Production Possibilities in Catchment Areas Under Dharabi Dam in Chakwal

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by

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O’ ALLAH

Open Our Eyes…
To See…
What Is Beautiful…

Our Minds…
To Know…
What Is True;

Our Hearts…
To Love…
What Is Good.

(Aa’meen)

I

Dedicate This Humble Task,

Fruit of My Thoughts and Study

To My

Affectionate "Grand Parents, Parents, Brothers, Sisters and to all my nephew and nieces"

Who Always Wished and helped

Me for my Studies

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Chapter 1

INTRODUCTION

Notwithstanding its declining share in GDP, agriculture is still the single largest sector, contributing 21 percent to GDP and employing 44 percent of the workforce. Pakistan's agriculture is classified as an irrigated one. Out of about 23.5 million hectares of its total culturable land, 19.62 million hectares come from irrigated area, giving about 90% of its total agriculture production. Culturable waste is about 8.32 million hectares. Like in other developing countries, poverty in Pakistan is largely a rural phenomenon; therefore, development of agriculture will be a principal vehicle for alleviating rural poverty (GOP, 2008).

There could be two possible approaches to increase the agricultural production viz. either by bringing more area under cultivation or increasing the yield per acre. The first option is almost flexible, however, the yield per acre could be increased. To increase the crop yield, water input is the most limiting factor particularly in the barani areas (Bhutta, 99).

The Punjab province contains about 70%, or 14.8 million hectares of Pakistan's total cultivated area. Of these 12.6 million hectares are irrigated of which 8.3 million hectares is irrigated through the Indus Basin irrigation system. Decentralized irrigation

system in the so-called barani (rainfed) tract of the Punjab province irrigate part of the remainder (International Irrigation Management Institute, 1999).

The 2.2 Million hectare Potohar Plateau has a great potential for agricultural and social development. Total cultivated area of Potohar Plateau is around 1.0 Million hectare. Out of this area the Potohar Plateau with the area of 0.24 million hectare (Mha) falls in the civil districts of Chakwal, Jhelum, Rawalpindi, Attock and federal territory of Islamabad (Bhutta,1999).

A common feature of the rain fed areas is that agriculture is not developed due to low yield, inconsistent and tardy rainfall over a year, losses of rainwater due to swift run off, small size holdings and primitive technology. At the same time, topography of Barani areas having sheer ground slopes, helps the rain water to flow with high velocity to the slant of numerous brooks, thus resulting in erosion of the fertile soils.

In the past, the rain fed areas were considered great peril for agriculture, thus almost all the resources were directed to the progress of the irrigated areas. However, our Barani areas are too big to be ignored as they sustain over 80 % of the country's livestock population, contribute 12% of Wheat, 53% Barley, 69% of sorghum, 31% of millets, 23% of rape seed/mustard, 65% of gram and 89% of ground nut and 17% of other pulses to the overall national production (Khan,1988).

The three month monsoon and erratic winter rain fall made the crop very uncertain in the Potohar Pleatue.On the other hand the topography of the hilly area with steep ground slopes, helps the rain water to form numerous streams. Due to high velocities, this water erodes the good land. Apart from damaging the land and the erosion of soil the rain water thus does not get a chance to soak down and develop any ground water reservoir. Agriculture in these areas, therefore, depends entirely upon rainfall, which at times is very meager. This cycle of drought is frequently experienced and now witnessed in recent years. Consequently, to conserve the rain run-off for agriculture, the only solution is to build dams, which would also eliminate the hazards caused by delayed rains at the time of sowing and growing when a little delay in rainfall may result into reduction of crop yield to less than half (Small Dam Organization, 2007).

In Potohar, there is capability for both water resource improvement (surface and subsurface) and its management (to improve the efficiency of the offered systems).Water resource development mainly refers to such projects as construction of large or small reservoirs, such as small dams, mini dams and ponds. The collection, storage, maintenance, consumption and management of these sources are of principal importance in these areas. Each millimeter of water collected, stored, conserved and saved in these areas can produce wheat by an average of about 10 kg/ha (Marshal and Holmes, 1988).

To raise the socio-economic formation of the farming society the construction of small and medium size dams was started in 1961 and by 1986 nineteen such dams had been completed encompassing a command area in excess of 17000 acres. Its unfortunate that for most of these soils no proper and detailed research for viability had been conducted which resulted in low percentage of command area development. Later on, under the Umbrella Project 12 dams were competed between 1987 and 1995 covering a command area of 17500 acres and rehabilitation of 9 old dams with command area of 12850 acres.

In case of small dams, the performance of irrigation systems normally remains low, despite major technical development efforts. According to NESPAK, 1991 description only 23% water of these dams was being used for crop production.

The Dharabi dam project is one of such efforts to develop water path by making the dam in Dhrab River, a tributary of Soan River out fall in Indus River at a distance of about 5 kilometers from village Balkasar of tehsil and district Chakwal. Total catchment area of dam site is 147.31Sq.Km (56.88 Square miles). Mean Annual rainfall in the Catchment area is 701.52 mm (28 inch).The proposed project will bring about 6400 Acres of land water under irrigation out of which 6000 Acres through gravity flow and 400 Acres through lift (Small Dam Organization, 2007).

After heavy investment on these small dams, less than one third of the proposed area was irrigated by small dams. Therefore, the desired changes in cropping

pattern could not be achieved (Iqbal and Shahid, 1992). Owing to high surface area to volume ratio, these small reservoirs are subject to high evaporation losses. On an average, small reservoirs lose 50% of their impoundments to evaporation in arid and semi-arid areas .The leaching and percolation losses in small reservoirs are about 20% of reservoir volume against 5% in large dams (Keller et al., 2000).

On the other hand these reservoirs positively found that due to the availability of water in these dams contributed to the crop productivity and the crop yield has been increased 36% in case of wheat and 51% in case of maize (Shah, 1984)

Table 1. shows the water resource developed by the construction of small dams. These small dams having a live storage of 214327 Acres and can irrigate more than 62764 acres.

Table 1 Water Resource Developed By the Construction of Small Dams In Potohar

District	Number of Dams	C.C.A (Acre).	Live storage (acres)
Rawalpindi	8	7958	14968
Chakwal	16	20699	76229
Attock	15	18629	45401
Jhelum	9	14328	32952
Islamabad	2	1150	44777
Total	50	62764	214327

Source: Small Dam Organization, Islamabad. 2007

The research study of the gross margins has been carried out at Dharabi dam. Dharabi dam is located in Tehsil Kalar Kahar District Chakwal.

About 5 to 10 % area of the surrounding villages is irrigated with the small dam water. Most of the farming community (95%) of the surrounding villages has small land holding, therefore, the small farmers would be direct beneficiaries in long and short-term activities of research from this irrigated site.

The Dharabi dam was selected because it was approachable and also keeping in view the significance for agriculture of the area. An applied agricultural component of International centre for Agriculture in Dry Areas (ICARDA) was also initiated research on water use efficiency in the catchment area of the dam. With the collaboration of the ICARDA the study has been conducted. From this study the existing water use for alternative crops and livestock combinations explored. This will help the research component of ICARDA Project to plan specific interventions to address the low water use efficiency issues at this target site. The information from this study would be used in the project villages as well as to other villages where similar circumstances are prevailing, as water requirements for crops are very significant.

STATUS OF DHARABI DAM

Small dams irrigation program

Punjab Small Dams Organization (SDO) was created in 1960 under the irrigation and power department. Small Dams organization was integrated into the

West Agricultural Development Corporation (WAPDC) in early 1962. Later on, when the WPADC was dissolved in 1972, SDO became part of the Punjab Department of irrigation and Power. Until 1986, Small Dams Organization had completed 18 small dams in Rawalpindi Division (Iqbal, 1989)

The Government of Punjab had constructed 50 small dams in the potohar regions. Besides supplying water for irrigation, these dams have many indirect effects. They help recharge the ground water, provide water for domestic and municipal purposes, control erosion, control floods in hilly and plain tracts, help to develop fish culture and also provide recreational activities (Iqbal, 1989)

There are fifty (50) small dams constructed in Potohar region. The detail of these small dams is given in Table 2

Table 2 Number of small dams in different districts of Potohar region

Districts	Number of small Dams
Islamabad	2
Rawal pindi	8
Chakwal	16
Attock	15
Jhelum	9
Grand Total	50

Source: Small Dam Organization, Islamabad. 2007

Salient features of Dharabi dam

Table 3 Silent features of Dharabi dam is given in table

C.C.A (acres)	Catchment Area (sq.miles)	Live Storage (Aft)	Capacity of Irrigation Channel (Cfs.)	Length of Canal (ft)
6400	56.88	37000	32	131800

Source: Small Dam Organization, Islamabad. 2007

Culturable Command Area (C.C.A):

The CCA is the area having potential to be utilized or brought under cultivation. The CCA of Dharabi dam is 6400 acres.

