IRRIGATION, AGRICULTURAL PRODUCTIVITY AND POVERTY ALLEVIATION: A CASE STUDY OF CHASHMA RIGHT BANK CANAL (CRBC) IN D.I.KHAN

Submitted by

Mahmood Shah

Supervisor

Dr. Khair u Zaman

DEPARTMENT OF ECONOMICS
GOMAL UNIVERSITY
DERA ISMAIL KHAN
FEBRUARY, 2008.
IRRIGATION, AGRICULTURAL PRODUCTIVITY AND POVERTY ALLEVIATION: A CASE STUDY OF CHASHMA RIGHT BANK CANAL (CRBC) IN D.I.KHAN

Mahmood Shah

A Thesis
Submitted to the
Department of Economics
Gomal University, D.I. Khan
in Partial Fulfillment of the requirements
for the Degree of Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
GOMAL UNIVERSITY
DERA ISMAIL KHAN
FEBRUARY, 2008.
CERTIFICATE FROM SUPERVISOR

Mr. Mahmood Shah has worked on the dissertation, “Irrigation, Agricultural Productivity and Poverty Alleviation – A Case Study of Chashma Right Bank Canal (CRBC) in D. I. Khan.” for PhD program in Economics under my supervision. It is certified that he has done this work by himself, and is ready to be presented for external examination.

Dr. Khair u Zaman
Department of Economics
Gomal University, D.I.Khan
NWFP, PAKISTAN

FEBRUARY, 2008.
DEDICATION

I dedicate this work to my beloved mother whose generosity and encouragement provided the strongest foundation for my education.
CONTENTS

List of Tables iv
Acknowledgements vi
Abstract vii

Chapter I Introduction 1
1.1 Problem Specification 1
1.2 Justification for the Study 10
1.3 Objectives of the Study 13
1.4 Hypotheses 14
1.5 Organization of the Study 14

Chapter II Review of Literature 15
2.1. Irrigation and Agricultural Productivity 15
2.2. Agricultural Growth and Poverty Alleviation 33
2.3. Agricultural Productivity, Income, Employment and Education 52
2.4. Cropping Pattern and Cropping Intensity 55
2.5. Concluding Remarks 57

Chapter III Research Methodology 58
3.1 Introduction 58
3.2 Universe of the Study 58
3.3 Sample Size and Sampling Procedure 58
3.4 Procedure for Data Analysis 60
3.5 Limitations of the Study 64
Chapter IV  General Descriptive Analysis of the Study Area 65

4.1 Introduction 65

4.2 Historical Background of D.I. Khan 65

4.3 Historical Examination of CRBIP 67

4.4 Description of the Project Area 69

  4.4.1. General 69

  4.4.2. Area and Population 70

  4.4.3. Physiography 71

  4.4.4. Climate 72

  4.4.5. Irrigation 72

  4.4.6. Agriculture 74

  4.4.7. Forestry 75

Chapter V  Demographic and Socio-Economic Characteristics of Sample Households 76

5.1 Introduction 76

5.2 Literacy Status of Sample Respondents 76

5.3 Distribution of Sample Respondents by Age 77

5.4 Average Monthly Income of Sample Households 78

5.5 Size of Sample Households 78

5.6 Farm Size and Land Distribution 79

5.7 Land Tenure of the Sample Households 80

5.8 Fragmentation of Land 81

5.9 Distribution of Sample Households by Tribes 82
5.10 Cropping Pattern on Sample Farms 83

Chapter VI Data Analysis, Results and Discussion 84

6.1 Introduction 84
6.2 Impact of CRBC on Area under cultivation 84
6.3 Impact of CRBC on Cropping Intensity 86
6.4 Impact of CRBC on Crop Yields 87
6.5 Estimated Results of Regression Models 91
6.6 Impact of CRBC on Livestock Keeping 93
6.7 Impact of CRBC on Household Income 95
6.8 With and Without Analysis 100
6.9 Impact of CRBC on Education and Health Status 103
6.10 Impact of CRBC on Employment 106
6.11 CRBC and Poverty Alleviation 107
6.12 Other Economic Activities 108
6.13 Tests of Hypotheses 112

Chapter VII Summary, Conclusions and Recommendations 114

7.1 Introduction 114
7.2 Summary 114
7.3 Conclusions 126
7.4 Recommendations 128

References 131

Abbreviations, Acronyms and Definitions 141

Questionnaire 143
## List of Tables and Figures

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Estimated Regression Coefficient</td>
<td>20</td>
</tr>
<tr>
<td>2.2</td>
<td>Agricultural Growth</td>
<td>31</td>
</tr>
<tr>
<td>2.3</td>
<td>Determinants of Poverty</td>
<td>49</td>
</tr>
<tr>
<td>4.1</td>
<td>Acreage and Production of Major Crops in D.I. Khan District</td>
<td>75</td>
</tr>
<tr>
<td>5.1</td>
<td>Sample Respondents Distinguished by Literacy Status</td>
<td>77</td>
</tr>
<tr>
<td>5.2</td>
<td>Sample Respondents Distinguished by Age</td>
<td>78</td>
</tr>
<tr>
<td>5.3</td>
<td>Sample Households Distinguished by Income Groups</td>
<td>78</td>
</tr>
<tr>
<td>5.4</td>
<td>Sample Households Distinguished by Size</td>
<td>79</td>
</tr>
<tr>
<td>5.5</td>
<td>Farm Size and Land Distribution in the Study Area</td>
<td>80</td>
</tr>
<tr>
<td>5.6</td>
<td>Sample Households Distinguished by Size of Landholdings</td>
<td>80</td>
</tr>
<tr>
<td>5.7</td>
<td>Distribution of Sample Households by Tenurial Arrangements</td>
<td>81</td>
</tr>
<tr>
<td>5.8</td>
<td>No. of Fragments on Sample Farms by Farm Size in Study Area</td>
<td>82</td>
</tr>
<tr>
<td>5.9</td>
<td>Number and Percentage of Sample Households by Tribes</td>
<td>82</td>
</tr>
<tr>
<td>5.10</td>
<td>Cropping Pattern of Sample Households on Irrigated and Un-irrigated Farms</td>
<td>83</td>
</tr>
<tr>
<td>6.1</td>
<td>Comparison of Area under cultivation before and after CRBC in the Study Area</td>
<td>85</td>
</tr>
<tr>
<td>6.2</td>
<td>Comparison of Cropping Intensity before and after CRBC in the Study Area</td>
<td>86</td>
</tr>
<tr>
<td>6.3</td>
<td>Comparison of Wheat Yield before and after CRBC in the Study Area</td>
<td>87</td>
</tr>
</tbody>
</table>
6.4 Comparison of Gram Yield before and after CRBC in the Study Area 88
6.5 Comparison of Sugarcane Yield before and after CRBC in the Study Area 90
6.6 Comparison of Rice Yield before and after CRBC in the Study Area 91
6.7 Estimated Regression Equations 93
6.8 Comparison of Livestock Keeping before and after CRBC in the Study Area 95
6.9 Comparison of Household Income before and after CRBC 96
6.10 Comparison of Household Consumption before and after CRBC 98
6.11 Comparison of Household Saving before and after CRBC 99
6.12 With and Without CRBC Comparison of Mean Values 101
6.13 With and Without Comparison using Dummy Variable Approach 102
6.14 No. of Households Sending Children to School before and after CRBC 103
6.15 Sample Households Perception Regarding CRBC’s Role in Their Education 104
6.16 Sample Households Perception Regarding CRBC’s Role in Their Health Status 105

**Figure**

6.1 Irrigation – Agricultural Productivity – Poverty Alleviation Linkages 111
ACKNOWLEDGEMENT

Research study is both a solitary and a shared activity and I have been blessed with supportive and critical teachers and friends whom I owe my fondest and most lasting debt of gratitude. The findings, interpretations and conclusions expressed in this dissertation are entirely those of the researcher. Naturally none of the teachers and friends bears the responsibility for my shortcomings. However, it will be sheer injustice not to recognize the learned personalities who guided and supported me in making this study a success.

It is indeed an honour and privilege for me to express my deepest sense of gratitude and heartfelt thanks to Dr. Khair-uz-Zaman, my advisor, who helped me a lot and supervised my research work. I am grateful to him for his valuable comments on an earlier draft of the thesis. I am also indebted to Dr. Muhammad Afzal, Chairman Department of Economics who provided me full support during my thesis. I greatly benefited from his constructive criticism during the whole course of this study.

I am thankful to all my associates and faculty members for their encouragement and timely assistance in collecting and processing the material.

I owe my thanks to my mother and family members whoso earnestly provided me financial support and their good wishes. Undoubtedly I am thankful to my wife who always encouraged and helped me at every juncture during the research process.

Mahmood Shah

February, 2008.
Abstract

The district Dera Ismail Khan (D.I.Khan), situated at the conjunction of three provinces of Pakistan, N.W.F.P, Punjab and Balochistan. It has very vast potential for socio economic development and consequent contribution to sustainable natural development. CRBC project is key factor as well as indicator of substantial development. Even since its initiation research has been conducted on its impact on the socio cultural and economic change in the area. The present has been undertaken to highlight widespread impact of CRBC on the change variables of living conditions in the study area. The sole objective of the study has been to identify the rate of change in living conditions to point out bottlenecks and to suggest tangible measures for policy guide lines.

Research methodology, strictly in accordance with accepted research design has been based on sampling techniques, data collection and processing and final analyses of the findings in order to recommend viable measures for improvement. The present study has been squarely focused on the evaluation of CRBC impact on the rate and size of change in life pattern under command area as compared to the area under Rod kohi (rain fed) and thus the purpose has been to measure factors for poverty reduction and increase in productivity.

This study was undertaken in seven selected villages of Dera Ismail Khan (D.I. Khan) district. It focused on the Stage II of Chashma Right Bank Irrigation Project (CRBIP). The data were collected in June-August 2004 by conducting a household level survey with the help of a pre-tested interview schedule. The size of sample was 139 households in the study area. The data showed that more than
half of the respondents were literate and it was evident that in irrigated area the ratio of literate farmers was higher than in un-irrigated villages. A vast majority (60%) of the sample respondents were up to 45 years of age. Majority of the households (71%) had monthly income of about 20,000/-. A vast majority of the people in the area still live below and close to poverty line. More than three-fifth (60.5%) of the households consisted of more than 10 members. As many as 34 percent of the sample households had farm size of less than 6 acres and accounted for 18% of the farm area. The average farm size in the study area was 27 acres. The average farm size in irrigated areas was less than (25 acres) than in un-irrigated area (32.5 acres). On the whole, 75% of the farms had land area up to 25 acres.

The regression analysis indicated that coefficient of irrigation was highly significant factor affecting crop yield. Its statistical significance showed that irrigation positively changed crop yield and this been possible due to the availability of irrigation water through the CRBC. Thus CRBC has played a very significant role in enhancing crop yield. The availability and supply of irrigation water due to CRBC has also enhanced household income. The framers of the area were of the opinion that their family incomes have significantly increased due to the availability of irrigation water through CRBC. Increase in households’ incomes have also led to increase in household consumption and saving. The CRBC has also played a phenomenal role in enhancing education in the area. There has been an increase in literacy rate after the CRBC. The study found that due to CRBC off-farm employment has increased in the study area.
The study has concluded that the CRBC plays a crucial role in the socio-economic development of the study area. It works just like an engine of development for the area under consideration. More area has now been brought under cultivation. The study further concluded that due to extensive and intensive farming, crop yields have also been increased. The livestock sector has also been developed. The study further concluded that the unemployment rate has gone down than before. On-farm as well as off-farm employment opportunities have been expanded. People have diversified their professions and new activities in the informal sector have been initiated. This has contributed to the family income and saving behaviour in the study area. The study concluded that although poverty still is the main issue of the area and majority of the people live below poverty line, yet the CRBC project has played a major role in poverty alleviation. The study recommended that the department of agriculture and department of agricultural extension should give special attention to further development of this sector in the area. The study also recommends that the government should pay due attention to land development and further cultivable wastes may be brought under cultivation by providing the farming community microfinance and credit. The farmers need to be made aware about the use of recommended agricultural practices through mass media. Education facilities must be strengthened and quality education needs to be provided in the area. Micro financial institutions should come forward and help the people in poverty alleviation. The cultivation of high value crops such as oil seeds, vegetables, orchards, etc. should be introduced. There must be an awareness campaign along with intensive demonstrations, etc. to get the farmers
to change from rod kohi view of irrigation to that of canal irrigated techniques. There are quite different methods and the traditional method isn’t suitable for canal-based irrigation. Basic problems to overcome include; excessive use of water, improper layout of fields, lack of proper leveling and poor selection of crops to be grown relative to soil suitability.
CHAPTER I
INTRODUCTION

1.1 Problem Specification

Pakistan like many other developing countries has primarily been an agricultural country. Agriculture in Pakistan is the lifeblood of the nation. Agriculture is the largest sector of the economic activity and plays a crucial role in the country’s economic development by providing food and raw materials and employment to a large proportion of the population. While agriculture held as important place in Pakistani economy, its efficiency remained at a low level. The analysis of the economy of Pakistan shows a wide diversification of the economy as a whole but it is a fact that agriculture is still the main sector. Its importance is clear from its contribution as 23 % to GDP, 42 percent to the total labor force and a major source of foreign exchange earnings. It is not only a base for the textile and sugar industries, it is also providing raw material to industrial sector. It provides a market for industrial products. So any improvement in the agricultural sector has a far reaching impact on the overall growth of the country’s’ GDP. (Govt. of Pakistan, 2004).

Because of its rich land resources, hard working man power and large irrigation system Pakistan had the obvious comparative advantage in the development of its agriculture which would have changed the fate of the majority of the people of the rural areas. But the early architect of Pakistan’s economy in 1950’s opted for import substitution industrialization, which was made possible through an overvalued exchange rate and physical controls over imports. This policy harmed the agriculture sector by transferring
the resources from agriculture sector to industrial sector. The lop sided industrial development resulted on one hand in the inefficient industries and on the other hand the agricultural sector performed unevenly and the country became more dependent on external financial assistance. The excessive dependence on external assistance to finance development plans robbed the economy to flourish efficiently. The result was that during 1980’s Pakistan economy performance was highly unsatisfactory in terms of current account and budget deficit, and to keep the economy to maintain the minimum growth rate, the country had to accept the unpalatable stabilization and Structural Adjustment Program prescribed by the IMF and the World Bank (Khan, 1994).

Despite seemingly inevitability of the “economic transformation” it is a fact that the agriculture plays a vital role in developing countries and especially in Pakistan. Agriculture not only provides food and employment to the people, raw material to most industries and earns foreign exchange, but it must also play a leading role in eradicating poverty in the less developed countries. Poverty alleviation is not only a national problem: in a shrinking world, it has become an international priority and a moral imperative (Bravo, 2002).

Agricultural Production based on modern technology requires all round institutional and infrastructural support. Since the absence or inadequacy of any element is likely to impinge on the realization of the full yield potential of modern technology, the basic policy should be to offer support by way of package consisting of different inputs. Among the inputs, water occupies an important place in the development of agriculture. (Reddy, 1995).
Agriculture sector in less developed countries like Pakistan are widely considered to play a vital role in the eradication of poverty. Despite the importance of the sector, the production potential in agriculture in many of the developing countries is mostly unrealized mainly due to under-investment in research and development, irrigation, rural infrastructure, rural education, and health. Consequently, the levels of productivity of the agriculture sector in these economies are far below the potential that the developed countries achieved several decades ago. The low levels of these factors in turn affect agricultural productivity adversely. Therefore, poverty is not only an effect but also a cause of low agricultural productivity (Ahmad, 2003).

Agricultural growth increases due to increased use of agricultural inputs, good organisation and technological change. Among agricultural inputs, water is an important pre-requisite for agricultural development. An assured water supply spells prosperity, creates employment potential, increases income and enhances capital formation. The need for regulated supplies of water and manure at regular intervals and requisite doses was long realized for the increase in the farm productivity. In fact the production of crops requires soil, water, seed, labour implements, proper planning and management (Reddy, 1995).

Irrigation has proved beneficial to the agricultural development of a country. In fact, irrigation forms the lifeline for sustained agriculture. It alleviates suffering, preserves life, averts famine and advances the material prosperity of the country. According to Sir Charles Trevelyan “Irrigation is everything in India; water is more valuable than land,
because when water is applied to land, it increases its productiveness at least six fold.” (Reddy, 1995).

Moreover, Knowels (1948) observed, “The Irrigation works have provided security of life, they have increased the yields and the value of the land and the revenue derived from it. They have lessened the cost of famine relief and have helped to civilize the whole region.”

In an agrarian economy like Pakistan, irrigation may be a good source of employment as well. Irrigation raises both employment and income content of land and thus adds to capital formation. Irrigation project has a considerable impact on the social and economic life of the people not only living within the command area but also outside the command area. New productive activities are created due to huge investment in the irrigation projects. The importance of irrigation may be judged from protective and productive angles. The protective irrigation makes up the moisture deficiency and enables the soil to provide proper and continuous growth of all crops. The productive irrigation enables rising of second and third crop in the lands. While the protective aspect helps in stabilizing agricultural production against droughts, the productive aspect cannot be neglected by an agriculturalist. Irrigation has third aspect also. Irrigation improves and maintains the property of the land by sustained and adequate water supply. (Reddy, 1995).

The growth of the agricultural sector aided by technological change has a comprehensive and a broad impact on the poverty alleviation of the people of the rural areas. As it reduces poverty in rural areas it also reduces inequalities. (Fan et al., 1999; Mellor, 2001; Desai, 2002).
Each one percent increase in per capita agricultural growth leads to 1.5 percent increase in per capita non-agricultural growth. Increasing incomes in agriculture are spent on locally produced goods and services and help to increase rural employment, reduce poverty and serve as a precondition in enhancing rural development (World Bank 1994). One of the common features of most of the less developed countries of the world is that they are confronted with multifarious economic problems. Poverty, food shortage, unequal distribution of wealth, inflation, unemployment, deficit in the balance of trade, unfavorable balance of payments, adverse terms of trade, financial crisis, debt crisis both internal and external, population pressure, illiteracy, etc. are their major problems (Himayatullah, Khan, and Asrar, 1999).

The future strategies of poverty alleviation in rural India will largely depend on irrigation. In addition, the irrigation benefits are more to the population living in the low income quintile as compared to the upper income quintile, because irrigation generates employment and other feedbacks in the rural economies. Increasing access to irrigation strategy helps the pro poor by reducing the severity of the poverty. Among all the variables selected for analyzing the poverty measures, irrigation has a crucial role in the reduction of poverty. Compared with rural literacy, irrigation has a much bigger marginal impact on the poverty reduction. (Bhattarai and Narayamoorthy, 2000).

As mentioned earlier, Pakistan is predominantly an agricultural based economy. However, despite all the facts, agricultural productivity in Pakistan is still below its potential level as compared to other developed countries as well some other developing countries of the world. Agriculture in Pakistan suffers from various problems. Lack of irrigation water is also one of the most serious problems confronting agriculture in the
country. Although the agriculture sector of Pakistan mostly rely on canal irrigation, it still needs an efficient and sustained system of irrigation to increase the agricultural productivity. This efficient and sustained system will in turn increase the cropping intensities and cropping pattern. It is also a fact that Pakistan has a best network of canal irrigation, but still a great amount of water go wastes. (Govt. of Pakistan, 2004).

Irrigated land accounts for 76 % of total agricultural land and more than 90.5 of the value of agricultural production. Irrigated land area increased at the rate of 1.5 % a year during the period 1950 – 95. The increase in irrigated area was most significant before 1980 (Farquee, 1997).

Poverty alleviation has always been on the top of agenda of all our successive governments. In Pakistan the poverty line derivation is based on income. It includes a 2250 calories daily intake of per person. The primary issue of our country is the poverty alleviation, which will never be resolved so long as we continue to neglect agriculture in our development priorities. (Kabir, 2006).

An average of 131.185 MAF (Million Acre Feet) inflow of water was registered during 1977 – 78 to 2002 – 2003, while the river flow in the same period was less by 0.1 percent as 131,062. In 1977 – 78 to 2002-2003 the average withdrawals of water from the canal head was 98.6 MAF, which declined to 97.5 MAf in the year 2003 – 04. The decline amounted to 1.1 percent. Government of Pakistan is trying its level best to improve the agriculture sector of the economy by achieving the maximum production of crop through sustained irrigation system by protecting the land from water logging and salinity, and also by controlling floods and soil erosion. In this regard the government of Pakistan is giving top priority to the development of irrigation system. To achieve these objectives
government of Pakistan is working on the proper management of the water resources through the construction of medium and large scale dams and canals. By managing the quality and quantity of the water resources not only agricultural production can be increased it will also help control floods, water logging, salinity and soil erosion. Along with the canal irrigation government is also paying attention to the management of ground water through tube wells. (Govt. of Pakistan, 2004).

It is also evident that agricultural productivity is adversely affected by shortage of water in 2000 – 2002 as the agricultural growth has declined to negative from 4.54 to – 2.64 and then – 0.07 (Govt. of Pakistan, 2003).

The North West Frontier Province (NWFP) is relatively backward in terms of agricultural productivity than Punjab and Sind. Major crops in NWFP include sugarcane, wheat, maize, gram (chickpea). Within the NWFP, the southern districts are comparatively poorer and per hectare yields of crops are lower as compared to the Peshawar Valley.

D.I. Khan is one of the southern districts in NWFP where majority of people live below poverty line. Literacy rate is low. Unemployment is widespread. Per hectare yields of crops is low. Area under cultivation is also low. The agricultural economy of the area has transformed a lot after the construction of Chashma Right Bank Canal (CRBC) because it has brought more area under cultivation than before and the yields of crops have increased manifold. Crops like sugarcane and rice, which were not cultivated before CRBC, are now the main crops in D.I. Khan (Sheladia Associates, Inc., 2001).

The Chashma Right Bank Irrigation Project (CRBIP) has a major role contributing to the agriculture sector of NWFP and Punjab. The project is expected to increase the production of major field crops and improve farm incomes for an estimated population of
822,000, stimulate employment and agro–industrial development, generates substantial foreign exchange savings annually and generally raise the economic status of the region. The primary reason for the large capital investment in the main canal an irrigation distribution system of CRBIP is to grow crops and thereby further the economic development of the province and reducing poverty. The major crops grown in Stage I and II are wheat in the rabbi season and rice in the kharif, sugarcane as a yearlong crop covers both seasons. Other crops in rabbi and kharif season are less than 10%. There is a large potential for introducing and / or expanding areas of other crops, with particular emphasis on high value low water requirement crops, vegetables, orchards, etc, to minimize the potential for water logging and salinity and cope with limited water supplies (Sheladia Associates, Inc., 2001).

In November 1970, the Water and Power Development Authority (WAPDA) prepared a feasibility report on the CRBIP, followed by PC – I in December 1973. In August 1977 the project was appraised by the Asian Development Bank (ADB). In late 1979, after physical works had already been started, it became clear that the CRBIP would cost substantially more than originally estimated. Following virtual cessation of construction, the Government of Pakistan (GOP) and WAPDA, the main executing agency for the CRBIP, made various studies on the CRBIP. These included the preparation of a revised PC-I dated May 1981, which involved subdivision of the overall project into three stages by segmenting the 258 km of main canal into increments of 79 km, 37 km, and 142 km respectively. In late 1981 the GOP requested ADB technical assistance to further examine the project, and this was under taken by a team of consultants during the second half of 1982. In early 1984, all pending issues on the revised CRBIP were formally
resolved, and the ADB reactivated loan for applications the Stage I main canal and associated civil works of the revised CRBIP. Stage I was completed in December 1986 and commissioned one month later (CRBIP, 1987).

