No. 2

THE ISLAMIC REPUBLIC OF PAKISTAN

# FEASIBILITY STUDY
# ON
# DEVELOPMENT OF IRRIGATION BASED UPON FLOOD FLOWS OF D.G. KHAN HILL TORRENTS

# MAIN REPORT

OCTOBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

THE ISLAMIC REPUBLIC OF PAKISTAN

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# PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct a feasibility study on Development of Irrigation based upon flood flows of D. G. Khan Hill Torrents and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team headed by Mr. Tadashi Ohori, Nippon Giken Inc, three times between April 1991 and March 1992.

The team held discussions with the official concerned of the Government of Pakistan and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

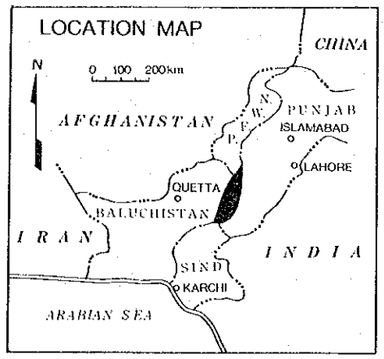
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

October 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency







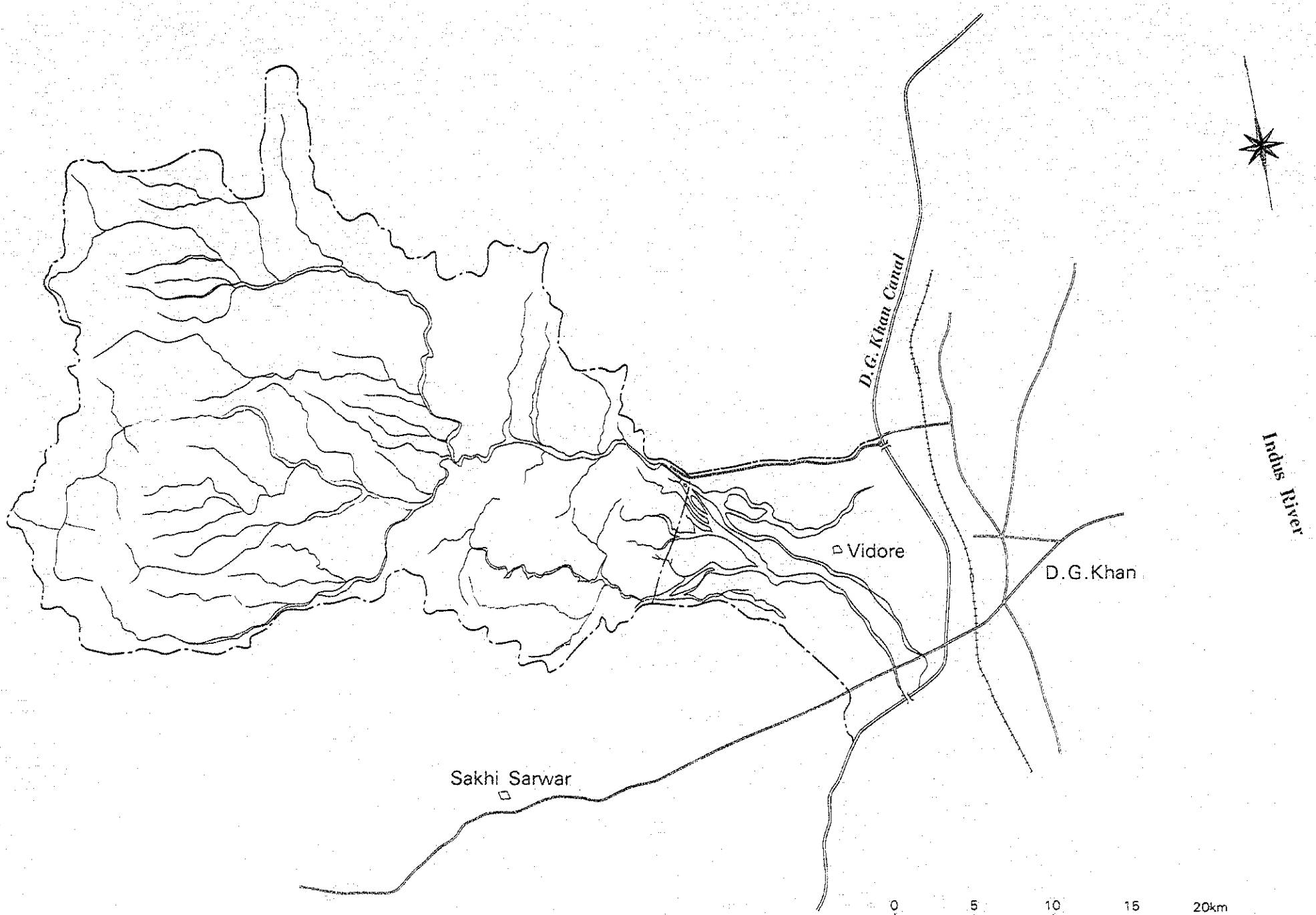
# GENERAL MAP OF THE STUDY AREA

SAB SARTOK
SARTAP
MET CHANDIA
BAGHAL CHUR CAM
BAGKAL CHUR
MAI GWASH
BULLAK
TOLAGH DAGAR
MAIA
CHAPPOR BHUN
SEHWAHAN
LAKHA
BAND LUKH
ER BAI
SOHREN KACH
GUAZRI THOKA
MANHAI
BAND BOM
RUNGHAN B.M.B
WASHAFI
TAGEMOR
BASAR LAHAR
KHAIRI TORRENT
ESCAPE
RASTMANI BASTI
KOCHA WADANI
GAJJUE KHAKAL
CHHABRI BRANCH
SUCHANI BRANCH
FEEDER BRANCH
WAHI KINGRANI
BASTI KALERI
TAK NALLAH
THAL WALI BASTI
BASTI TALAI
BASTI GADRA
VIDORE
BASTI MANDRANI
DALANA NALLAH
BASTI JADLI
DALANA
BASTI BARA
SARWAR TALAI
ALIANI
BASTI KHAIRA
MURADANI
BASTI CHOBIN
BASTI ODHANA
SAKHI SARWAR
TO BEWATA
H.T.XING
R.D. 185560
H.T.XING
R.D. 242300
DERA GHAZI KHAN CANAL
TO TAUNSA
RAILWAY
D.G.KHAN-D.I.KHAN ROAD
TO D.I.KHAN
TO MUZAFFARGARH
DERA GHAZI KHAN
TO RAJANPUR
TO RAJANPUR
0 5 10km

LEGEND

- Watershed
- Irrigable Area
- Drainage Basin Boundary
- Bondary between Watershed and Irrigable Area
- Hill Torrent
- D.G. Khan Canal
- Metalled Road
- Unmetalled Road
- Railway
- Village

# GENERAL MAP OF VIDOR AREA




SATELLITE IMAGE (False Color) UIDORE HILL TORRENT

# SUMMARY

## 1. The Study Area

- The Study area consists of 13,600 sq.km. of watershed of Slaiman Mountain Range and 159,000 ha of fan plains at the foothills so- called Pachad area. The area is western side of D.G. Khan Main Canal and Dajal Branch Canal running down from Taunsa intake structure. From the watershed, about 200 large or small hill torrents run down to the pachad plain. Among them there are 13 major hill torrents, and 12 of them excluding Kaha hill torrent are subject to study for development.

- The Study area is in semi-arid or arid zone. Annual mean rainfall is about 450 mm in northwestern hill area and about 200 mm in the pachad area. More than half of the annual rainfall is concentrated in July and August in monsoon season. Southern part of the area receives less rainfall than northern part.

- Land use in the Study area is quite limited to grazing and production of cereals and fodders by irrigated farming with use of flood water of hill torrents. In the southern part, river water in Pitok and Sori Janubi hill torrents are highly saline and not applicable for irrigation.

