield in Kg per ha was also improved from 11,756 pre CRBC construction (1980) to 12,974 after CRBC in 2000. The table 1 reveals that since the inception of CRBC, the production of almost all Kharif fruits has increased. A comparison of pre and post CRBC conditions of Kharif fruits indicates that a positive change in production value has been recorded.

Micro Level Analysis (Kharif Production)

In micro level analysis, the Kharif crop production in all the five sample villages has been discussed. The data reveals that in the sample village Jarra, the production of all the Kharif crops has increased after the inception of CRBC. The analysis reveals that the yield per ha also improved after CRBC. The data reveals that positive changes in production have been recorded in sugarcane, maize, sorghum and Kharif fruit, whereas negative changes have occurred in rice. It is also clear from the data that production value of sugarcane has increased. The analysis reveals that after CRBC the Kharif production of majority crops has been increased in Chera. The analysis reveals that positive change in production has been recorded for sugarcane, maize and pulse, whereas several folds after CRBC and that of rice has been reduced.

The analysis reveals that in Gomal the production of almost all the Kharif crops has been increased after inception of canal irrigation in the form of CRBC. The data reveals that after CRBC a positive change in production has been recorded for rice, sugarcane, maize and pulse, whereas negative changes has occurred in the production of millet and sorghum. It is also clear that positive change in production value has been registered for rice, sugarcane, maize and pulse, whereas negative changes have been recorded for millet and sorghum.

In sample village Buchari, after inception of CRBC positive changes in production has been recorded for all Kharif crops. It was found that prior to CRBC rice, sugarcane, maize and pulses were not cultivated, however after CRBC rice, sugarcane, maize, sorghum and pulses have been cultivated in the mouza. The data reveals that after CRBC, maximum production changes have been recorded for rice followed by maize, sugarcane, pulse and sorghum. The analysis indicates that large-scale production value has been recorded for sugarcane followed by rice, maize, pulse and sorghum.

Negative changes have occurred in oilseed, millet, sorghum and fruit. The data indicates that the yield in kg per hectare of majority of crops have been increased after CRBC. It is also clear that after CRBC, positive changes in production value have been recorded for sugarcane and pulse, whereas negative changes have occurred in oilseed, millet, sorghum and fruit.

As discussed earlier Khudaka is one of the sample village located off the CRBC

Macro Level Analysis (Rabi Production)

The Table 2 reveals that after the inception of CRBC, the production of almost all the Rabi crops have increased. The improvement in the agricultural production has been recorded in wheat, pulses and fruits, whereas negative change in agricultural production has occurred comman area. The analysis reveals that both pre and post CRBC the Kharif production was found zero.
Therefore, no changes have been detected after comparing pre and post CRBC conditions.

In barley and oilseed. The table 2 reveals that after comparing pre and post CRBC condition positive changes in production value has been recorded for wheat, pulses and fruit, whereas negative production value has been registered for barley and oilseed. The analysis also reveals that after the inception of CRBC, the yield in kg per ha of all the Rabi crops has been enhanced. The Table 2 reveals that after the inception of CRBC there has been constant increase in the wheat production. Before CRBC, wheat production was 22,200 tonnes as against 73,544 tonnes after CRBC. The analysis reveals that after CRBC there has been 331% enhancement in the wheat production. This indicates positive impact of CRBC on the wheat production. The analysis reveals that after CRBC both production and yield per ha is increasing.

In D.I. Khan district before CRBC, barley production was 600 tonnes, which after CRBC has been reduced to 557 tonnes. The Table 2 reveals that after comparing pre and post CRBC production value, a negative change of 0.13 million rupees has been recorded. Consequently, the acreage is gradually shrinking but the production and yield per ha is improving. This is mainly due to the introduction of canal irrigation.

Prior to CRBC, production of Rabi pulses was 800 tonnes as against 8,184 tonnes (almost ten-fold increase) after inception of CRBC. The analysis reveals that after comparing pre and post CRBC production value a net positive change of 221.5 million rupees has been recorded. As a result of CRBC, the pulse production was greatly increased. Likewise, the yield in Kg per ha has been improved from pre CRBC 90 kg to post CRBC 408 kg per ha.

**Micro Level Analysis (Rabi Production)**

In micro level analysis, the Rabi crop production in all the five sample villages has been discussed. In sample village Jarra, there has been gradual increase in the Rabi production after the inception of CRBC. The data indicates that yield per ha has enhanced for almost all Rabi crops. After comparing pre and post CRBC condition a positive change in production has been recorded for wheat and fruit, whereas negative changes have occurred in barley, pulse and oilseed. The analysis similarly, prior to CRBC, the production of Rabi oilseed was 3,100 tonnes, which was reduced to 576 tonnes after CRBC. The table 2 reveals that after CRBC, a negative change of 75.8 million rupees has been recorded in production value of oilseed.