In February 1986, the GOP requested further technical assistance from the Bank for the preparation of Stage II of the CRBIP. Technical Assistance (TA-803) was approved by the Bank on 8th October 1986, and agreed by the GOP, the Government of NWFP and WAPDA in March 1987. Consultants arrived in Pakistan on 15th April 1987, and after preliminary discussions with official from the GOP, NWFP Government and WAPDA, fieldwork commenced in D.I. Khan from 24th April 1987 (CRBIP, 1987). Stage II construction started in 1988 from RD 260 to RD 380 and was completed in 1995. It provided 36 km of main canal, 15 distributaries canals of 169 km length, 552 water courses of about 1052 km length, and branch and main surface drains for 94000 acres. Stage III runs from RD 380 to RD 851 and consists of 144 km of main canal. Construction of Stage III has recently been completed. (Sheladia Associates, Inc., 2001). The present study focuses on the Stage II of CRBIP because it is close to D.I. Khan and its adjacent areas. The study takes into account main crops including wheat, rice, gram (chickpea) and sugarcane.
1.2 Justification for the Study

The present study focuses on the Stage II of the CRBC three stages. The reasons for the selection of Stage II are as under:-

a) Stage II has been completed in 1995. It is imperative to study the socio-economic impact of any such project after its full fruition and its consequences.

b) Stage I was partially irrigated by the Paharpur Canal and by tube wells. While Stage II was totally irrigated by the Rod kohi system. While Stage III is partially located in Punjab Province and partially in NWFP. This overlap in the location of Stage III creates research difficulties in selection of a sample area as an exclusively independent variable that effect upon the existing milieu. The Stage II avoids this diversity in the area and also wide variance in the structure of societal variables.

c) The area under command of Stage II is a socio-cultural enclave and its value system is embedded in history. So the radical changes in socio-economic indicators are measurable. Stage II of CRBC has been selected for study because of its exclusiveness in the area as well as a distinct socio-cultural pattern of the inhabitants.

Some important studies were also conducted to know the impact of CRBC such as by Zaman (1983) and by Sheladia Associates (2001).

The study by Zaman was conducted in the early phase of the construction of CRBC Stage I. It was too early to study the socio economic impact of CRBC on agricultural productivity and poverty alleviation and also CRBC was in the stage of construction.
While stage II started in 1988. This study was just like a feasibility report of the entire CRBC.  

Another important study was conducted by Sheladia Associates. It gathered data on every aspect especially on engineering and construction of CRBC. It simply compared the main socio-economic and cultural indicators. It compared the crop yield, area, cropping intensity and income with some previous year, but nothing was explained with reference to consumption, saving, education, health and also another important aspect of poverty alleviation was not touched.  

This study can be hopefully unique and very useful on the ground that the impact of irrigation is studied on crop yield, area, cropping intensity, cropping pattern, income, consumption, saving, education, health, livestock and employment etc. Secondly, this study has covered the important aspect that how the agricultural productivity affects poverty alleviation.  

This study is undertaken with a view to compare the poverty/standard of living before and after CRBC on the basis of some indicators, as noted above. The previous studies used a simple comparison of various variables, while in this study the proper statistical methods, techniques and econometrics models have been used for the comparison of the various indicators. The introduction of these techniques can hopefully raise the status of this research at world level. The procedure and process of building of an econometric model can be hopefully useful in the empirical analysis of data base and would provoke further research in line with the design.
Another important characteristics of this study is that it has made a comparison of the irrigated areas with un-irrigated areas (With and without analysis), while the other studies have ignored this aspect.

In the panoramic perspective and insightful investigation into the integrating variables can be of much utility for researchers, economists, academicians, policy makers and planners.
1.3 **Objectives of the Study**

The main objectives of the study are as follows:

1). To examine the socio-economic characteristics of the sample households and the study area before and after the construction of CRBC

2). To assess and compare the per acre yields of various crops before and after the CRBC in the study area.

3). To investigate the impact of CRBC on farm productivity, household incomes and poverty alleviation in the study area.

4). To find out the perceptions of sample households about the CRBC and to diagnose various constraint facing farming community regarding irrigation facilities in the study area.

5). To determine the role of CRBC in poverty alleviation in the study area.

CRBC is a gigantic project and has multidimensional objectives. That includes ambitious targets of achieving the level of socio-economic development as well as development of agriculture with a view to improving the lot of peoples residing in the project area of the district D.I.Khan. The objectives of the project are lofty and desirable and if those are realized, it will be great achievement and will certainly improve the fate of this downtrodden area and its multiplier effects will also spill over to other parts of the country.
1.4 Hypotheses

The study tests the following hypotheses.

1). There is a significant difference between the socio-economic conditions of sample households before and after CRBC.

2). There is a significant difference between per acre yield of crops before and after CRBC.

3). Area under cultivation and cropping intensity has changed before and after CRBC.

4). Household average monthly income, consumption and saving have changed before and after CRBC.

5). CRBC has led to enhance rural employment and alleviated poverty in the study area.

1.5 Organization of the Study

This study is prepared into six chapters. Chapter II gives a review of the relevant literature. Research methodology is discussed in detail in chapter III. Chapter IV describes general descriptive analysis of the sample households and study area. Chapter V discusses the demographic and socio – economics characteristics of sample household. Chapter VI discusses data analysis, results and discussion that is the main findings of the study and tests the study hypotheses. Summary, conclusions and recommendations are given in chapter VI.
CHAPTER II

REVIEW OF LITERATURE

There are various studies conducted in Pakistan and some other parts of the world to study the relationship between irrigation, agricultural productivity, and poverty alleviation, but of all these studies, I have selected the most relevant studies in the literature review. Studies on irrigation and agricultural productivity are reviewed in section 2.1. Section 2.2 of this chapter is based on a critical review of studies relating agricultural productivity and poverty alleviation. Section 2.3 gives a review of studies on impact of agricultural productivity on income, consumption, employment, etc. Section 2.4 gives a review of the studies relating to cropping pattern and cropping intensity. Finally, section 2.5 gives the concluding remarks.

2.1 Irrigation and Agricultural Productivity

Under irrigation and agricultural productivity, there are very useful studies such as (Merry and Wolf, 1986; Chaudhry, 1986; Badruddin, 1987; Kumar and Mruthyunjaya, 1992; Byerly, 1994, Faruque, 1995; Khan, 1997; Sivasubramayan, 2000; Iqbal and Ahmad, 2001; Bhattaria, Sakthibaidal and Hussain, 2002) which focus on the role of irrigation in enhancing agricultural productivity.

Chen (1977) has explored the sources of growth in five Asian countries, viz., Korea, Japan, Hong Kong, Taiwan and Singapore as these Asian economies have been growing at 10 percent per annum or more in the post-war period. The major objectives of the study were to examine in broad terms the input and non-input sources of growth in the economies under study. Owing to the measurement and data problems, the analysis of
resources reallocation was confined to the reallocation of human resources from the agricultural to non-agricultural sector.

The irrigation system of Pakistan is based on the Indus River and its tributaries, and constitutes the largest irrigation system in the world today. It provides irrigation to about 17 million hectares out of a total of 20 million hectares of cultivated land in the Indus basin. The system is designed to spread the existing supplies of water at the minimum possible cost to the largest number of cultivators in the settled command area. Irrigation is the lifeblood of agriculture in Pakistan. Without irrigation, there would be virtually no agriculture [Merry and Wolf (1986)].

Govt. of Pakistan (1988) recognizing the importance of the irrigation development for solving several of its economic problems, the Government of Pakistan has made massive investment in the construction of dams, link canals, public tube wells, and other water related projects to enhance the water availability at farm gate. These development efforts have made possible the substantial progress in the increasing water availability to Pakistan agriculture. Even today nearly ¼ th of the country’s population subsists under extreme poverty conditions; almost 59 % lives in rural areas.

Chambers (1988) concluded that in spite of the fact that greater improvement has been made in the world food security but it is also clear that agricultural productivity cannot alone win a war against poverty and hunger. Poverty reduction is more related with increased food production and more employment in the agriculture sector. The dream of more production by increasing crop yield and employment can only be achieved through the expansion of irrigation system.
Kumar, Praduman and Mruthyunjaya (1992) have used Divisia-Tornqvist index for computing total output, total input, TFP & input price indices for wheat grower in Haryana, UtterPardesh, and Punjab (Indian states), based on micro level farm data. Inputs included are land, seed, manure, fertilizer, pesticides, herbicides, labor, (machine labor, animal) and irrigation.

These are calculated as under.

**Total output Index (TOI)**

\[
\text{TOI} = \frac{\text{TOI}_t}{\text{TOI}_{t-1}} = \pi_j \left( \frac{Q_j}{Q_{j,t-1}} \right) \left( \frac{R_{jt} + R_{jt-1}}{2} \right)
\]

**Total input Index**

\[
\text{TI} = \frac{\text{TI}_t}{\text{TI}_{t-1}} = \pi_i \left( \frac{X_i}{X_{i,t-1}} \right) \left( \frac{S_{i,t} + S_{i,t-1}}{2} \right)
\]

**Total Factor Productivity (TFP)**

\[
\text{TFPI}_t = \left( \frac{\text{TOI}_t}{\text{TI}_t} \right) 100
\]

**Input price Index (IPI)**

\[
\text{IPI}_t = \frac{\text{IPI}_t}{\text{IPI}_{t-1}} = \pi_i \left( \frac{P_i}{P_{i,t-1}} \right) \left( \frac{S_{i,t} + S_{i,t-1}}{2} \right)
\]

Where \( R_{jt} \) are the share of output \( j \) in total input cost, \( X_i \) is input \( i \) and \( P_i \) is price of input \( i \), all in period \( t \).

The wheat production under modern seed varieties in Indian states has increased. The use of fertilizer as an input has also shown an increase of 4% in Punjab, 8.1% in Haryana, 6% in Utter Pradesh etc. The use of Pesticides & herbicides is negligible except in Punjab & Haryana, where this input has increased quickly. The use of human labor has fallen, while the share of machine labor has increased sharply. TFP results reveal that input index has increased and output index has also increased, due to increase in input & technological change (irrigation). So, TFP growth rates in the wheat sector in the Indian states under consideration during the period (1971-89) are much better than growth of TFP not only in Indian & Pakistan crop sector, but also in U.S (Post war agriculture). The estimated parameter of TFP indicates the result that the market infrastructure, research and irrigation are more important sources of growth of TFP.

Hossain and Sen (1992) have reviewed rural poverty, its extent and trends, and analyzed its determinants based on secondary information. Agriculture is the main source of rural income. Agriculture growth has a more direct effect on rural poverty alleviation than national economic growth. This study shows that agricultural growth has been stimulated mainly by a relatively rapid diffusion of new technology. The expansion of irrigation facilitated the growing of an additional crop.
during the dry season. Following points are important in the study. Firstly, an
important part of poverty alleviation is to identify and emphasize elements of
growth policy, which are likely to have the strongest and most immediate favorable
effect on rural poverty. The spread of new technology (particularly modern
irrigation) in agriculture can considerably reduce the rural poverty. Secondly, the
development of rural infrastructure positively affects the level of rural poverty.
Rural electrification has greater poverty alleviation effects than the transport
network. Thirdly, access to non-agricultural employment provides scope for income
mobility for land less poor households.

Shah (1993). In India in 1970 people living below the poverty line were 50 % but in 1990
it decreased to about 35 % [ Datt(1998)], while in Bangladesh people living below the
poverty line fell significantly during this period. However, at the same time the people
living below the poverty line increased in absolute terms in both the countries. To
eradicate the poverty the government in both the countries increased its funding by
investing in irrigation.

Arena (1994) indicated that 30 % of the population of Pakistan lived in absolute
poverty. It has been established that agriculture income is the major source of
income inequality in rural Pakistan.

Byerly and Derek (1994), Pakistan reliance on an extensive pattern of development
in agriculture becomes clear from the large increase in area under irrigated crops by
1.8 % per annum since 1950-51. The increase in area has been in turn made possible
a large increase in availability of water. Between 1960-61 and 1990-91, the
availability of water doubled, while Rabi crops trebled and Kharif crop more than doubled.

Faruq (1995) has concluded that during 1977-88 the recovery in agricultural growth to nearly 4 % per annum from a dismal 2 % during 1972-77 was an important element in overall expansion. Agriculture production during this period was helped by large augmentation of irrigation water supplies from Tarbela Dam and the dramatic increase in the domestic production and use of fertilizer. He adds that rapid alleviation of rural poverty depends upon rapid agricultural growth but to achieve growth additional reforms are required to maximize poverty reduction.

Chaudhry, Chaudhry, and Qasim (1996) reviewed the growth performance of Pakistan’s agriculture from 1950-1995. The long-term growth rate of agriculture, although respectable, exhibited considerable fluctuations from year to year or even from decade to decade. For example, most of the fifties and early seventies were characterized by lack of growth. Accelerating and high growth rates were in the 1960s where annual agricultural growth rate rose to above 6% but the performance has not been satisfactory since 1979 – 80, and average growth rates have barely exceeded the population growth rate. However, growth rates of area and productivity have varied from time to time. The annual growth rates of productivity per acre were negative in fifties, while increased to 7.55 % in the sixties. It is very much clear from the analysis of the paper that the agricultural price policy pursued in Pakistan had adverse effect on investment and technology, production, employment and income distribution and needs to be changed.

Khan, Ali and Anania (1996), examined the factors behind low crop yield in Cholistan. Both the quantitative & qualitative analysis has been taken. The quantitative findings
provide valuable insight into various sources of productivity in terms of acreage effects, capital input effect and irrigation water availability effect. The impact of capital, human capital, land, labor, education, credit and water availability on wheat and cotton yield is measured quantitatively. Uniform data was taken for 348 observations and 450 farmers interviewed. The equation in functional form is

\[ Y = f (K, H, N, L, De, Dc, Dw) \]

\( Y \) represent cotton & wheat yield, while \( (K) \) is taken as expenditure on seed, fertilizer & pesticides, human capital \( (H) \) taken as family expenditure on food & health; labor \( (N) \) employed in number, land \( (L) \) in acres; dummy variable for education \( (De) \) taken as zero & one for less than five and five or more years of education, dummy variable for credit \( (Dc) \) taken as zero and one for informal & formal sources respectively; and dummy variable for water \( (Dw) \) zero, one and two for corresponding level of irrigation water availability

In its estimable form

\[ Y = \beta_0 + \beta_1 K_i + \beta_2 H_i + \beta_3 N_i + \beta_4 L_i + \beta_5 De + \beta_6 Dc + \beta_7 Dw + \epsilon. \]

<table>
<thead>
<tr>
<th>No of observations</th>
<th>y = dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressor</td>
<td>coefficient</td>
</tr>
<tr>
<td>Intercept</td>
<td>-36227.2</td>
</tr>
<tr>
<td>K</td>
<td>11.1</td>
</tr>
<tr>
<td>L</td>
<td>3303</td>
</tr>
<tr>
<td>Dw</td>
<td>6719</td>
</tr>
</tbody>
</table>

\( \text{Adj. } R^2 = 0.667 \quad \text{DW stat} = 1.76 \quad \text{F. Stat} = 230 \)
Only capital, land and irrigation water has turned out significant constraints on production with positive coefficients. The variable for land & capital are significant at 99 percent level, while the dummy variable for water is significant at 97 percent level. The size of Adj. $R^2$ is about 68% showing strong relationship of the explanatory variables with the crop yield. All the indicators show that the results are statistically valid & that the model in its final estimated form is well specified, while rests of the variables are insignificant.

Mellor (1996) has outlined the various reforms for the irrigation sector by the Pakistan’s government. The reforms are evaluated because irrigation is the critical variable influencing the poverty rates and is a significant determinant of overall economic growth rates. Pakistan has maintained a growth rate in agricultural GDP of over 4 % for the past two decades. That places Pakistan among the fast agricultural growth countries (Mellor, 1995). Thus, agriculture has been able to play a significant stimulative role in overall economic growth in Pakistan. The case for radical institutional reforms in irrigation must be made at least on the grounds that the growth rate could have been a great higher if institutional reforms had been made in irrigation institution: or more compelling that the past growth rate is not only sustainable but will decline sharply with major deleterious effects on the overall growth rate and in poverty levels, without major institutional change in the irrigation system.

Hassan (1997) analyzed the trend of agricultural productivity in Pakistan since independence. He reported that the 1960 saw a surge in the agricultural growth rate of 5 % per annum, exceeding internationally by Malaysia and Thailand. The improvement was the result of significant investment in water resources. Again, during 1977 – 78 the
recovery in agricultural growth to nearly 4 % per annum from a dismal 2 % during 1972 – 77 was an important element in overall expansion. Agricultural production during this period was helped by large augmentation of irrigation water supplies from Tarbella Dam and the dramatic increase in the domestic production and use of fertilizers. Pakistan reliance on an extensive pattern of development in agriculture has become clear from the large increase in area under irrigated crops by 1.8 % per annum since 1950 – 51. To a considerable extent, the increase in agricultural output has come from the expansion of cropped area due to enormous increase in availability of inputs, especially water. Future agricultural growth will have to come from improving the efficiency use of major inputs such as water and fertilizer as well as greater agricultural diversification. Since 70 % of the population still lives in the rural areas, sustained agricultural growth has been an important factor in poverty alleviation.

Gill and Mustafa (1997) has concluded that irrigation paves the way for the adoption of high yielding crop varieties and ultimately, for the alleviation of poverty in the country. Irrigation not only helps improves agricultural production, but also plays an important role in poverty reduction both directly and indirectly. Directly, it helps by increasing agricultural production and productivity especially that of food grains, which in turns helps in eradicating the problems of malnutrition by making food available to the rural poor at affordable prices. Indirectly, irrigation helps in increasing the employment of unemployed landless laborers and small and marginal farmers through its positive impact on cropping intensity and agricultural productivity; the increased employment, in turn, puts more purchasing power into the pockets of the poor. Further, the nature of irrigation distribution will also determine the direction and level of impacts it will create on the
reduction of inequalities, poverty reduction and malnutrition in the rural areas. They maintained that income inequality leading to poverty is attributed mainly to irrigation inequalities, which have risen overtime.

Khan (1997) has reported that agricultural growth has been modest and quiet uneven. Agricultural output has grown annually at just about 3.5 %. The growth experience has been highly uneven between various regions even within one province, particularly between region with and without irrigation. Of course, provinces with limited irrigation facilities and infrastructure have been seriously handicapped. He adds that increased inputs have been the predominant source of increase in agricultural production, including crop area, irrigation water, seeds, fertilizes machinery, credit and agriculture labor. Since independence the cultivated area, irrigated and cropped areas have all increased. One result of increased availability of irrigation water has been a 40 % increase in irrigation intensity and a 26 % in cropping intensity. All the inputs have doubled, trebled or quadrupled, as the water availability has increased from 3.2 to 5.8 acre-feet per hectare.

Amjad and Kemal (1997). The paper provides a consistent time series estimate of poverty for the period 1963-64 to 1992-93 for both the rural as well as the urban areas. Examines the influence of macroeconomic policies on the poverty levels, of such factors as economic growth, agricultural growth; terms of trade for the agriculture sector, employment. Policies pursued to alleviate poverty, has increased poverty levels mainly because of decline in growth rates, with drawl of subsidies on agricultural inputs and consumption, decline in employment.

Gafar (1998) attempted to gather some of the evidence that identified and described the extent of poverty and inequality in some Caribbean countries. It also examined the
interrelationship between growth, inequality and poverty. It also correlated poverty with
health and education. The data for the Caribbean countries suggested that literacy rate,
life expectancy and daily calorie intake were positively correlated with the level of
perception GDP while crude birth rate, infant mortality rates and Human Poverty Index
(HPI) were negatively associated with the level of per capita GDP. The data also
suggested that various income groups (quantities) benefited from economic growth, so
economic growth generally led to worsening inequality. The results showed a negative
relationship for Caribbean countries for the incidence of poverty and level of per capita
GDP. The statistical evidence suggests that the relationship of poverty and growth in
mean income was quite elastic (around -2) which has decreased the poverty in Guayana
and Jamaica.

Faruqee (1998) stated that irrigation is the lifeblood of agriculture in Pakistan. Swift
alleviation of rural poverty depends on rapid agricultural growth, which in turn depends on
government policy, price reforms that improve the incentives facing farmers are specially
urgent. But to achieve growth, additional reforms are required to maximize poverty
reduction.

Jehangir et al, (1998) estimated the operational distribution of land holdings in the Rechna
Doab. This study aimed at analyzing the two relationships. Firstly, the relationship of
cropping intensity with the size of the holdings and secondly, the impact of irrigation on
cropping intensity. Irrigation played a significant role in reducing the culturable waste area
in 1960s (as the elasticity coefficient for irrigation was negative as well as significant at 99
percent level of confidence). Period after 1960s, there was not much improvement in the
proportionate area under irrigation, which could play a significant role in reducing culturable
waste area. All the coefficients have the expected size and sign, proving the argument of an inverse relationship between farm size and cropping intensity, as these were significant at 99 percent confidence level. This relationship persists during, as well as, after the Green Revolution period. Regarding the effects of irrigation on cropping intensity, these are positive and significant at the 99% confidence level during 1980s.

Sivasubramaniyan (2000) discussed the irrigation impact in terms of cropping intensity, crop pattern & productivity of land in 1988-89 – 1991-92. A survey was conducted in 1992, from 210 farmers in two multi village tanks in KPT and DMT in Tamil Nadu. Analysis shows that access to well water and location of land have a significant bearing on cropping intensity (CI). Well farmers have higher CI than non-well farmers. Between the non-well head & tail, reach farmers the former segments cropped the land more intensively than the later. As for as cropping pattern is concerned, in most of the KPT village farmers grow annual crops, as banana, sugar cane apart from paddy. However, in DMT only paddy is grown. As for as productivity analysis is concerned, output per acre of both Gross Cropped Area (GCA) and Net Sown Area, (NSA) under well farmers are generally more than the non well farms in all the villages. The output per acre of GCA ranges from Rs.3321 to 5054 in two different villages, while output per acre of NSA ranges from Rs.5801 to Rs.11512. This difference is mainly due to variations in CI and crop pattern.

Iqbal, Khan and Ahmad (2001) analyzed empirically the various factors responsible for enhanced wheat productivity during 1999-2000 and provides basis for devising a strategy to sustain wheat production in future. This paper is based on primary data from 643 wheat growers of major irrigated zone. Data is analyzed using statistical package for social sciences (SPSS). A regression equation was estimated assuming a
modified Cobb-Douglas type production function for wheat. This was done in order to
determine the contribution made by various inputs and improved wheat
management practices towards higher wheat productivity. The assessed factors
include wheat acreage, weeding, irrigation, land preparation, seed rate, planting
method, fertilizer use, timely sown wheat acreage, etc. The effect of these factors on
wheat yield is investigated through Multiple Regression using OLS method

\[
\ln \text{yield} = \beta_1 + \beta_2 \ln \text{cult} + \beta_3 \ln \text{Srate} + \beta_4 \ln \text{Irrigt} + \\
\beta_5 \ln \text{Totfert} + \beta_6 \ln \text{PN Ration} + \beta_7 \ln \text{Plodged} + \\
\beta_8 \ln \text{PCHMWEED} + \beta_9 \ln \text{PDEEPLOW} + \beta_{10} \ln \text{PFYM} + \beta_{11} \ln \text{PSOWNLAT} \\
+ \beta_{12} \ln \text{DTENURE} + \beta_{13} \ln \text{DCREDIT} + \beta_{14} \ln \text{DLOAMLND} + \beta_{15} \ln \text{DEEPSOR} \\
+ \beta_{16} \ln \text{DYERAR} + U
\]

Where \( \ln = \) Natural Logarithm

\( \ln \text{YIELD} = \) Ln of wheat yield (in 40Kg) per Acre.
\( \ln \text{CULT} = \) Ln of common cultivation per Acre.
\( \ln \text{SRATE} = \) Ln of seed rate (Kg/Acre)
\( \ln \text{IRRIGT} = \) Ln of number of irrigation per Acre.
\( \ln \text{TOTFER} = \) Ln of total fertility nutrients applied (Kg/Acre).
\( \text{PNRATIO} = \) P-nutrients to N-nutrients ratio.
\( \text{PLODGED} = \) Proportion of wheat acreage affected by lodging
\( \text{PCHMWEED} = \) Proportion of wheat Acreage weeded through
Chemical control Method.
\( \text{PDEEPLOW} = \) Proportion of wheat acreage of deep plowing
\( \text{PFYM} = \) Proportion of wheat acreage where farm yard manure applied
\( \text{PSOWNLAT} = \) Proportion of seed acreage sown after Non: 30th
\( \text{DTENURE} = \) Dummy variable of tenancy (owner =1, Else =0).
\( \text{DCREDIT} = \) Dummy variable for Credit use (credit = 1, Else=0).
\( \text{DLOAMLND} = \) Dummy variable for Loan Lands (Loanland=1 Else=0)
\( \text{DSEEDSOR} = \) Dummy variable for seed source (own/ fellow Farmer
produced seed =one, Else = 0).