- Population of the total 12 major hill torrent areas except Kaha hill torrent, is estimated at 363,000 in 1991. Social infrastructures such as public utilities, roads, railway, markets, etc. are mostly located in the area irrigated by D.G. Khan Irrigation Canal. No major industries other than agriculture are operated in the Study Area.

## 2. Constraints for Development

- Watersheds of hill torrents are almost denuded. Erosion of surface soil is so badly on-going that soil moisture and nutrients are critically being lost. In the downstream reaches of the torrents, large amount of sedimentation and flood flows are therefore often emerged.

- Specific flood peak runoff of each hill torrent differs from 0.8 to 4.6 cms./sq.km in 1/25 probable year. These figures are not extremely large but the peak flows differ so much, due to large watershed, from 520 cms. for 160 sq.km of Sakhi Sarwar hill torrent to 3,740 cms. for 4,880 sq.km of Sanghar hill torrent. Such flood flows

gives large amount of flood damages on the areas irrigated by D.G. Khan Canal and Dajal Branch Canal, and the damages have come to one of constraints for further development of the local agriculture as the sole industry in the area. Flood damage by 1/25 probable flood is estimated as much as Rs. 25 million.

- One of traditional methods of farming is to construct earthen or masonry structure across the watercourse. Intercepted by the structure, water is lead to main canal and then diverted to small canals by small structures. Water is, in conformity with water right, lead finally to plots enclosed by small dikes. These works and operation have traditionally been controlled by farmers and/or their leaders. Due to labor outflow into the canal irrigation area in 1960's and to the Middle East in 1970's and 1980's, social structure has so much changed that the organizational power to control flood flows has also been lost. Highly erosive flood flows often change the watercourse and are thereby leaving large area dried up on one hand, and the flows are concentrated into the areas of downstream ends to cause severe damage on the other hand.

- Annual mean runoffs of hill torrents, as available water source, differ from 17 MCM of Sakhi Sarwar hill torrent to 780 MCM of Sanghar hill torrent. It may be said sufficient water is available. The biggest constraint for agricultural development of pachad area is that available water is given in no other manner but only by floods.

## 3. Strategy for Development

- Key for agricultural development in the Study Area is flood control and effective management of soil moisture. This will be achieved only by application of watershed conservation technologies, use of flood dispersion structures, and water diversion canals and structures and proper water management.

  The installation plan of flood dispersion structures at downstream from darrah point is to distribute the flood water more effectively, without changing the historical practices and water rights, to the farm lands through solid and permanent structures of gabion and masonry. The floods are dispersed at upstream and do not reach directly to the downstream area. Thus, the flood damages will be minimized and flood water will be led into the pachad. In spite of these merits, this measure will not always ensure the stable farming in the pachad.

i) Timing and magnitude of floods are not predictable and a scheduled farming will not be possible.

ii) Larger amount of flood water will be taken into wahs, from the improved dispersion structure, which may exceed the manageable limits of farmers for further distribution of water to downstream. Otherwise, the intaked flood flow may cause flood damage to the pachad area itself.

iii) The hill torrent flood may change the course before it reaches the dispersion structure. After emerging from the gorges (darrah) into the piedmont plain, the course of flood flows is affected by natural and artificial features. High suspended silt and bed load of flood water (about 800 - 1,800 $m^3/km^2$/year) are deposited in its recession period as it flows into the unconfined course in the mild plain. These phenomena are more apparent in recession of large floods. The course of streams in case of small to medium floods are affected by sediment deposition from previous larger floods. After the construction of dispersion structures, flood flows will display similar characteristics both upstream and downstream of the structures. Flood flow may, at any time, change their courses again. Confinement of flood flows into channels by high embankments will also be subject to sedimentation which is costly to remove.

It is, therefore, concluded that although the construction of flood dispersion structures is an effective measure to control floods and to provide flood irrigation to the pachad, the effects of this measure are limited only for a short time of period without achieving the ultimate goal of stable agricultural development in the pachad. The construction of flood dispersion can be considered as the first approach for development and other measures for watershed improvement including afforestation should be considered.

What is required for the long-term stable farming in the pachad is, by measures for watershed conservation, to overcome the following two points, which would supplement the functions of dispersion structure simultaneously.

i) Improvement of the flood flow regime ie., reduction of flood peak discharge and prolongation of runoff period.

ii) Reduction of sediment yield from the watershed

After materialization of the above, the hill torrent floods will become milder and this will contribute to prolong the lifespan of the flood dispersion structure. Moreover, the decrease in soil losses and sediment yields will make the repeatedly proposed reservoir dam plan feasible from the viewpoint of its economic evaluation.

The above-mentioned development strategy is summarized as follows.

i) Short-term and emergency stage (the first phase)
To mitigate the flood damages in downstream reach and to restore the traditional flood irrigation farming in pachad area by the construction of flood dispersion structures and improvement of distribution canals.

ii) Middle and long-term stage (the second phase)
To commence the watershed conservation measures concurrently with the above-mentioned works so that the agricultural development, restoration of vegetation and decrease in soil losses and sediment yields can be materialized in the watershed area.

iii) Last stage (the final phase)
To construct large dams for water reservoir and flood control in order to establish the stable agriculture in both pachad and the watershed areas by transferring existing traditional flood irrigation farming to the scheduled irrigation farming.

## 4. Selection of Project Area

- For selection of a hill torrent to merit Phase II Study, each hill torrent area was examined in accordance with the following criteria. Vidore hill torrent was finally selected after the careful examination.

1. Benefits from reduced flood damage in the canal irrigation area.
2. Potential for development of hill torrent farming.
3. Effectiveness of watershed conservation measures.

- Vidore hill torrent was found most potential for development. The watershed is 877 sq.km in Punjab Province and accessible through roads. Out of 19,560 ha of pachad area, cultivable area is 13,270 ha with 55,410 population. Amount of benefits from flood control in the area is next to Chachar hill torrent but topographical and geological feature of the area is most advantageous to achieve and enjoy effects of watershed conservation.

## 5. Feasibility Study on Vidore Hill Torrent

- Pursuant to the development strategy, the Project plan for Vidore hill torrent area is herein examined. Urgent issues to be overcome are reduction of flood damage and development of irrigated agriculture by use of flood flows, and the short-term plan (the first phase: Case A) has to be programmed for prompt implementation.

  In addition, in order to reduce sediment yield and flood peak flows from the watershed, watershed conservation measures have also to be programmed as a medium- to long-term plan (the second phase) so as to avail irrigation by reservoir water in future. In the course of examination of economic viability of the Project, what is most concerned is possible and marginal intensity of investment for watershed conservation.

  In this Report, the second phase plan (Case B) is programmed to be the Project Plan. The final phase plan has to be carried into implementation after affirmation of the effect of the second phase plan.

Case A : the first phase plan, namely short-term and emergency measures to obtain the optimum economic feasibility, and to affirm the practicability of the second phase plan

Case B : the second phase plan, a middle to long-term plan to carry out the watershed conservation measures in addition to Case A. The larger area to be covered with the watershed conservation measures (in which the recovery of vegetation is expected) gives larger profit for the programming of the final phase plan, however, it requires larger investment and longer period for the implementation. The following two cases are herein examined including the implementation of Case A to find a desirable implementation on period.

Case B - 1 : Implementation Period - 5 year time
Case B - 2 : Implementation Period - 10 year time

- Project benefits

i) Benefit of flood control

The benefit of flood control is appraised as the decrease of flood peak flow by watershed conservation measures and the decrease of excess water reaching the downstream area by the installation of irrigation facilities such as dispersion and diversion structures. In the case of Case B - 2, all the flood flows are to be used for irrigation purpose in pachad area.