Catchment Area:

The catchment area is the overall adjoining area of the dam where from water flows towards the dam. The catchment area of Dharabi dam is 56.88 square miles..

Live Storage:

The live storage capacity is the minimum level of water that can be utilized for irrigation and drinking purposes, in the dam. The live storage capacity of Dharabi Dam is 37000 A Ft.

Thus this study will play a significant role in identifying the Production possibilities of the communities of two villages i.e. Chak khushi and Kalar kahar

located in the Dharabi dam command area. It reflects somehow a true picture of farmer's economic condition in the form of gross margins at enterprise and at a farm level. The coefficients estimated from the study will be used for analysis of different models constructed for farm level under different resource system.

The general objective of the study is to assess the production possibilities in rain fed and irrigated farmers with an emphasis on specific objective of the study will be as follows:

1 To study the gross margins at farm enterprises.

2 To identify different production possibilities of water shed communities of Dharabi dam.

3 To support farmer in decision making among different farm enterprises.

Chapter 2

REVIEW OF LITERATURE

Khan et al. (1988) evaluated 22 small dams in Punjab and found that average cropping intensity was 110.9% and average land use intensity was 92.3%. He suggested that formal and informal organizations of farmers could play a significant role in the effective utilization of water, proper construction, rehabilitation, operation and maintenance of watercourses.

Government of Pakistan (1991) reported in the Evaluation of Small dams in Punjab and NWFP that crop intensities achieved were very low compared to the targets given. These ranged from 22 to 29 % at dams in Punjab against an average target of 81%.Water supplied from dams was costly than any other source but it definitely had unmeasured social benefits.

NESPAK (1991) reported that the achieved crop intensities will be very low compared to the set targets. These ranged from 22 to 29% at dams in Punjab against an average target of 84%, where as, in NWFP it ranged from 33 to 39% against a target of 81%.

Iqbal and shahid (1992) concluded that less than one third of the proposed area was being irrigated by small dams. Therefore, desired changes in cropping pattern

could not be accomplished. They suggested weekly rotational schedule/ wara bandi in which equitable and reliable distribution of water could be made possible. Agriculture extension service was required to motivate farmers to bring about desired changes in cropping pattern and adopt recommended practices.

Bennie *et al.* (1994) reported that in arid and semi-arid areas, 60 to 85% of the rainfall evaporates from the soil surface before making any contribution to production.

Azhar (1995) reported that in Pakistan, farmers were unaware of the irrigation scheduling for their crops. 75% of the farmers apply less water than the crop water requirements, two third of farmers apply first irrigation very late. Farmers were unaware of the consequences of the delayed irrigation. The delays in irrigation negatively affect the wheat yield. A delay in irrigation after 30 days could cause yield reduction of 30Kg/ha per day.

Shahid *et al.* (1996) reported that the Small Dams Organization has been quite successful in achieving construction related physical targets of the small dam projects. However, follow up activities after dams' construction have been weak. After dam construction, efforts should be made to bring culturable command area under irrigation, which ultimately could contribute towards better quality of life and living standards of rural community. They considered a slight shift in cropping pattern towards the high value crops including rabi fodder, rabi and kharif vegetables as a

positive contribution of small dams project at both newly built and rehabilitated small dams.

Cheema and Bandaragoda (1997) conducted base line survey for farmers organizations of Mirwal and Shahpur dams. The cropping and land use intensities were 123.4 and 63.5 under the ittigated area of Mirwal dam, respectively whereas these were 117.7 and 90 % at Shahpur dam, respectively. Iqbal (1989) reported cropping intensity of 121.3% in the irrigated area of Shahpur dam.

Directorate of Soil Conservation (1997) reported that the barani area always suffered from shortage of water.Under the project 323 mini dams and 693 ponds were constructed and about 9000 acres has been brought under irrigation. These mini dams and ponds were being utilized for irrigation and fish farming. With the development of water resources and through other soil and water activities the farmers were getting an increased income of Rs. 51.00 Million, also the value of the land had been increased.

Bhutta (1999) suggested that to fully exploit the benefits of additional investment made at small dams in the form of improved irrigation network, not only the share of high value crops in the cropping pattern should be improved, but some non-traditional crops may also be introduced.

IIMI (1999) reported that the small dams system offered a precious opportunity for the sincere promotion of reforms in the irrigation sector. They will be independent of the large scale Indus Basin irrigation System and therefore, more easily manageable by smaller units of water users organizations and support service personnel.

Tarar (1999) suggested that changing the water distribution practices from the existing natural co-operation basis to weekly rotational schedule by giving share according to the size of land holdings in which water could be made available to every farmer in the command area according to his weekly turn

Asianics Agro-Dev. International (2000) reported that half of the world's dams were built exclusively or primarily for irrigation, and an estimated 30 to 40% of the 270 million hectares of irrigated lands worldwide rely on dams. Dams were estimated to contribute to 12-16% of food production.

Botha *et al.* (2003) concluded that the use of mulch in the basins reduced evaporation significantly, contributing to the increase in yield, by 30 to 50%, compared to production under conventional tillage.

Ogbeide *et al.* (2003) reported that communities that host small dams have risks imposed on them and pay unwarranted and unacceptable costs of the benefits derivable from the small dams.

Mugabe *et al.* (2003) reported that water resource development and management are concomitant. Without proper management; the water resource developed can be lost without playing a significant role in the crop production and socio-economic development of the area. Proper management requires adequate knowledge of water availability, water requirement and productive water use.

Beukes (2004) reported that irrigated agriculture draws water mainly from dams and water transfer schemes between catchments on which the retention of sufficient runoff has been ensured

Renfro (2005) reported that improved soil moisture will open new opportunities for diversifying farming activities in rain-fed areas. Due to the watershed programs cropping intensity will be increased significantly and it is observed that cropping intensity is increased by 13-25%.

Chapter 3

MATERIALS AND METHODS

3.1 SURVEY SCHEDULE

3.1.1 Informal Survey

Informal survey was conducted through checklist to verify different concepts at farms level, which were mainly: level of water use on dam, dam condition, and the research system applied on that site.

3.1.2 Questionnaire Formation

Through informal survey, based on title and in the light of objectives of study the questionnaire covering important aspects of output and input costs components was prepared and was tested in field for accuracy. During pre-testing there was observed some flaws and complications in questionnaire, those were removed in final questionnaire given in Annex-4. Then formal survey was conducted.

3.1.3 Formal Survey

Formal survey was conducted in September 2007, through which information about different aspects of Dharabi dam command area like resource farmer interview, crops and livestock were collected.

3.1.4 Selection of Respondents and Collection Of Data

The primary data pertaining to the gross margins of the command area of Dharabi dam from two villages (Kalar kahar & Chak Khushi) were collected on the basis of stratified random sampling. Data was collected by making two categories of farmers. First, farmers using dam water (irrigated), second, farmers from control area (rainfed).

The sample size for study was 60 as mentioned in Table 4. Farmers from both categories were selected randomly. The data was collected through face to face interview with each individual farmer. Questionnaire was in English language (Annex-4) but questions were interpreted in local language for farmers and exact reply was written instantaneously.

Table 4 Categories of farmers

Categories	No. of farmers	Sample farmer percentage
Irrigated	30	50%
Rain fed	30	50%
Total	60	100%

The data thus collected was sorted out, tabulated and enterprise budgets were prepared and gross margins were calculated for the purpose of analysis.

3.2 CALCULATION OF GROSS MARGINS

Gross Margin at Enterprise level

Enterprise gross margin was calculated by enterprise gross income minus the variable expenses attributable to that enterprise. In order to calculate gross margins, budgets were prepared at enterprise level for different crops and livestock in both the villages.

Revenues from out put and costs of different variable inputs used were calculated. Gross Margins were calculated at average sample size level by taking a difference in the activity per unit revenue and per unit variable cost.

Gross Margin at Farm Level

Gross Margin at average farm level was calculated by different area allocation to different enterprises multiplied by Gross Margin / unit area.