\textit{U} = Random variable with zero mean and constant variance.  

In the model estimated, \(R^2 = 0.45\) is a good fit in view of the cross sectional data. It implies that 45\% variation in yield is explained by the independent variable included in the model. The result of the production function shows that, the number of cultivation with common cultivator (Ln CULT) contributes positively and significantly to wheat yield. Similarly, preparation of land, using deep tillage implements also has a positive impact on yield. The coefficients of seed rate, number of irrigation and application of total chemical fertilizer nutrients are positive & highly significant, except the coefficient for seed rate, which is significant at 10 \%. The effect of a more balanced use of P\&N nutrients was positive & highly significant. The coefficient for proportion of wheat acreage sown later than 30\textsuperscript{th} Nov: was negative & highly significant showing that a delayed sowing of wheat reduces per acre yield of wheat. Similarly, an increase in wheat acreage affected with lodging, effects yield adversely & significantly. The results presented in the model reveal that additional coverage of wheat acreage with chemical weed control methods, increases wheat yield significantly. However, the use of farmyard manure (FYM) has a positive but insignificant effect on wheat yield. The coefficient of variables representing dummies for loam land and production year were positive & significant at 5\% & 1\% level of significance respectively, showing that wheat yields are higher on loam lands and the year 1999-2000 observed an upward shift of the function. The dummies for seed source and credit had a positive impact but insignificant.  

Bhattarai, Sakthivadivel, and Hussain (2002) have quantified the impact of irrigation on agriculture productivity along with the impact of inputs other than irrigation on agriculture productivity. The study also takes into account two important poverty measures in India. The study showed with the help of the regression analyses that irrigation has a positive impact on the agricultural productivity. It is also evident from the
regression result that irrigation has a positive and significant impact on the growth as well as productivity of all factors. Elasticity calculated is positive as 0.32 and significant. The conclusion that can is drawn from the analysis is that when irrigated area increased by one percent the productivity of all factors, which is total factor productivity (TFP) increased by about 0.32 percent in India between 1970 to 1994. The impact of irrigation is very high when it is compared with the impact of the productivity of other inputs as high yielding varieties of seeds, fertilizer, machinery and other infrastructure. The elasticity of the other inputs is 0.04 to 0.09. Poverty measures taken by the author to see the direct impact of other inputs are head count ratio and rural per capita consumption. The data was taken between 1970 – 93. The author used the same inputs to analyze the agriculture productivity. It was shown in the study that 60 percent of the rural population lives below the poverty line and it was very high in 1970 in India, which was measured by head count ratio. Irrigation development was also very low during that period. But after 1990 due to the development of irrigation projects the situation improved. Due to development of irrigation, the rural poverty declined which shows a negative relationship between irrigation facilities and rural poverty. It also showed a strong positive relationship between irrigation and irrigated area. There is also a strong negative correlation between gross irrigated area and rural poverty. As more and more area came under cultivation due to irrigation, the rural poverty declined. The analyses of the data showed that taking into account the time trend, the poverty declined in India in 1973 to 1993. This was also shown in the study that the above variables have also brought a positive change in the consumption model, as the per capita consumption of the rural population has also increased. The findings of the study suggest that to alleviate poverty
in India, due attention should be given to the development of irrigation. The development of irrigation has to be at the top of the agenda of poverty alleviation. The findings in addition states that people living in the low-income quintile will benefit more as compared to the population living in the upper income quintile. The basic reason for this is that the increase in the employment opportunities and other feedbacks impacts are generated to increase the living standard of the lowest income quintile. The conclusion that can be drawn from the above study is that improvement in the irrigation system will pave a way for development not only in agriculture sector but also in all the sectors of the economy. Because, it gives employment directly and indirectly to the people in the developing countries. It will in turn be a best policy to check and control the menace of poverty.

Bravo (2002) has studied the inevitability of the “economic transformation”. As stated in the study, that agriculture sector is playing a pivotal role in the development of the most of the developing economies and especially Pakistan. Study shows that agriculture sector provides food to the masses, provides direct and indirect employment to the people. It is also a source of foreign exchange earnings. It creates the demand for other domestic products. The other important function of the agriculture is that it helps in reducing poverty in the developing countries.

Palmer-Jones, and Sen (2003) extends earlier work by Datt & Ravallion, 1998. The author has established a strong positive correlation between the growth of agriculture sector and the rural poverty. It is shown by the author that the poverty between 1962 – 90 was low due to high growth in the agriculture sector. Along with mechanization and fertilizer usage, it is evident that irrigation is more important for agricultural growth and
povert alleviation. The analysis of the data of poverty and agriculture growth shows that all those Indian states who invested a larger amounts in the agriculture sector has increased agricultural productivity along with reduction in poverty. Among the objectives of the study, the important one is to find the relationship between irrigation and agriculture growth. Thus this argument takes the following relationship, which is there is a strong positive correlation at the regional level between irrigation and agriculture productivity. To explore this relationship a district level data is used to estimate following model

\[ \text{Ag-grth} = a_2 + b_2 \text{Grth - tract}_j + C_2 \text{Grth. fert}_j + d_2 \text{Grth.ml}_j + e_2 \text{Lev.irr}_j + e_2 \text{Grth-irr}_j \]

Where on the right hand side the independent variables are growth in the number of tractors, fertilizers used, number of male laborers the level of irrigation and the growth in the irrigated area. The period taken is 1962 – 90. The data shows that 1987 - 88 to 1993 – 94 the poverty measured by head count ratio has declined from 49.1 percent to 42.5 percent. The model takes 281 numbers of observations. Following table explains the results of the above model.
Table 2.2 Agriculture Growth during 1962 - 90

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.008*** (3.68)</td>
<td>0.008*** (4.49)</td>
</tr>
<tr>
<td>Grth-ir</td>
<td>0.04** (2.34)</td>
<td>-</td>
</tr>
<tr>
<td>Lev- ir62</td>
<td>0.02*** (6.02)</td>
<td>-</td>
</tr>
<tr>
<td>Lev-90</td>
<td>-</td>
<td>0.01*** (9.46)</td>
</tr>
<tr>
<td>Grth-ml</td>
<td>-0.04*** (1.98)</td>
<td>-0.04 (2.10)</td>
</tr>
<tr>
<td>Grth-fert</td>
<td>0.02 (1.31)</td>
<td>0.02* (1.90)</td>
</tr>
<tr>
<td>Grth-tract</td>
<td>0.04*** (4.19)</td>
<td>0.03*** (3.28)</td>
</tr>
<tr>
<td>SE of estimates</td>
<td>0.008</td>
<td>0.08</td>
</tr>
<tr>
<td>Adjusted R- Square</td>
<td>0.198</td>
<td>0.317</td>
</tr>
<tr>
<td>No. of Observations</td>
<td>281</td>
<td>281</td>
</tr>
</tbody>
</table>

Note: Growth in land productivity during 1962 – 90 is the dependent variable, while *, ** and *** shows 10 %, 5 % and 1 % level of significance respectively.

Analysis of the table by the author shows a strong role of irrigation in the given period. Which is explained in column I? It shows that irrigation along with tractor and fertilizer, the India experienced a high growth in its agriculture sector. It also shows that the cropped area between the mentioned periods has also increased due to irrigation. The analysis of this study shows that during the study period the development in the irrigation paved the way for increased agricultural productivity and the cropped area. Growth of other inputs as tractor and fertilizer has also increased during the given period.

Hussain and Hanjra (2004) tried to clarify the linkages between irrigation and poverty by offering an objective review of recent research on the subject. The key questions addressed were: (a) what is the role of irrigation development and management in poverty alleviation? (2) What are the linkages and pathways through which irrigation contribute to poverty
alleviation? (3) What is the magnitude of anti-poverty impacts of irrigation? In addition, what are the determinants of anti-poverty impacts of irrigation? The extensive review suggested that there were strong linkages between irrigation and poverty. These linkages are both direct and indirect. Direct linkages operate via localized and household-level effects, and indirect linkages operate via aggregate or sub national and national level impacts. Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value subsistence production to high-value market-oriented production. Increased production makes food available and affordable for the poor.

Huang.Q et al (2005) studied the case of China. Data of 60 villages from 6 provinces was randomly selected and a sample of 1192 household was taken. The paper covered three important areas. First, the author has studied the status of irrigation in China. Secondly, it studied the nature and the consequences of the irrigation that what is the impact of irrigation on agriculture productivity, yield per acre and the revenue. The study showed that irrigation has a positive impact on agricultural productivity and per acre yield. Per acre yield has increased for all the crops in the study area. Due to increase in per acre yield, the income of the farmers has also increased. This shows that irrigation has a strong positive correlation with crop revenue and income. This in turn has reduced poverty in China. The study also points out another important relation that in spite of the fact that due to increases in capital cost and the cost of production those areas who invested in irrigation still faced positive returns.
2.2 Agricultural Growth and Poverty Alleviation.

Burki (1973) identified those variables that have been most effective in lowering the incidence of poverty. First strategy is growth performance. Among Hong Kong, Indonesia, Republic of Korea, Malaysia and Taipei the performance of China was substantially good and poverty reduced. Secondly, it has been observed that high growth even when it is accompanied by moderate inflation, powerfully supports an anti poverty program both directly through its effects on incomes and indirectly by facilitating the financing of income transfers. Thirdly, the East Asian education experience show, education as an instrument for reducing poverty, the experience of Malaysia & Indonesia are illuminating. In both cases, the economic growth made a substantial contribution, but increased schooling also played a vital role.

Ahluwalia (1978) has studied the extent and incidence of poverty and the studied the performance of agriculture in India. The author has covered an important aspect taking the time series data. The period taken was 1956 – 57 to 1973 – 74. The first aspect showed a strong negative correlation between irrigation and agricultural productivity. Second aspect is that increase performance of agriculture reduces poverty in India as a whole. The author has shown a linear time trend. Trend shows that poverty declined in 1955 from 50 % to 40 % in 1960 – 61. Poverty increased in 1965 and reached to its maximum as 56.6 % in 1967. After that, poverty declined. A linear time trend is fitted which yields following results. The result shows that as for as rural poverty in India is concerned there was no increase or decrease in the rural poverty over the whole period. One of the hypotheses in the study was that in India during the mentioned period the agricultural performance has reduced poverty. The
hypothesis has been proved that agricultural growth has strong inverse relationship with poverty.

Ahluwalia, Carter and Chenry, (1979) studied the degree of poverty and the impact of growth on the poverty of developing countries. Author has taken 36 countries in the sample. The analysis of the data shows that in spite of the impressive growth in most of the developing countries over a period of 25 years, the poor are benefitted very less. The analysis states that growth in poorest economies is very slow, while in developing economies although growth process continues but the increase in income of the poor is below average. To counter or check poverty various policies have been proposed and formulated, but the poverty has not reduced significantly. The paper developed a quantitative analysis of the impact of GNP on poverty, population growth on poverty and the impact of income distribution on poverty. The author used simulation analysis. The author is of the view that it is a wishful thinking to eliminate the abject poverty to the end of this century. Poverty reduction is a combination of different policies. Along with other policies, the author is of the opinion that if poor countries improve the growth rate, along with reduction in population growth, accompanied by equitable distribution, the goal of poverty reduction can be achieved.

Korangkaew (1985) investigated the nature, the courses and contribution of agriculture in the economic development of Thailand in general and the relation between agriculture development and rural poverty and income inequalities in particular. The study indicated that during 1960’s, the nature of agriculture production increased at a rate of 5.5% per annum and the rural poverty fell to 43 percent from 61 per cent in 1962-63 to 1968-69. In Thailand the proportion of population under poverty in 1962-63 was estimated at 57%.
From 1962-63 onward the poverty incidence in Thailand began its secular decline as the national economy surged forward at a rate of 8% per annum between 1960-70 and 7% between 1970-1980. For the whole Kingdom the proportion of poor fell from 57% in 1962/63 to 39% in 1968/69, 33% in 1975/76 and finally to 24% in 1981. The development policies in Thailand have thus been successful in this regard. The estimates of income inequalities for their population (showing Gini coefficient) had indicated quite conclusively that the income distribution in Thailand had become more unequal as the country continued its economic development.

Mathur (1985) studied the correlation between agriculture productivity and poverty alleviation. Ahluwalia (1978) and Saith (1981) developed models to estimate the impact of agriculture growth on poverty in India. The author in this study has tried to see the difference in the results of the above-mentioned studies and presented a general model, which clearly explains the impact of agriculture growth on poverty.

Model is as under

\[ Pov_t = a_0 + a_1 (NDPAR_t + NDPAR_{t-1}) + a_2 t. \]

\[ Pov = \text{indicator of rural poverty}, \]
\[ NDPARP = \text{Net Domestic Product in agriculture per rural person}. \]

Saith gave his model as

\[ Pov_t = b_0 + b_1 DIAP_t + b_2 DCPIAL_t + b_3 t \]

Where

\[ DIAP = \text{deviations in the index of agricultural production in percentages} \]

\[ DCPIAL = \text{deviation in the CPI in percentages for agriculture laborer}. \]

Based on the above model the author presented an equation to analyze the impact of agriculture growth on rural poverty.

\[ Pov_t = \alpha_0 + \alpha_1 (NDPAR_t + NDPAR_{t-1}) + \alpha_2 CPIAL_t + \alpha_3 t \]
Three more relationships are added to the above specification as

\[ \text{NDPAR}_t = \beta_0 + \beta_1 \text{IAP} + \beta_2 t \]
\[ \text{IAP} = \gamma_0 + \gamma_1 t \]
\[ \text{CPIAL} = \theta_0 + \theta_1 t \]

After that, following equation is estimated

\[ \text{Pov}_t = (\alpha_0 + 2\alpha_1 \beta_0 - \alpha_3 (\beta_1\gamma_1 + \beta_2)) + 2\alpha_1 \beta_1 \text{IAP}_t + \alpha_2 \text{CPIAL}_t + (2 + \alpha_1 \beta_2 + \alpha_3) t \]

The above equation was estimated for three-poverty measure as denoted by P-I, all India aggregate data. P-II is state level data and SPI is Sen.’s Poverty Index for three different periods 1956-57 to 1973-74. The P-II, which is a second period the data for this year is excluded because according to Saith, it was not reliable. In the next period, which is period three, the data on 1960 – 61 to 1970 – 71 was included. The main differences between two models are in data and the choice of the explanatory variables. It is found that agricultural growth reduces rural poverty even if the agriculture growth is measured in terms of value added or by the method of gross output. The conclusion of the author is same as that of Ahluwalia and Saith’s. The author also finds that due to inflation the rural poverty increased. The same is concluded in the hypothesis given by Saith. It is concluded that the study supports Ahluwalia conclusion that agriculture growth has negative relationship with rural poverty or rural poverty is reduced through development in agriculture sector.

Godfrey et all (1993), Has worked on the hypothesis that development in agriculture GDP will reduce poverty in rural areas in the developing countries. Cross section data is used for the analysis. The analysis indicates that if the growth of GDP is taken to combat poverty than it takes a long time. The suitable approach to combat poverty is the combination of equitable, sustained growth accompanied by the
distribution of income. In the model given below \( p \) shows each country’s rural population head count ratio, while \( x \) shows the real agriculture GDP per head, and \( g \) is Gini coefficient. For the estimation of \( p \), linear, Semi – log and double log equations are fitted by OLS. Among these the best-fitted equation is of double log form as

\[
\log e p = 6.194 - 0.274 \log e x + 1.65 \log e g
\]

(13.4) (2.94) (6.50)

\( R^2 = 0.70 \quad n = 21 \)

The negative sign of \( x \) confirms the hypothesis that real growth in the agriculture sector reduces rural poverty. Regression coefficient is statistically significant only at 5 % level and the elasticity at the mean points is \(-0.27\). As for as \( g \) is concerned it gives a positive sign as expected and shows a significant regression coefficient and its elasticity at the mean is substantial and is \(1.65\). Through the estimation of the equation, one can get the negative relationship between agriculture GDP and the rural poverty.

Equation after differentiation becomes

\[
\frac{I}{p} \cdot \frac{dp}{dt} = -0.27 \frac{I}{X} \cdot \frac{dX}{dt}
\]

The equation shows that GDP per head increases by 3 % per annum and poverty reduces by 0.81 % which is as \(0.27 \times 3 = 81\%\).

Srinivasan (1993) has quoted from different studies in Pakistan that agriculture has a strong interaction with rural poverty and it is quite higher than urban poverty.

Gosh (1996) used a cross section data for his study. The study covers four points of time, which are 1972 – 73, 1977 – 78, 1983 and 1986 – 87. This paper studies the impact of
agriculture development on rural poverty and the impact of other factors on rural poverty in the Indian states. The study showed an inverse relationship between agriculture production and the rural poverty. As for as other factors are concerned which effect rural poverty are, by increased employment and reasonably good level of real wages. If these factors are improved then productivity can be reduced. The improvement in other specific inputs can be made by irrigation and increasing the land productivity, subsidized credit facility and other related inputs. This study also examines whether the benefits of the agriculture growth has trickle down to the rural poor. Two equations are estimated to see the effect of various factors on the rural poverty, first takes the general factors and the second takes the specific factors as an independent variable

\[
RPOV = \alpha_0 + \alpha_1 SDPAR \quad (1)
\]

\[
RPOV = \beta_0 + \beta_1 AVMSH + \beta_2 RWAL + \beta_3 CDURM \quad (2)
\]

Where

- \( RPOV \) is rural poverty,
- \( SDPAR \) is domestic product of agriculture
- \( AVMSH \) shows the size of average marginal holdings
- \( RWAL \) is the real wage rate for male laborers and
- \( CDURM \) shows unemployment (current day) of rural males

Ordinary Least Square method is used to study the given data.

The results of the above equations are as under

\[
RPOV = 70.88 - 0.054SDPAR \quad (0.008)* \quad R^2=0.466
\]

\[
RPOV = 94.30 - 24.328 AVMSH - 9.436RWAL + 1.041CDURM \quad (9.479)* \quad (1.066)* \quad (0.564) **
\]
(Figures in the parenthesis are standard error: ** and * significant at 5 and 1 percent respectively, n = 56). The SDPAR shows a negative and significant relationship with rural poverty. Paper suggests that if the performance of the agriculture sector is improved which is measured by improvement in SDPAR will certainly reduce rural poverty and this development has a trickle down effects in India. The analysis of the trickle down effect can be very much seen if the first equation is taken in four points of time individually. Results of the four periods is as under

\[
\begin{align*}
1972-73: & \quad \text{RPOV} = 89.46 - 0.090 \text{SDPAR} \quad R^2 = 0.696 \\
1977-78: & \quad \text{RPOV} = 83.11 - 0.069 \text{SDPAR} \quad R^2 = 0.586 \\
1983: & \quad \text{RPOV} = 68.11 - 0.055 \text{SDPAR} \quad R^2 = 0.547 \\
1986-87: & \quad \text{RPOV} = 52.33 - 0.031 \text{SDPAR} \quad R^2 = 0.473
\end{align*}
\]

Fig: in Parenthesis are standard error, * shows 1 % significance level, where n =14.
The analysis of the above-mentioned four periods shows that rural poverty has an inverse relationship with agriculture production. However, the analysis of the four equations also shows that the $R^2$ has declined continuously from 0.096 to 0.473. This explains that the explanatory power of the SDPAR is declining. It is due to the reason that the value of the SDPAR coefficient has declined from -0.09 to -0.031 from 1972-73 to 1986-87. The result sufficiently shows the trickle down effect. This consistent decline shows that alone agriculture production cannot do more to bring poverty down. The estimated equations further give another clue that the contribution of other specific factors is more than 63 %. Therefore, the contribution of the other factors is more in reducing rural poverty. AVMSH has inverse relationship with rural poverty and its coefficient is negative. Negative coefficient of other factors as RWAL and the positive relationship with rural
poverty by CDURM also suggest that to reduce rural poverty, employment in the agriculture be increased. Wage rate should be such that it should satisfy the basic needs.

Hussain and Ishfaq (1997) have discussed the agriculture production and poverty in Pakistan. In this paper, two considerations are taken into account and these considerations support each other. First, is to investigate that how agriculture production is related to poverty? The second consideration is to estimate the determinants of agriculture productivity over time. Result of the study indicates a negative relationship between agriculture production and poverty. Although, the poverty has reduced in Pakistan but not to great extent, due to negative factors. These negative factors or forces are high growth of population and increased food prices. As for as the factors that determine agriculture productivity are concerned, they has a significant role which has increased the agriculture production. The factors that have increased the agriculture production are increase in the cropped area and fertilizer.

Chaudhry and Chaudhry (1997) have provided an excellent review of agricultural development in historical perspective in terms of growth, income distribution and rural poverty. They argue that a growth rate of 5 % had given rise to positive changes in income distribution and poverty. They suggest that the pursuit of a high growth policy is expected to guide Pakistan’s future development strategy.

Datt and Ravallion (1997b). The authors used a large database. This was taken from National Sample Survey Organization (NSSO). Data was collected to see the changes in growth and poverty in the Indian states. The major findings of the paper are that pro poor growth mean growth in the agriculture sector. This study has rejected the previous view that “Green Revolution” has not brought any change. This study confirms that it had led
to poverty reduction and that the pro poor growth has a trickle down effect. On methodological grounds and careful modeling point of view, this study has an improvement over the previous research. Datt and Ravillion (DR’s) has used an improved version of the Saith (1981) model. Datt and Ravillion used explanatory variables some are time independent and some are time dependent. The time independent is literacy and infrastructure and time dependent are growth of agriculture and non-agriculture output. A strong negative relationship holds between poverty in rural area and agricultural development. Datt and Ravallion show that higher productivity has delivered both absolute and relative gains to the rural poor in the India. A share of these gains was via the growth component or wages and lower food prices rather than improved distribution.

The benefits of higher yields and productivity growth to the poor were not confined to those near the poverty line but reached deeper. Over all, long-term elasticity of poverty to yield increase is five times higher than short run values. This implies that it is higher yield (food security) combined with higher wages (supplemental income security) that matters for poverty alleviation. They have also demonstrated that states with higher investments in physical and human infrastructure have performed better in promoting growth and alleviating poverty than poorly endowed states. For example, states with smaller irrigated areas such as Maharashtra achieved lower reduction in poverty than states with greater irrigated areas such as Punjab and Haryana. Datt and Ravillion study utilized a data set, which contained time series data and other variables.

Datt and Ravallion (1998) took a sample of 24 households with average age of 35 years. Authors have tried to get answer of the question that what is the share of the poor people living in the rural areas when agriculture growth take place. The model estimated by the
authors took the determinants as agriculture wages, consumption and poverty measure and food prices. They have made a conclusion that increase in agriculture productivity has not only brought absolute gains but also brought a relative benefits to rural poor in India. Study also found that a big share in the decline of rural poverty was due to increased wages and increased prices of the output. In addition, the benefits accruing to poor were not only for those who are near the poverty line.

Pradhan and Saluja (1998). This paper is based on the analysis of different studies taken to measure the poverty incidence and to find poverty determinants. Some important influential papers were analyzed on the incidence of poverty and relating the incidence with different factors like the agricultural output, agricultural real wages, inflation, relative food prices etc. Agricultural output and the public expenditure are still the dominant factors affecting the incidence of poverty. According to the study, agricultural growth is still the most dominant sector for the poverty reduction.

Pant and Pradhan (1998) have analyzed the impact of economic growth on the income distribution and poverty by using a six-sector macro- econometric model. This is linked to an income distribution block, comprising of six rural and six urban household groups, estimated from the MIMAP- India survey. This study gives the baseline scenario of income distribution and poverty during 1994–95 to 2000– 01. In this framework, income distribution and poverty under different macro situations could be attempted. The study shows that all the agricultural dependent household groups (self-employed in agriculture and agricultural laborer) experience worsening of poverty situation in 1995-96 as compared to 1994-96due to slow down of agricultural growth. Urban poverty declines at a faster pace as compared to
rural poverty. Other two indicators related to poverty, i.e. poverty gap ratio and FGT index of poverty also depict similar trend as observed in the case of head count ratio.