Change in Flood Peak and Annual Runoffs (at Darrah in Vidore Hill Torrent)

| Proba-bility | Flood Peak Flow(cms.) | | | | Annual Total Runoff (MCM) | | | |
|---|---|---|---|---|---|---|---|---|
| | Present | Case-A | B-1 | B-2 | Present | Case-A | B-1 | B-2 |
| Mean | - | - | - | - | 122.79 | 122.79 | 115.26 | 110.68 |
| 1/2 yr | 688 | 688 | 484 | 418 | 107.54 | 107.54 | 100.01 | 95.80 |
| 1/5 yr | 1,109 | 1,109 | 789 | 665 | 149.97 | 149.97 | 141.30 | 136.12 |
| 1/10 yr | 1,405 | 1,405 | 1,031 | 880 | 186.39 | 186.39 | 177.12 | 171.23 |
| 1/25 yr | 1,795 | 1,795 | 1,306 | 1,103 | 242.18 | 242.18 | 232.53 | 225.58 |

N.B. Watershed area at Darrah : 770 sq.km

ii) Increase of farm land

Irrigable Area by Probability

(ha)

| Proba-bility | Cultivable Area | Irrigable Area | | | |
|---|---|---|---|---|---|
| | | Present | Case A | Case B-1 | Case B-2 |
| Annual mean | 13,348 | 3,885 | 6,495 | 6,011 | 5,890 |
| 1/2 yr | 13,348 | 3,878 | 5,848 | 5,358 | 5,152 |
| 1/5 yr | 13,348 | 4,525 | 8,427 | 7,848 | 7,601 |
| 1/10 yr | 13,348 | 4,868 | 10,343 | 9,732 | 9,470 |
| 1/25 yr | 13,348 | 5,237 | 12,338 | 11,838 | 11,706 |

iii) Benefit by watershed conservation

| | Case B-1 | Case B-2 |
|---|---|---|
| Area of Vegetation Restoration (sq.km) | 148 (17 %) | 291 (33 %) |
| Decrease of Peak Flow (%) | 28 to 30 | 38 to 40 |
| Sediment Yields ($m^3/km^2/yr$) (present 1,100 $m^3/km^2/yr$) | 700 | 500 |
| Capacity of Livestock in Watershed (heads) (present: max. 25,000 heads) | 43,600 | 60,000 |

- In conformity with the development strategy, the following Project components have been formulated.

1. Flood control measures in the pachad area (Case A & B):

   Construction of flood dispersion structures.

   No.1 Dispersion Structure

   (Weir; 329 m-long and 0.8 m-high. Protection dike; 1.23 km)

   No.2 Dispersion Structure

   (Weir; 325 m-long and 0.7 m-high. Protection dike; 3.0 km)

   Diversion Dike

   (Total length 2.29 km. Dike height 1.9m)

2. Measures for agricultural development in pachad area (Case A & B):

   Rehabilitation of water distribution facilities.

   Chhabri Branch Canal (5 canals. Total 9.94 km)

   Suchani Branch Canal (7 canals. Total 11.88 km)

   Phullar Branch Canal (3 canals. Total 7.15 km)

   Road.

   Rehabilitation (Width 7.3 m. Total 13.0 km)

   New Construction (Width 7.3 m. Total 1.2 km)

3. Watershed conservation

Items of Watershed Conservation Works

| | Case B-1 Zone II & III | Case B-2 Zone II, III, IV and V |
|---|---|---|
| Earthen Bund (nos.) | 2,158 | 3,387 |
| Gully Plugging (nos.) | 1,980 | 3,600 |
| Water Point (nos.) | 15 | 62 |
| Pond (nos.) | 6 | 6 |
| Grass Hedge (km) | 1,955 | 2,750 |
| Seeding ($km^2$) | 121 | 247 |
| Total Projected Area ($km^2$) | 139 | 288 |
| Share of Vegetation Restoration (%) | 17 | 33 |

- Project cost and economic evaluation

| Alter-native | Imple.Period (year) | Proj.Cost (Rs.mil.) | Proj.Benef. (Rs.mil.) | B/C (%) | EIRR |
|---|---|---|---|---|---|
| Case A | 2 | 106.6 | 52.93 | 1.94 | 19.89 |
| Case B-1 | 5 | 222.1 | 22.19 | 1.23 | 11.80 |
| Case B-2 | 10 | 313.2 | 12.37 | 1.11 | 10.43 |

Case A : This case is not able to secure its lasting project benefit since watershed conservation measures are not included. However, the economic evaluation of this case was made in order to affirm better effects by carrying out the watershed conservation measures.

Case B-1 : Due to the short-term implementation period as 5 years, the effects of watershed conservation are not fully merged. In other words, vegetation covers only 17% of the watershed area, 28-30% of flood peak flow is reduced and sediment yield decreases from 1,100 to 700 cu.m/sq.km/yr. Upon 1/25 year probable flood, dispersion of the flood is not sufficient that 200 cms. of surplus water reaches downstream area. Furthermore, the implementation period of 5 years is not long enough to educate local farmers on benefits of Vetiver grass (or Saccharum munja) contour hedges and rotational grazing.

Case B-2 : Though economic feasibility of this case is marginal, the benefits from watershed conservation are of considerable amount. In other words, vegetation covers 33% of the watershed, 38-40% of flood peak flow is reduced and sediment yield decreases to 500 cu.m/sq.km/yr. By achievement of the above, the continuity of benefits from flood control as arisen in Case A can be secured. Furthermore, after restoration of stable and productive watershed, it will become possible to promote irrigated agriculture and other activities by constructing reservoir dams. Accordingly, this alternative plan will enable to transform the present farming from unstable flood irrigation farming into stable irrigation farming in future.

- Recommendations for implementation of the Project

(1) The Study Team recommends prompt implementation of the Case B-2.
Flood control of hill torrent is an urgent issue for the Project on one hand, but the essential for the development of the area is to transform the present unstable flood-dependent farming into stable and scheduled irrigated farming in pachad area. For achievement of this, no measures but control on deterioration of watershed and recovery of vegetation in the watershed are inevitable.

For watershed conservation, the Project employs planting of contour hedge with Vetiver grass as one of the most effective methods. Rotational grazing, in combination with the hedge, is also a major component. It is, therefore, quite essential to educate farmers and secure their cooperation for hedge planting, rotational grazing and introduction of sowing of seeds of fodder crops.

(2) These technologies for watershed conservation may be managed even by farmers themselves. After implementation of the measures, what are given therefrom are those favorable to the local population such as farm lands newly formed, conserved soil and soil moisture, increase in number of livestock, etc. For the implementation, it is strongly recommended to put much stress on campaign and educational activities to the dwelling farmers.

(3) The climatic tolerance and the effectiveness of watershed conservation of Vetiver grass have been studied and certified by the World Bank, ICRISAT and other organizations. Saccharum munja, locally grown wild, may similarly be

applicable. The study on the possibility to introduce local grasses and trees including Saccharum munja is recommended.

(4) This Project consists of neither large/many reservoir dams nor check dams as development measures. On the contrary, the Project aims to accelerate greenization by recovery of vegetation in the watershed to conserve soil from erosion. This Project will possibly enable rich landscape or even orchard farming in future. From the viewpoint of environmental conservation, the Project shall be implemented assertively as a pilot project for hill torrent area development in Pakistan.