Economic techniques used

The Economic techniques used were:

- Enterprise Budgeting
- Whole farm Budgeting
- Marginal Analysis

Estimation of activity variable costs, revenues, and gross margins

The total cost of the variable input used to produce one unit of each enterprise consists of money costs and opportunity costs. The opportunity costs were estimated for the operations performed by owned farm machines, family labour and farm inputs (Farm yard manure and seed). The money costs were paid for inputs like fertilizer, herbicide, insecticide, fuel, improved seed, casual hired labour, picking and transplanting. The total variable costs to produce an activity x j were measured as

$$cj = \sum_{i=1}^{k} \sum_{t=1}^{T} Pijt \qquad aijt$$

Where pijt is the unit price of the ith variable input applied to activity xj in time period t ; aijt is the amount if ith input used by activity xj in time period t ; the subscript t = 1,….T identify the time intervals with in the activity's production period

The revenue earned by production activities is the type and quantity of outputs, and their market price. The types of output per activity were categorized into main product and by product. Given the prices received for each output; the total revenue earned from each unit of activity x j was measured as

$$rj = \sum_{n=1}^{N} \sum_{t=1}^{T} Pnjt \qquad Ynjt$$

Where pnjt is the unit price of the nth output of activity j in time period t ; Ynjt is the yield of the nth output produced from one unit of activity j in time period t ; and n = 1,…,N denotes the outputs.

The contribution of each enterprise to farm profitability is that activity's gross margins; that is the difference between an activity's per unit revenue and variable input costs per unit, computed as

$$\mathbf{Gj = rj – cj}$$

Where r j is an activity's per unit revenue and c j is an activity's per unit variable input

3.1.4 LIMITATIONS OF THE STUDY

The general limitation confronting almost every developing country in the field of research today is the lack of understanding and appreciation of the practical utility of the research endeavors on the part of the sampled respondents, along with a common mistrust in the research agency for fear of tax levies etc.

For the sake of drilling into the minds of the farmers the clear purpose and objectives of the study, they had to be explained not to conceal the facts. They had to be assured that the researcher collecting the data belonged to the PMAS Arid Agriculture University, Rawalpindi and were in no way involved in the tax estimation and would keep all information supplied by them as highly confidential.

Lack of proper record also turned out to be a serious difficulty in collecting the accurate data. The researcher then had to partially depend upon farmer's memory. Hence some degree of error can be present.

Chapter 4

RESULTS AND DISCUSION

This chapter analyses the farm household characteristics, farm household assets, farm characteristics, farm inputs, farm outputs, production possibilities and household's income.

4.1 FARM HOUSEHOLD CHARACTERISTICS

A farm household was defined to include all those individuals who operated at farm holding and their dependants who lived for at least three months at the house in a village (Iqbal, 1989). Farm household characteristics deal socioeconomic conditions with family size, age distribution, educational status etc of the respondent farmers.

4.1.1 Village profile

To explore the existing system, an exploratory survey has been conducted in the area of Dharabi watershed. A comprehensive questionnaire has been prepared covering about all aspects of watershed communities like availability of basic facilities, demography, land and land use pattern, agricultural production, agricultural machinery, soil, water, rangelands utilization, marketing and labor etc. The questionnaire was processed through a series of consultative process and interactive sharing with experts and specialists in national agricultural research institutes like

PARC, BARI, SAWCRI and Project coordinator. After survey of the area data has been collected through focused group discussion with communities from 10 districts.

4.1.2 Nature and Location of Off Farm Work

It is important to study the nature and location of off farm work because it indicates the type and level of employment available within village (Iqbal, 1989). It was observed during survey as given in Table 5 that about 12 and 24 percent of the adult male members of respondent farmers were participating in off farm work in both irrigated and rain fed areas. It might be due to inadequate work for them on their farm. Off farm work includes casual non-farm work, government service and private Service.

It was clear majority of the workers were working outside the village which indicates less availability of employment opportunities in the village. People in this area had a trend of government services. Also some people were engaged in different kinds of jobs in the adjoining villages.

4.1.3 Family Labour

Farmers' economic conditions do not allow them to hire labor on permanent basis. Therefore it was observed during survey that farmers used their family labor partly for on farm and partly for off farm work to supplement their income. All family members of respondent farmers including male, female and children were also engaged at different levels in different cultural practices all round the year, Farmers,

Table 5. Number Of Off Farm Workers

	Irrigated	Rainfed
Total No of Family members	287	223
Off farm Workers	35	55
Percent of off farm work	12%	24%

poor economic conditions, large family size and small land holdings were possible reasons for employing family labor instead of permanent hired labor.

4.1.4 Access to Institutional Support Services (Agricultural Extension Services)

The major purpose of agricultural extension service was to bridge the gap between the modern technology evolved at the research farms and that practiced by the majority of the traditional farmers. Agricultural Extension Department had employed the field staff for this purpose.

The field survey revealed that at Dharabi dam command area very few farmers knew about the agricultural extension services. It might be owing to both the farmers poor education level and inefficiency of the department of Agricultural extension. It means that construction of Dharabi Dam was not followed by supporting services of government institutions that was essential to better utilize the dam water.

4.2 FARM HOUSEHOLD ASSETS

It mainly deals with farm assets such as present value of land, farm machinery farm implements and livestock.

4.2.1 Farm assets

Land was the major item of the total farm household assets. The present per hectare value of rainfed and irrigated land was reported to be about 357890/- and 537120 rupees respectively.

4.2.2 Farm Machinery

Farm machinery is in too much use in barani areas as a means to get higher production as well as a time saving technique. The size of land holdings in barani areas is small. In barani areas the farming is done on subsistence level, that is why, mostly people are engaged in the off farm works too, and women have been given the responsibility to do farming. It makes more use of farm machinery in barani areas (Iqbal, 1989). The same trend was observed in the sample area. All the rainfed sample farmers were using tractor and tractor driven implements. It was observed during survey that the use of farm machinery was less in irrigated area as far as sowing of crops was concerned, as the farmers used broadcast method for sowing of different crops.

4.2.3 Livestock

Livestock is an important sector of agriculture in Pakistan and accounts for nearly 52.2 percent of agricultural value added and about 11 percent of the GDP. Its net foreign exchange earning of the country during the same period. The role of livestock in rural economy may be realized from the fact that 30 ~35 million rural population is engaged in livestock raising (GOP, 2008).

Livestock are an important source of motive power for land cultivation, milk and milk products. Almost every rural household maintained livestock in order to supplement their cash income (Iqbal, 1989). During survey it was observed that in village Kalar kahar mostly people had buffaloes and cows. Buffaloes were more in number in irrigated lands (average 1.5 buffaloes per irrigated former than 0.45 buffaloes per rain fed farmer) because of availability of fodder crops in former areas. People kept buffaloes to get milk and their dung for fuel. Livestock were handsome source of their cash income.

4.3 OTHER ASPECTS OF DAM CONSTRUCTION

The resource farmer interview (given in Annex-2) was asked from four responsible persons of the both the villages. It was about the community contribution in the planning construction and maintenance of Dharabi Dam.

4.3.1 Community Contribution In Planning

The construction of Dharabi small dam had been almost completed. The village community had forced to initiate the project. The government agencies prepared the design/outlay of the dam. The village community was not involved in any amendment in the outlay.

4.3.2 Community Contribution in Dam Construction

For construction village community provided labor to a large extent. Government financed the whole project. During construction employment opportunities were generated for the villagers on average 150 men worked per day.

4.3.3 Realization of Actual Plan

The estimated area to come under dam irrigation was about 6400 acres and about 2/3rd of the village communities were expected farm household beneficiaries from dam water in village Kalar kahar. At the time of study about half of the estimated area was under dam irrigation and about half of the households, beneficiaries from dam water. The other half households of the Kalar kahar village, even having their lands very close to the dam site, could not benefit from dam irrigation, except by using turbine engines. It was due to the reason that barani lands are not leveled in that area that is why the water distribution is not proper. It was observed that the dam had been construction at some more elevation the number of beneficiaries would have been more. The community could also get additional benefits by proper and organized warabandi.