Ali and Tahir (1999) analyzed the long run correlation among growth, poverty and inequalities in the context of Pakistan. He obtained a consistent time series on poverty measures for all Household Income and Expenditure Surveys (HIES) from 1963-64 to 1994-95. He showed that one percent increase in income while keeping the distribution constant reduces poverty equally in the rural and the urban areas to the tune of 0.31 to 0.32 of that one percent. Growth has worsened the income inequality at the national level but more so in the rural areas. Increase in inequality, keeping growth unchanged, has increased poverty more in the urban than in the rural areas. Overall, the dominant effect of growth has been of poverty reduction.

Rashid, (1999) swift alleviation of rural poverty depends upon rapid agricultural growth. But to achieve growth additional reforms are required to maximize poverty reduction.

Eastwood and Lipton (2000) have addressed two questions. The first question is what link growth has with the reduction of poverty, when there are differences in the (i) inequalities of income and (ii) what should be the type of growth? The growth that has taken place has not redistributed the income that is why it is neither pro poor nor anti poor. The most interesting and paradoxical findings came out from the analysis of 23 (developing countries) cross-country studies. There are variations within and cross-country case (i) those countries where growth has taken place but there are high inequalities than this growth is anti poor. (ii) Countries where agriculture growth is anti poor. Second question is about the links as what is link of asset to distribution of income and how redistribution is linked to the agriculture growth. It is a fact that inequalities
matter and these inequalities are anti poor and anti development. If severe income inequalities are removed than the growth will be pro poor. In terms of elasticity, if there are high inequalities than the elasticity of poverty to growth will be low. In developing countries where growth is more pro poor than the growth is more stimulated if population growth rate declines, income redistribution and a technicSal progress takes place in agriculture sector.

Shamsuddin, Radam and Liew (nd), Major objectives of the study are (a) to identify major issues in the agriculture sector that may affect agricultural productivity (b) to estimate total factor productivity (TFP) and (c) to identify possible strategies to achieve greater agricultural production. The study period is from 1961-1994. The author has highlighted various problems in the Malaysian agriculture. These problems are increased production cost, structure of the market, barriers on free trade, low agriculture productivity, instability of prices and availability of land for agriculture. The growth of TFP is calculated for three input model for the agriculture sector of the Malaysia. That includes land, capital and value added.

\[
\{\ln VA_{t} - \ln VA_{t-1}\} = SK \{\ln K_{t} - \ln K_{t-1}\} + SL \{\ln L_{t} - \ln L_{t-1}\} + \\
SR \{\ln R_{t} - \ln R_{t-1}\} + ST.
\]

Model is based on Gallop-Jorgenson Model.

Where VA is value added of output.

SK is share of capital input = \[\frac{\delta \ln Q (K,L,R,t)}{\delta \ln K}\]

SL is share of Labor input = \[\frac{\delta \ln Q (K,L,R,t)}{\delta \ln L}\]

and SR is the share of land input = \[\frac{\delta \ln Q (K,L,R,t)}{\delta \ln R}\]
While $ST = \frac{\delta \ln Q}{\delta t}$

ST is the residual.

The analysis shows that agriculture productivity in Malaysia has increased except the periods of global economic recession in 1975, 1978, 1983 and 1987. The growth of total factor productivity was 3.3 % in the period under consideration. Growth of TFP in the 1960 was high at 5.7 % and in 1980 it was 3.8 %. The growth rates declined in 1990 at 1.9 %. Due to agriculture development, the use of inputs in agriculture sector has also increased. The information on agricultural production and inputs was used for the estimation of the growth of TFP in Malaysia. $R^2$ is 0.995, which clearly explain the explanatory power of the variable by 99 %. The value of 1.96 of Durban Watson states no auto correlation. TFP is directly related to the growth in the productivity of capital while the technological development is also linked with productivity of capital.

Warr, Peter (2000) examined the large reduction achieved in the absolute poverty incidence in East and South Asian economies. He also examined the rate of growth in the agricultural, industrial and services sector. Head count measure has been used to measure the poverty. India, Malaysia, Thailand, China Indonesia, Philippines and Taipei are taken in the study. The period under study is 1960 to 1990. Both urban and rural areas are taken in the sample. This paper analyzed the changes in the determinants of poverty in all the above countries and explained the differences in the poverty of the said economies. Average rate of the reduction in poverty was different in all these countries. In India, the decline in average poverty rate was about 0.7 %. In China and Taipei it declined by 1.6 % per annum. For rest of South East Asian nations was 0.9 %, 1.6 %, 1.9 % and 1.4 % for
Philippines, Malaysia, Thailand and Indonesia respectively. As far as the real growth of GDP is concerned, it was calculated for the same periods. It was in China and Taipei 6.9 %, India 1.9 % and for the rest of the South East Asian nations were 4.3 % (Malaysia), 1.1% (Philippines), 4.2 % (Indonesia and Thailand). The author has taken the correlation between the growth of GDP and poverty reduction in the same periods. The conclusion drawn is that the former has not made any difference in the reduction of poverty. At the initial stages, the author took time series data but in the later stage, the pooled data of above countries was taken. Data shows that all the above mentioned six countries has witnessed a significant decline in the poverty, but the poverty reduction rate was lower in India as compared to China, Taipei and other four economies of South East Asia.

Poverty incidence was given by

$$P = \left( \frac{NP^R + NP^U}{N} \right)$$

Where

$$P^R = \frac{NP^R}{NR}$$ shows rural population in poverty

$$P^U = \frac{NP^U}{NU}$$ shows urban population in poverty

Only one independent variable that is growth of GDP is taken. Slope of the coefficient was explained by the inclusion of dummy variable to study the relationship. Overall slope coefficient defined by dummy variables was 1 % and highly significant. The individual studies of the countries show that dummy variables were insignificant. This implies that for all the six countries, the relationship between the incidence of absolute poverty and per person economic growth was same and significant. It also implies that there is no significant difference in the impact of growth on poverty reduction in the six countries.

As far as the sectoral growth is concerned, it was different in each nation. The share of agriculture in the economy was reasonably high in Thailand and Indonesia, but it was low
in other four countries of the South East Asia. Author gave secondary importance to the
development of sectoral growth and gave more importance to the overall growth for the
reduction of poverty. The author made it clear that major determinant of poverty
reduction is overall growth not the sectoral growth. It is also authenticated by the value of
$R^2$, which is 40 %. This again suggests that overall growth is more important in reducing
poverty as compared to sectoral development. However, at the same time the growth in
the agricultural sector has more to do with poverty reduction when it is compared with
the development of the other sectors. Therefore, agriculture growth has the capacity of
poverty reduction.

Thirtle et al (2001) found that for a sample of 40 countries, the elasticity of
incidence of poverty to agricultural productivity growth was about 1 %, that is, the
percentage of those living below the dollar a day poverty line fell by close to 1% for
every percentage in agricultural productivity.

Bhattarai, Sakthivadivel, and Hussain (2002) have quantified the impact of irrigation on
agriculture productivity along with the impact of inputs other than irrigation on
agriculture productivity. The study also takes into account two important poverty
measures in India. The study showed with the help of the regression analyses that
irrigation has a positive impact on the agricultural productivity. It is also evident from the
regression result that irrigation has a positive and significant impact on the growth as well
as productivity of all factors. Elasticity calculated is positive as 0.32 and significant. The
conclusion that can is drawn from the analysis is that when irrigated area increased by
one percent the productivity of all factors, which is total factor productivity (TFP)
increased by about 0.32 percent in India between 1970 to 1994. The impact of irrigation
is very high when it is compared with the impact of the productivity of other inputs as high yielding varieties of seeds, fertilizer, machinery and other infrastructure. The elasticity of the other inputs is 0.04 to 0.09. Poverty measures taken by the author to see the direct impact of other inputs are head count ratio and rural per capita consumption. The data was taken between 1970 – 93. The author used the same inputs to analyze the agriculture productivity. It was shown in the study that 60 percent of the rural population lives below the poverty line and it was very high in 1970 in India, which was measured by head count ratio. Irrigation development was also very low during that period. But after 1990 due to the development of irrigation projects the situation improved. Due to development of irrigation, the rural poverty declined which shows a negative relationship between irrigation facilities and rural poverty. It also showed a strong positive relationship between irrigation and irrigated area. There is also a strong negative correlation between gross irrigated area and rural poverty. As more and more area came under cultivation due to irrigation, the rural poverty declined. The analyses of the data showed that taking into account the time trend, the poverty declined in India in 1973 to 1993. This was also shown in the study that the above variables have also brought a positive change in the consumption model, as the per capita consumption of the rural population has also increased. The findings of the study suggest that to alleviate poverty in India, due attention should be given to the development of irrigation. The development of irrigation has to be at the top of the agenda of poverty alleviation. The findings in addition states that people living in the low-income quintile will benefit more as compared to the population living in the upper income quintile. The basic reason for this is that the increase in the employment opportunities and other feedbacks impacts are
generated to increase the living standard of the lowest income quintile. The conclusion that can be drawn from the above study is that improvement in the irrigation system will pave a way for development not only in agriculture sector but also in all the sectors of the economy. Because, it gives employment directly and indirectly to the people in the developing countries. It will in turn be a best policy to check and control the menace of poverty.

Palmer, Richard Jones and Kunal Sen, (2003) extends earlier work by Datt and Ravallion, 1998. The author has established a strong correlation between the growth of the agriculture sector and the reduction of poverty. The study showed that during the period of 1962-90, high growth brought decline in poverty. Along with mechanization and fertilizer usage, another variable that brought a significant change in the poverty reduction is the irrigation, which brought a growth in the agriculture sector. Analysis of the paper stated that agriculture growth brought a significant decline in the poverty. One of the objectives of the study was that whether the same relationship holds at the regional level or not. Thus this argument was tested with following hypothesis that in India an inverse relationship lies between agriculture growth and rural poverty.

A model of rural poverty is estimated as

$$P_j = a_1 + b_1 \cdot \text{AGR\_grth}_j + C_1 \cdot X_j$$

Where

- $P_j = \text{Rural Head Count Ratio}$
- $\text{AGR\_grth}_j = \text{land productivity per hectar in agriculture sector}$
- $X_j = \text{other variables that has impact on } P_j$. 
This model was used to test and see whether poverty has declined in the period due to agriculture growth. The measure of poverty used is the head count ratio. The data showed a positive response that poverty in 1987-88 has declined from 49.1% to 42.5% in 1993-94.

**Table 2.3 - Determinants of poverty**

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>64.1***</td>
<td>51.9***</td>
<td>44.1***</td>
<td>23.3**</td>
<td>0.12***</td>
</tr>
<tr>
<td></td>
<td>(15.96)</td>
<td>(5.31)</td>
<td>(4.84)</td>
<td>(2.38)</td>
<td>(3.26)</td>
</tr>
<tr>
<td>Ag_growth</td>
<td>-1046.5***</td>
<td>-1009.3***</td>
<td>-986.4***</td>
<td>-535.5***</td>
<td>-0.41***</td>
</tr>
<tr>
<td></td>
<td>(5.54)</td>
<td>(4.95)</td>
<td>(4.73)</td>
<td>(-2.79)</td>
<td>(3.20)</td>
</tr>
<tr>
<td>ST</td>
<td>-</td>
<td>.13(1.17)</td>
<td>.20*(1.85)</td>
<td>-.13(1.24)</td>
<td>0.16(1.18)</td>
</tr>
<tr>
<td>SC</td>
<td>-</td>
<td>-.27(1.24)</td>
<td>.46**(2.28)</td>
<td>.31*(1.74)</td>
<td>0.02(0.17)</td>
</tr>
<tr>
<td>Lit</td>
<td>-</td>
<td>-.39*</td>
<td>_</td>
<td>-.17 (0.96)</td>
<td>-0.26 1.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.92)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sm_farm</td>
<td>-</td>
<td>.20 (1.46)</td>
<td>.20 (1.35)</td>
<td>-.01 (0.42)</td>
<td>0.08 (0.53)</td>
</tr>
<tr>
<td>Ag-lab</td>
<td>-</td>
<td>.22 (1.49)</td>
<td>.002 (0.26)</td>
<td>.19 (1.57)</td>
<td>0.19 (1.59)</td>
</tr>
<tr>
<td>HCR 72-3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.61**(5.09)</td>
</tr>
<tr>
<td>SE of estimate</td>
<td>12.35A</td>
<td>11.53</td>
<td>11.82</td>
<td>9.48</td>
<td>0.045</td>
</tr>
<tr>
<td>Adj. R-square</td>
<td>0.338</td>
<td>0.423</td>
<td>0.394</td>
<td>0.610</td>
<td>0.290</td>
</tr>
<tr>
<td>No. of Obs</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>59</td>
</tr>
</tbody>
</table>

- Note: *, ** and *** shows level of significance at 10%, 5% and 1% respectively.

OLS is used in the model. In the table column 1 shows the regression result of the relationship of agriculture growth and poverty. Result indicates that a 1% increase in the
agriculture productivity will decrease poverty by 0.59%. Thus it shows a strong negative correlation between agriculture growth and poverty alleviation. The impact of agriculture growth on poverty only accounts to 34 %, which confirms the relationship studied by others as Vaidyanathan (1992) and Datt and Ravallion (1998). Although in additional columns, it is shown that the agriculture growth coefficient remained highly significant at 1 % level. To test the robustness of the result another measure squared poverty gap (column 5) is used to measure the intensity of poverty. All the columns gives the same result that agriculture growth has not only reduced the poverty but also a reduction in the intensity of poverty. All the columns give a strong negative relationship between agriculture growth and poverty. Thus, the hypothesis that agriculture growth will decline poverty in India is valid.

Huang.Q et al (2005) studied the case of China. Data of 60 villages from 6 provinces was randomly selected and a sample of 1192 household was taken. The paper covered three important areas. First, the author has studied the status of irrigation in China. Secondly, it studied the nature and the consequences of the irrigation that what is the impact of irrigation on agriculture productivity, yield per acre and the revenue. The study showed that irrigation has a positive impact on agricultural productivity and per acre yield. Per acre yield has increased for all the crops in the study area. Due to increase in per acre yield, the income of the farmers has also increased. This shows that irrigation has a strong positive correlation with crop revenue and income. This in turn has reduced poverty in China. The study also points out another important relation that in spite of the fact that due to increases in capital cost and the cost of production those areas who invested in irrigation still faced positive returns.
2.3 AGRICULTURAL PRODUCTIVITY, INCOME, EMPLOYMENT AND EDUCATION

Lockheed et al (1980) and Lockheed (1987) have studied the elasticity of output due to changes in education. In another model, they gave the percentage increase in output in response to a unit change in education. Similarly, in another one they calculated the percentage increase in output of a farm with the farmer’s educational level specified as dummy variable. In their studies, they have used another model to give the marginal increase in output in response to a unit change in education, whereas another model gave the increase in output with the farmer’s specified number of year of education, compared with illiteracy. The results of these studies showed that education significantly influenced methods of production, use of modern inputs, like fertilizer, seeds, machine and selection of crops. Socio-cultural factors and the caste system (in India) substantially influenced the impact of education on agricultural productivity and other variations. Non-formal education also significantly and positively contributed to agricultural output, influencing both technical and allocative efficiency of the farmers.

Tilak B.G. Gandhyala (1993), in his research paper presents an analysis on the role of education in rural development and in farm efficiency in the Asian countries. It also showed the methodologies adopted in analyzing the impact of education on agricultural productivity. Variety of approaches being adopted to study the effect of education on agricultural productivity, including simple coefficient of correlation, simple & multiple linear and non-linear regression equation, internal rates of return, while the use of Cobb Douglas production function dominates the research. As Lockheed et. al (1980)
summarized, at least five variants of the production function that have been used in the literature as follows.

\[ \ln y = a_0 + a_1 \ln L + a_2 \ln T + \beta \ln E + \gamma E_{XT} \]  
\[ \text{eq (1)} \]

\[ \ln y = a_0 + a_1 \ln L + a_2 \ln T + \beta E + \gamma E_{XT} \]  
\[ \text{eq (2)} \]

\[ \ln y = a_0 + a_1 \ln L + a_2 \ln T + \beta D + \gamma E_{XT} \]  
\[ \text{eq (3)} \]

\[ y = a_0 + a_1 L + a_2 T + \beta E \]  
\[ \text{eq (4)} \]

\[ y = a_0 + a_1 L + a_2 T + \beta D \]  
\[ \text{eq (5)} \]

Where \( y \) refers to output, \( T \) area under cultivation, \( L \) labor input, \( E \) the educational level, \( E_{XT} \) indicator of Exposure of the farmer to extension and \( D \) is defined that takes the value of 1 if \( E \) takes a value in a specified range and zero otherwise. (Lockheed, 1987). \( \beta \) in equation (1) gives the elasticity of output with respect to education. In equation (2), \( \beta \) shows the percent increase in agriculture output in response to a unit change in education. Equation (3) \( \beta \), gives the percent increase in agriculture output of a farm with the farmer’s educational level specified as \( D \). Equation (4) it gives the marginal increase in output in response to a unit change in education, and in equation (5) \( \beta \) gives the increase in output with the farmers specified number of year of education, compared with illiteracy. Equation 4 and 5 are less used than first these equations. Paper shows that education significantly influences methods of production, use of modern inputs, like fertilizer, seeds, machine and selection of crops. Socio-cultural factors and the caste system (in India) substantially influence the impact of education on agricultural productivity & other variations. Non-formal education also significantly and positively contributes to agricultural output, influencing both technical and allocative efficiency of the farmers.
Gafar (1998) in his paper attempts to gather some of the evidence that identifies and describes the extent of poverty and inequality in some Caribbean countries. It also examines the Interrelationship between growth, inequality & poverty. It also correlates poverty with health & education. The data for the Caribbean countries suggest that literacy rate, life expectancy and daily calorie in take are positively correlated with the level of perception GDP while crude birth rate, infant mortality rates and Human Poverty Index (HPI) are negatively associated with the level of per capita GDP. Data suggest that various income groups (quantiles) benefits from economic growth, so economic growth generally leads to worsening inequality. The paper gave a negative relationship for Caribbean countries in the incidence of poverty and level of the per capita GDP. The statistical evidence shows that the relationship of poverty with growth in mean income is quite elastic (around -2) which has decreased the poverty in Guayana & Jamaica. Evidence reveals that the liberalization of agricultural prices and a competitive exchange rate has led to increase agricultural production, which has reduced rural poverty. The data demonstrates a direct link between education & poverty. Those in the upper quantiles of the expenditure distribution who benefits most from public spending on higher education.

Dollar and Kraay (2000). The author showed in his article that increase in income of the poor is gradual and increases in one to one with the growth. A sample of 80 countries for four decades was studied. The author concludes that those policies, which maximize the growth, will help the poor. To maximize the growth policies if these are favored by fiscal discipline, good rule of law and free trade will benefit the poor. He gave a suggestion that the government should not act upon pro poor growth policies rather government has to adopt those policies which overall maximizes the economic growth. These policies
should also avoid inflation and should maintain fiscal discipline. Dollar & Kraay estimated the regression model, which is

\[ \bar{y} = \beta_0 + \beta_1 \bar{x} + \beta_2 x + \varepsilon \]

The equation is estimated by using OLS. It has the poverty elasticity of 1.06. It showed that when \( \beta_1 = 1 \) then growth in mean income transferred to the bottom 20% of the population is one for one. However, here elasticity is just significantly greater than one. It shows that when elasticity is greater than one the growth will favor the pro poor and one percent increase in total income increases the income of bottom 20% by more than 1%. In cross-country regression, the problem of heteroscedasticity is unavoidable. The appropriate method is to use weighted least square while the author has used un-weighted method of estimation.

2.4 CROPPING PATTERN AND CROPPING INTENSITY

WASIM (-----), Basic objective of the study is to examine the farm size cropping intensity relationship just after the advent of green revolution for the Punjab Province and secondly to examine the importance of irrigation in raising cropping intensity. Nineteen districts of Punjab are taken for the study. Methodology used in this paper is a log-linear form model, to study the relationship between farm size and cropping intensity in all the districts of Punjab.

It was calculated as

**Cropping intensity (C1) =**

\[
\frac{\text{Total cropped area reported by a farm size group}}{\text{Total cultivated area reported in that group}} \times 100
\]

Similarly, Average size of farm (X) is calculated as
Net operational area reported by a farm size group. \( \times 100 \)
Total number of farms in that group

The equation used is

\[
\log I (\text{District}) = \log a + b \log X (\text{District})
\]

(I is Cropping Intensity (C.I) and X is Average size of the farm)

This equation is computed for all the districts separately. Besides regression, correlation coefficients were also worked out between farm size and canal irrigation \( r_{12} \) and between farm size & tube well irrigation \( r_{13} \). It is based on Agricultural Census data of 1972. The evidence shows an inverse relationship between the size of the farm and intensity of cropping, as the coefficient of cropping intensity proved statistically significant at the 1 % level of significance. The explanatory power of all the equations was quite satisfactory and the value of \( R^2 \) ranged from 0.5247 to 0.978. In most of the previous studies about the farm size-irrigation relationship an inverse relationship holds \( (-r_{12}) \). In this study, also 53% of the districts still show negative relationship between farm size and irrigation base \( r_{12} \). However reverse is true for tube well irrigation base, as 74 % of the districts show a positive \( r_{13} \). It is suggested that an adequate supply of irrigation water would be potentially suited to the needs of the small farmers with widespread implications for the rapid growth of agricultural output.
2.5 Concluding Remarks

A thorough review of the above mentioned studies shows that irrigation, agricultural productivity and poverty are closely related. Majority of the studies have shown that irrigation has increased the agricultural productivity, while some other studies show that increased agricultural productivity has led to poverty alleviation in many developed countries. However, very few studies have been conducted on the relationship between irrigation, agricultural productivity and poverty in Pakistan. In particular, no such study has ever been undertaken in the study area, except [An Economy in Focus (1980) and Zaman (1983)]. The important point in this study is that it has exclusively focused on the relationship between irrigation, agricultural productivity and poverty alleviation. There were missing links in these studies. There is no other study, which has examined in depth the change in socio-economic conditions as well as impact of the CRBC on the agricultural development. Both these studies have dealt with the socio-economic conditions, status of agriculture in the command area before the construction of CRBC and the project target. It is presumed, that the construction of CRBC has radically changed the rural scene and its multiplier effects are visible even by a lay man. Thus, the present study would be the first attempt in this regard. It would help policy makers, researchers, academicians, and many others in various ways. The present study would be based on an updated analysis and would be a useful addition to the existing literature in this area. Thus, it is highly desirable that a study is undertaken to investigate in depth the multidimensional effects of CRBC on the command area falling in the D.I.Khan district. The development of agriculture needs tremendous attention by reallocating resources from unproductive channels to the agriculture.
CHAPTER III

RESEARCH METHODOLOGY

3.1 Introduction

This chapter highlights the research methodology used for conducting this study.

3.2 Universe of the Study

The area under CRBC stage II constitutes the area of this study. This area consists of 36 km of main canal, 15 distributaries canals of 169 km length, 552 watercourses of about 1,052 km length, and branch and main surface drains for 94,000 acres. The total population of the stage II area was 147,000 in 2000 is located in the vicinity of D.I. Khan city.

3.3 Sample Size and Sampling Procedure

Although there are a large number of villages in the study area, however, it was difficult to include all those villages in our study. A three stage sampling technique was used for the selection of a representative sample. As a first step Stage II of the CRBC was selected because it was completed in 1995 and we can now analyze its impact. Secondly, this area was purely un-irrigated before the CRBC. Thirdly, this area is located in the vicinity of D.I. Khan City. In addition, keeping in view financial and time constraints, this area was convenient for research. Stage I was purposively not selected as it was partially irrigated by Paharpur Canal and partially by tube wells. While Stage III is also not included in the present study as it has been very recently completed and it is too early or premature to study the socio-economic impact of CRBC on the command area, secondly, part of the
Stage III lies in the Punjab Province, so it was excluded on the basis of time and financial constraints.