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## ABBREVIATIONS

| | | |
|---|---|---|
| ADBP | - | Agricultural Development Bank of Pakistan |
| AEC | - | Atomic Energy Commission |
| AO | - | Agricultural Officer |
| CCA | - | Cultivable command area |
| CRBC | - | Chashma Right Bank Canal |
| DA | - | Director of Agriculture |
| DDA | - | Deputy Director of Agriculture |
| EADA | - | Extra Assistant Director of Agriculture |
| FA | - | Field Assistant |
| GDP | - | Gross Domestic Product |
| GNP | - | Gross National Product |
| GOP | - | Government of Pakistan |
| HYV | - | High Yielding Varieties |
| JICA | - | Japan International Cooperation Agency |
| MFAC | - | Ministry of Food, Agriculture and Cooperatives |
| NESPAK | - | National Engineering Services (Pakistan) |
| NWFP | - | North West Frontier Province |
| PARC | - | Pakistan Agricultural Research Council |
| PHE | - | Pakistan Health Engineering |
| Rs | - | Rupees |
| WAPDA | - | Water and Power Development Authority |

# TERMINOLOGY

| | | |
|---|---|---|
| Bajra | - | Millet. |
| Barani | - | Land that depends on natural precipitation. |
| Bund | - | Embankment. |
| Darrah | - | Gullet, or exit point of a stream or hill torrent from a mountain. |
| Fodder | - | Forrage crops. |
| Gabion | - | Rock bound in wire bags. |
| Gandah | - | Any obstruction constructed across the bed of a torrent or its branch for diverting floodflows. |
| Ghee | - | Clarified animal fat. |
| Gram | - | Chickpea. |
| Haqooq | - | The area or channel having water rights on floodflows of hill torrents. |
| Jowar | - | Sorghum. |
| Katcha | - | Construction using local materials. |
| Kala Pani | - | Perennial flow of a hill torrent. |
| Kamara System | - | A system prevalent in D.G.Khan area where work for diversion of floodflows is carried out on a self-help basis in accordance with the share fixed under Minor Canal Act of 1905. |
| Kharif | - | The hot(summer) season (April to September). |
| Lath | - | Bounded area on piedmont lands of the Suleiman range. |
| Markaz | - | Subdivision of Tehsil. |
| Moza | - | Village. |
| Nallah | - | River bed created by hill torrents, usually dry. |
| Nakka | - | Outlet structure from watercourse into farm ditch. |
| Non-Haqooq | - | The area or channel having no water rights on floodflows of hill torrent. |
| Oilseeds | - | Rape, mustard. |

| | | |
|---|---|---|
| Pachad | - | It means west side of any reference line. In D.G.khan and Rajanpur districts, the area lying on the western side of Canal irrigated area upto the toe of hills. |
| PC-1 | - | Project concept paper used to clear a project in the Government. |
| Piedmont | - | Flat land at the base of a range. |
| Rabi | - | The cool (winter) season (October to March). |
| Rhod Kohi | - | Torrent-watered cultivation practiced by spreading hill torrents. |
| Sad | - | A small diversion bund. |
| Sailaba | - | Land that depends on seepage water or river floods in riverine areas. |
| Sardar | - | Chief. |
| Shakh | - | A natural channel off-taking from main hill torrent. |
| Tehsil | - | Political subunit of a District. |
| Union Council | - | The smallest administrative unit. |
| Wah/Wahi | - | A natural channel off-taking from branch. |
| Wakra | - | Any obstruction constructed in wah for basin irrigation of fields. |

## WEIGHTS AND MEASURES

| | | |
|---|---|---|
| 1 foot (ft) | - | 30.5 centimeters (cm) |
| 1 mile (mi) | - | 1.609 kilometers (km) |
| 1 acre (ac) | - | 0.405 hectare (ha) |
| 1 square mile (sq mi) | - | 259 ha |
| 1 cubic feet (cu ft) | - | 0.028 cubic meters (m3)<br>MCM million cubic meter |
| 1 acre foot (ac ft) | - | 1,233 m3<br>MAF million acre feet |
| 1 cu ft / sec. (cusec) | - | 0.028 m3 / sec. |
| 1 maund (md) | - | 37.3 kg |
| 26.8 md | - | 1.0 metric ton (mt) |
| 1 quintal | - | 100 kg |
| 1 reduced distance (RD) | - | 1000 ft |

# CHAPTER 1 GENERAL BACKGROUND

## 1.1 Background to the Study

In the Seventh Five-Year Plan (1988 - 1993) the Government of Pakistan lays emphasis on the establishment of sound national finance and economy and the alleviation of poverty. In order to achieve these objectives, the Government focuses on the acceleration of rural area development across the country. Agricultural development is consequently placed to become one of the most important measures for the uplift of rural areas.

Crop yields in the barani (rainfed) areas are generally one third to half of those in irrigated areas because of the shortage of water resources. The barani areas are depressed economically and their development lags behind that of canal-irrigated areas. Those areas of the barani tract which fall under the influence of hill torrents must, in order for agriculture to survive, harness available water resources in a dramatic way. Agriculture in these areas depends on the hill torrent flows caused by the high intensity rainfalls concentrated in the summer season. The distribution and intensity of rainfall, however, is highly variable and makes agriculture in the hill torrent areas a risky occupation that depends on flood flows.

The D. G. Khan Study Area is one of 14 such major hill torrent areas in Pakistan. It is located to the west of the River Indus in Punjab, and shares boundaries with Sind, Baluchistan, and the North West Frontier Province (NWFP). The Suleiman Hills, a denuded mountain range with a patchy soil cover, create hill torrent flash flows to the piedmont plains extending from the foot of the hills to the riverain areas of the Indus.

Approximately 390,000 hectares in the piedmont plains were put under irrigation by the construction of the D. G. Khan and Dajal Branch Canal Systems extending from Taunsa Barrage. In addition to this the Chashma Right Bank Canal Irrigation and the Extension of Dajal Branch Projects are scheduled to be implemented to increase the irrigated area. The remainder, or approximately 500,000 hectares, lies between the hills and the canal irrigated areas and its inhabitants engage in torrent-watered cultivation. This area is called the Pachad.

The torrent-watered cultivation is the system of indigenous irrigation in the Pachad where the people, under an organized method of cooperation, construct annually small diversion bunds and divert flood flows to their fields.

Subsequent to the construction of the D. G. Khan Canal System, a number of inhabitants of the hill torrent and hilly areas migrated to the canal-irrigated areas and the towns to gain alternative incomes free of the risks of torrent-watered agriculture.
Proper maintenance of the earthen and gravel structures required to offtake and distribute flood flows to farm land have therefore become difficult to carry out and many of these structures have eroded and lost their functions. As a result, high peak flashy flows from the hill torrents reach the canal-irrigated areas and cause heavy damages to canal structures, standing crops, roads, railway lines, and occasionally result in the loss of human life. The unpredictability and violence of hill torrents has been the primary constraint to the development of the Study Area. It is imperative that they be controlled and water made available for agriculture.

The Government of Pakistan, with above background, requested to the Government of Japan for technical cooperation in formulating the development strategy for D. G. Khan area and executing the Feasibility Study. In response to the request, the Government of Japan has decided to undertake the Study. JICA, accordingly, the official agency responsible for the implementation of technical cooperation programme of the Government of Japan, has dispatched the preliminary study team to Pakistan in 1990. The Scope of Work (S/W) for the Study was then concluded between the Ministry of Water and Power, the Government of Pakistan and JICA.

# CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

## 2.1 The Nation

### 2.1.1 Physical Geography

The Islamic Republic of Pakistan lies between 25°30' and 36°45' north latitudes and 61° and 75°30' east longitudes. Situated in the north-west of the Indo-Pak subcontinent, it is bounded on the north and north-west by the Himalayan, Hindukush and Karakoram mountain ranges. On the north-west and west there is a 2,500 kilometers long frontier with Afghanistan and 800 kilometers with Iran, while on the north-east and east it is bounded by Kashmir and the Indian states of Punjab, Rajasthan and Gujarat. On the south lies the 1,200 kilometers long coast with the Arabian Sea.

Much of Pakistan is mountainous or highland. Its northernmost territories consist of tangled mountains among which the western Himalayas run into the high Karakoram and Hindukush ranges. From these the Indus River breaks out through gorges to the plains. West of the Indus lies Chitral, a region of hill ranges, deep gorges and high plateaux. South of this, on the Afghan border, structures are simpler and consist of a series of mountain arcs such as the Suleiman range which are lower in height than the northern ranges and enclose belts of plateau country. Contrasting with this high and often mountainous terrain is the plain country to the south-east. Part of the great Indo-Gangetic plain, it consists for the most part of the alluvium brought down by the Indus and its tributaries, the Jhelum, Chenab, Ravi and Sutlej. The southern part of the border with India extends through the waterless wastes of the Thar desert.