4.3.4 The Maintenance of Water Supply Channels and Water Courses

Small Dam organization was mainly responsible for the maintenance of water supply channels. The contribution of community in the maintenance of dam and its peripheries was almost negligible. The maintenance status of the water channels was poor. The main reasons for poor condition of water channels were:

1. Improper look after by Government agencies and
2. Soil sedimentation and growth of grasses in water channels.

4.4 FARM CHARACTRISTICS

Farm characteristic deal with salient features of farm, land distribution pattern land use intensity, soil types, fragmentation of land holdings, cropping systems, cropping intensity and Tenure status.

4.4.1 Salient Features of Farms

Production per unit area depends on size of the farm (Iqbal 1989). The main problem of the barani tract was that mostly there were small sized land holdings and fragmented that might reduce the total production of crops from these very fertile lands (Iqbal 1989). The same was true for both the villages. The land utilization pattern of sample farms by farm size in both the villages was given in Table. 6.

The data relating to the land utilization pattern of dam command area given in table 8 shows that in Dharabi dam command area, the average farm size was 3.12 ha, out of which 2.98 ha per farm was cultivated area. Of the farm the average size of rainfed area was relatively higher than average size of irrigated area. The average size of rainfed and irrigated lands were 2.17 and 1.97 ha respectively.

4.4.2 Land Distribution Pattern

The land distribution pattern of rain fed and irrigated lands in both the villages given in Table 7. The average size farm of less than 2 ha of land of irrigated area was greater than that of rain fed area. It as evident from the date that 75% of irrigated farmers and 48% of rainfed farmers had land holding less than 2 ha. The average size of farm of 2~5 ha and more than 5 ha land in fainfed area was greater than that of irrigated area. It was due to the reason that most of the sample respondents of irrigated area also had rainfed land holding in rainfed areas so the sample size for percent distribution of rainfed land was greater than that of irrigated area.

The sample size was large because most of the sample respondents of irrigated area also have rainfed land holding in rainfed areas so the sample size for percent distribution of rainfed land was greater than that of irrigated area.

4.4.3 Land Use Intensity

Land use intensity is defined as the ratio of cultivated area to the operational holdings and is expressed in percentage. The data relating to the land use intensity of both the villages was collected during the field survey and is presented in Table 7.
It indicates that the land use intensity of rain fed area was less than irrigated.

4.4.4 Soil Types

There can be four types of soils in the barani areas, namely, Lepara, Maira, Khunder & rocky (Iqbal, 1989). Lepara land is the best quality land and majority of the sample farmers of Dharabi dam command area had lepara land.

Table 6 Land Utilization Pattern of Sample Farms by Farm size

Land Utilization Pattern	Farm size (Ha)
Average size of Total land holding	3.12
Average size of cultivated land	2.98
Average sizes of uncultivated land	0.41
Average size of irrigatged land holidng	1.97
Average size of Rainfed land holding	2.17

Table 7 Land Use Intensity

Operational Holdings	Land use intensity (%)
Irrigated	51
Rainfed	32.5

4.4.5 Fragmentation of Land Holding

Fragmentation refers to the existence of a number of physically scattered parcels of land belong to the same operating farm unit. The sample respondents usually had fragmented land in the Dharabi Dam command area.

4.4.6 Cropping Systems

Cropping systems represents the percent allocation of different crops in an area (Iqbal, 1989). The cropping system of sample farmers was determined separately for irrigated part of dam command area and un irrigated (barani) part of dam command area by using the formula:

$$\text{Percentage allocation} = \frac{\text{Crop area}}{\text{Total rain fed / irrigated area}} \times 100$$

The percent area allocation to different crops in irrigated and barani lands is given in the table 8.

The data in table 8 shows that the percent allocation of area to different crops in irrigated area was 129% and that in the rainfed area, 65%. The results reveal that percent area allocation of irrigated area was almost double than that of the rainfed area.

4.4.7 Cropping Intensity

Cropping intensity is defined as the ratio between the area under crops and the area operated by the farmers and is reported as percentage (Iqbal, 1989). Cropping intensity was calculated separately for irrigated and rainfed areas. Iqbal and Khan (1991) had argued that cropping intensity of an area was influenced by soil condition, climate, and availability of labor, water and farm machinery. A higher cropping intensity indicated multiple cropping which could help in raising total revenue per cultivated acre. The data related to cropping intensity is given in Table 9

The table 9 showed that rabi cropping intensity of irrigated area was only 64.8%, it was very much less. As compared to this the irrigated Kharif cropping intensity was found to be 71.4%. It might be due to the fact that for irrigated Kharif crops in case water is not applied still there is rain and crop can grow well.

The kharif cropping intensity of rain fed lands was found to be low as 25.93%. It was due to the fact that in Kharif season farmers of rainfed area left fields fallow. The farmers fulfilled fodder requirements by grasses from fallow lands. The rainfed cropping intensity in rabi season was found to be 36.38%. It was due to the fact rainfed farmer take risk, prepares the soil if rain happens then they can get higher yields otherwise they will get something instead of nothing.

Table 8 Percent Area Allocation to Different Crops

Crops	Percent area allocation %
Crop in irrigated area	
Wheat	52.1
Sorgham	12.34
Maize	14.5
Ground nut	6.9
Millet	2.1
Canola	0.57
Reddish	1.12
Turnip	0.34
Spinach	0.51
Tori	0.01
Carrot	0.05
Cauli Flower	0.03
Okra	0.67
Tomotoes	0.72
Melon	0.13
Bittergourd	4.3
Onion/chillies	3.9
Tinda	0.05
Total crops in irrigated area	**100%**
Crops in Rain fed area	
Wheat	33.41
Sorgham	9.84
Gram	3.22
Maize	4.91
Ground Nut	7.43
Gram	3.24
Sesame	0.257
Total crops in Rainfed area	**65%**

Table 9 Cropping Intensity Of Irrigated and Rainfed Crops

	Rabi cropping intensity %	Kharif Cropping intensity (%)
Irrigated	64.8%	71.4%
Rainfed	36.38	25.93

4.4.8 Tenurial Status

Tenurial status is another variable which may affect the division of farmers for long term investment in the farm and adoption of improved farming practices (Iqbal 1989). The data regarding the tenancy status of Dharabi dam sample farmers indicated that 100% of them were owner operators.

4.5 FARM INPUTS USE

Farm input use and level of farm output have a direct bearing on farm income realized (Iqbal, 1989). This part section deals with the cultural practices and farm inputs use.

4.5.1 Cultural Practices

Appropriate tillage can contribute to better plant nourishment, which ultimately can result in increased crop production (Iqbal, 1989). The data relating to the average number of ploughing and planking are given in table 10

The average number of ploughing and planking varied from crop to crop. On an overall basis, the average numbers of ploughing per cropped hectare of rainfed area were higher as compared to that of irrigated one. It is due to the reason that rainfed farmers want to conserve moisture, so after monsoon rains they plough the soil many times to conserve moisture for next crop. Table 10 also shows that in irrigated areas of Dharabi dam command area, mostly farmers were also growing vegetables that require

smooth seed bed and as such number of ploughing and planking for vegetables were higher as compared to those for other crops sown in that area.

4.5.2 FARM INPUT

The main input used by the farmers of both the villages were farm yard manure, chemical fertilizers, see and seed rate, farm labor, irrigation for crops and feeding arrangement of livestock.

4.5.2.1 FARM YARD MANURE

Application of farmyard manure helps in improving the texture & fertility of soil. The doses of FYM are dependent on the farm size and livestock strength. About half of fertilizer requirements are fulfilled by FYM (Iqbal, 1989). The data on use of farmyards manure was collected on 40 kg basis. During survey it was observed that the use of farmyard manure was more in irrigated area and applied to most of the crops. It was due to the fact that farmers in irrigated area had more number of livestock. The amount of farmyard manure used in vegetables was generally higher. The amount of farm yard manure used in both irrigated and a rainfed area is given in Table 11.

Table 10 Average number of Ploughing and planking of crop per Hectare on Sample Farms

Crops	Number of ploughing and Planking in Irrigated area	Number of Ploughing and Planking in Rainfed area
Wheat	5	6
Maize	5	5
Sorghum	4	5
Groundnut	3	4
Vegetables	7	-

Table 11 Average Quantity of Farm Yard Manure (40 Kgs/ha) applied on sample Farms

Crops	Farm yard manure in Irrigated area (40 Kg/ha)	Farm yard manure in Rainfed area (40 Kg/ha)
Wheat	5.01	2.34
Maize	9.87	4.35
Sorghum	7.8	6.4
Groundnut	-	-
Vegetables	10.8-15.3	-

4.5.2.3 CHEMICAL FERTILIZER

Chemical fertilizer use has become a common practice among the farmers and they apply some quantity of fertilizers to their major crops, either at the time of sowing or at any other appropriate stage. As a result of this higher crop output could be obtained. Dose of fertilizer applied can vary with fertility status of the soil, farmer's knowledge and their financial resources (Iqbal, 1989). The dose of fertilizer was computed in terms of nutrient kilograms per treated hectare. The chemical fertilizers, which were in common use of sample farmers of both of the villages were urea, DAP. The average quantity of chemical fertilizer (Kg/ha) applied on irrigated and rainfed farms is given in Table 12.