In order to select a representative sample for the present study, in the second step five villages, namely, Gomal Kalan, Garah Hayat, Kurai, Khuthi, and Draban Khurd were purposively selected. These villages are such that they represent the study area. Two villages Gomal Kalan and Khuthi are situated near CRBC and rest of the three villages are relatively away from the main canal. All the five villages are selected on the ground that they grow more or less the same crops. Similarly, various other points were kept in consideration while selecting these villages. The selection of the farmers constituted the last stage of sampling. A list of households was prepared in each of the sample villages and then systematic random sampling method was used to select sample respondents. A total of 139 households in these villages were taken as sample for this study. The heads of sample households were interviewed. In case a respondent has no time or refused to be interviewed, a head of the next household was interviewed. This was helpful in reducing sample bias and in collecting reliable information.

To study the socio-economic impact of CRBC, two un-irrigated villages namely Gara Jamal and Zandani were also included in the sample survey. The logic behind this is to compare area under cultivation, cropped area, cropping pattern, cropping intensity, per acre yield etc of irrigated and un-irrigated villages.

A questionnaire was formulated to obtain informations on crop production, prices, size of farm, cropped area, irrigation water, labor, fertilizer, education, income, consumption etc. In order to gather reliable data required for this study, an interview schedule was designed before sample survey. The interview schedule contained many relevant
questions. It was pre-tested in the study area and was modified in the light of feedback from the farmers. Irrelevant questions were deleted and other necessary questions were included in the revised version of the interview schedule. The revised interview schedule was used for data collection. The data were collected in June-August 2004.

3.4 Procedure for Data Analysis

The main objective of this study is to find the effects of various inputs specially irrigation on the agricultural productivity of the CRBC command area and secondly how this agricultural productivity alleviates poverty in the study area. These are the major objectives of the study.

To achieve the objective we use regression analysis, t-test, Chi-square and dummy variable approach. This study quantifies the incremental benefits of major factor inputs (such as irrigation, cropped area, labor, fertilizer, education) to the output. The main objective of this study is to estimate the contribution of irrigation and other factors in the agricultural productivity. To measure it quantitatively the equation in functional form is:-

\[ Y = f(I, A, F, L, E) \]

We adopt the Cobb-Douglas production function in the following form.

\[ Y_i = e^{\beta_0 I^{\beta_1} A^{\beta_2} F^{\beta_3} L^{\beta_4} E^{\beta_5} e^{\epsilon_i}} \]

Applying natural logarithms (ln) on both sides

\[ \ln Y_i = \beta_0 + \beta_1 \ln I + \beta_2 \ln A + \beta_3 \ln F + \beta_4 \ln L + \beta_5 \ln E + u_i \]

Where

\[ \ln Y_i = \text{Natural logarithm of per acre yield of the ith crop}, \]

\[ A = \text{area under crop in acres}, \]
\( L \) = labor used in man days during the entire crop season,

\( I \) = No. of irrigations,

\( F \) = Use of Fertilizer in kilograms,

\( E \) = highest level of education gained by the farmer,

\( \ln \) = natural log, and \( \beta_0 \) are regression coefficients.

\( u_i \) = Random error term independently and identically distributed with zero mean and constant variance.

The model is estimated by employing Ordinary Least Square (OLS) estimation method.

The dependent variable (Y) is natural log of yield of various crops in kgs. Firstly we have restricted ourselves to only four major crops in the study namely wheat, gram, rice and sugarcane. The other less important crops are ignored because they were based on the memory and guesswork of the farmers. Secondly, canal irrigation enables wider choice of crop varieties as well as a wider choice of minor crops (such as vegetables, fruit, and oilseeds). Fodder crops are grown both in Rabi and Kharif seasons, but the output is not quantified, as it is fed directly to the livestock. The surveyed farmers have provided information on total yield of each crop at the individual farm level, and price per maund of each crop. Data on various inputs (water, fertilizer, man days) have been collected on a per acre basis, and cropped area at the farm level.

Among the independent variables, area (A) is represented by the total area under the ith crop. F is the fertilizer variable. It aggregates all types of fertilizers used on per acre area. Total fertilizer input at the farm level has been obtained by multiplying the per cropped acre fertilizer nutrient in kilograms with area under the said crop. In the irrigated area
fertilizer is widely used and is an important input, while the use of fertilizer is zero in the un-irrigated (barani or rod kohi) area.

Farm labor is an important input in the production function. Data on labor (L) have been collected in man days on a per acre basis for each crop. The appropriate measure of labor input is obtained by breaking down farm labor into its main activities, i.e. ploughing, irrigating, hoeing, sowing, harvesting and threshing. The first three are performed mainly by family labor. Hired labor is used for the last three activities. Labor input is not differentiated into skilled or unskilled. In our estimation of the production function, we include the number of adult male family workers on the farm as the measure of labor input. This is the only reliable measure of labor available in the data in our selected villages. Data on irrigation is collected from the surveyed farmers in number of irrigations per cropped acre. One irrigation on average equals 3 acre inches of water. Total irrigation input in acre inches at the farm level is obtained by multiplying the number of irrigation per acre with 3, and then multiplying the data in inches with total cropped area at the farm level (Sahibzada, 2002).

Irrigation is very important and crucial input in the production function. Measure of irrigation used is acre feet of water available per crop in the production function.

Another important determinant of agricultural productivity is level of education of the farmers. $E$ in the model is the input of highest level of education of the farmers.

The collected data were analyzed in Statistical Package for Social Sciences (SPSS) using various statistical tests and other econometric models.
3.4.1 Paired-sample t-test

In order to compare per acre yields of crops, area under cultivation, cropping intensity, land use intensity, cropping patterns, income, consumption, and savings before and after CRBC a paired sample t-test was used which is given as follows:

\[
    t = \frac{(\bar{X}_1 - \bar{X}_2) - d_0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}
\]

Where \(\bar{X}_1\) = mean value after the CRBC, \(\bar{X}_2\) = mean value before the CRBC, \(d_0\) = mean of the difference between paired observations, \(S_i^2\) = sub-sample variance and \(n_i\) = sub-sample size (Walpole, 1982).

3.4.2 Chi-Square Test

Similarly, a chi-square test was also used to find out association between various attributes with the help of cross-tabulations.

3.4.3 Dummy Variable Approach

An easy way to analyze the impact of CRBC on crop yields, area under-cultivation, cropping intensity, land use intensity, household income, saving and consumption is to use the dummy variable approach of the following form.

\[
    Y_i = \beta_0 + \beta_1 D_i + \epsilon_i
\]

Where \(Y_i\) is the average value of the variable, \(\beta_0\) is the vertical intercept and \(D_i\) is the dummy variable assuming value equal to unity for post-CRBC scenario and zero
otherwise, and $\varepsilon$ is the stochastic error term. If $\beta_1$ is significant then it implies that CRBC has significant impact on the average value of the variable under consideration.

3.5 Limitations of the study and Data

The main limitation of the study is that it was conducted only in the Stage II of the command area of CRBC. Because of time and financial constraints the entire command area of the CRBC could not be included in the present study. Similarly, within the Stage II, only five villages are taken as the target population from which the sample respondents were interviewed. Most of the farmers of study area were uneducated and they had not kept any record of their production, yields, costs, income, consumption, saving. Thus, the data collected may not be perfectly accurate. However, they were very cooperative and they provided reliable data based on their memories. After applying various statistical tests and econometric models, it was found out that the impact of CRBC was very significant in enhancing agricultural productivity and poverty alleviation.
CHAPTER IV
GENERAL DESCRIPTIVE ANALYSIS
OF THE STUDY AREA

4.1 Introduction

This chapter presents the socio-economic and agricultural features of the study area.
Historical background of D.I. Khan is given in section 4.2. This is followed by the
historical examination of the CRBIP in section 4.3. Other socio-economic features of the
area are explained in section 4.4.

4.2 Historical Background of D.I. Khan

The original settlers in the Dera Ismail Khan area were Jats, an Indian agricultural caste,
who continue to live in the district today. The first group of outsiders who settled on the
plains (daman) was Lodhi Pukhtun tribesmen who arrived by way of the western
Suleiman Mountains in the early 13th century. The next important group of settlers was
Baluch from the south that came in the employ of the rulers of Multan, across the Indus.
In 1480, two major Rind tribe founded the Deras that bear their names today. Their clan
ruled in the area for the next 300 years until the Durrani rulers of Afghanistan deposed
them.

The Lohani Pushtuns, a branch of the Lodhis and nomads (Powindahs) who were also
traders, migrated to the area from Ghazni in Afghanistan in the 16th century. Among them
were Marwats, Daulat Khles and Mian Khels who continue to have prominence in the
district today. In the early 17th century the Daulat Khels (the tribe of the Nawab of Tank)
quarreled with the Marwats and Mian Khels and assisted by the Gandapurs, a tribe of Ushtarani Saiyads, drove them out of Tank to such places as Paniala, Musa Khel and Daraban where they are living today. Other Pushtun tribes of note who subsequently settled in the area were the Shiranis and Bhittanis who live in the two frontier regions that border the district.

Following Durrani rule, the area experienced a period of independence under the Saddozai Pushtuns, Tribal relations of the ruling Afghanistan, until the Sikhs imposed their authority briefly, prior to the establishment of British rule in 1849. By the early 19th century, the broad pattern of settlement in the area which persists to the present time had taken shape. As the Gazetteer remarks: “After annexation (1849) the Districts of the Province were to a large extent colonized by settlers from the tribal territories beyond the border and from Afghanistan. The stream of immigration from these sources is now weakens the descendants of the first settlers having occupied most of the cultivable area” (Imperial Gazetteer (1907)).

Thus, the Pushtuns owned large tracts of land and were the dominant social group; the Baluch and the Jats had smaller holdings and many, sharecroppers. More recently, since the end of the British period, Mahsud and Wazir tribesmen from the Waziristan border area began to move into the area and buy land, a trend that continues today.
4.3 Historical Examination of CRBIP

The Chashma Right Bank Irrigation Project (CRBIP) lies on the right or west bank of the River Indus between the barrages of Chashma and Taunsa in the Districts of Dera Ismail Khan (North West Frontier Province – NWFP) and Taunsa (Punajab Province).

The CRBIP lies partly on recent alluvial landforms of the River Indus, and partly on piedmont alluvial plains derived from the hills of Waziristan to the west. The project is based on the supply of irrigation from the Chashma Right Bank Canal (CRBC) headworks located on the River Indus at the Chashma Barrage.

Development of irrigation on the right bank of the Indus began in 1902 with the construction of the old Parharpur Canal which diverted water from the run of the river to what is now essentially Stage I. Then in 1970, work on the Chashma Barrage was initiated and it became operational in 1972. After commissioning the Chashma Barrage, the Government of Pakistan placed increased importance on the development of irrigation facilities on the right bank of the Indus River and, in 1973, a PC-I was prepared which laid out the details and budget for CRBIP. The construction of the main canal commenced in 1978 with financial assistance from the Asian Development Bank (ADB), but it was soon thereafter interrupted due to serious underestimates of costs. The PC-I was revised in 1981 to reduce the scope, introduce more cost effective methods and spread implementation of the project over three stages. Eventually, the work recommenced and Kreditanstalt fur Wiederaufbau (KfW) later joined the ADB as a major financier of the project.
The project was conceived to achieve two purposes:

1. To provide a sustainable irrigation system and sustainable associated farming systems obtaining increased crop production on 570,000 acres of land; and
2. To accelerate growth by increasing productivity, diversifying production, increasing employment and strengthening institutional support.

The goals of the project are of a higher order and represent those things to which the project ultimately hopes to contribute, they are: Socio-economic development, Sustained growth with improved income distribution, and poverty alleviation.

As mentioned earlier, the CRBIP was initiated beginning in 1978, but the major construction effort in Stage I, covering 84 km of main canal from RD 0 to RD 260, was started in 1984. Stage I consisted of rehabilitation of the old Parharpur Canal and construction of a new main canal, 13 distributaries of 237 km length, and 838 watercourses of about 1,513 km length to serve 150,000 acres cultivable command area (CCA). The main canal was commissioned in February 1987, but the full water delivery network was completed in 1989.

The Stage II construction started in 1988 from RD 260 to RD 380 and was completed in 1995. It provided 36 km of main canal, 15 distributaries canals of 169 km length, 552 watercourses of about 1,052 km length, and branch and main surface drains for 94,000 acres.

The Stage III runs from RD 380 to RD 851 and consists of 144 km of main canal, 36 distributaries and minors totaling about 500 km in length, 1,450 watercourses of about
2,750 km length, and drainage works. Stage III is being constructed in three contracted areas – 66, 67 and 68 – and has a command area of about 326,000 acres. The Stage III has now been completed recently (PIME, 2001).

4.4 DESCRIPTION OF THE PROJECT AREA

4.4.1 General

Agriculture is the dominant economic activity of the study area. More than 85 percent of the population is involved in agricultural and allied sectors. It has always been the main objective of Government policy to develop agriculture and, towards this end, irrigation water supply and drainage have received the highest priority in the development plans of this area.

There are vast tracts of potentially productive lands on the Right Bank of Indus River in the D.I. Khan and D.G. Khan plains which are lying uncultivated. These lands have remained barren through centuries because they had no source of water available. A few perennial streams that debouch in these plains emanate from the Suleiman range of mountains which receive only meager rainfall and no significant snowfall. These streams bring limited quantity of perennial water, the largest of which is Gomal River (100 cusecs); the smallest being Chowdwan Zam (30 cusecs). Down towards south in the Taunsa Tehsil of D.G Khan District, the situation is similar (Sheladia Associates, Inc. 2001).
Besides these streams, there are numerous flood channels traversing the lands between the Suleiman range and Indus River. At times they bring large volume of floods which cause extensive erosion. The inhabitants of the areas have acquired skill in the utilization of flood flows. The Paharpur Canal and Massu Wah inundation canal irrigates small strips of the vast D I Khan and D G Khan plains.

After independence, the extremely limited groundwater potential close to the banks of the river was tapped in parts of D I Khan District. South of D. I. Khan proper, even this limited potential vanishes an in entire Taunsa and southern part of D.I. Khan only a few tube wells were installed to cope with deficient water requirements.

### 4.4.2 Area and Population

Between Indus Rive and the Suleiman range (area relevant to the Project) a total of 2.14 million acres of land is available. About 800,000 acres is cultivated, out of which 177,000 acres receive water from the canals of Paharpur and Massu Wah and the tube wells installed. The balance of 623,000 acres is cultivated through *barani* (rainfed) farming and flood irrigation, where cultivation depends on the vagaries of rains. Precipitation is insufficient during the greater part of the year. The seasonal variation in rainfall and consequent shortage of soil moisture results in severally limited crop production and types of crops grown. Even in a good year as much as 50 percent of the crops fail.

The total population of project area, according to 1998 Census is about 860,000 persons. (494,000 in D.I. Khan Tehsil and 366,000 in Taunsa Tehsil). Projecting population growth at an average rate of 3 % per annum, population in the project area for 2000
works out as 911,600 persons, 635,000 persons in D.I. Khan and 365,000 persons in D.G. Khan.

The main occupation of inhabitants is agriculture. Handicrafts on small scale as cottage industries are also prominent being practiced in D.I. Khan. Labour that does not find any job in the project area is exported outside, within and outside the country. The agricultural production of the area is perhaps one of the lowest in the country and failures of the order of 54% of the area sown in Kharif and 62% of the area sown in Rabi. Under such conditions, it is natural that the per capita income in this part of Pakistan is much below the, average. The agricultural production has remained static for the past many years and the pressure of population has mounted. Means have, therefore, to be found to increase production in this area. The project area is served by road and air. Black top metalled roads connect the area with Bannu and Tank in the North and with D. G. Khan in the South.

4.4.3 Physiography

Physiographically the Tehsils of D.I.Khan and Taunsa (D.G. Khan District) are vast alluvial plain, sloping at the rate of about 5 feet to a mile from the foot of the Suleiman Range towards River Indus, the slope being steeper in the sub-mountainous vicinity. In the sub mountainous region the plain consists of sand out wash merging itself into the vast piedmont plain. There are scattered sand dunes and gravel fans in the vicinity of northern and western hill. Generally the soil of the plains is free of drainage but some of the areas are of heavy composition with limited internal drainage. The water table in the
immediate vicinity of the river bank is about 6 ft below the surface. The depth to the ground water increases to about 30 ft in the northern and western parts of the area.

4.4.4 Climate

The climate of the area can be described as arid and hot. The average annual rainfall does not exceed 10 inches while daily maximum temperatures exceed 100°F. The precipitation is almost uniform geographically but it varies drastically during seasons from year to year. Summer monsoon brings in most of the rainfall and the peak is in July. Average humidity is higher in July–August whereas it is low during November–January. Humidity generally varies from as low of 40% to as high of 70%. Evaporation from free surface varies from high to moderate with seasons and ranges from 55 inches to 65 inches.

4.4.5 Irrigation

Due to low precipitation and high evaporation, there is a scarcity of water across the project area. Storage dam sites in the Suleiman range to the west of the command were investigated and it was found that potential storage capacity is small compared with the command area to be irrigated. The flood plain area is underlain by good quality groundwater at depths up to 10 feet and is currently being utilized in some areas by private tubewell development. The main source of supplemental water for the proposed project is Indus River.

Chashma Barrage at the head of the CRBC command area became operational in 1972; there was an adhoc interprovincial agreement that up to 5,000 cusecs could be diverted
through the existing head regulator at this barrage for the CRBC Project. But now releases will be in accordance with Water Apportionment Accord on 10 daily bases.

Project area in D.I. Khan was commanded by the Pharpur Canal up to 19%, an irrigation system originally constructed in the early 1900’s and subsequently upgraded. This scheme used to draw water from the Chashma Barrage, but the water duty available was inadequate to meet projected crop water requirements Pharpur canal system required remodeling for increase in its capacity.

With the completion of Stage I in December 1986, the Pharpur Canal has also been remodeled and connected to CRBC through link feeders at appropriate locations to receive adequate irrigation supplies to achieve the target irrigation intensity of 150 percent. In addition, Distributaries, in Stage I (05 Nos.) and in Stage II (15 Nos.) were also completed and commissioned for commanding an area of 140,000 and 90,000 acres in respective stage.

The irrigation mostly depends on hill torrents which are controlled by the Deputy Commissioner/Collector/ District Coordination Officer (DCO). The system known as Rod Kohi Irrigation system is governed over a century old kuliyat and Rewajat, meticulously worked out. About hundred years back the then Deputy Commissioner, D. I. Khan, Mr. Gee planned an inundation canal from the Bilot creek to ensure regular irrigation for the area. The extension of this creek was named as Paharpur canal which started its operation in 1907. However, it remained a seasonal canal and became a full-fledged perennial canal in 1970 with the completion of headwork of Chashma barrage. The construction of two stages of Chashma Right Bank Canal has provided an additional
236000 acres with canal water. The stage III of the gravity canal will extend this facility to another 1,14000 acres of land.

4.4.6 Agriculture

The major crops of the district are wheat, grams, barley, tara mira, mustard, rapeseed, jowar and millet in the Rod Kohi/barrani areas. Rice and sugarcane cultivation has increased during the last three decades and is averaging good yield. Melon, once the most famous and paying crop of the “Daman” tract in general and Kulachi lands in particular have over the years suffered greatly due to the melon fly attack. Detail of acreage and production of some major crops grown in the district for the year 1998-99 is given in Table 4.1.
Table 4.1 Acreage and Production of Major Crops in D.I. Khan District

<table>
<thead>
<tr>
<th>Crop</th>
<th>Areas in hectares</th>
<th>Production in tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
<td>Un-Irrigated</td>
</tr>
<tr>
<td>Kharif</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>1107</td>
<td>31</td>
</tr>
<tr>
<td>Rice</td>
<td>9304</td>
<td></td>
</tr>
<tr>
<td>Jowar</td>
<td>659</td>
<td>1545</td>
</tr>
<tr>
<td>Bajra</td>
<td>232</td>
<td>537</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>8665</td>
<td>-</td>
</tr>
<tr>
<td>Cotton</td>
<td>341</td>
<td>4</td>
</tr>
<tr>
<td>Mung</td>
<td>1953</td>
<td>457</td>
</tr>
<tr>
<td>Rabi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>33949</td>
<td>15261</td>
</tr>
<tr>
<td>Gram</td>
<td>5004</td>
<td>16166</td>
</tr>
<tr>
<td>Barley</td>
<td>509</td>
<td>211</td>
</tr>
</tbody>
</table>

Source: Govt. of Pakistan (1999).

4.4.7 Forestry

The entire area of the district is culturable with the exception of the northern mountain range of Koh-e-Surkh and the deep cut ravines of the hill torrents. This area comes to over 50 percent of the total culturable area of the province. The soil is mostly made of the alluvial silt brought by these hill torrents and is the most fertile soil of the country, which is suitable for cultivation of all types of crops and orchards.
CHAPTER V

DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE HOUSEHOLDS

5.1 Introduction

This chapter describes selected demographic and socio-economic characteristics of sample households and farms. Literacy status is given in section 5.2. Section 5.3 highlights sample respondent age. Household monthly income is given in section 5.4. Size of households and farm size are discussed in section 5.5 and 5.6 respectively. Section 5.7 gives land tenure system and followed by fragmentation of land in section 5.8. Section 5.9 describes sample farmers distinguished by tribe. Cropping pattern in irrigated and un-irrigated villages is given in section 5.10.

5.2 Literacy Status of Sample Respondents

Human resource development plays an important role in economic development. Literacy and education enable farmers to increase agricultural productivity by better management of other resources. It is widely believed that literate farmers have usually higher crop yields than illiterate farmers. The data in Table 5.1 indicate distribution of sample respondents by literacy status in the study area.
Table 5.1 Sample Respondents Distinguished by Literacy Status

<table>
<thead>
<tr>
<th>Village</th>
<th>No. of Literate</th>
<th>No. of Illiterate</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>11</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Kurai</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>9</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>16</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>8</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Zandani</td>
<td>7</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>All</td>
<td>71 (51%)</td>
<td>68 (49%)</td>
<td>139 (100%)</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

The data show that 51 percent of the respondents were literate as compared to 49 who were illiterate. Although there is no much variation in literacy status across village, but it is evident that in irrigated area the ratio of literate farmers is higher (54 %) than in un-irrigated villages (42 %). It could be because of the reason that in irrigated areas the household income may be higher than in un-irrigated areas and that literacy is positively affected by household income.

5.3 Distribution of Sample Respondents by Age

Like education, Age of economic agents have an important bearing upon productivity. It is expected that age and experience are positively correlated up to certain extent and an inverse correlation may emerge thereafter. Distribution of sample respondents is given in Table 5.2. Majority (60 %) of the sample respondents are up to 45 years of age and 40 % are above 45 years of age.
Table 5.2 Sample Respondents Distinguished by Age

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>No. of Respondents</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>25-35</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>35-45</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>45-55</td>
<td>42</td>
<td>30</td>
</tr>
<tr>
<td>55 and above</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>All</td>
<td>139</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

5.4 Average Monthly Income of Sample Households

Table 5.3 shows the distribution of sample households by income group in the study area. The data show that majority of the households (71 %) fall in income group of up to Rs. 20,000 per annum. Only 15 % and 14 % of the sample households fall in income group of Rs. 20,000-30,000 and Rs. 30,000 and above. This implies that majority of the people in the area still live below and close to poverty line.

Table 5.3 Sample Households Distinguished by Income Groups

<table>
<thead>
<tr>
<th>Income Group</th>
<th>No. of Households</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Rs. 10,000</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>Rs. 10,000-20,000</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>Rs. 20,000-30,000</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Rs. 30,000-50,000</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Rs. 50,000 and above</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>All</td>
<td>139</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

5.5 Size of Sample Households

Household size may affect the supply of owned labour involved in farming activities. Table 5.4 classifies sample households by size. On the whole, majority (60.5 %) of the
households consists of more than 10 members. No significant variation in households falling in different sizes was found in the sample villages.