In D.I. Khan district, important Rabi fruits are citrus, guava and banana. The yield in kg per ha was improved from 11,000 kg per ha pre CRBC in 1979-80 to 15,000 kg after CRBC (Table 2). This indicates farmer trend towards horticulture and awareness as a result of CRBC. After inception of CRBC, banana was found on 19 ha as against nil before CRBC. The overall Rabi fruits acreage, production and yield in kg per ha has shown positive changes. After comparing pre and post CRBC production value, a net positive change of 66.96 million rupees has been recorded in Rabi fruits (Table 2).
Table 2 D.I. Khan district, Pre and Post CRBC Rabi Production

<table>
<thead>
<tr>
<th>Period</th>
<th>Indicators</th>
<th>Wheat</th>
<th>Barley</th>
<th>Pulse</th>
<th>Oilseed</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre CRBC</td>
<td>Yield in Kg/ha</td>
<td>416</td>
<td>322</td>
<td>90</td>
<td>370</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Production in tones</td>
<td>22,200</td>
<td>600</td>
<td>800</td>
<td>3,100</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Value in million rupees</td>
<td>222</td>
<td>1.8</td>
<td>24</td>
<td>93</td>
<td>2.44</td>
</tr>
<tr>
<td>Post CRBC</td>
<td>Yield in Kg/ha</td>
<td>1,531</td>
<td>692</td>
<td>408</td>
<td>354</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Production in tones</td>
<td>73,544</td>
<td>557</td>
<td>8,184</td>
<td>576</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Value in million rupees</td>
<td>735.4</td>
<td>1.67</td>
<td>245.5</td>
<td>17.2</td>
<td>69.4</td>
</tr>
<tr>
<td>Change</td>
<td>Change in value (in million rupees)</td>
<td>513.4</td>
<td>-0.13</td>
<td>221.5</td>
<td>-75.8</td>
<td>66.96</td>
</tr>
</tbody>
</table>


Further indicates that after CRBC the gross production of Rabi crops have been increased several fold. A positive change in production value has recorded for wheat and fruit, whereas negative changes occurred in barley, pulse and oilseed. The negative changes are attributed to the farmer’s preferences to more profitable and high return crops under canal irrigation. In sample village Gomal, the production and value of all the Kharif crops have increased after CRBC. The data indicate that after CRBC, yield in kg per ha has increased several folds. This has positively affected the production value and as a result high production value has been recorded for wheat, pulse, oilseed, fruit and barley, respectively. After inception of CRBC, the gross production of Rabi crops has been multiplied.

In Buchari, after CRBC the Rabi production has been increased. The data indicate that after CRBC negative changes in production has been recorded for barley and oilseed, whereas positive changes have been detected for wheat and pulse. After availability of assured water the farmer switched over to high return crops like wheat as against barley and oilseed. Likewise, after CRBC large-scale increase in production value of wheat and pulse has been registered. The analysis reveals that in Chera after CRBC positive changes in production and value have been recorded. The data indicate that positive production changes

**Ex Post Impact Analysis**

The crop varieties grown in pre CRBC were different from that of post CRBC crop varieties grown by the farmers. After CRBC, great changes have occurred in almost all sectors. Increasing awareness, accessibility, irrigation etc. encouraged farmers to switch over to new and high rewarding crops. Field survey reveals that high proportion of the farmers is now using approved seed obtained have occurred in wheat and pulses, whereas negative changes have been registered for oilseed. The analysis also indicates that yield in kg per ha of all the Rabi crops have been increased, as a result the production of wheat and pulses have multiplied during the study period. The analysis reveals that negative change in the oilseed is mainly due to the preferences to wheat and pulses as against oilseed. After CRBC the production value of wheat and pulses has enhanced, whereas that of oilseed has decreased.

The analysis reveals that in Khudaka after CRBC negative changes have occurred in all the Rabi crops. This is a unique situation when compared with the other four sample villages.
Prior to CRBC wheat, barley, pulse and oilseed was cultivated but after CRBC (2003-04) even a single plot was not cultivated. It is mainly due to the non-availability of water and drought spell over the Pakistani territory. The data reveal that a negative change has been registered for wheat, barley, pulse and oilseed.

From the agricultural farms or local market. Prior to CRBC, farmer mainly relied on the traditionally old seed variety. They usually reserved part of their production as a seed for next season and in effect, the production remained low. Therefore, after CRBC, reliance on the traditional seed varieties has substantially reduced. However, in canal irrigated area farmers have used modern seed varieties obtained from the local market. Only in Gomal, about one third of the respondents said that prior to CRBC they used modern seeds obtained from the agriculture farm. It is because of the fact that Gomal is located close to the agricultural farm at RattaKulachi and D.I. Khan city. In the sample villages, prior to CRBC, majority of the farmer have used local seed, which clearly reflect farmer’s trend towards old and traditional means of agriculture in the area. However, in Khudaka, all the farmers were of the view that they are getting seed from the local market, as their farming depends on the availability of Rod Kohi irrigation system, which is very uncertain and hence, it is very wasteful to keep seed for uncertain season that some time extend to even twelve years.