The comparison among crops of irrigated and rain fed areas showed that the use of chemical fertilizer in terms of nutrient kilograms per treated hectares was more in case of irrigated areas except for sorghum. The use of chemical fertilizer was much higher in vegetables as compared to other crops. It was due to the reason that more water was available to irrigated formers they were getting more yield, and grow vegetables on commercial bases.

Table 12 Average Quantity of Chemical Fertilizer (Kgs/ha) applied on sample farms.

Crops	Chemical fertilizer in Irrigated area (Kg/ha)		Chemical Fertilizer in Rainfed area (Kg/ha)	
	N	P	N	P
Wheat	69.1	52	36.7	27.8
Maize	112	52.5	45	20.5
Sorghum	106.7	-	145	-
Groundnut	-	-	-	-
Vegetables	114.1-170	66-115.3	-	-

Table 13 Average Seed rate (Kg) of crops on sample farms

Crops	Average seed rate in irrigated area (Kg/Ha)	Average seed rate in Rainfed area (Kg/Ha)
Wheat	170	107
Maize	32.6	57
Sorghum	94.5	119.2
Groundnut	98.1	116
Vegetables	4.25~6.25	-

4.5.2.3 Seed and Seed Rate

The use of certified seeds was not a practice in this area probably mainly owing to lack of extension services and low literacy rate. Farmers in Dharabi dam command area were reported to use domestic seeds for rabi and kharif crops and purchased seeds for vegetables.

The seed rate used by farmers for wheat in irrigated area was higher than that in rain fed. It was thus because farmers in irrigated area used broadcast method for wowing of wheat while farmers in rain fed area used drill for this purpose. The seed rate for other crops in rain fed area was generally higher as compared to irrigated ones, because due to doughtiness and lack of proper moisture the chances of seed germination are less in rain fed area than in irrigated one.

4.5.2.4 Irrigation

Main purpose of Dharabi dam was to irrigate the crops. Adequate availability of irrigation facilities was essential to obtain higher crop yield. The main irrigation method from Dharabi dam, was through water channels and water courses network. Water distribution among farmers was done through warabandi. Farmer used water on their turn. Land leveling is an important factor, which determines the irrigation method. The lands of this region were not well leveled, some being at high level and others at low level reveling distribution of dam water through ordinary water course / channels are inefficient method of water distribution.

Adequate availability of irrigation facilities is essential to obtain higher crop yield. The information relating to the average number of irrigations applied to various crops was collected during the field survey and is presented in table 14.

During the survey a discrepancy was observed for some crops like maize and some vegetables among the number of irrigation applied by sample farmers and those recommended by the Department of Agriculture, Government of the Punjab, Lahore. This discrepancy might be attributed to inadequate extension services in the area.

The water from Dharabi dam is not used for drinking purpose. It is used domestically by households for washing clothes etc. However, its main purpose is to irrigate the crops. Other source of irrigation in Dharabi dam command area was hand pump.

4.5.2.4a Water Rates

The water rates paid by farmers of Dharabi dam command area are given in the table 16.

Table 14 Average Number of Irrigations applied to various crops

Crops	Average Number of Irrigation / season
Wheat	5
Groundnut	2
Maize	07
Sorghum	04
Onions	11
Chilles	15
Tomato	12
Reddish	14
Spinach	13
Garlic	09
Potato	11
Okra	09
Turnip	14

Table 15 Recommended Average Numbers of Irrigations

Crops	Recommended
Wheat	4~5
Maize	5~6
Groundnut	5~6
Berseem	10~12
Vegetables	10~12

Table 16 Water Rates for Different Crops

Crops	Water rates
Wheat	256
Maize	212
Groundnut	196
Berseem	154
Vegetables	558

4.5.2.5 Farm Labour

Family members were generally carrying out farm work while some causal labour was hired at the time of crop harvest and also for other activities like irrigating the fields, interculture and pesticide sprays. The employment of permanent hired labour was found to be negligible. Time spent by family labour, causal hired labour and permanent hired labour in form activities was converted into the opportunity cost.

4.5.2.6 Livestock Feeding Arrangements

The forage source for livestock varies from season to season. Mostly all the barani farmers used maize and sorghum (Jowar) as kharif fodder and oilseeds used as rabi fodder. Cotton seed cake and wheat bran were major type of concentrates used for livestock. The feeding cost of livestock on irrigated and rainfed sample farms is given in Table 17.

4.6 FARM OUTPUT

This part deals with the farm outputs of crops. This section also relates to the production and sale of milk.

Table 17 Feeding Cost of Livestock on Sample Farms

Type of Fodder	Irrigated areas Feeding cost in Rs.	Rainfed areas Feeding cost in Rs.
Rabi fodder	15500	10400
Kharif Fodder	9668	7250
Straw	72500	5910
CSC	6100	5560
Health Treatment	1800	1250
Wheat grind	1450	1050
Other feed expenditure	1200	750
Gur / raw sugar	450	690
Total cost	108668	32860
Cost per animal unit	7842	7520

A data shows that feeding cost per adult animal unit was significantly higher on irrigated area as compared to rain fed area.

4.6.1 Crop Yield

The data on average yield of various crops in overall dam command area, is presented in table 18.

A comparison of the data given in table reveals that the average yield of major crops was significantly higher on irrigated part of the dam command area than that of rain fed one. This may be attributed to higher fertilizer dose (table 15), and access to dam water in the irrigated part of the dam command area.

4.6.2 Average Prices Received For Crops

The data regarding the average prices received for crops during the study period was also collected during the field surveys and is presented in Table 19.

The data shows that the average prices of vegetable were relatively higher as compared to other crops except groundnut

TABLE 18 Average Yields of Major Crops on Sample Farms

Crops	Average Yield in Irrigated areas (40Kg/ha)	Average yield in Rainfed areas (40 Kg/ha)
Wheat	50	37.34
Maize	71.14	30.03
Sorghum	158	98.8
Groundnut	69.16	59.28
Vegetables	158-198	

Table 19 Average Prices (Rs. 40kgs) of Various Crops

Crops	Price (Rs/40 Kgs)
Wheat	800
Maize	500
Sorghum	70
Groundnut	2000
Vegetables	500~1900

4.6.4 Main Marketing Problems

The following were reported to be the main marketing problems in the Dharabi dam command area.

1. The farm to market roads was absent either or in non metaled form. It kept farmers from sending their product to market at proper time and in large quantity.
2. There was no bridge on nalla manda and farmers had to face difficulty to cross it without proper transportation.
3. There was no proper transportation facility available in the area.

4.6.5 Milk Production, Consumption and Sale

Buffaloes, cows, goats and sheep all contribute to milk production. In farm enterprises, milk production supplements and stabilizes farm income. Milk is also an important component of human diet. According to the house hold and income expenditure survey 2004, the average consumer spends one fourth of his food budget on milk. The data regarding annual production, consumption and sale of milk on sample farms was collected during field survey and presented in table 20

Table 20 Milk Production, Consumption and Sale of milk (kgs) on sample farms

Mile production	Liters per animal
Irrigated	2300
Rainfed	1950

The farm house hold consumed about 60-70% of the total milk production where as the remaining production was sold out to supplement their income. The comparison indicates that irrigated farmers had higher milk production as compare to the rain fed. It might be due to better feeding of animal at irrigated farms.

4.7 FARM AND HOUSEHOLD INCOME

4.7.1 Gross Margin Analysis

Gross marginal analysis is a technique, which assists farm managers when calculating profitability of alternative plans. Gross margin may be define as returns above variable costs, and are expressed per unit of some common resource (per hectare or per head of animal). It is a very useful measure of efficiency for both single activity farm business and multiple activity plans of a business. (Chaudhry *et al*., 1995).