Table 5.4 Sample Households Distinguished by Size

<table>
<thead>
<tr>
<th>Village</th>
<th>≤5</th>
<th>5-10</th>
<th>10-15</th>
<th>≥15</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Kurai</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>2</td>
<td>12</td>
<td>15</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Zandani</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>All</td>
<td>16 (11.5%)</td>
<td>39 (28%)</td>
<td>61 (44%)</td>
<td>23 (16.5%)</td>
<td>139 (100)</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

5.6 Farm Size and Land Distribution

Farm size and farm area operated play an important role in agricultural productivity. There is disagreement among researcher regarding farm size and productivity. What is an optimal size of farm depends upon many different factors. It may vary from situation to situation. Regarding farm size and distribution of farm area, the data in Table 5.5 show that as many as 34 percent of the sample households had, on the average, farm size of less than 6 acres and accounted for 18 % of the farm area. Majority (72 %) of the farm households had less then or up to 20 acres of land and accounted for 61 percent of the farm area. Only few (5 %) of the households had farm size of 50 acres and above. However, this group had 20 % of the total land.
Table 5.5 Farm Size and Land Distribution in the Study Area

<table>
<thead>
<tr>
<th>Farm Size Categories (acres)</th>
<th>No. of Households</th>
<th>Farm Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6</td>
<td>47 (34 %)</td>
<td>18</td>
</tr>
<tr>
<td>6-20</td>
<td>67 (48 %)</td>
<td>43</td>
</tr>
<tr>
<td>20-50</td>
<td>18 (13 %)</td>
<td>19</td>
</tr>
<tr>
<td>50 and above</td>
<td>7 (5 %)</td>
<td>20</td>
</tr>
<tr>
<td>All</td>
<td>139 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

The information given in Table 5.6 indicates average farm area and percent of farms having area below 25 acres in the sample villages and the study area. The average farm size in the study area was 27 acres. The average farm size in irrigated areas (first five villages) was less (25 acres) than in un-irrigated (last two villages) area (32.5 acres). On the whole, 75 % of the farms had land area up to 25 acres.

Table 5.6 Sample Households Distinguished by Size of Landholdings

<table>
<thead>
<tr>
<th>Village</th>
<th>Average Farm Size</th>
<th>Percent of Farms Less than 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>24.7</td>
<td>80.6</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>28.3</td>
<td>83.2</td>
</tr>
<tr>
<td>Kurai</td>
<td>21.6</td>
<td>77.8</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>25.2</td>
<td>79.6</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>24.8</td>
<td>80.7</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>34.2</td>
<td>63.7</td>
</tr>
<tr>
<td>Zandani</td>
<td>30.8</td>
<td>60.4</td>
</tr>
<tr>
<td>All</td>
<td>27</td>
<td>75.1</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

5.7 Land Tenure of the Sample Households

There were three different types of land tenure system in the study area. A vast majority (74 %) of the sample farmers were owners, 14 % owner-cum-tenant and 12 percent pure tenants or sharecroppers. The distribution of sample households, as given in Table 5.7, is
in line with the distribution of farmers by tenure at the district level. Owner cultivators are usually expected to have higher crop yields than pure tenants as the latter have insecurity regarding using of land. Keeping in view uncertainty and risk, the tenants may not invest more in land development. However, comparison between crop yields of owners and tenants may point out important implications for policy makers.

<table>
<thead>
<tr>
<th>Tenure</th>
<th>No. of Households</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owners</td>
<td>103</td>
<td>74</td>
</tr>
<tr>
<td>Owner-cum-tenant</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Tenants</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>All</td>
<td>139</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

5.8 Fragmentation of Land

Sub-division and fragmentation of farmland is a serious problem of our agriculture. This leads to decrease in farm productivity and minimizes the adoption of improved farm technology. Regarding fragments on sample farms by farm size in the study area, Table 5.8 shows that more than seventy five percents of sample farms were fragmented in 5 or more parcels. Similarly, 15 % had two parcels and 6.5 % were in only parcel. Further details may be seen in Table 5.8.
### Table 5.8 No. of Fragments on Sample Farms by Farm Size in the Study area

<table>
<thead>
<tr>
<th>Farm Size Categories (acres)</th>
<th>1</th>
<th>2-4</th>
<th>5-7</th>
<th>7-10</th>
<th>10 or more</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6</td>
<td>3</td>
<td>7</td>
<td>25</td>
<td>8</td>
<td>4</td>
<td>47</td>
</tr>
<tr>
<td>6-20</td>
<td>4</td>
<td>8.7</td>
<td>37</td>
<td>11.6</td>
<td>5.7</td>
<td>67</td>
</tr>
<tr>
<td>20-50</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>50 and above</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>All</td>
<td>9</td>
<td>20.7</td>
<td>74</td>
<td>23.6</td>
<td>11.7</td>
<td>139 (100)%</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

### 5.9 Distribution of Sample Households by Tribes

The study area has many different tribes. Majority (73%) of the sample households belong to *Jat*. Some (16%) of the households are *Balouch*, *Syed*, *Wazir*, *Awan*, and *Marwat* account for 2.9%, 2.2%, 0.7%, respectively. Thus the study area is dominated by *Jats* and *Balouchs*. The Number and percentage of different tribes living in the study area is given in Table 5.9.

### Table 5.9 Number and Percentage of Sample Households by Tribes

<table>
<thead>
<tr>
<th>Tribe</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jat</td>
<td>101</td>
<td>72.7</td>
</tr>
<tr>
<td>Balouch</td>
<td>22</td>
<td>15.8</td>
</tr>
<tr>
<td>Syed</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>Wazir</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Awan</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Marwat</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>5.0</td>
</tr>
<tr>
<td>All</td>
<td>139</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Survey (2004)
5.10 Cropping Pattern on Sample Farms

Like other parts of the country, there are two crop seasons in D.I. Khan. In the irrigated villages major crops grown during *kharif* are rice grown on 42% land area, sugarcane (39%), mung (9%), maize (5%), jowar, bajra, and cotton 5.5%. On the other hand, in un-irrigated villages in the study area, only jowar, bajra, cotton, maize and mung are grown. In the *rabi* season, wheat, gram (chickpea) and barley are the main crops in irrigated villages where 86 % of the farm area is cultivated to wheat. In un-irrigated villages almost half of the land is sown to wheat (48%) and gram (51%). Only little (0.66%) is allocated for barley cultivation. Table 5.10 gives details of cropping pattern on irrigated and un-irrigated sample farms in the study area.

**Table 5.10 Cropping Pattern of Sample Households on Irrigated and Un-irrigated Farms**

<table>
<thead>
<tr>
<th>Crop</th>
<th><em>Kharif</em></th>
<th>Irrigated</th>
<th>Un-irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>4.97</td>
<td>100</td>
<td>1.20</td>
</tr>
<tr>
<td>Rice</td>
<td>41.79</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Jowar</td>
<td>2.96</td>
<td>100</td>
<td>60.04</td>
</tr>
<tr>
<td>Bajra</td>
<td>1.06</td>
<td>100</td>
<td>20.86</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>38.92</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.53</td>
<td>100</td>
<td>0.15</td>
</tr>
<tr>
<td>Mung</td>
<td>8.77</td>
<td>100</td>
<td>17.75</td>
</tr>
<tr>
<td><em>Rabi</em></td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Wheat</td>
<td>86.02</td>
<td>100</td>
<td>48.24</td>
</tr>
<tr>
<td>Gram</td>
<td>12.7</td>
<td>100</td>
<td>51.10</td>
</tr>
<tr>
<td>Barley</td>
<td>1.30</td>
<td>100</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Source: Survey (2004)
6.1 Introduction

This chapter presents main findings of the study. In section 6.2 area under cultivation by sample farmers before and after CRBC are compared. Section 6.3 compares cropping intensity before and after CRBC. Section 6.4 compares crop yields in the study area before and after CRBC. Section 6.5 presents regression results of crop yield estimation. Impact of CRBC on livestock keeping is discussed in section 6.6. Section 6.7 gives a comparison of household income, consumption and saving before and after the CRBC. Section 6.8 compares with and without mean values in the study area. Section 6.9 shows the impact of CRBC on education as well health status in the study area. Section 6.10 explains the impact of CRBC on employment. The link between CRBC and poverty alleviation is discussed in section 6.11. Section 6.12 tests of hypotheses.

6.2 Impact of CRBC on Area under cultivation

The data in Table 6.1 show that area under cultivation has grown manifold due to the construction of CRBC. The table reveals that in five villages the area under cultivation has increased significantly because these five villages are located under CRBC Command area whereas the area cultivated has more or less remained stagnant in the two villages (Gara Jamal and Zindani).
## Table 6.1 Comparison of Area under cultivation in the Study Area (Acres)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>235</td>
<td>460</td>
<td>2.45**</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>189</td>
<td>509</td>
<td>3.16*</td>
</tr>
<tr>
<td>Kurai</td>
<td>190</td>
<td>432</td>
<td>2.10**</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>220</td>
<td>403</td>
<td>2.31**</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>253</td>
<td>768</td>
<td>4.29*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>207.4</td>
<td>215.8</td>
<td>1.60</td>
</tr>
<tr>
<td>Zandani</td>
<td>249.3</td>
<td>254.4</td>
<td>1.47</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** show statistical significance at 1% and 5%, respectively. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

A dummy variable approach also confirmed the above results. The estimated equation is given as under:

\[
Y_1 = 298.24 + 136.36 \, D_1
\]

\[
(12.9) \, (3.15)
\]

\[R^2 = 0.53\]

Where \(Y_1\) is area under cultivation, \(D_1\) is dummy variable for post-CRBC scenario.

Figures in parentheses are t-ratios. The equation indicates that area under cultivation has significantly increased after CRBC.
6.3 Impact of CRBC on Cropping Intensity

The construction of CRBC has not only led to expansion of area under cultivation but also increased cropping intensity in the study area. The cropping intensity in the five villages has increased because of supply of irrigation water due to CRBC. This is so because the availability of irrigation water has made it possible to crop the cultivated area twice in a year. But the cropping intensity in the two unirrigated villages has been stagnant. Table 6.2 gives detail of such information.

Table 6.2 Comparison of Cropping Intensity in the Study Area

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>56%</td>
<td>80%</td>
<td>2.35**</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>50%</td>
<td>90%</td>
<td>3.12*</td>
</tr>
<tr>
<td>Kurai</td>
<td>51%</td>
<td>84%</td>
<td>2.33**</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>55%</td>
<td>79%</td>
<td>2.31**</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>45%</td>
<td>90%</td>
<td>3.29*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>50%</td>
<td>52%</td>
<td>1.70</td>
</tr>
<tr>
<td>Zandani</td>
<td>48%</td>
<td>49%</td>
<td>1.57</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** show statistical significance at 1% and 5%, respectively. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.
6.4 Impact of CRBC on Crop Yields

Wheat: Wheat being a staple food crop and requiring a relatively easy production technology is grown almost consistently in all sample villages. Table 6.3 gives a comparison of wheat yield before and after CRBC. The data show that there has been a significant increase in wheat yield in the villages which are located in the CRBC command area. However, there has been no significant change in wheat yield in those villages which fall outside the CRBC command area. The results are supported by the t-statistics.

Table 6.3 Comparison of Wheat Yield in the Study Area (kgs/Acre)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>240</td>
<td>1835</td>
<td>3.45*</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>256</td>
<td>1827</td>
<td>3.12*</td>
</tr>
<tr>
<td>Kurai</td>
<td>260</td>
<td>1890</td>
<td>4.12*</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>263</td>
<td>1870</td>
<td>3.45*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>253</td>
<td>1790</td>
<td>3.29*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>259</td>
<td>280</td>
<td>1.80</td>
</tr>
<tr>
<td>Zandani</td>
<td>260</td>
<td>275</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * shows statistical significance at 1% level. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

A dummy variable approach also used to wheat yield data and it confirmed the results in Table 6.3. The estimated equation is given as under:
$$Y_w = 255.85 + 1139.78 \ D_1$$

\[(6.8) \quad (3.10)\]

$$R^2 = 0.482$$

Where $Y_w$ is wheat yield. $D_1$ is dummy variable for post-CRBC scenario. Figures in parentheses are t-ratios and indicate that wheat yield has significantly increased after CRBC.

**Gram:** Gram is the second most important crop of CRBC in rabi season. Gram is used by farmers of the area in many different forms. The gram yield has also increased in the study area. Although the gram crop does not need much water but still availability of irrigation water has increased gram yield. The Table 6.4 compares gram yields before and after the construction of CRBC.

**Table 6.4 Comparison of Gram Yield in the Study Area (kgs/Acres)**

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>220</td>
<td>1080</td>
<td>3.47*</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>224</td>
<td>1075</td>
<td>3.14*</td>
</tr>
<tr>
<td>Kurai</td>
<td>218</td>
<td>1069</td>
<td>4.16*</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>225</td>
<td>1070</td>
<td>3.45*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>230</td>
<td>1069</td>
<td>3.29*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>216</td>
<td>224</td>
<td>1.59</td>
</tr>
<tr>
<td>Zandani</td>
<td>218</td>
<td>226</td>
<td>1.43</td>
</tr>
</tbody>
</table>

Source: Survey (2004)
Note: * shows statistical significance at 1% level. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of the villages are situated in CRBC command area. A dummy variable approach also used to gram yield data and it confirmed the results in Table 6.4. The estimated equation is given as under:

\[ Y_g = 221.57 + 608.85 D_1 \]

(3.8) (4.16)

\[ R^2 = 0.41 \]

Where \( Y_g \) is gram yield. \( D_1 \) is dummy variable for post-CRBC scenario. Figures in parentheses are t-ratios and indicate that gram yield has significantly increased after CRBC.

**Sugarcane:** Sugarcane has become an important cash crop of the study area which contributes significantly to the household income. Before the construction of CRBC sugarcane crop was not cultivated in the study area because the sugarcane crop can’t be grown without water. But after the CRBC, it is now grown in the command area and the yield data have been given for the five villages as sugarcane crop is not cultivated in unirrigated villages. This shows that the impact of CRBC has been significant in case of sugarcane.
Table 6.5 Comparison of Sugarcane Yield in the Study Area (kgs/Acres)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>-</td>
<td>38014</td>
<td>-</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>-</td>
<td>37990</td>
<td>-</td>
</tr>
<tr>
<td>Kurai</td>
<td>-</td>
<td>38009</td>
<td>-</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>-</td>
<td>38012</td>
<td>-</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>-</td>
<td>37989</td>
<td>-</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zandani</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * shows statistical significance at 1% level. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

**Rice:** Rice has become a major kharif crop, after wheat and sugarcane. It occupies the largest area. It is another high water use crop after sugarcane. This crop was not grown in the study area before CRBC. But now it is an important food staple as well as cash crop for the people of the area. Table 6.6 shows the rice yield in the study area.
Table 6.6 Comparison of Rice Yield in the Study Area (kgs/Acres)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>-</td>
<td>3205</td>
<td>-</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>-</td>
<td>3212</td>
<td>-</td>
</tr>
<tr>
<td>Kurai</td>
<td>-</td>
<td>3215</td>
<td>-</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>-</td>
<td>2995</td>
<td>-</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>-</td>
<td>2985</td>
<td>-</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zandani</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Survey(2004)

Note: * shows statistical significance at 1% level. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

6.5 Estimated Results of Regression Models

The estimated regression equations are given in Table 6.7. The dependent variable in these models is crop yield. The independent variables include area under the crop, fertilizer, No. of irrigation, labour and education. The results indicate that almost all the independent variables significantly affect the yields of various crops. In case of wheat all explanatory variables except labour have statistically significant coefficients. The coefficient of irrigation is highly significant at 1% level. Similarly for gram crop all variables except fertilizer have statistically significant coefficients. This is because the gram does not need much fertilizer as compares to other crops. Coefficient of irrigation
variable is also significant for gram at 5%. Regarding sugarcane, all of the explanatory variables have statistically significant coefficients. However, the coefficient of irrigation is also significant at 1% level. In case of rice crop, all variables except education have significant coefficients. Like wheat and sugarcane, the coefficient of irrigation is also highly significant.

The above analysis indicates that irrigation is one of the most significant factors affecting crop yield. Its statistical significance shows that irrigation positively changes crop yield and this been possible due to the availability of irrigation water through the CRBC. Thus CRBC has played a very significant role in enhancing crop yield.
Table 6.7 Estimated Regression Equations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Gram</th>
<th>Sugarcane</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>45.6</td>
<td>38.6</td>
<td>2034.5</td>
<td>1825.4</td>
</tr>
<tr>
<td>Area under Crop</td>
<td>0.75*</td>
<td>0.34</td>
<td>1.18**</td>
<td>0.21*</td>
</tr>
<tr>
<td></td>
<td>(2.10)</td>
<td>(1.54)</td>
<td>(3.21)</td>
<td>(2.13)</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>1.67**</td>
<td>0.68</td>
<td>0.86**</td>
<td>0.9**</td>
</tr>
<tr>
<td></td>
<td>(2.64)</td>
<td>(1.54)</td>
<td>(3.24)</td>
<td>(2.65)</td>
</tr>
<tr>
<td>Irrigation Nos.</td>
<td>0.96**</td>
<td>0.67*</td>
<td>0.85**</td>
<td>0.96**</td>
</tr>
<tr>
<td></td>
<td>(4.10)</td>
<td>(2.05)</td>
<td>(3.15)</td>
<td>(3.64)</td>
</tr>
<tr>
<td>Education</td>
<td>0.45*</td>
<td>0.24*</td>
<td>0.45*</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(2.13)</td>
<td>(2.23)</td>
<td>(2.35)</td>
<td>(1.49)</td>
</tr>
<tr>
<td>Labour</td>
<td>0.43</td>
<td>0.32*</td>
<td>0.37*</td>
<td>0.34*</td>
</tr>
<tr>
<td></td>
<td>(1.63)</td>
<td>(2.43)</td>
<td>(2.25)</td>
<td>(2.12)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.45</td>
<td>0.39</td>
<td>0.47</td>
<td>0.38</td>
</tr>
<tr>
<td>No. of Observations</td>
<td>139</td>
<td>139</td>
<td>139</td>
<td>139</td>
</tr>
<tr>
<td>F. Stat</td>
<td>20.4</td>
<td>19.4</td>
<td>23.4</td>
<td>21.6</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are t-ratios. * and ** shows significance at 5% and 1%, respectively.

6.6 Impact of CRBC on Livestock Keeping

Agriculture is still the major economic activity of the area. The livestock sector contributes also to the local economy in the form of meat, milk, wool, hides and skins as
well as cash. Crop farming and livestock keeping are associated activities in the study area. The livestock activity has increased after the CRBC. Because the availability of water for irrigation has increased area under cultivation, cropping intensity as well as crop yields. This has led to local people to keep more livestock as there is ample amount of animal feed available now.

Livestock assumes a special position in agrarian settings such as that of D.I. Khan. In a non-monetized agriculture, animals supply not only livestock products but also are a major source of power for ploughing, irrigation (Persian Wheel), threshing and transportation of agricultural products. The number of landless farmers and purely livestock holders has been estimated at about 20% of the total farmers. They keep livestock mainly for their own purpose—milk, meat, and eggs for own consumption; dung for fuel and fertilizer; wool, skins and off-springs, as cash reserve, with some products sold in the market. The number of livestock indicates his wealth (Sheladia Associates, Inc., 2001). Table 6.8 compares the average number of livestock keeping per sample village before and after the CRBC.
Table 6.8 Comparison of Livestock Keeping Before and After in the Study Area

<table>
<thead>
<tr>
<th>Type of</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo</td>
<td>60</td>
<td>84</td>
<td>2.47*</td>
</tr>
<tr>
<td>Cattle</td>
<td>250</td>
<td>345</td>
<td>2.57*</td>
</tr>
<tr>
<td>Sheep</td>
<td>560</td>
<td>869</td>
<td>3.14**</td>
</tr>
<tr>
<td>Goat</td>
<td>573</td>
<td>983</td>
<td>4.16**</td>
</tr>
<tr>
<td>Camel</td>
<td>50</td>
<td>26</td>
<td>-3.45**</td>
</tr>
<tr>
<td>Donkey</td>
<td>55</td>
<td>68</td>
<td>2.29*</td>
</tr>
<tr>
<td>Horses</td>
<td>10</td>
<td>4</td>
<td>-2.59*</td>
</tr>
<tr>
<td>Poultry</td>
<td>2000</td>
<td>4589</td>
<td>4.43**</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** shows significance at 5% and 1%, respectively.

The data show that the number of buffalo, cattle, sheep, goats, donkeys and poultry have increased significantly. The population of horses and camel has gone down. According to the sample respondents the increase in livestock has enhanced household income and savings. The socioeconomic conditions of the people of the area have been improved after CRBC.

6.7 Impact of CRBC on Household Income

The availability and supply of irrigation water due to CRBC has not only increased area under cultivation’, cropping intensity, and crop yield; but it has also enhanced household income. Before the advent of CRBC there was no water available for irrigating farmer’s fields except rains and flood irrigation (Rod Kohi). Agricultural sector is mainly subject
to natural vagaries in general; in the study area it is relatively subject to more such calamities. Because the climate is harsh and there are less rains in the area. Thus, the CRBC has revolutionized the rural sector of the area.

The framers of the area were of the opinion that their family incomes have significantly increased due to the availability of irrigation water through CRBC. The data in Table 6.9 provide detail of household’s income before and after the CRBC scenario.

**Table 6.9 Comparison of Household Income Before and After CRBC(Rs)**

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>12754</td>
<td>50,565</td>
<td>4.53*</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>13562</td>
<td>55987</td>
<td>5.68*</td>
</tr>
<tr>
<td>Kurai</td>
<td>11645</td>
<td>65098</td>
<td>6.21*</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>13873</td>
<td>57865</td>
<td>3.21*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>15462</td>
<td>65748</td>
<td>6.34*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>10764</td>
<td>15985</td>
<td>2.12**</td>
</tr>
<tr>
<td>Zandani</td>
<td>12,986</td>
<td>15637</td>
<td>2.09**</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** show statistical significance at 1% and 5%, respectively. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

Table 6.9 shows that household monthly incomes in all of the sample villages have increased. However, incomes of those households who are beneficiaries of the CRBC have increased significantly. Keeping others things constant, the impact of CRBC on
household income has been phenomenal. This implies that CRBC has played an important role in the socio-economic development of the area.

A dummy variable approach is also used to household income data and it confirmed the results in Table 6.9. The estimated equation is given as under:

\[ Y_y = 13006.37 + 33691.28D_1 \]

\[ (15.2) \quad (13.8) \]

\[ R^2 = 0.49 \]

Where \( Y_y \) is households’ income and \( D_1 \) is dummy variable for post-CRBC scenario. Figures in parentheses are t-ratios and indicate that household’s income has significantly increased after CRBC.

Increase in households’ incomes has also led to increase in household consumption. The data in Table 6.10 shows that household consumption expenditures have increased more significantly in the sample villages which fall in the CRBC command area than those which fall outside the CRBC area. This is quite convincing to infer that CRBC plays an important role in the socioeconomic uplift of the area.
Table 6.10 Comparison of Household Consumption Before and After CRBC (Rs)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>12664</td>
<td>45,567</td>
<td>4.23*</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>13461</td>
<td>46,987</td>
<td>5.43*</td>
</tr>
<tr>
<td>Kurai</td>
<td>11535</td>
<td>55093</td>
<td>6.01*</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>13773</td>
<td>53865</td>
<td>3.11*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>15342</td>
<td>54748</td>
<td>6.31*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>10650</td>
<td>13,065</td>
<td>2.02**</td>
</tr>
<tr>
<td>Zandani</td>
<td>12,883</td>
<td>13,656</td>
<td>2.04**</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** show statistical significance at 1% and 5%, respectively. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

A dummy variable approach is also used to consumption expenditure data and it confirmed the results in Table 6.10. The estimated equation is given as under:

\[ Y_c = 12890 + 33691.28 \, D_1 \]

(12.2) \hspace{1cm} (8.6)

\[ R^2 = 0.47 \]

Where \( Y_c \) is consumption data and \( D_1 \) is dummy variable for post-CRBC scenario.

Figures in parentheses are t-ratios and indicate that household consumption expenditures have significantly increased after CRBC.

Saving is the difference between households’ income and their consumption expenditures. The impact of CRBC has almost been the same on household savings as on
their income and consumption. The saving of households have expanded more in the area irrigated by CRBC than that which is still unirrigated. Data in the Table 6.11 supports this claim.

Table 6.11 Comparison of Household Saving Before and After CRBC

(Rs)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>90</td>
<td>4,998</td>
<td>3.33*</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>101</td>
<td>9,000</td>
<td>4.23*</td>
</tr>
<tr>
<td>Kurai</td>
<td>110</td>
<td>10,005</td>
<td>5.01*</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>100</td>
<td>4,000</td>
<td>3.15*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>80</td>
<td>11,000</td>
<td>5.34*</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>114</td>
<td>2920</td>
<td>2.04**</td>
</tr>
<tr>
<td>Zandani</td>
<td>103</td>
<td>1981</td>
<td>2.01**</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** show statistical significance at 1% and 5%, respectively. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.