The Pakistan plains have an annual cycle of three seasons. The cool season (December to January) has relatively low average temperatures (Lahore, 12°C January). Karachi, farther south and on the coast, is rather warmer (18°C January average). This season is dry, apart from rain brought by northwesterly disturbances. The hot season (March to May) is dry and builds up to very high temperatures (Lahore, 31.5°C May average, but up to 48.5°C by day). From June to September the south-west monsoon brings more wind, lower temperatures and rains that are everywhere relatively light (340 mm in four months in Lahore) and fall off to little or nothing westward into Baluchistan and southward into Sind and the Thar desert. The mountains of Pakistan have a climatic regime modified by altitude, with a winter maximum of rainfall in the north-west, but are again characterized by aridity. Much of Pakistan would, in fact, be agriculturally unproductive without artificial irrigation and the country has had to develop what is the

largest canal-irrigation network in the world. This has resulted in 15.7 million hectares (76 per cent) of the cultivated area being irrigated, of which 72 per cent has canal-irrigation.

AREA IRRIGATED BY DIFFERENT SOURCES IN PAKISTAN (million hectares)

| | 1969/70 | 1979/80 | 1989/90 |
|---|---|---|---|
| Canals | 9.26 | 10.74 | 11.23 |
| Tanks | 0.01 | 0.05 | 0.06 |
| Wells | 0.84 | 0.34 | 0.23 |
| Tubewells | 1.11 | 2.74 | 3.97 |
| Others | 1.27 | 0.87 | 0.19 |
| Total | 12.49 | 14.74 | 15.68 |

Source: Economic Survey, 1990/91.

After centuries of occupation by man and his animals there is very little natural vegetation left except for poor, semi-desert scrub in uncultivated portions of the plains and in Baluchistan and montane forests in parts of the western and northern hills. However, even this surviving vegetation has been degraded by man, for instance through the practice of pastoralism in Baluchistan and in the western hills and plateaux, and Pakistan is critically short of timber.

The soils of the plains exhibit considerable variety. Those of the Thar desert tend to be poor and sandy and there is a good deal of natural salinity in the more arid tracts, especially in Sind. More fertile alluvium follows the main rivers and spreads more widely in the Punjab but there is the danger of man-induced salinity and alkalinity associated with the spread of irrigation and the consequent rise of the water-table and capillary ascent of salts to the surface. Indeed, large areas of land have gone out of cultivation for this reason. The hill areas of Pakistan, on the other hand, tend to have poor, skeletal mountain soils, though better conditions prevail in some innermost valleys.

The total area of Pakistan is 796,095 square kilometers, or 79.6 million hectares, of which about 20.7 million hectares (26 per cent) are cultivated. The greater part of the cultivated area is in the provinces of Punjab (11.5 million hectares) and Sind (5.4 million hectares), which comprise the Indus Basin agro-climatic zone.

LAND UTILIZATION STATISTICS IN PAKISTAN (million hectares)

| | 1987/88 | 1988/89 | 1989/90 |
|---|---|---|---|
| Total area | 79.61 | 79.61 | 79.61 |
| Reported area | 57.78 | 57.86 | 57.86 |
| Cultivated area | 20.66 | 20.73 | 20.73 |
| • Net sown | 14.72 | 14.97 | 14.97 |
| • Current fallow | 5.94 | 5.76 | 5.76 |
| Uncultivated area | 37.12 | 37.13 | 37.13 |
| • Culturable waste | 9.26 | 9.26 | 9.26 |
| • Forest | 3.46 | 3.50 | 3.50 |
| • Area not available for cultivation | 24.40 | 24.37 | 24.37 |

Source: Economic Survey, 1990/91.

Most of the mineral wealth is concentrated in the mountainous regions of Pakistan and difficulty of access delays exploration. Twenty types of mineral had been identified at the time of independence, but only coal, rock salt, chromite, gypsum and limestone were mined. Fireclay, silica sand, celestite, ochres and iron ore are now exploited and there may be commercial deposits of copper, manganese, bauxite and phosphates. Pakistan's most important energy resource is natural gas, found at Sui and other locations in the Indus Plain. Exploration has also revealed a number of oilfields and there are hopes of self-sufficiency in petroleum.

### 2.1.2 Population

According to the 1981 Population Census the population of Pakistan was 84.3 million, making it the ninth most populous country in the world (see Table 2-3). In 1987 it crossed the 100 million mark and in 1991 was estimated at 113 million. The population has expanded quite rapidly, having doubled between 1961 and 1985, and its rate of growth has also risen from 2.8 per cent per annum in the 1960s to 3.1 per cent at present, well above the South Asian annual average of 2.4 per cent. Although there has been a decline in the crude birth rate (from 49 per thousand in 1961 to 42 per thousand in 1981), the crude death rate has declined faster (from 23 per thousand in 1961 to 15 per thousand in 1981), resulting in an increase in the population growth rate. The population of Pakistan is expected to pass the 150 million mark by the year 2000.

Pakistan, despite the rapid growth of population over the last 25 years, is still not a very densely populated country. In 1991 the density of population was estimated at 142 persons per square kilometer, as compared to 106 in 1981. The majority of the

population lives in the fertile Indus river plain in the Punjab and Sind and the other major geographical areas of the country are far less hospitable. There are therefore wide variations in population density between the provinces. In 1981 the figure for Baluchistan was just 12 per square kilometer, while it was 230 in the Punjab, 148 in the North-West Frontier Province, and 135 in Sind.

ADMINISTRATIVE DIVISIONS IN PAKISTAN; 1981

| | Area (sq km) | Population |
|---|---|---|
| Provinces: | | |
| • Baluchistan | 347,190 | 4,332,376 |
| • North-West Frontier Province | 74,521 | 11,061,328 |
| • Punjab | 205,344 | 47,292,441 |
| • Sind | 140,914 | 19,028,666 |
| Federally Administered Tribal Areas | 27,220 | 2,198,547 |
| Federal Capital Territory: Islamabad | 906 | 340,286 |
| Total | 796,095 | 84,253,644 |

Source: Economic Survey, 1990/91.

Pakistan has experienced rapid urbanization and the share of urban population has increased from 17.8 per cent in 1951 to 28.2 per cent in 1981. The average annual growth rate of urban population was 4 per cent in the 1960s and 4.3 per cent in the 1970s. However the concentration of urban population has tended to decline: in 1981 there were 54 cities which accounted for 75 per cent of the urban population (compared to 41 in 1951). Out of these the 7 largest accounted for 51 per cent of the urban population. In 1981 the largest cities were Karachi, Lahore and Faisalabad.

There is a considerable ethnic diversity within Pakistan. The Punjabi are the principal ethnic group, comprising about two-thirds of the total population. Other major groups are the Sindhi (13 per cent), Pushtun (8.5 per cent), Urdu (7.6 per cent) and Baluchi (2.5 per cent). Tribal divisions are most noticeable in the western hills but also in the plains where there are Janglis (once nomads but now largely cultivators), Thiringiuzars (camel-herders) and other groups. Punjabi, Baluchi, Pashtu (the language of the Pathans) are spoken. The official languages are Urdu and English.

### 2.1.3 Administrative Divisions

Today the territory of Pakistan comprises the four provinces of Punjab, Sind, North-West Frontier and Baluchistan, the Federally Administered Tribal Areas (the Gilgit

Agency in the north and the tribal areas along the border with Afghanistan), and the Federal Capital Territory of Islamabad. Pakistan also administers Azad Jammu and Kashmir. The provinces are autonomous units and each has a Provincial Assembly empowered to make laws for that province. For administrative purposes, each province is divided into a number of divisions, each of which is divided into districts, themselves sub-divided into tehsils.

## 2.2 National Economy and Agriculture

### 2.2.1 National Economy

The record of economic growth in Pakistan has been good, with Gross National Product (GNP) increasing at about 6 per cent per annum between 1960 and 1990. The growth rate of Gross Domestic Product (GDP) during 1990/91 is estimated at 5.6 per cent and per capita income at current market prices is reckoned at Rs 9,218 the same year, against Rs 8,107 in 1989/90 (see Table 2.1). In dollar terms, this amounts to a per capita income of US$ 410 (at an exchange rate of Rs 22.5 per dollar) which was, after Sri Lanka, the highest in South Asia. This growth has been achieved with a relatively low rate of domestic investment and savings but capital inflows in the form of remittances and foreign aid have been substantial.