To calculate Gross Farm Income firstly, enterprise budgets were prepared. For enterprise budgets returns and costs of different enterprises were calculated, in estimating the returns from an agricultural enterprise or a production system, an important distinction is drawn between variable and fixed cost. The market value of

the produce (and that of any by-product) of a production system is defined as its output. Normally this value is based on prices of the farm. When the variable costs are subtracted from the estimate of the output, the remainder is called the Gross Margin (Chaudhry *et al*., 1995).

The difference between the output and the variable costs, usually calculated on per acre or per hectare basis, is a very useful measure of the performance of an enterprise and the contribution that it can make to farm income or profitability.

Gross margin at average farm level was calculated by different area allocation to different enterprises multiplied by Gross Margin / unit area. The gross margins of crops at farm level are presented in Table 21 prices used for different crops to calculate outputs is given in Annexure 3.

The value of Gross margin per unit area/ha of irrigated and rainfed crops were 18152.44 and 15837.28 rupees, respectively. Thus, irrigated crops fetched more returns than rainfed crops. The calculation of gross Margin and other performance indicators for livestock enterprise follow essentially the same principles as for cropping enterprises. The value of output per unit farm of buffaloes and cows is given in table 22.The value of output per unit of irrigated livestock was higher than rainfed ones. It was due to the fact the availability of fodder to irrigated livestock's

TABLE 21 GROSS MARGINS OF CROPS AT FARM LEVEL

Crops	Observed Average	Gross Margin	Gross Return
	Area allocation Ha)	Per unit area/ha	At Farm Level
Irrigated Crops			
Wheat	2.23	13456	30006.9
Soghum	0.43	13025	5600.75
Maize	0.51	20456	10432.6
Groundnut	0.26	69540	18080.4
Berseem	0.17	1913	325.21
Raddish	0.04	31567	1262.68
Turnip	0.06	23456	1407.36
Spinach	0.02	14321	286.42
Carrot	0.002	25613	51.226
Cauliflower	0.0048	24367	116.962
Tori	0.005	23416	117.08
Coriander	0.001	2130	2.13
Okra	0.03	43521	1305.63
Tomatoes	0.02	36781	735.62
Melon	0.03	24367	731.01
Bitter gourd	0.01	21456	214.56
Onions	0.19	10987	2087.53
Chilies	0.12	14356	1722.72

Garlic	0.08	23222	1857.76
Tinda	0.009	32781	295.029
Brangil	0.0006	12233	7.3398
Total	4.2224		76646.9
Irrigated GM per unit Farm			18152.44
Rainfed crops			
Wheat	1.24	10231	12686.44
Sorghum	0.51	4567	2329.17
Maize	0.11	7685	845.35
Groundnut	0.25	61238	15309.5
Gram	0.16	29876	4780.16
Total	2.27		35950.62
Rainfed GM per unit farm			15837.28

Table 22 Value of Output per Unit Farm of Buffaloes and Cows.

Livestock	Value of output in irrigated area in rupees	Value of output in Rain fed area in rupees
Buffalo	91400	48725
Cow	61433	43200

4.7.2 Nature of Farm Costs

Farm costs include cash cost and imputed cost. Cash costs are those costs which are met “Out of pocket’. The items included in the cash cost are seed, fertilizer, farm yard manure, causal labor hired, permanent labor, threshing, payment to artisans and livestock rearing (Iqbal, 1989).

Imputed cost is defined as the cost for which no cash expenditure is incurred; instead these are met by using resources already available with the farm household. Imputed costs include the imputed wages of family workers, rental value of land etc (Iqbal, 1989). In the study the costs of family labor, rental value of land, irrigation labor, and additional labor from time to time for different activities were used as imputed costs.

The cost per unit of crops of irrigated farm is higher than rainfed farm. It was due to the more usage of inputs. The average annual cost per unit farm of irrigated and rainfed crops were found to be 21569.52 and 13466 rupees respectively. The cost per unit of animal of irrigated and rainfed areas presented in table 23 was also calculated by same procedure.

Table 23 Average annual Cost per Unit Sample Farm

Crops	Observed Average	Cost	Cost
	Area allocation HA	Per unit area/ha	At Farm Level
Irrigated Crops			
Wheat	1.31	24567	32182.77
Soghum	0.43	8678	3731.54
Maize	0.51	13426	6847.26
Groundnut	0.26	9658.5	2511.21
Barseem	0.17	12453	2117.01
Raddish	0.04	22345	893.8
Turnip	0.06	24537	1472.22
Spinach	0.02	21987	439.74
Carrot	0.002	18617	37.234
Cauliflower	0.065	19876	1291.94
Tori	0.005	9768.6	48.843
Coriander	0.001	6745	6.745
Okra	0.03	20567	617.01
Tomatoes	0.02	36781	735.62
Melon	0.03	14678	440.34
Bitter gourd	0.01	21456	214.56
Onions	0.19	53261	10119.59
Chiliies	0.12	67545.2	8105.424

Garlic	0.08	6931	554.48
Tinda	0.009	16782	151.038
Brangil	0.0006	18796	11.2776
Total	3.3626	449455.3	72529.65
Cost per unit Farm			21569.52
Rainfed crops			
Wheat	1.24	9125	11315
Soghum	0.51	4567	2329.17
Maize	0.11	7685	845.35
Groundnut	0.25	61238	15309.5
Gram	0.16	29876	4780.16
Total	2.27	113597	35950.62
Cost per unit farm			13466

Table 24 Cost of per Unit Animal of irrigated and Rainfed Farms

Livestock	**Cost per unit animal in irrigated area**	**Cost per unit area in Rainfed area**
Buffalo	6542	6231
Cow	4131	3980

Table 25 Whole Farm Budget

Enterprise	Irrigated		Rainfed	
	Benefits	Costs	Benefit	Cost
Crops	34582	28634	16724	9865
Livestock	168568	12462	106542	14580
Whole Farm	186524	56420	124580	19040

The cost per unit animal of irrigated area for buffalo and cow was higher than rainfed ones.

4.7.3 Whole Farm Budget

The farm budget is a physical and financial plan for the operation of the farm for some period of time. The total farm budget is prepared as an aid in organizing the entire farm business.

In whole farm economic analysis, the farm is considered as complete entity. The whole crop and livestock production programme is reviewed and the use of farm resource is considered on an overall basis. This type of analysis is undertaken to show the anticipated consequences, in terms of selected measures of performance, of some proposed farm plan. The costs and returns analysis accounts cash and non cash costs as well as both fixed and variable costs (Chaudhry et al., 1995). The whole farm budget was prepared by adding the benefits of crops and livestock of irrigated area and also the costs of crops and livestock of irrigated area. Same was adopted for the calculation of whole farm budget for rainfed area. The whole farm budget of irrigated and rainfed farms are presented in Table 25

In whole farm budget the costs and returns of irrigated area, both are greater than rainfed ones

4.7.4 Benefit Cost Ratio

It is a profitability indicator, which expresses the relationship between the sum of net benefits and capital costs over the life of the project. It is in fact, a form of input output analysis that is useful for on farm trails. Cash and non cash costs and benefits are included in deriving appropriate ratios (Chaudry et al., 1995).

To calculate the benefit cost ratio, the benefits and costs of irrigated crops and livestock were added, respectively. And then ration of benefit to cost was calculated. Same procedure was adopted for rainfed ones. The benefit cost ration of crops and livestock are in Table 26 and 27 respectively

Here, it was observed that the output level in relation to input use level was lower for irrigated farms.

The same procedure was adopted for livestock as that for crops. The benefit cost ration of irrigated livestock was higher than rainfed one. The difference of benefit cost ration of irrigated and rainfed buffalo was significant. The benefit cost ration of irrigated as 14.06 and was found greater than rainfed buffalo 7.10.

Table 26 Benefit Cost Ratio of crops (per Farm unit)

Crops	Benefit	Cost	B/c Ratio
Irrigated	42568	34354	1.2359
Rainfed	24731	18765	1.3145

Table 27 Benefit Cost Ratio of livestocks (per Farm unit)

Livestock	Benefit	Cost	B/C Ratio
Irrigated Buffalo	105412	9784	10.77
Rainfed Buffalo	56785	6586	7.10
Irrigated Cow	56435	4120	13.69
Rainfed cow	46780	4230	11.06

4.7.5 Marginal Analysis

The purpose of marginal analysis was to reveal just how the net benefits from an investment increase as the amount invested increases. An easier way of expressing this relationship is by calculating the marginal rate of return. This is simply the marginal net benefit divided by the marginal cost expressed as a percentage. The marginal analysis is a highly useful measure of judging and ascertaining farmer's acceptability of new innovations at the farm level. The marginal rate of return of Dharabi dam is presented in Table.28

$$MRR = \frac{\text{Incremental NB}}{\text{Incremental TCV}} \times 100$$

$$= \frac{65078}{13468} \times 100$$

$$= 483\%$$

This means that for every Rupee invested in the application of dam water facility, farmers can expect to recover Rs. 1 and also obtains an Additional Rs.4.83.