A dummy variable approach is also used to household saving data and it confirmed the results in Table 6.11. The estimated equation is given as under:

\[ Y_s = 99.71 + 6172.29 D_1 \]

(13.2) (4.53)

\[ R^2 = 0.41 \]
Where $Y_s$ is household savings and $D_1$ is dummy variable for post-CRBC scenario.

Figures in parentheses are t-ratios and indicate that household savings have significantly increased after CRBC.

6.8 With and Without Analysis

In addition to before and after analysis, we also performed with and without analysis by using t-test. With here refers to mean values in irrigated areas and without means mean value in un-irrigated villages of the study area. Table 6.12 compares area under cultivation, cropping intensity, crop yields, household income, consumption, and saving. The data show that area under cultivation, cropping intensity, wheat yield, gram yield\(^1\), household income, consumption and saving in CRBC command area are significantly higher than in area which falls outside CRBC command area.

---

\(^1\) We can not compare rice and sugarcane yield in with and without analysis as these crops are not cultivated in un-irrigated areas of the two villages.
Table 6.12 With and Without Comparison of Mean Values

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>With</th>
<th>Without</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under cultivation</td>
<td>514.4</td>
<td>235.1</td>
<td>4.5**</td>
</tr>
<tr>
<td>Cropping intensity</td>
<td>84.6</td>
<td>50.5</td>
<td>2.47*</td>
</tr>
<tr>
<td>Wheat Yield</td>
<td>1842.4</td>
<td>277.5</td>
<td>3.4**</td>
</tr>
<tr>
<td>Gram yield</td>
<td>1072.6</td>
<td>225</td>
<td>4.1**</td>
</tr>
<tr>
<td>Household Income</td>
<td>59052.6</td>
<td>15811</td>
<td>3.6**</td>
</tr>
<tr>
<td>Consumption</td>
<td>51252</td>
<td>13360.5</td>
<td>2.58*</td>
</tr>
<tr>
<td>Saving</td>
<td>7800.6</td>
<td>2450.5</td>
<td>3.4**</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** indicate significance at 5% and 1% level.

With and without analysis was also conducted by using dummy variable approach the detail of which is given in Table 6.13.
Table 6.13. With and Without Comparison using Dummy Variable Approach

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Constant</th>
<th>Coefficient (t-ratio)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under cultivation</td>
<td>235.1</td>
<td>514.4 (4.5**)</td>
<td>0.34</td>
</tr>
<tr>
<td>Cropping intensity</td>
<td>50.5</td>
<td>84.6 (2.47**)</td>
<td>0.36</td>
</tr>
<tr>
<td>Wheat Yield</td>
<td>277.5</td>
<td>1842.4 (3.4**)</td>
<td>0.42</td>
</tr>
<tr>
<td>Gram yield</td>
<td>225</td>
<td>1072.6 (4.1**)</td>
<td>0.34</td>
</tr>
<tr>
<td>Household Income</td>
<td>15811</td>
<td>59052.6 (3.6**)</td>
<td>0.43</td>
</tr>
<tr>
<td>Consumption</td>
<td>13360.5</td>
<td>51252 (2.58*)</td>
<td>0.37</td>
</tr>
<tr>
<td>Saving</td>
<td>2450.5</td>
<td>7800.6 (3.4**)</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * and ** indicate significance at 5% and 1% level.

The dummy variable approach shows that area under cultivation, cropping intensity, wheat yield, gram yield, household income, consumption and saving were significantly higher in villages in CRBC command area (with) than in villages outside CRBC command area (without).
6.9 Impact of CRBC on Education and Health Status

Education plays an important role in the development of a country. It leads to efficiency as well as potential of individuals to increase their earnings. Due to increase in crop yield and incomes the people of the area currently send children to schools more than before. The CRBC has also played a phenomenal role in enhancing education in the area. The date in Table 6.14 show that the proportion of household that send children to school after CRBC has increased. The chi-square value shows that there been a strong association between CRBC and households proportion that send children to school.

Table 6.14 No. of Households Sending Children to School Before and After CRBC (%)

<table>
<thead>
<tr>
<th>Village</th>
<th>Before CRBC</th>
<th>After CRBC</th>
<th>Chi-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>13</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>18</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Kurai</td>
<td>19</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>13</td>
<td>29</td>
<td>21.9*</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>15</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>14</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Zandani</td>
<td>17</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: * shows statistical significance at 5%. Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area. The sample respondents perceived that there has been an enormous increase in literacy rate after the CRBC. Table 6.15 gives information on the perceptions of sample
households’ heads regarding positive impact of CRBC on their education status. The data show that between 69-83% of households in the CRBC area hold positive views about the role of CRBC in providing education in their villages. The respondents outside the CRBC’s command area were also asked about their perception regarding CRBC role in this regard. They opined that although they did not benefit directly from the CRBC, their perception about CRBC’s role was very positive. This shows that the role of CRBC has been very important in expanding education in the area.

**Table 6.15 Sample Households Perception Regarding CRBC’s Role in Their Education (%)**

<table>
<thead>
<tr>
<th>Village</th>
<th>Positive Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>75</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>83</td>
</tr>
<tr>
<td>Kurai</td>
<td>69</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>78</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>80</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>62</td>
</tr>
<tr>
<td>Zandani</td>
<td>59</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: Gara Jamal and Zandani are outside the CRBC command area whereas the rest of the villages are situated in CRBC command area.

The sample respondents were also asked about the indirect effects of CRBC on the health status in the study area. The perception of the sample households was good in this regard. They reported that they could spend more on health related facilities than before. On
the one hand the, government has increased health facilities through hospitals, dispensarys and doctors. On the other hand, the people through increased incomes spend more on health by visiting even private clinics which are quite expensive than government hospitals. In addition, their education has also improved their awareness about health related issues. Table 6.16 shows households’ perceptions about the role of CRBC in health sector of the area.

Table 6.16 Sample Households Perception Regarding CRBC’s Role in Their Health Status (%)

<table>
<thead>
<tr>
<th>Village</th>
<th>Positive Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khutti</td>
<td>78</td>
</tr>
<tr>
<td>Gara Hayat</td>
<td>86</td>
</tr>
<tr>
<td>Kurai</td>
<td>76</td>
</tr>
<tr>
<td>Gomal Kalan</td>
<td>85</td>
</tr>
<tr>
<td>Draban Khurd</td>
<td>85</td>
</tr>
<tr>
<td>Gara Jamal</td>
<td>65</td>
</tr>
<tr>
<td>Zandani</td>
<td>63</td>
</tr>
</tbody>
</table>

Source: Survey (2004)

Note: Gara Jamal and Zandani are outside the CRBC command area whereas the rest of villages are situated in CRBC command area.
6.10 Impact of CRBC on Employment

Rural and urban employment enhances family income. Majority of the people of the area are employed in off-farm activities before the advent of CRBC. However, after the CRBC the on-farm as well off-farm employment opportunities have increased. Majority (80%) of the sample respondents reported that due to CRBC off-farm employment has increased in the study area. Similarly, 75% of the sample respondents indicated that off-farm employment opportunities have also improved.

Off-Farm Employment Patterns: While the vast majority of people of the area are employed in agriculture and related activities, considerable off-farm employment opportunities have developed as land has been brought under agricultural production as a result of the canal. Agro-processing has been developed significantly, and agro-inputs shops, agro-machinery, poultry production and bee keeping business have established. Markets for daily use commodities are now well established.

Commerce and trade opportunities for the whole study area have improved, stemming from increased production realized with the canal and the improved road access. Wheat, rice, sugar, straw products and by-products of sugar, dates, milk, meat, fish, pulses, gram and oil are the most attractive commodities for trading outside the project area, which will promote development of the entire area.

The main agro-based industries of the study area are sugar mill, rice mills, oil extraction mills, pulse mills, fishponds, poultry farms, textile mills, woodwork centers, seed markets, livestock and poultry markets (every Friday), gur markets, and daily fruit and vegetable markets. A majority of the people living in the study area have agro-business in livestock, fruits (date palm, mango, citrus), seeds, fish farming and vegetable etc.
Off farm employment will continue to play a vital role in overall development of the area. Some of the activities that are expected to increase: teaching in schools, rice mills laborers, flour mills laborers, shop keeping, stone crushing, brick kiln laborer, automotive and mechanical technicians, artisans of the different profession e.g. mason, carpenter, cook, tailors, and barbers etc.

An increase in these kinds of jobs permits a greater inflow of cash into the rural households. This helps to raise standards of living and promote the expectations that will create greater demand for services and manufacturing.

6.11 CRBC and Poverty Alleviation

Poverty is rampant in the study area but this study does not include the measurement of the poverty. In this study the relative poverty (before and after CRBC) has shown. A thorough examination of the previous sections indicates that the CRBC has reduced poverty in the area. In addition to increasing crop production and farm and family incomes, improved irrigation access contributed much to the poverty alleviation in the form of improved employment and livelihoods in the command area. Indirect benefits, such as more stable rural employment as well as higher rural wage rates help landless farm laborer to obtain much share from increased agricultural productivity. Because it has brought more area under cultivation than before. Cropping intensities have been increased. Crop yields have been enhanced. Incomes of households, consumption, and saving have been enhanced. On-farm employment and off-farm economic activities have made it possible to improve the socio-economic conditions of the people of the area. Poverty is not only judged on the bases of the quantitative variables such as income, consumption, saving, employment etc. Some qualitative variables also indicate that
poverty has decreased in the study area after the CRBC. Before CRBC there was a joint family system. In a family of eleven members there was only one bread winner. After the CRBC the same joint family has divided into three families and instead of one bread winner now there are three persons earning the livelihood. There has been an increase in the number of pucca houses in the study villages after the CRBC. Education and health levels have been improved than before. There are now more schools in private sector in the area than before. The number of vehicles in the area has increased. People now spend more than before especially on wedding. Electronic appliances including refrigerators, air conditions, TV, VCRs. Clean drinking water supply has been provided now. Thus, one can infer that the CRBC has led to alleviate poverty in the area.

6.12 Other Economic Activities:

D.I. Khan has a multicultural society that allows women to work to a limited degree. They work in many of the sectors including agriculture, livestock, and handicrafts, etc. But cultural barriers prohibit women from working in most of the public sector, particularly outside their native villages. Traditionally, women play an active role in sowing and harvesting of crops, fodder collection, livestock management, and poultry farming. Of course, they remain primarily responsible for child rearing and household chores. Males participate in all sectors of the work force and are engaged in farming, labor, and small business in addition to their involvement in the public sector. In addition to women, children also work with parents in the fields. The female workforce presents a large untapped potential, and as cultural norms relax this potential will be available. The survey findings indicate that many women work on the land. They now mostly participate in sowing and harvesting of crops as well as weeding. Their most
time consuming activities are guarding the fields and cleaning and storage of productions. About one-third of the women contribute valuable services to the promotion of livestock activities. And increasingly are involved in farm level processing and handicrafts.

Through the construction of a network of roads, the study area has improved market access as well as living conditions of the entire project population as access to all services have dramatically improved. These roads have reduced the transport cost element of inputs, tractor rental, and harvesting and indeed of all goods purchased for the household. The study villages have developed their own local markets where they buy and sell goods and services of their needs. Now the people of the area don’t have any problems marketing their output.

The respondents reported that now due to advent of CRBC the crime rates have been gone down. Thus the overall impact of CRBC in the development has been very phenomenal.

The extensive review of the data suggests that there are strong linkages between irrigation and agricultural productivity and between agricultural productivity and poverty alleviation. That data also shows a strong linkage between irrigation and poverty. These linkages are both direct and indirect. Direct linkages shows local and household level effects while indirect effects shows aggregate sub national and national impacts. Irrigation benefited through higher production, higher yields, increased area under cropping, higher and year round farm and off farm employment. Direct effects also shows more diversified cropping pattern and from low valued subsistence production to high valued market oriented production. This increased production made food available and affordable for all and especially for poor.
The indirect linkages work through regional, national, and economy wide effects. Irrigation investment acts as production and supply shifters and has a strong positive effect on growth. The indirect effects shows increased markets in the command area, better health and sanitation conditions, demand for education and better education, availability of drinking water, increased in non farm employment, decrease in crime rate, rural to urban migration has reduced as people are getting employment at their door step in the agriculture sector. Irrigation benefits the poor and landless in the long run through farm and off farm employment and through low food prices.

The data analysis and the findings supports the findings or are in continuation of the findings of Datt and Ravillion (1998), (Fan et al., 2002; Fan et al., 2000 a , b), Hussain and Hanjra (2004) etc.

The total beneficial impacts of irrigation, both direct and indirect can be explained in the following diagram
6.1 IRRIGATION - AGRICULTURAL PRODUCTIVITY - POVERTY ALLEVIATION LINKAGES
6.13 Tests of Hypotheses
The present study tested the following hypotheses.

Hypothesis No. 1:

The first hypothesis stated that there was a significant difference between the socio-economic conditions of sample households before and after CRBC. The data analysis indicated that there was significant difference between the socio-economic conditions of sample households before and after the CRBC. Thus, the study supports the first hypothesis.

Hypothesis No. 2:

The second hypothesis of the study was that there was a significant difference between per acre yield of crops before and after CRBC. Thorough examination of section 6.4 shows that the crops yield have significantly increased due to irrigation water availability after CRBC. The yields of wheat, gram, sugarcane and gram have significantly improved. We therefore accept our null hypothesis of a difference between crops yield before and after CRBC. This leads us to reject our alternative hypothesis that there is no significant difference between crops yield before and after CRBC.

Hypothesis No.3:

This hypothesis stated that area under cultivation and cropping intensity has changed before and after CRBC. If we look at the data analysis regarding area under cultivation and cropping intensity before and after CRBC, it is evident that area under cultivation and cropping intensity has increased due to CRBC. Thus the alternative hypothesis of no significant difference between area under cultivation and cropping intensity is rejected.
Hypothesis No. 4

The present study also tested a null hypothesis that household average monthly income, consumption and saving have changed before and after CRBC. The t-test results of household income, consumption and saving comparison shows that these have changed significantly in upward direction. We therefore accept the null hypotheses and reject our alternative hypothesis that the sample household has no different levels of income, consumption and saving before and after CRBC.

Hypothesis No.5:

The study tested another hypothesis that CRBC has led to enhance rural employment and alleviated poverty in the study area. This hypothesis is accepted as the CRBC has led to increase in rural employment and has alleviated rural poverty to a great deal.
CHAPTER VII
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter presents summary, conclusions and recommendations of the study. Section 7.2 summarizes main findings of the study. Conclusions of the study are given in section 7.3. Finally, policy recommendations are given in section 7.4.

7.2 Summary

NWFP is comparatively less developed in terms of agricultural productivity than Punjab and Sind. Major crops in NWFP include sugarcane, wheat, maize, gram (chickpea). Within the NWFP, the southern districts are comparatively poorer and per hectare yields of crops are lower as compared to the Peshawar Valley. D.I. Khan is one of the southern districts in NWFP where majority of people live below poverty line. Literacy rate is low. Unemployment is widespread. Per hectare yields of crops is low. Area under cultivation is also low. The agricultural economy of the area has transformed a lot after the construction of Chashma Right Bank Canal (CRBC) because it has brought more area under cultivation than before and the yields of crops have increased manifold. Crops like sugarcane and rice, which were not cultivated before CRBC, are now the main crops in D.I. Khan.

The Chashma Right Bank Irrigation Project (CRBIP) has a major role contributing to the agriculture sector of NWFP and Punjab. The projects is expected to increase the production of major field crops and improve farm incomes for an estimated population of
822,000, stimulate employment and agro–industrial development, generates substantial foreign exchange savings annually and generally raise the economic status of the region. The primary reason for the large capital investment in the main canal an irrigation distribution system of CRBIP is to grow crops and thereby further the economic development of the province and reducing poverty. The major crops grown in Stage I and II; wheat in the rabbi season and rice in the kharif, sugarcane as a yearlong crop covers both seasons. Other crops in rabbi and kharif season are less than 10 %. There is a large potential for introducing and / or expanding areas of other crops, with particular emphasis on high value low water requirement crops, vegetables, orchards, etc, to minimize the potential for water logging and salinity and cope with limited water supplies.

In November 1970, the Water and Power Development Authority (WAPDA) prepared a feasibility report on the CRBIP, followed by PC – I in December 1973. In August 1977 the project was appraised by the Asian Development Bank. In late 1979, after physical works had already been started, it became clear that the CRBIP would cost substantially more than originally estimated. Following virtual cessation of construction, the Government of Pakistan (GOP) and WAPDA, the main executing agency for the CRBIP, made various studies on the CRBIP. These included the preparation of a revised PC-I dated May 1981, which involved sub division of the overall Project into three stages by segmenting the 258 km of main canal into increments of 79 km, 37 km, and 142 km respectively. In late 1981 the GOP requested bank technical assistance to further examine the project, and this was under taken by a team of consultants during the second half of 1982. In early 1984, all pending issues on the revised CRBIP were formally resolved, and the bank reactivated loan for applications the Stage I main canal and associated civil
works of the revised CRBIP. Stage I was completed in December 1986 and commissioned one month later.

In February 1986, the GOP requested further technical assistance from the Bank for the preparation of Stage II of the CRBIP. Technical Assistance (TA-803) was approved by the Bank on 8th October 1986, and agreed by the GOP, the Government of NWFP and WAPDA in March 1987. Consultants arrived in Pakistan on 15th April 1987, and after preliminary discussions with official from the GOP, NWFP Government and WAPDA, fieldwork commenced in D.I. Khan from 24th April 1987 (CRBIP, 1987). Stage II construction started in 1988 from RD 260 to RD 380 and was completed 1995. It provided 36 km of main canal, 15 distributaries canals of 169 km length, 552 water courses of about 1052 km length, and branch and main surface drains for 94000 acres. Stage III runs from RD 380 to RD 851 and consists of 144 km of main canal. Construction of Stage III has recently been completed.

The present study focuses on the Stage II of CRBIP because it is close to D.I. Khan and its adjacent areas. The study takes in account main crops including wheat, rice, gram (chickpea) and sugarcane. The study was conducted in the stage II of the CRBIP. Because the stage III has just recently been completed and its impact can’t be estimated; although it can be done after some more years. Stage II covers approximately 37 km with water allocation of 800 cubic feet with an area of 94,000 acres served by 16 distributaries.

The main objectives of the study are to examine and discuss the socio-economic characteristics of the sample households and the study area before and after the construction of CRBC, to compare the per acre yields of various crops before and after
the CRBC in the study area, to investigate the impact of CRBC on farm productivity, household incomes and poverty alleviation in the study area, to find out the perceptions of sample households about the CRBC and to diagnose various constraint facing farming community regarding irrigation facilities in the study area and to suggest policy recommendation as to how the role of CRBC could be harnessed in poverty alleviation in the study area.

The study tested the following hypotheses which include (1) There is a significant difference between the socio-economic conditions of sample households before and after CRBC (2) There is a significant difference between per acre yield of crops before and after CRBC (3) Area under cultivation and cropping intensity has changed before and after CRBC (4) Household average monthly income, consumption and saving have changed before and after CRBC (5) CRBC has led to enhance rural employment and to alleviate poverty in the study area.

The data were collected in June-August 2004 by conducting a household level survey in seven selected villages of D.I. Khan. Five of sample villages are located in the command area of CRBC. These included Khutti, Gara Hayat, Kurai, Gomal Kalan, and Draban Khurd. The other two villages are situated outside the CRBC command area and these are Gara Jamal and Zindani. The size of sample was 139 households in the study area. The data were collected with the help of pre-tested interview schedule.

The data showed that more than half of the respondents were literate and the rest were illiterate. Although there was no much variation in literacy status across village, but it was evident that in irrigated area the ratio of literate farmers was higher than in un-irrigated villages.
Vast majorities (60%) of the sample respondents are up to 45 years of age and 40 % are above 45 years of age. The data showed that majority of the households (71 %) were in income group of up of Rs. 20,000 per month. Only 15 % and 14 % of the sample households were in income group of Rs. 20,000-30,000 and Rs. 30,000 and above. This implies that majority of the people in the area still live below and close to poverty line.

On the whole, majority (60.5 %) of the households consists of more than 10 members. No significant variation in households falling in different sizes was found in the sample villages. The data also showed that as many as 34 percent of the sample households had, on the average, farm size of less than 6 acres and accounted for 18 % of the farm area. Majority (72 %) of the farm households had less then or up to 20 acres of land and accounted for 61 percent of the farm area. Only few (5 %) of the households had farm size of 50 acres and above. However, this group had 20 % of the total land.

The information also indicated average farm area and percent of farms having area below 25 acres in the sample villages and the study area. The average farm size in the study area was 27 acres. The average farm size in irrigated areas (first five villages) was less (25 acres) than in un-irrigated (last two villages) area (32.5 acres). On the whole, 75 % of the farms had land area up to 25 acres.

There were three different types of land tenure system in the study area. A vast majority (74 %) of the sample farmers were owners, 14 % owner-cum-tenant and 12 percent pure tenants or sharecroppers. Owner cultivators are usually expected to have higher crop yields than pure tenants as the latter have insecurity regarding using of land. Keeping in view uncertainty and risk, the tenants may not invest more in land development.
However, comparison between crop yields of owners and tenants may point out important implications for policy makers.

Sub-division and fragmentation of farmland was a serious problem of our agriculture. This leads to decrease in farm productivity and minimizes the adoption of improved farm technology. Regarding fragments on sample farms by farm size in the study area. The data showed that more than seventy five per cents of sample farms were fragmented in 5 or more parcels. Similarly, 15 % had two parcels and 6.5 % were in only parcel.

The study area had many different tribes. Majority (73 %) of the sample households belong to Jat. Some (16 %) of the households are Balouch, Syed, Wazir, Awan, and Marwat account for 2.8%, 2 %, 0.7%, respectively. Thus the study area is dominated by Jats and Balouchs.

There are two crop seasons in D.I. Khan. In the irrigated villages major crops grown during kharif are rice grown on 42% land area, sugarcane (39%), mung (9%), maize (5%), jowar, bajra, and cotton. On the other hand, in un-irrigated villages in the study area, only jowar, bajra, cotton and mung are grown. In the rabi season, wheat, gram (chickpea) and barley are the main crops in irrigated villages where 86 % of the farm area is cultivated to wheat. In un-irrigated villages almost half of the land is sown to wheat (48%) and gram (51%). Only little (0.66%) is allocated for barley cultivation.

The data showed that area under cultivation had grown manifold due to the construction of CRBC. The construction of CRBC has also increased cropping intensity in the study area. The cropping intensity in the five villages has increased because of supply of irrigation water due to CRBC. This is so because the availability of irrigation water has
made it possible to crop the cultivated area twice in a year. But the cropping intensity in
the two unirrigated villages has been stagnant.
Wheat being a staple food crop and requiring a relatively easy production technology was
grown almost consistently in all sample villages. The data showed that there had been a
significant increase in wheat yield in the villages which are located in the CRBC
command area. However, there has been no significant change in wheat yield in those
villages which fall outside the CRBC command area.
Gram is the second most important crop of CRBC in rabi season. Gram is used by
farmers of the area in many different forms. The gram yield has also increased in the
study area. Although the gram crop does not need much water but still availability of
irrigation water has increased gram yield.
Sugarcane has become an important cash crop of the study area which contributes
significantly to the household income. Before the construction of CRBC sugarcane crop
was not cultivated in the study area because the sugarcane crop can’t be grown without
water. But after the CRBC, it is now grown in the command area and the yield data have
been given for the five villages as sugarcane crop is not cultivated in unirrigated villages.
This shows that the impact of CRBC has been significant in case of sugarcane.
Rice has become a major kharif crop, after wheat and sugarcane. It occupies the largest
area. It another high water use crop after sugarcane. This crop was not grown in the study
area before CRBC. But now it is an important food staple as well as cash crop for the
people of the area.
The results of the regression equations indicated that almost all the independent variables significantly affected the yields of various crops. In case of wheat all explanatory variables except labors had statistically significant coefficients. The coefficient of irrigation was highly significant at 1% level. Similarly for gram crop all variables except fertilizer have statistically significant coefficients. This is because the gram does not need much fertilizer as compares to other crops. Coefficient of irrigation variable is also significant for gram at 5%. Regarding sugarcane, all of the explanatory variables have statistically significant coefficients. However, the coefficient of irrigation is also significant at 1% level. In case of rice crop, all variables except education have significant coefficients. Like wheat and sugarcane, the coefficient of irrigation is also highly significant.