Economic policy in Pakistan has centered on five-year plans. The first three of these, which operated during the 1950s and 1960s, emphasized growth and the transformation of the economy. Industrialization was the key aim in the 1950s and agriculture was relatively neglected. More attention was paid to this sector in the 1960s but importance continued to be placed on industrial investment incentives. During this period the economy grew rapidly but the benefits of growth were seen to go disproportionately to a small section of the population.

The Fourth Five-Year Plan (1970-1975) stressed social justice and a system of industrial sanctions and permits was formulated. However, the political upheaval which followed the secession of the eastern wing of the country prevented it from being implemented and the interval from 1972 to 1977 was covered by annual plans which lacked medium-term perspective. The economy was also hit by the effects of the first oil shock and world recession, as well as increased bureaucratization. Many sectors of the economy were nationalized and there was virtually no private sector industrial investment. There was, nevertheless, continued implementation of technical change in agriculture, involving the adoption of Green Revolution technology, and the beginnings of large-scale labor migration to the Middle East.

Five-year planning was resumed after the change of regime in 1977. The main aims of the Fifth Five-Year Plan (1978-1983) were to stabilize the economy, restore rapid but balanced growth, develop backward regions, ameliorate health, education and water supply facilities, and improve the situation of the poorest sections of the community. Real GDP was targeted to grow by 7 per cent on average, real agricultural output by 6 per cent and real manufacturing output by 12 per cent. Private sector industrial investment was to be revived and smaller sector units denationalized.

The implementation of the Fifth Five-Year Plan is considered to have been successful, considering the effects on Pakistan of the second oil shock and the fall in commodity prices of the early 1980s. Real GDP grew by an annual average of 6.4 per cent although agricultural output growth, despite a series of good monsoons, averaged only 4.4 per cent. Manufacturing output grew by 9 per cent. Inflation, after surging in the first years of the plan, fell back later. Many of the controls on the economy were liberalized or abolished and the balance of payments current account deficit was held in check. Pakistan became self-sufficient in all basic foodstuffs except edible oils and development expenditure in backward regions was accelerated.

The Sixth Five-Year Plan (1983-1988) aimed to tackle some of the major weaknesses in the Pakistan economy: low investment and savings ratios; low agricultural productivity; heavy reliance on imported energy, especially oil; and traditionally low spending on health and education. The Pakistan economy grew over its period at the targeted average rate of 6.5 per cent and would have exceeded the target had it not been for the severe droughts of 1986 and 1987. It continues, nevertheless, to be beset by constraints. In addition to the extremely low domestic savings ratio, there is a narrow and vulnerable export base, a tax system which largely exempts the agricultural sector and relies on indirect taxes, particularly import duties, and more recently the burden of debt service.

The major thrust of the Seventh Five-Year Plan (1988-1993) is on achieving efficient growth of output and improving the quality of life of the people. It provides for a total outlay in the public sector of Rs 350 billion and the share of outlays to be devoted to energy was increased, while those for industry and housing were reduced. The seventh plan gives great priority to private investment, which is put at Rs 266 billion. The ratio of private to public investment is expected to rise from 42:58 in 1988 to 48:52 in 1993 and it is intended that public sector corporations should finance most of their own investment programs.

During the first two years of the plan GDP grew at 4.8 per cent, as against the target of 6.5 per cent par annum. Average growth in agriculture was 5 per cent and above the plan target. The manufacturing sector grew by 4.9 per cent per annum against a targeted 8.1 per cent. A growth of 4.4 per cent was recorded in the services sector, below the plan target of 6.3 per cent. National savings were 14.9 per cent of GNP and domestic savings 12.9 per cent of GDP, in both cases above target. These achievements are mixed. While the GDP growth rate is significantly below target, the achievements on private investment and savings have been encouraging. However, the rate of inflation has averaged 8.3 per cent.

### 2.2.2 Agriculture

#### (1) The Importance of Agriculture

Agriculture is the largest of the sectors contributing to economic activity in Pakistan, providing 25 per cent of GDP, employing 50 per cent of the labor force, and sustaining 75 per cent of the population. The sector directly accounts for 25 per cent of total exports and cotton textiles and other agro-based manufactured exports account for an additional 35 to 40 per cent of total exports. In 1990 the sector claimed 15.3 per cent of the public sector development plan (including the fertilizer subsidy), 18.5 per cent of private fixed investment and 11 per cent of total fixed investment. The provinces of Punjab and Sind are the granary of Pakistan, whereas the North-West Frontier Province and Baluchistan are food-deficit regions (see Table 2.2).

Agricultural growth has been strong, even though it has not always met ambitious planning targets. It has also fluctuated considerably. Shortly after independence, a strategy of industrialization based on import substitution was launched. As a result, industry expanded rapidly while agriculture stagnated. Attempts were made to promote agricultural growth in the 1960s and large-scale public investment was undertaken through the Indus Basin Replacement Works and the Salinity Control and Reclamation Projects. Land reforms were also introduced. The result was that agriculture grew by 3.2 per cent per annum between 1961 and 1965 and, after the introduction of high-yield varieties of wheat and rice, grew even more rapidly (the growth rate in the early years of the Green Revolution, i.e. from 1967 to 1970, was 7.8 per cent per annum). In the 1970s agricultural growth slowed to 1.7 per cent per annum but it has since revived and from 1979 has been of over 4 per cent per annum.

Between 1961 and 1987 food production increased threefold. The increase was more rapid than that of population and resulted in improved consumption per capita. The growth in major non-food items has kept pace with incremental food production, but when crops are grouped according to whether they are exported, imported or non-traded one finds that growth of export crops such as cotton and rice has been rapid, that growth of import-substituting crops such as wheat and sugar has been somewhat slower, and that production of non-traded crops (except maize) has either stagnated or declined over the period. There has therefore been a tendency to neglect non-traded crops other than maize and the decline in gram production and the indifferent performance of other pulses, which are the main source of protein for the poor, has resulted in deficits and rising prices. In 1982 the Government had to arrange emergency imports of pulses and since then some imports have occurred in most years.

The cropping pattern in Pakistan has, of course, not remained static. Since the 1960s the share of foodgrains, cash crops, vegetables, fruits and condiments has risen steadily while that of pulses, oilseeds and other crops (mainly fodder) has declined. Among foodgrains the share of wheat, rice and maize climbed from 82 per cent in 1960 to 91 per cent in 1990. Along with the change in cropping pattern there has also been an increase in land utilization. Since 1951 cultivated area in Pakistan has augmented by over 5 million hectares, cropped area by about 8 million hectares, and cropping intensity by 15 per cent.

Agricultural growth is accounted for by the changing technological environment in agriculture and output and input pricing policies that led to the introduction of high-yield varieties in wheat, rice and more recently cotton, subsidies on fertilizer and pesticides, and greater availability of irrigation water. In this context the most dramatic changes have been in the use of fertilizer. Total fertilizer use surged from 19,000 nutrient tons in 1960 to 1,000,000 tons in 1973 and 1,900,000 in 1990. All crops but sugarcane registered threefold or more increases in the use of fertilizer between 1973 and 1986. Furthermore, total credit disbursed by Government institutions, cooperatives and commercial banks expanded in real terms nearly twenty five times between 1961 and 1987. This was accompanied by wider tubewell and canal irrigation so that farm-gate water availability rose from 78,912 MCM in 1966 to 144,261, MCM in 1990.

Farm mechanization in this period also proceeded rapidly. In 1966 only 4,113 tractors were imported but by the end of the 1980s the annual import figures had increased to over 20,000. There are now nearly 300,000 tractors in use in the country.