4.7.6 Total Household Income

Total farm income is the most commonly used measure of economic performance of the farm. The total farm households income was calculated by the addition of gross margins of crops and livestock (obtained by enterprise budgets) and also the off farms income for both irrigated and rain fed areas. The average annual total household income of users and non users is given in the table 29

The total household income of irrigated area is much greater than rainfed area. Livestock contribute about 80% and 83 % in total farm income in irrigated and rainfed areas, respectively in the study area. The off farm income share of rainfed area 2.97% was more than irrigated one 2.85.

4.7.7 Average off farm household income

The off farm households receive their income from professional and non professional sources. Professional source includes artisan income, while non professional source comprised of income from farm labor, non farm labor government service, private service and livestock rearing. The average off farm household income is also included in the total household income.

Table 28 Marginal Rate of Return

	Irrigated	Rain fed	Differences
Benefits	167546	102468	65078
Costs	31486	18018	13468

Table 29 Total Household Income

Enterprise	Irrigated		Rainfed	
	Household income (Rs.)	% share	Household income (Rs.)	% share
Crops	38981	19.4	19217	15.8
Livestock	156732	77.4	97685	80.5
Off farm income	6543	3.2	4356	3.5
Total	202256		121258	

SUMMARY

Barani area can play a significant role in attaining self sufficiency in food. However, water is a limiting factor for agriculture development in these areas. Therein agricultural production mainly depends upon the nature and extent of rainfall. Nevertheless, there is high potential for the development and management of water resources in these areas. Crop yield could be increased manifolds by adopting proper water resource development and management practices. Water resource development and management are concomitant. Otherwise, the water resource developed would be lost without playing a significant role in the crop production.

Keeping in view all these problems, small Dam Organization constructs 50 small Dams in Barani tract under four different projects. ICARDA (International Centre of Agriculture in Dry Areas) is doing applied research on enhancing water productivity on Dharabi dam in District Chakwal. With the collaboration and financial support of ICARDA the present study on Production Possibilities in catchment areas, Tehsil Kalar Kahar, was carried out.

For the purpose of the study, the farmers were divided into two categories irrigated and rainfed farmers. The data on different aspects to calculate Gross Margin from both categories was collected on comprehensive Questionnaire.

From the survey farms, it was found that the irrigated farm seems to be enjoying more water advantages over the rain fed because of availability of water. The analysis by different categories of farmers did not reveal any considerable difference in respect of general education, technical education and experience. It was observed that people in this area have trend for government services. The socio economic conditions of the village Chak Khushi not up to mark. The educational facilities available were only up to elementary school level for both girls and boys. The basic infrastructure and basic facilities like post office, bus stand, hospital electricity, telephone, sewerage system etc were not available in the villages of the study areas.

The average irrigated land holding and rainfed landholding was 1.97 ha and 2.17 ha respectively, about 75% irrigated land and 48% of rainfed land was found less than 2 ha. The land holdings in both the villages were fragmented.

Rabi and Kharif cropping intensity of irrigated area were found to be 64.8% and 71.4% respectively. Land is the major item of the total farm household assets. The present worth value of irrigated land is almost double than the rainfed land. It was observed that livestock were the handsome source of the cash income of the people of the village Kalar kahar (irrigated).

As far cultural practices, average number of ploughing and plankings of rainfed lands were more than the irrigated ones. To conserve moisture numbers of ploughing were more in rainfed area. The other inputs like chemical fertilizer, Farm Yard manure

was found to be applied in greater amount in irrigated area than in rainfed one. The farm yard manure applied to irrigated wheat was 5.01 m/ha and 2.34 m/ha to rainfed wheat.

The chemical fertilizer N and P applied to irrigated wheat was 69.1 and 52 Kgs/ha, respectively and 36.7 and 27.8 Kgs/ha, respectively in rainfed area. The irrigation method in irrigated area from Dharabi dam was through water channels and water courses network, Hand pump was the water sources other than dam water in both the villages.

Average yield of major crops in irrigated farms was found to be more than that in rain fed. The more yield of irrigated farms was due to availability of dam water. The wheat in irrigated area was found to be 50 m/ha and 37.7m/ha in rain fed area. The irrigated farmers cultivate vegetables on commercial basis and it proved to be strong source of income. The yield of vegetables was found to be 160~190 m/ha in irrigated area. As far as marketing of crops was concerned the farmers sold their product to nearly markets. There were some problems faced by farmers while doing marketing, as these was no metaled and not any other efficient source of transport present in the respective area.

The value of out put per farm of crops and livestock of irrigated farms was found to be significantly more than rainfed. For irrigated crops the value of out put per unit farmer was found Rs. 18152.44 and for rainfed farm it was 15837.28. The value of output per unit farm of livestock's in irrigated area was found to be Rs. 152833 and in

rainfed area it was Rs. 92925. The cost of per unit farm of crops and livestock was found to be more irrigated farm than in rainfed farms. The cost per unit of irrigated crops was found to be Rs. 21569.52 and for rainfed it was Rs. 13466. For livestock's in irrigated area the cost per unit animal was found to be Rs. 10673 and for rainfed area it was found to be Rs. 10221. It might be due to fact the usage of input was more in irrigated farms.

The average annual total house hold income of irrigated farms was found to be more than that of rainfed. The total household income of irrigated area was Rs, 186124 and for rainfed it was found to be Rs. 124580. It was found out that the livestock's contribute about 80% of the share of the total household income in irrigated area and in rainfed area they contribute about 83%. In rainfed farms the percentage share of off farm income about 2.97% was found to be more than irrigated farms which was about 2.8%.

CONCLUSION

There is need for research in the barani (rainfed) area of Pakistan to diagnose factors limiting productivity and to develop recommendations that can be adopted by farmers to improve productivity. Past research has often not provided recommendations that are relevant to farmers of the area. They have generally been developed without economic analysis to determine the most profitable and least risky practices. Moreover recommendations have not considered differences in land type, rainfall and crop rotation in the area and have provided general recommendations to cover the entire region. In addition, the recommendations provide a complete package of technology, which is very costly for farmers to adopt. Given these deficiencies of research, and poor extension services, it is not surprising that many farmers have not adopted the recommendations being provided by research and extension.

It was observed during study that farmers in both the irrigated as well as the rainfed must shift from conventional crops to high value crops. They must start farming on the commercial basis. They can increase their income by an appreciable amount by commercial farming of vegetables. As they have opportunity they can send their product to nearby Islamabad urban market.

Government authorities must take care for the maintenance of dam structure and watercourses network. In order to meet the safety requirements a program of periodic inspection of dam should be introduced in Dharabi dam command area.

The area adjoining to the dam sites where water of Dharabi dam was not available. Lift irrigation scheme or system should be provided so that number of beneficiaries of dam water can be increased.

There is need for proper agricultural extension service in the command area of Dharabi dam that they bridge the gap between the modern technology involved at the research farms and that practiced by the majority of the traditional farmers through massive transfer of technology. Proper agricultural extension service can provide guidance to farmers how they can maximize the profit by increasing the output level and decreasing input use level.

The sampled farmers in both the villages were generally found lacking in technical knowledge regarding crop production and livestock rearing, it thus clearly necessitates organizing training programs and strengthening of agricultural extension services through modern method. Majority of the farmers complained about the non availability of agricultural extension service. To fully exploit the benefits of additional investment made at small dams in the form of improved irrigation network, not only the share of high value crops in the cropping pattern should improve, but also some in traditional crops may also have to be introduced. This requires an enlightened and

imaginative extension service. Extension stall should be able to motivate farmers to bring about desired changes in cropping pattern and adopt recommended farming practices.

LITERARTURE CITED

Ashraf, M., F.U. Hassan, M. A. Khan (1999). Water conservation and its optimum utilization in barani areas. Journal of Science, Technology and Development, 18(1): 28-32.