In D.I. Khan district, agricultural inputs particularly availability of canal irrigation have played a pivotal role in boosting the agricultural production. With the assured water supply in the form of CRBC, large scale of cultivable waste was brought under cultivation (see Figure 2a and b), choices of crops were increased, cropping intensity was accelerated and revenue generation was started that boost-up the agricultural production. The analysis reveals that prior to CRBC, the yield of almost all the crops were very low, while after CRBC, the yield of both Rabi and Kharif crops have been increased. The study reveals that CRBC has improved the socio-economic condition of the residents particularly in the CRBC command area. Hence, this is one of the long-term, but significant positive impacts on the local residents.

In D.I. Khan district, while talking about the strengths the participants living in different environmental settings pointed out that, they had good quality lands capable of producing high valued crops, vegetables and fruits. The analysis reveals that farmers are getting good crops and orchard yields particularly in areas where canal irrigation exists. The respondents also reported few weaknesses, which were hindering the agricultural production of the study area. Large track of D.I. Khan is off the CRBC command area and falls under the arid agro-ecological zone. Similarly, extensive area has also saline underground water, whereas in stage I of CRBC, certain areas were affected by waterlogging and salinity.

The analysis reveals that there are several opportunities that could be utilized for the uplift of D.I. Khan district. The respondents were of the view that in order to increase agricultural production a large-scale cultivable waste could be brought under cultivation. They also pointed out various other opportunities that included guaranteed and assured supply of canal irrigation which could further increase the choice of crops and agricultural production. It was found from the analysis that extensive area with Rod Kohi irrigation could be brought under assured canal
irrigation. Respondents also pointed out that better crop management and provision of quality inputs at appropriate time might also lead to high agricultural production.

In the study area when the participants were further inquired, they said that cultivation of water loving crop such as rice and sugarcane in the head reaches could adversely affect the tail user. The respondents were of the opinion that preference to new water loving crop is one of the major threats, which could reduce the cropping intensity and would lead to the hazard of waterlogging and salinity in the future. The analysis further reveals that pest attack and diseases were also considered the potential threats to the crops production particularly in the CRBC command area. The sample respondents pointed out that without soil analysis, application of fertilizer may cause soil infertility. Similarly, lack of awareness about the use and management of weedicides and pesticides in the CRBC command area might lead to decrease in agricultural production.

**Conclusion**

Prior to CRBC, the yield varied from year to year depending upon the availability of water supply. Generally, the production and yield per hectare is higher over the irrigated areas than the un-irrigated areas. The analysis found that after CRBC the agricultural production of all crops has been increased several fold. This is mainly due to the inception of canal irrigation in the form of CRBC. Hence, the analysis supports the research hypothesis that after the inception of CRBC the agricultural production has enhanced.

The analysis revealed that there has been substantial increase in the agricultural production after the inception of CRBC. High agricultural production was largely confined to the CRBC command areas. In D. I. Khan district, the agricultural production of almost all the Rabi and Kharif crops was enhanced as a result of CRBC. The increase in agricultural production was recorded in rice, sugarcane, wheat, cotton, maize, pulses and orchard, whereas negative change in agricultural production occurred in millet, barley, sorghum and oilseed. Similarly, after the advent of canal irrigation in the form of CRBC the yield in kg per ha of all the crops have been improved.

The macro and micro level analysis revealed that after inception of CRBC, the agricultural production of almost all the Kharif as well as Rabi crops have improved. The increase in agricultural production has been predominantly recorded in water loving crops such as rice and sugarcane. The analysis revealed that after inception of CRBC new water loving crops have been introduced. In order to reduce the existing and foreseen adverse consequences of waterlogging and salinity suitable crops selection should be made instead of reclamation. Some crops require large amount of water, whereas others need only small quantity. With irrigation, large amount of water goes as deep percolation. Consequently, due emphasis should be made on suitable crops selection. The analysis also revealed that after CRBC the yield in kg per ha of all the Kharif and Rabi crops have improved.

The study further revealed that after the inception of canal irrigation the acreage, production and yield of crops have been greatly improved. High agricultural productivity is largely confined to the CRBC command areas. It is evident that these areas are inching forward in agricultural productivity mainly due to the introduction of canal irrigation. Contrary to this,
low productivity has been noted outside the CRBC command area. The proposed Chashma Right Bank 1st lift Irrigation Project command limited area of D.I. Khan district. Therefore, this low productive area outside the CRBC needs special attention of the agricultural scientists, planners and decision makers at district, provincial and federal level to execute future development schemes in agricultural sector.

Farm management is one of the techniques applied for maximizing crop production with a minimum expenditure. It includes soil treatment, preparation of fields, regulation of fertilizer doses, controlled irrigation, proper drainage, use of improved seeds, plant protection measures and crop rotation etc. It is necessary that the farmer of the area should be made aware of farm management.

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