## (2) The Structure of Agricultural Holdings

Agricultural production in Pakistan is carried out under several types of tenancy and farm size arrangements. Tenancy as a production arrangement was formerly widespread but has been declining since independence, initially because of attempts by the Government at tenancy reform, which aimed at giving greater security to tenants, and later in the 1960s and 1970s because of the tensions created by technological change. These tensions were primarily due to heightened productivity and greater claims by landowners as a result of greater investment in new inputs. In the Punjab, area cultivated by pure tenants declined from 37 per cent in 1960 to 19 per cent in 1980. Rented area of owner-cum-tenants, on the other hand, increased somewhat and this class of cultivators was the most successful in innovating and deriving benefits from technological change. There is also evidence of change in tenurial arrangements with a greater tendency to rent out land on fixed cash rents as opposed to share-cropping.

Landownership data are unreliable because of the practice of registering land under false names. However, a comparison of the patterns of landownership in 1972 and 1980 in the Punjab indicates there were slightly more medium-sized farmers, i.e. farmers owning more than 7.5 acres (3.0 ha) but less than 25 acres (10.0 ha), in 1980 compared to 1972. Similarly, area owned by medium-sized farmers was also somewhat larger in 1980, which may imply that technological change has been accompanied by the bankruptcy of small farmers and greater landlessness.

Landholding patterns are not conducive to improved yields. At independence, less than 1 per cent of farms accounted for over 25 per cent of agricultural land. Despite land reforms tenancy, share-cropping and fragmented holdings remain problems. The 1980 Agricultural Census indicates there were a total of 4 million farms in that year, of which 20 per cent were less than 2.5 acres (1.0 ha) but accounted for 2.3 per cent of total farm area. At the other end of the scale, farms above 150 acres (60 ha) constituted 0.3 per cent of the total but

covered 8.4 per cent of farm area. About 48 per cent of farm area was tenanted and 52 per cent owner-cultivated.

### (3) The Cropping Pattern

Soil and climate conditions define two cropping patterns in Pakistan. These are wheat in the Rabi season (the cool season which extends from October to March) and cotton or rice in the Kharif season (the hot season which extends from April to September). The wheat-cotton combination is sown in those districts where the sub-ground water level is low and November is frost-free, while the wheat-rice combination requires plenty of moisture in the Kharif season. Cotton became commonplace in the colonial period and fine quality rice was grown later primarily for the export market in which Pakistan enjoys a virtual monopoly.

The six major foodgrains grown in Pakistan are wheat (66 per cent), rice (18 per cent) maize (7 per cent), bajra (4 per cent), jowar (3 per cent) and barley (2 per cent), which together are grown on 11.9 million hectares. After adding 1.5 million hectares of pulses, the total food crop area comes to 13.4 million hectares. The main cash crops in Pakistan are sugarcane, cotton, oilseeds and tobacco, which together account for 3.8 million hectares. In addition, 0.7 million hectares are under fruits and vegetables (plus condiments) and 2.8 million hectares are planted to other crops, primarily fodders. This indicates that the principal food crops are wheat and rice, while the principal cash crops are sugarcane and cotton. These crops account for 68 per cent of cropped area and 89 per cent of gross value added in the crop sector.

AREA UNDER IMPORTANT CROPS (thousand hectares)

| | Wheat | Rice | Bajra | Jowar | Maize | Barley | Pulses | Sugarcane | Cotton |
|---|---|---|---|---|---|---|---|---|---|
| 1980/81 | 6,984 | 1,933 | 406 | 394 | 769 | 259 | 1,253 | 825 | 2,108 |
| 1981/82 | 7,223 | 1,976 | 559 | 392 | 739 | 222 | 1,321 | 947 | 2,214 |
| 1982/83 | 7,398 | 1,978 | 438 | 390 | 790 | 263 | 1,335 | 912 | 2,263 |
| 1983/84 | 7,343 | 1,999 | 553 | 391 | 798 | 200 | 1,307 | 897 | 2,221 |
| 1984/85 | 7,259 | 1,999 | 606 | 395 | 809 | 190 | 1,416 | 904 | 2,242 |
| 1985/86 | 7,403 | 1,863 | 561 | 372 | 804 | 189 | 1,451 | 780 | 2,364 |
| 1986/87 | 7,706 | 2,066 | 509 | 399 | 816 | 182 | 1,522 | 762 | 2,505 |
| 1987/88 | 7,308 | 1,963 | 293 | 320 | 854 | 145 | 1,204 | 842 | 2,568 |
| 1988/89 | 7,730 | 2,042 | 510 | 431 | 866 | 159 | 1,395 | 877 | 2,619 |
| 1989/90 | 7,845 | 2,107 | 512 | 440 | 863 | 155 | 1,496 | 854 | 2,599 |

Source: Adapted from Economic Survey, 1990/91.

### (4) Crop Output

Wheat is the most important crop in terms of area, value added, and its role in consumption. Production climbed rapidly from around 7 million tons in the early 1970s to reach 12.4 million tons in 1983, although poor weather subsequently reduced output in 1984, 1985, 1987 and 1988. In 1989, however, production reached 14.4 million tons and was estimated to have been 14.3 million tons in 1990. There has been a steady enlargement of the area under wheat. Between 1961 and 1990, area increased from 4.6 to 7.8 million hectares. Over the same period wheat output more than tripled from 3.8 to 14.3 million tons. Thus the larger proportion of the increase in output was due to an increase in wheat yields, which doubled over this period. These increases were achieved through intensive use of fertilizer and high-yield varieties as well as tubewell irrigation. The weather, however, continues to be a crucial factor, particularly in the unirrigated areas. Earlier hopes of achieving regular surpluses for export have receded and imports have had to be made in recent years to maintain stocks.

Several varieties of rice were grown in different areas of Pakistan until the late 1960s. Since then, however, two varieties have come to dominate. They are Basmati (a long-grained aromatic variety) and Irri (high-yield varieties). In 1969 about 0.6 million hectares were planted with Basmati and by 1987 the area had increased to 0.9 million hectares. The principal constraint on area expansion is soil quality, since basmati requires a special soil and climate, and

large expansion is consequently difficult. Furthermore, yields have fluctuated considerably over this period, reflecting the influence of weather and pests on this crop. Total output has nevertheless increased by 60 per cent, primarily due to area expansion, and basmati constitutes a valuable export crop (around 25 per cent of the output is exported). The importance of irri rice has increased faster and output has more than doubled since 1970, mainly on account of area cropped as yields have not progressed very much since then. Nearly 50 per cent of irri rice is retained for domestic consumption.

Cotton is Pakistan's primary cash crop and its largest agricultural export but production can be erratic if there is poor weather and insect infestation. In 1984, for example, autumn storms and insects resulted in a crop 40 per cent below target, with only 495,000 tons produced, compared with 824,000 tons the previous year. Since then cotton production has recovered sharply, with output reaching 1.0 million tons in 1985, over 1.2 million tons in 1986 and 1987, and about 1.4 million tons on average every year since then. The area planted with cotton has increased from 2.1 million hectares in 1981 to an estimated 2.7 million hectares in 1990 but the larger part of the increase in output has come from higher yields. In 1990 the overall yield was 560 kilograms per hectare, with significantly higher yields in the Punjab. This puts yields in Pakistan above the world average, although in 1983 they were well below. In 1990, about 60 per cent of production was exported. Pakistan plays a central role in the world cotton market and has become one of the biggest exporters of raw cotton.

Sugarcane output in Pakistan has doubled since the early 1960s but the progress of yields has not been significant. In 1961, the yield was 30 tons per hectare and in the last three years it has average 40 tons per hectare. Yields have also been subject to considerable variation and reached their peak in the late 1960s, at 42.5 tons per hectare. In 1961 sugarcane was grown on about 0.4 million hectares. This has increased to 0.9 million hectares in 1990. Thus most of the output expansion has come from area enlargement rather than yields.