The analysis indicated that irrigation was one most significant factor affecting crop yield. Its statistical significance showed that irrigation positively changed crop yield and this been possible due to the availability of irrigation water through the CRBC. Thus CRBC has played a very significant role in enhancing crop yield.

The data show that the number of buffalos, cattles, sheep, goats, donkeys and poultry have increased significantly. The population of horses and camel have gone down. According to the sample respondents the increase in livestock has enhanced household income and savings. The socioeconomic conditions of the people of the area have been improved after CRBC.

The availability and supply of irrigation water due to CRBC has also enhanced household income. Before the advent of CRBC there was no water available for irrigating farmer’s fields except rains and flood irrigation (Rod kohi). Agricultural sector is mainly subject to
natural vagaries in general; in the study area it is relatively subject to more such calamities. Because the climate is harsh and there are less rains in the area. Thus, the CRBC has revolutionized the rural sector of the area.

The framers of the area were of the opinion that their family incomes have significantly increased due to the availability of irrigation water though CRBC. The data showed that household monthly incomes in all of the sample villages have increased. However, incomes of those households who are beneficiaries of the CRBC have increased significantly. Keeping others things constant, the impact of CRBC oh household income has been phenomenal. This implies that CRBC has plays an important role in the socioeconomic development of the area. Increase in households’ incomes have also led to increase in household consumption. The data shows that household consumption expenditures have increased more significantly in the sample villages which fall in the CRBC command area that those which fall outside the CRBC area. This is quite convincing to infer that CRBC plays an important role in the socioeconomic uplift of the area.

The impact of CRBC has almost been the same on household savings as on their income and consumption. The saving of households have expanded more in the in the area irrigated by CRBC than that which is still unirrigated.

Education plays an important role in the development of a country. It leads to efficiency as well as potential of individuals to increase their earnings. Due to increase in crop yield and incomes the people of the area currently send children to schools more than before. The CRBC has also played a phenomenal role in enhancing education in the area. The sample respondents perceived that there has been an enormous increase in literacy rate
after the CRBC. Table 6.13 gives information on the perceptions of sample households’ heads regarding positive impact of CRBC on their education status. The data show that between 69-83% of household in the CRBC area hold positive view about the role of CRBC in providing education in their villages. The respondents outside the CRBC’s command area were also asked about their perception regarding CRBC role in this regard. They opined that although they did not benefit directly from the CRBC, their perception about CRBC’s role was very positive. This shows that the role of CRBC has been very important in expanding education in the area. The sample respondents were also asked about the indirect effects of CRBC on the health status in the study area. The perception of the sample households was good in this regard. They reported that they could spend now more on health related facilities than before. On the one hand the, the government has increased health facilities through hospitals, dispensaries and doctors. On the other hand, the people through increased incomes spend more on health by visiting even private clinics which are quite expensive than government hospitals. In addition, their education has also improved their awareness about health related issues. Rural and urban employment enhances family income. Majority of the people of the area are employed in off-farm activities before the advent of CRBC. However, after the CRBC the on-farm as well off-farm employment opportunities have increased. Majority (80%) of the sample respondents reported that due to CRBC off-farm employment has increased in the study area. Similarly, 75% of the sample respondents indicated that off-farm employment opportunities have also improved. A thorough examination of the previous sections indicates that the CRBC has reduced poverty in the area. Because it has brought more area under cultivation than before.
Cropping intensities have been increased. Crop yields have been enhanced. Incomes of households, consumption, and saving have been enhances. On-Farm employment and off-farm economic activities have made it possible to improve the socio-economic conditions of the people of the area. There has been an increase in the No. of pucca houses in the study villages after the CRBC. Education and health levels have been improved than before. There are now more schools in private sector in the area than before. The number of vehicles in the area has increased. People now spend more than before especially on wedding. Electronic appliances including referigetors, air conditions, TV, VCRs. Clean drinking water supply has been provided now. Thus, one can infer that the CRBC has led to alleviate poverty in the area.

D.I. Khan has a multicultural society that allows women to work to a limited degree. They work in many of the sectors including agriculture, livestock, and handicrafts, etc. But cultural barriers prohibit women from working in most of the public sector, particularly outside their native villages. Traditionally, women play an active role in sowing and harvesting of crops, fodder collection, livestock management, and poultry farming. Of course, they remain primarily responsible for child rearing and household chores. Males participate in all sectors of the work force and are engaged in farming, labor, and small business in addition to their involvement in the public sector.

In addition to women, children also work with parents in the fields. The female workforce presents a large untapped potential, and as cultural norms relax this potential will be available. The survey findings indicate that many women work on the land. They now mostly participate in sowing and harvesting of crops as well as weeding. Their most time consuming activities are guarding the fields and cleaning and storage of productions.
About one-third of the women contribute valuable services to the promotion of livestock activities. And increasingly are involved in farm level processing and handicrafts.

Through the construction of a network of roads, the study area has improved market access as well as living conditions of the entire project population as access to all services have dramatically improved. These roads have reduced the transport cost element of inputs, tractor rental, and harvesting and indeed of all goods purchased for the household. The study villages have developed their own local markets where they buy and sell goods and services of their needs. Now the people of the area don’t have any problems marketing their output.

The respondents reported that now due to advent of CRBC the crime rates have been gone down. Thus the over all impact of CRBC in the development has been very phenomenal. Floods are also controlled due to CRBC.
6.3 Conclusions

The study has concluded that the CRBC plays a crucial role in the socio-economic development of the study area. It works just like an engines of development for the area under consideration. The CRBIP has made irrigation water available for the fields of farmers. This has brought more area now under cultivation which could not be cultivated previously due to the dearth of water. It has also increased land use intensity as well as cropping intensity in the area.

The study further concludes that due to extensive and intensive farming, crop yields have also been increased. Wheat, gram, sugarcane and rice yields have been enhanced manifolds. Some new cash and food crops have been introduced after the CRBIP.

In addition to gain the crop farming, the livestock sector has been developed. On the whole the number of cattle, buffaloes, sheeps, goats, and poultry has increased. This had to increase in the households’ incomes.

Increase in family income has increased household saving and consumption expenditures. The standard of living of the people of the area has improved a lot as compared to the situation before the construction of CRBC.

The study also concluded that literacy ratio and education level has been improved. Due to the spread of education, the efficiency of the farmers has increased. There has been a positive change in the way of living of the people. They enjoy now better facilities than before.

The study further concluded that the unemployment rate has gone down than before. On-farm as well as off-farm employment opportunities have been expanded. People have
diversified their professions and new activities in the informal sector have been initiated. This has contributed to the family income and saving behaviour in the study area. The study concluded that although poverty still is the main issue of the area and majority of the people live below poverty line, yet the CRBC project has played a major role in poverty alleviation.
7.4 Recommendations

The study has made the following policy recommendations.

1) Although improvements have been brought in agriculture, yet agriculture of the area is still faced with many problems. It is recommended that the department of agriculture and department of agricultural extension give special attention to further development of this sector in the area. The farmers must be advised on right and timely operations and agricultural practices.

2) The study also recommends that the government must pay due attention to land development and further cultivable wastes may be brought under cultivation by providing the farming community microfinance and credit.

3) The farmers need to be made aware about the use of recommended agricultural practices through mass media.

4) The area of the study in backward and education level is not at par with other areas of the country. Education facilities must be strengthened and quality education needs to be provided in the area.

5) There is a strong link between micro credit and poverty alleviation. For this purpose micro financial institutions should come forward and help the people in poverty alleviation.

6) Sugarcane and rice are the main crops of the area. These crops will increase water logging and salinity problems, actions must be taken at the government level to ensure how to resolve this problem. One solution could be the cultivation of high value crops such as oil seeds, vegetables, orchards, etc.
7) Agricultural extension and on-farm water management will have to promote better farm layouts, land leveling, water management, etc., to achieve increased and optimum crop production.

8) Scientific based crop rotations including leguminous crops should be introduced.

9) If it is to be effective, Agricultural Extension Services must be vastly improved. A change in leadership and management is a must; The Extension mandate and how it can be achieved must be reviewed and revised; sufficient, committed and well trained staff is a must; the necessary resources must be available to enable the staff to provide field services; and sufficient funds must be available for effective training programs (including appropriate demonstrations); all of this is required if realistic agronomic contributions to CRBIP are to be made.

10) Extension must approach and promote crop production in a holistic manner, not one isolated factor at a time- good seed this year, increased fertilizer use next year, etc. For example, at present, there is gap of over 70 % or more between existing and achievable yields for wheat, thus a great scope for improvement. To approach potential yields, requires that proper knowledge and management of inputs – soil water, quality seed, fertilizer, plant protection, etc are applied in an optimum integrated manner. This is referred to as “a package of production technologies”. If any one of the factors is non optimum then the potential cannot be reached. If all inputs are the best available, but proper and timely irrigations not applied, then target yields will not be reached and resources will be wasted.

11) There must be an awareness campaign along with intensive demonstration s, etc. to get the farmers to change from rod kohi view of irrigation to that of canal
irrigated techniques. There are quite different methods and the traditional method isn’t suitable for canal-based irrigation. Basic problems to overcome include; excessive use of water, improper layout of fields, lack of proper leveling and poor selection of crops to be grown relative to soil suitability.
REFERENCES


136


### ABBREVIATIONS – ACRONYMS – DEFINITIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.W.F.P</td>
<td>North West Frontier Province</td>
</tr>
<tr>
<td>D.I.Khan</td>
<td>Dera Ismail Khan</td>
</tr>
<tr>
<td>C.R.B.C</td>
<td>Chashma Right Bank Canal</td>
</tr>
<tr>
<td>C.R.B.I.P</td>
<td>Chashma Right Bank Irrigation Project</td>
</tr>
<tr>
<td>W.A.P.D.A</td>
<td>Water and Power Development Authority</td>
</tr>
<tr>
<td>G.O.P</td>
<td>Government of Pakistan</td>
</tr>
<tr>
<td>A.D.B</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>C.C.A</td>
<td>Cultivable Command Area</td>
</tr>
<tr>
<td>P.I.M.E</td>
<td>Project Impact Monitoring and Evaluation</td>
</tr>
<tr>
<td>D.G.Khan</td>
<td>Dera Ghazi Khan</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>PC – I</td>
<td>Planning Commission Proforma – I</td>
</tr>
<tr>
<td>RD</td>
<td>Reduced Distance</td>
</tr>
<tr>
<td>TFP</td>
<td>Total Factor Productivity</td>
</tr>
<tr>
<td>DC</td>
<td>Deputy Commissioner</td>
</tr>
<tr>
<td>GCA</td>
<td>Gross Cropped Area</td>
</tr>
<tr>
<td>NSA</td>
<td>Net Sown Area</td>
</tr>
<tr>
<td>CI</td>
<td>Cropping Intensity</td>
</tr>
<tr>
<td>P &amp; N</td>
<td>Potassium and Nitrogen</td>
</tr>
<tr>
<td>HYV</td>
<td>High yielding Varieties</td>
</tr>
<tr>
<td>NDP</td>
<td>Net Domestic Product</td>
</tr>
<tr>
<td>SPI</td>
<td>Sen’s Poverty Index</td>
</tr>
<tr>
<td>NSSO</td>
<td>National Sample Survey Organization</td>
</tr>
<tr>
<td>HIES</td>
<td>Household Income Expenditure Survey</td>
</tr>
<tr>
<td>DW</td>
<td>Durbin Watson Value/Index</td>
</tr>
<tr>
<td>HPI</td>
<td>Human Poverty Index</td>
</tr>
<tr>
<td>PCI</td>
<td>Per Capita Index</td>
</tr>
<tr>
<td>MAF</td>
<td>Million Acre Feet</td>
</tr>
<tr>
<td>Acre</td>
<td>0.4047 ha</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cusec (cfs)</td>
<td>28.32 liters/sec; 0.02832 cubic meters/sec</td>
</tr>
<tr>
<td>Kanal</td>
<td>1/8 acres; 0.0506 ha</td>
</tr>
<tr>
<td>MAF</td>
<td>1234 million cubic meters (MCM)</td>
</tr>
<tr>
<td>Acre – foot</td>
<td>1233.5 cubic meters</td>
</tr>
<tr>
<td>Acre – foot</td>
<td>43560 cubic feet (Acre foot is the volume of water covering one acre)</td>
</tr>
<tr>
<td>Barani</td>
<td>Rain fed</td>
</tr>
<tr>
<td>Daman</td>
<td>Piedmont plain west of the Indus river flood plain cut by hill torrents</td>
</tr>
<tr>
<td>Distributary</td>
<td>A branch canal that takes off from main canal</td>
</tr>
<tr>
<td>Jowar and Bajra</td>
<td>Sorghum and Millet</td>
</tr>
<tr>
<td>Katcha</td>
<td>Construction using local materials, clay, straw etc, of poor quality</td>
</tr>
<tr>
<td>Kharif</td>
<td>Summer cropping season (April to September)</td>
</tr>
<tr>
<td>Literate</td>
<td>A person who can read and write with understanding in a language</td>
</tr>
<tr>
<td>Pakka</td>
<td>Constructed with manufactured material, of good quality</td>
</tr>
<tr>
<td>Rabi</td>
<td>Winter cropping season (October to March)</td>
</tr>
<tr>
<td>Rod</td>
<td>Flood Channel</td>
</tr>
<tr>
<td>Rod Kohi</td>
<td>Flood/ spate irrigation system from hill torrents</td>
</tr>
<tr>
<td>Tehsil</td>
<td>Group of villages forming administrative subdivision in a district</td>
</tr>
<tr>
<td>Watercourse</td>
<td>The channel taking water from a Distributary to the farmers field</td>
</tr>
</tbody>
</table>
QUESTIONNAIRE

1. Name -----------------------------------------------

2. Village ---------------------------------------------

3. Age -----------------------------------------------

4. Sex Male Female

5. Literacy Level Educated Uneducated

6. If Educated 
   i) Post Graduate----------- ii) Graduate --------------
   iii) Matric and above --------- iv) Under Matric---------
   v) Primary Level

7. Education of other family members.
   i) Post Graduate----------- ii) Graduate --------------
   iii) Matric and above --------- iv) Under Matric---------
   v) Primary Level vi) Illiterate --------------

8. Educational facilities before CRBC
   Primary School High School College
   Boys Girls Boys Girls Boys Girls

9. Change in educational facilities after CRBC Yes ------ No -------

10. Population of the area; Male ------ Female ------ Total ------

11. Household Size; Small ------ Large ------------

12. Dependents; Male--------- Female------ Children------
13. Family System:  
Unit --------  Extended --------

14. No of school going children  
Before CRBC --------------  After CRBC --------------

15. Occupation:  
Farming  Trade  Govt; job  Others

16. Land tenure;  
Owner--------  Sharecropper--------  Tenant --------

17. Do you think CRBC has brought change in land tenure?
   a) If Yes, how?  ------------------------------------------
   b) If No, how?  ------------------------------------------

18. Size Holdings (Farm size)

   Before CRBC  
   i)  Less than 50 acres  
   ii)  50 to 100 acres  
   iii)  100 to 200 acres  
   iv)  200 to 500 acres  
   v)  500 acres and above

   After CRBC  
   i)  Less than 50 acres  
   ii)  50 to 100 acres  
   iii)  100 to 200 acres  
   iv)  200 to 500 acres  
   v)  500 acres and above

19. Nature of holdings  
Fragmented --------  Consolidated --------

20. Crops grown before CRBC (Cropping Pattern)

   a) Wheat  b) Gram  c) Rice  d) Sugarcane  e) Maize
   f) Pulses  g) Millet  h) Mustard oil  i) others

21. Crops grown after CRBC (Cropping Pattern)

   a) Wheat  b) Gram  c) Rice  d) Sugarcane  e) Maize
   f) Pulses  g) Millet  h) Mustard oil  i) others
22. Crops area before CRBC
   a) Percentage under wheat crop
      i) 100 %  ii) More than 50%
      iii) Less than 50 %
   b) Percentage under sugarcane
      i) 100 %  ii) More than 50%
      iii) Less than 50 %
   c) Percentage under rice
      i) 100 %  ii) More than 50%
      iii) Less than 50 %
   b ) Percentage under gram
      i) 100 %  ii) More than 50%
      iii) Less than 50 %

23. Inputs before CRBC
   a) Seed-----  b) Fertilizer----------
   c) Pesticides --------  d) Any other------
   a) Seed-----  b) Fertilizer--------
   c) Pesticides ------  d) Any other—

24. Seed varieties before CRBC
   Old  New
   a) If old varieties why?  Easily available  Cheaper
   b) If new varieties why?  Easily available  More productive

25. Change in seed varieties after CRBC
   Yes  No
   If Yes, Why?  i) Increased land utilization  ii) More output
      iii) Water availability
26. Fertilizer (kinds). Chemical before CRBC
   i) If not chemical why?  Expensive  Scarce supply
   ii) If chemical  More productive  Adequate supply

27. Change in fertilizer varieties after CRBC  Yes  No
   If Yes, Why?  i) Increased land utilization  ii) More output
                  iii) Water availability

28. Use of pesticides and insecticides before CRBC  Yes  No

29. Change in pesticides and insecticides after CRBC
   a) Increased  No change
   b) If not used, why?  i) Ineffective  ii) Expensive
                        iii) Harmful  iv) Don’t know the use

30. Mode of irrigation before CRBC
   i) Tube well  ii) Rain fed  iii) Rod Kohi  iv) Any other

31. Area irrigated before CRBC  Area irrigated after CRBC
   i) 100 %  ii) more than 75 %  i) 100 %  ii) more than 75 %
   iii) 50 %  iv) Less than 50 %  iii) 50 %  iv) Less than 50 %

32. Credit availability  Yes  No
   a) If yes, what sources?  i) Friends and relatives  ii) ZTBP
                                iii) Commercial Banks  iv) Cooperative societies
   b) If No, why?  i) In adequate institutional arrangement
                           ii) High interest  iii) Cumbersome process

33. Whether credit availability increased after CRBC?  Yes  No

34. Sources of information about inputs  Sources of information about inputs
<table>
<thead>
<tr>
<th>(Before CRBC)</th>
<th>(After CRBC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Public / Private ------------</td>
<td>i) Public / Private ------------</td>
</tr>
<tr>
<td>ii) Newspapers -------------</td>
<td>ii) Newspapers -------------</td>
</tr>
<tr>
<td>iii) Radio / T.V ------------</td>
<td>iii) Radio / T.V ------------</td>
</tr>
<tr>
<td>iv) Friends / Relatives --------</td>
<td>iv) Friends / Relatives --------</td>
</tr>
</tbody>
</table>

35. Income status (Agriculture)

(Before CRBC per annum) | (After CRBC per annum)
---|---
| i) More than one lack---------- | i) More than one lack---------- |
| ii) 50,000 to one lack ---------- | ii) 50,000 to one lack ---------- |
| iii) 25000 to 50000 ---------- | iii) 25000 to 50000 ---------- |
| iv) Less than 25000 ---------- | iv) less than 25000 ---------- |

36. Monthly consumption

(% of income before CRBC) | (% of income after CRBC)
---|---
| 50 % -------- | 50 % -------- |
| 75 %--------- | 75 %--------- |
| 100 % ------- | 100 % ------- |
| Dis-saving ------ | Dis-saving ------ |

37. Monthly Saving

(% of income before CRBC) | (% of income after CRBC)
---|---
| 50 % -------- | 50 % -------- |
| 75 %--------- | 75 %--------- |
| 100 % ------- | 100 % ------- |
| Dis-saving ------ | Dis-saving ------ |

38. Mode of saving (Investment)

Bank | Bonds | Capital goods | Any other
---|---|---|---

39. Machinery before CRBC | Machinery after CRBC
i) Tractor----- ii) Thresher----- i) Tractor----- ii) Thresher-----

iii) Harvester----- iv) Any other iii) Harvester----- iv) Any other

40. Machinery status before CRBC   Machinery status after CRBC
   Self ------ Owned ------ Self ------ Owned ------
   Hired ------ Hired ------

41. Mode of purchase
   i) Self------ ii) Loan from F/R ------ iii) Bank

42. Out put per acre (before CRBC)   Out put per acre (after CRBC)
   i) Wheat----- ii) Sugarcane i) Wheat----- ii) Sugarcane
   iii) Rice ----- iv) Gram ------ iii) Rice ----- iv) Gram ------

43. Satisfaction level (output) before CRBC
   Yes------ No -------- Reasons -----------------------------------

44. Satisfaction level (output) before CRBC
   Yes------ No -------- Reasons -----------------------------------

45. Output level after CRBC i) Increased   ii) Not increased
   a) If increased how much % -------------------------------
   b) If increased, why? -----------------------------------
   c) If not increased, why? -----------------------------------

46. Family members working on farm   Family members working on farm
   (Before CRBC)   (After CRBC)
   i) Adults: Male ----- Female ------ i) Adults: Male ----- Female ------
   ii) Children -------------- ii) Children --------------
<table>
<thead>
<tr>
<th>Question</th>
<th>Before CRBC</th>
<th>After CRBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>47. Total farm workers before CRBC</td>
<td>Own family members</td>
<td>Own family members</td>
</tr>
<tr>
<td>i) Own family members</td>
<td>Hired labor</td>
<td>Hired labor</td>
</tr>
<tr>
<td>ii) Hired labor</td>
<td>Permanent</td>
<td>Permanent</td>
</tr>
<tr>
<td>iii) Permanent</td>
<td>Part time</td>
<td>Part time</td>
</tr>
<tr>
<td>48. Methods of Farming (Before CRBC)</td>
<td>Old</td>
<td>Modern</td>
</tr>
<tr>
<td>a) If old, why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) If modern, why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49. Methods of Farming (After CRBC)</td>
<td>Old</td>
<td>Modern</td>
</tr>
<tr>
<td>a) If old, why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) If modern, why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50. Supply of modern means of agriculture:</td>
<td>Adequate</td>
<td>Inadequate</td>
</tr>
<tr>
<td>51. If inadequate, why?</td>
<td>i) Smaller demand</td>
<td></td>
</tr>
<tr>
<td>ii) Traditional means preferred as that are cheaper and easily available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52. Irrigation water supply after CRBC</td>
<td>Adequate</td>
<td>Inadequate</td>
</tr>
<tr>
<td>53. Marketing facilities after CRBC</td>
<td>Increased</td>
<td>Not increased</td>
</tr>
<tr>
<td>54. Cropping pattern after CRBC</td>
<td>Changed</td>
<td>Not changed</td>
</tr>
<tr>
<td>55. If changed how?</td>
<td>i) Due to CRBC</td>
<td>ii) Credit availability</td>
</tr>
<tr>
<td>ii) Lucrative return</td>
<td></td>
<td>iv) Any other</td>
</tr>
<tr>
<td>56. Agro based industries (after CRBC)</td>
<td>Increased</td>
<td>Not increased</td>
</tr>
<tr>
<td>57. Employment level (after CRBC)</td>
<td>Increased</td>
<td>Not increased</td>
</tr>
<tr>
<td>58. Income level (after CRBC)</td>
<td>Increased</td>
<td>Not increased</td>
</tr>
<tr>
<td>59. Consumption level (after CRBC)</td>
<td>Increased</td>
<td>Not increased</td>
</tr>
</tbody>
</table>
60. Agriculture research and extension (after CRBC)

   Yes           No

61. Agriculture research and extension (after CRBC)

   Yes           No

62. If yes, do you practice their recommendations?

   Yes           No

63. If no, why?

   i) Not feasible        ii) Ineffective

64. Provision of Roads, Banks and Telephone after CRBC

   Increased       Not increased

65. Provision of Schools, Health Centers, Population Welfare Centers after CRBC

   Increased       Not increased

66. Change in outlook and lifestyle

   Improved       Not improved

67. If improved, how?

   i) Use of electronics gadgets
   ii) Bricks houses
   iii) Modern means of transport

68. Do you think that your social life has ameliorated?

   Yes           No