Azhar A.M. (1995). Yields in canal command areas. Journal of Engineering and Applied Sciences. 4(1):109-116

Bennie ATP, Hofman JE, Coetzee MJ and Very HS (1994) Storage and Utilization of Rain Water in Soils for Stabilizing Crop Production in Semi-Arid Areas. (In Afrikaans). WRC Report No. 227/1/94. Water Research Commission, Pretoria.

Bhutta I.A. (1999). Achievments and issues in 20th Century in Small Dams (Rainwater Harvesting). In Proceedings of the national workshop on Water resources achievements and issues in 20th Century and challenges for the next millennium. Pakistan Council of Research in Water Resources, Islamabad-Pakistan, pp.64-69

Botha JJ, Van Rensburg LD, Anderson JJ, Hensley M, Machelli MS, Van Staden PP, Kundhlande G, Groenewald DG and Baiphethi MN (2003) Water Conservation Techniques on Small Plots in Semi-Arid Areas to Enhance Rainfall Use Efficiency, Food Security, and Sustainable Crop Production. WRC Report No. 1176/1/03. Water Research Commission, Pretoria

Chaudry, M. A., B. Ahmad and M. Sharif . 1995. Hand Book for Economic Analysis of Experimental Data. Agri. Social sciences Res. Centre, Faculty of Agri. Eco. and Rural Sociology, Uni. of Agri., Faislabad.p.23-28

Cheema and Bandaragoda D.J. (1997). Base line survey for farmers organizations of mirwal and Shahpur small dams, Punjab, Pakistan. International Irrigation Management institute.

Directorate of Soil conservation. 1997. A Brief on Second Barani Area Development Project.Directorate of Soil Conservation Punjab, Rawalpindi.p.15-16

GOP. 2008. Economic Survey. Govt. Pakistan, Finance Division, Economic Advisory Wing. Islamabad. 8.

Gujarati, D. N. (1995). Basic Econometrics New York: McGraw-Hill, Inc.

IIMI (1999). Social Organization for improved system management and sustainable irrigation agriculture in small dams (Inception report). International irrigation Management institute.

Iqbal, M.S. 1989. Bench mark survey of khokhar Zer/ Surlah Small Dams. Punjab Eco. Res. Inst., Lahore. Pub. No.254. 117

Iqbal, S. M and S. A. Khan.1991.An assessment of Agriculture Development in the existing Small Dams Command Area. Punjab Eco. Res. Ins., Lahore. Pub. No. 280. 53-75

Iqbal M.S., S.A. Shahid (1992). An Assessment of agricultural development in the rehabilitated small dams command area. Punjab Economic Research Institute, Lahore

Keller, A., R. Sakthivadivel and D. Seckler (2000).Water scarcity and the role of storage in development. International Water Management Institute (IWMI) research Report No. 39.

Khan M.J., M.A Khan, M. Shraf, S.A. Shahid (1998). Screening Survey of potential Small Dam Sites in Punjab. Punjab Economic Research Institute, Lahore Publication No.242.

Kidsom, A. (2003). An essay in Production Functions and Empirical study in Total Factor Productivity Growth, http://www.geocities.com/jeab_cu/paper/product.htm (assessed, 02/05/2003).

Macours, K., and Swinnen, J. F. M. (1997). Causes of Output Decline in Economic Transition: The Case of Central and Eastern European Agriculture. Department of Agricultural Economics Policy Research Working Paper, Katholieke Universiteit Leuven, Belgium.

MINFAL, (2008). Economic Survey of Pakistan, 2007-2008. Ministry of Food, Agriculture and Livestock, Government of Pakistan

Molnar, I. (1965). Production in Relation to Rainfall, Super phosphate and Erosion, Australian Journal of Agricultural Economics 9(2):169-175

Mugabe, F. T., Hodnett, M. G. , Senzanje, A. , 2003. Opportunities for increasing productive water use from dam water: a case study from semi-arid Zimbabwe. Agric. Water Manage. 62,149–163

NESPAK (1991). Evaluation of small dams in Punjab and N. W. F. P. Volume II − Part A-C, Govt. of Pakistan, Planning and Development Division.

Ogbeide H. E., E.Uyigue, S. Oshodin (2003) Socio-economic and Environmental Performance of Dams. Case Study of Ojirami Dam Nigeria.

Renfro, R. Z. “The value of participation in development- relevance to soil and water conservation”internetsite:http://www.adbi.org/files/the_value_of_participation_in_ development_keynote_final.pdf.(March 9, 2005)

Shahid S. A., M. Ashraf, K. Ata, Mazhar-ul-Haq (1996). Evaluation of Small Dams Project in Punjab. Punjab Economic Research Institute.

Tarar, R. N. (1999), Surface water achievements and issues in 20th century, Proceedings: National workshop on water resources achievements and issues in 20th century and challenges for the next Millennium, June 28-30, 1999, PCRWR, Islamabad

Annex-1

Cost of input Use

Particulars	**Unit**	**Wheat (Ha)**		**Maize(Ha)**	
		Irrigated	Rainfed	Irrigated	Rainfed
Deep Ploughing	No	-	1	-	1
Ploughing	No	4	3	2	2
Ploughing &Planking	No	2	3	1	2
Drill	No	-	1	-	-
Manure	40kg	6.98	3.24	14.75	5.86
Seed	Kg	172	118	34.6	63
Fertilizer N	Kg	76.1	42.36	124.6	48.64
P	Kg	55	34.5	56.8	24.8
Irrigation labor	Hr	6.9	-	6.7	-
Water rates	Rs	256	-	234	-
Land rent	Rs	14678	5698	14678	5698
Labor(Additional)	Day	40	40	-	40
Harvesting	Day/kg	149.33kg	149.33kg	40	60
Threshing	Day/kg	149.33kg	149.33kg	-	-
Interculture	Day	-	-	79	60
Labor (Thinning)	Day	-	-	-	60
		Sorghum		**Ground Nut**	

		(Ha)		**(Ha)**	
		Irrigated	Rainfed	Irrigated	Rainfed
Deep Ploughing	No	-	1	-	1
Ploughing	No	4	3	2	2
Ploughing & Planking	No	2	3	1	2
Drill	No	-	1	-	-
Manure	40kg	9.38	6.24	-	-
Seed	Kg	108.2	124.6	98.6	122
Fertilizer N	Kg	111	142.5	-	-
P	Kg	-	-	-	-
Irrigation labor	Hr	6.9	-	6.9	-
Water rates	Rs	256	-	234	-
Land rent	Rs	14678	5698	14678	5698
Labor(Additional)	Day	40	40	-	40
Harvesting	Day	60	60	60	60
Threshing	Day	-	-	-	-
Interculture	Day	-	-	40	40
Labor (Thinning)	Day	-	-	-	60

Particulars	Unit	Vegetables
Ploughing	No	4
Ploughing & Planking	No	3
Manure	40 kg	12.2.-14.8
Seed	Kg	5-6
Fertilizer N	Kg	110.5-182
P	Kg	70-120.2
Irrigation labor	Hr	7.24
Water rates	Rs	624
Land rent	Rs	14678
Labor(Additional)	Day	40
Harvesting	Day	40
Interculture	Day	40
Labor (Thinning)	Day	7.46
Plant protection measures	No	1.4

Annex-2

Yield of Crops

Particulars	**Unit**	**Wheat**		**Maize (Ha)**	
		Irrigated	Rain fed	Irrigated	Rainfed
Grain/Produce	40 kg	60	31.3	62.7	26.6
Straw/by product	40 kg	64.5	56.84	91.75	60.54
Thinning	40 kg	-	-	-	60.64
		Sorgham		Groundnut	
		Irrigated	Rainfed	Irrigated	Rainfed
Grain/ produce	40 kg	168	96.4	72.16	62.16

Yield of Vegetables

Particulars	Unit	Vegetables
GRAIN/Produce	40 kg	169-210

Annex-3

Prices of Enterprises (Crops and Livestock) to calculate Out puts

Enterprises	Prices
Crops	Prices in Rs 40/kg
Wheat	800
Maize	600
Sorghum	60
Ground nut	200
Berseem	90
Potato	600
Onion	1000
Carrot	300
Cauliflower	420
Tauri	400
Okra	450
Tomatoes	500
Melon	120
Garlic	600
Brangil	450
Buffalo milk per liter	30
Cow milk per liter	30