PRODUCTION OF IMPORTANT CROPS (thousand tons)

| | Wheat | Rice | Bajra | Jowar | Maize | Barley | Pulses | Sugarcane | Cotton |
|---|---|---|---|---|---|---|---|---|---|
| 1980/81 | 11,475 | 3,123 | 214 | 230 | 970 | 176 | 526 | 32,359 | 715 |
| 1981/82 | 11,304 | 3,430 | 272 | 225 | 930 | 158 | 468 | 36,580 | 748 |
| 1982/83 | 12,414 | 3,445 | 220 | 222 | 1,005 | 185 | 694 | 32,534 | 824 |
| 1983/84 | 10,882 | 3,340 | 256 | 222 | 1,014 | 140 | 710 | 34,287 | 495 |
| 1984/85 | 11,703 | 3,315 | 284 | 230 | 1,028 | 132 | 726 | 32,140 | 1,008 |
| 1985/86 | 13,923 | 2,919 | 258 | 219 | 1,009 | 134 | 797 | 27,856 | 1,208 |
| 1986/87 | 12,016 | 3,486 | 233 | 236 | 1,111 | 134 | 801 | 29,926 | 1,309 |
| 1987/88 | 12,675 | 3,241 | 135 | 181 | 1,127 | 112 | 548 | 33,029 | 1,468 |
| 1988/89 | 14,419 | 3,200 | 201 | 248 | 1,204 | 123 | 624 | 36,916 | 1,426 |
| 1989/90 | 14,316 | 3,220 | 204 | 262 | 1,179 | 131 | 768 | 35,494 | 1,456 |

Source: Adapted from Economic Survey, 1990/91.

### (5) Livestock

Livestock rearing contributed about 30 per cent to the value of agricultural production in 1990 and the agricultural sector relies on animals for over 80 per cent of its motive power. During the past ten years livestock rearing has sustained an annual growth rate of 6 per cent and leather is an increasingly important export product: exports in 1989 were worth Rs 4.7 billion compared with around Rs 1 billion a decade ago. There are also plans to make poultry a major export, with the Middle East as the primary market. Livestock rearing is, however, still relatively undeveloped and the Government has recently expanded the size of crossbreeding programs and taken other measures to increase productivity. There has also been greater private investment in milk processing plants. As per capita incomes increase, demand for meat and dairy products is likely to increase as well. In 1990, there were an estimated 17.6 million head of cattle, 14.7 million buffaloes, 35.4 million goats and 29.2 million sheep.

LIVESTOCK POPULATION IN PAKISTAN (thousand numbers)

| | Buffaloes | Cattle | Goats | Sheep | Poultry |
|---|---|---|---|---|---|
| 1980/81 | 11,900 | 15,800 | 25,800 | 22,100 | 67,400 |
| 1981/82 | 12,100 | 15,900 | 26,700 | 22,800 | 73,500 |
| 1982/83 | 12,400 | 16,100 | 27,700 | 23,500 | 89,500 |
| 1983/84 | 12,700 | 16,300 | 28,700 | 24,200 | 100,600 |
| 1984/85 | 13,100 | 16,500 | 29,700 | 25,000 | 113,700 |
| 1985/86 | 13,400 | 16,700 | 30,800 | 25,800 | 109,500 |
| 1986/87 | 13,700 | 16,900 | 31,900 | 26,600 | 129,700 |
| 1987/88 | 14,000 | 17,100 | 33,000 | 27,400 | 144,500 |
| 1988/89 | 14,300 | 17,200 | 34,200 | 28,300 | 164,600 |
| 1989/90* | 14,700 | 17,600 | 35,400 | 29,200 | 184,700 |

Source: Economic Survey, 1990/91.

Note: * Estimated.

### (6) Forestry and Fishing

Forestry accounted for an estimated 0.3 per cent of GDP in 1990. Forests cover 3.5 million hectares, a little over 4 per cent of the country's area, and productive forests cover only 1.3 million hectares. Even these are difficult to exploit because of their location in the mountainous north and production of timber and fuelwood is well below domestic requirements. Total forest production in 1990 was 509,000 cubic meters, down from a peak of 1.1 million cubic meters in 1957. Afforestation schemes to develop fast growing species are being implemented and the Government has launched a tree plantation program which includes the development of irrigated tree plantations in the Indus basin.

Fish, which contributed an estimated 0.7 per cent of GDP in 1990, serves as an important and cheap source of protein. The sector contributed 2.3 per cent of exports in 1990, prawn and shrimps being the main items. In 1989, of a total catch of 446,000 tons, 78 per cent was caught at sea and 22 per cent inland. From 1983 to 1988 the inland catch increased by 55 per cent and the sea catch by 21 per cent.

## (7) Irrigation

Pakistan is situated in arid and semi-arid climatic zones and is heavily dependent on irrigation. Of the country's total area of 79.6 million hectares, 20.7 million hectares were cultivated in 1990 and a total of 15.7 million hectares were irrigated, most of it in the Punjab and Sind. It is estimated that four-fifths of cropping depend on irrigation and that the increase in cultivated land by over a third since 1947 has largely been due to improvements in irrigation. However, there is still believed to be scope for extension of the irrigation system to potentially cultivable areas as well as improvement in the management of the existing system, which is geared to extensive rather than intensive farming. Of equal importance to new irrigation works is reclaiming irrigated land that has become saline through waterlogging, especially in Sind. Surface water resources contribute approximately two-thirds of total water availability and ground water resources one-third.

The Indus basin irrigation system, which covers two-thirds of the country's cropped area, is the largest contiguous irrigation system in the world, including 22 dams and barrages, 57,000 kilometers of canals and 107,000 watercourses. On March 21, 1991 an accord on Apportionment of the Waters of the Indus was approved, resolving a dispute that had persisted for seventy years. The accord allocates a total of 68,974 MCM to the Punjab and 60,121 MCM to Sind. There will be no restrictions on the provinces to undertake new projects within their agreed shares. For the implementation of this accord, an Indus River System Authority will be established in Lahore and will have representation from all four provinces. Water availability in 1991 is estimated at 146,727 MCM.

## (8) The Role of Agricultural Policies

Pakistan has implemented a complex set of exchange rate, subsidy and pricing policies which have altered over time the nature of incentives facing the agricultural sector. In retrospect, the net effect of these polices reflects a clear pattern of rather severe discrimination against the agricultural sector in the earlier period, giving way to a substantially improved incentive structure from the 1980s.

Between 1950 and 1972 Pakistan maintained an over-valued foreign exchange rate. As a result producers of agricultural export commodities received less for

their products than would have been the case with a market-clearing exchange rate. On the other hand the overvalued exchange rate lowered the domestic price of imported inputs. Although the official Rupee continues to be overvalued, it is closer to its market value now than was the case in the 1960s.

From the beginning public utilities such as railways, airlines, electricity, gas telephone and telegraph were the monopoly of the Government. In the 1970s nationalizations also turned banking, life insurance, shipping, cotton and rice export into Government Monopolies and the number of parastatals dealing with agriculture multiplied as the Government expanded its role in the distribution of agricultural inputs such as fertilizer, pesticides and seeds.

In these public enterprises the principle of full cost pricing has seldom been used so that subsidies are widespread: fertilizer has always been subsidized; the price of irrigation water does not cover the cost of operation and maintenance; and until recently pesticides were also subsidized. Food subsidies are primarily for the benefit of urban consumers while export rebates are for manufactured goods and subsidy on fertilizer is partly for high cost domestic producers. Subsidies on agricultural inputs have accounted for 30 to 50 per cent of all subsidies, which have been 5 to 10 per cent of Government expenditure over the period 1973-87.

On the other hand the trading of many agricultural products is entirely carried out by private enterprise. Coarse grains, spices and condiments, fruits and vegetables, gur, sugar, gram and pulses, meat, milk and eggs are some of the main commodities which fall under this category. Their internal movement from one area to another is practically free and prices follow courses determined by the laws of supply and demand.

Public intervention, however, occurs in the marketing of main foodgrains, sugarcane, cotton and tobacco. The procurement of wheat at prices fixed from season to season is made to meet food requirements and ensure economic prices to growers. Similarly, rice is procured for export purposes and to provide incentives to growers. In the case of sugarcane, mills have to purchase the cane at prices fixed by the Government. With respect to cotton, prices for both lint and seed cotton are announced in each season and ginneries have to purchase seed cotton from growers at fixed prices and sell lint cotton at specified prices.